Vol. 25, No. 4, 2021 | DOI: 10.26794/2587-5671 | ISSN 2587-5671 (Print) ISSN 2587-7089 (Online)

FINANCE: THEORY AND PRACTICE

Scientific and practical journal. Former title: Bulletin of the Financial University. Published since 1997

The edition is reregistered in the Federal Service for communication, informational technologies and media control: PI No. FS77-70021 of May 31, 2017

Publication frequency — 6 issues per year

Founder: Financial University

The aim of the journal is the scientific discussion of topical issues in the field of finance and related fields

The journal is Scopus indexed, in the Russian Science Citation Index (RSCI), in the core of the RSCI, in the Web of Science — Russian Science Citation Index (RSCI), is included in the listing of periodicals recommended by the Higher Attestation Commission for the publication of the main results of the postgraduate and doctoral dissertations.

All articles of journal Finance: Theory and Practice are published with a digital object identifier (DOI).

The journal is distributed only by subscription Subscription index 82140 in the consolidated catalogue "The Press of Russia". The journal is publicly available (Open Access) on the website http://financetp.fa.ru/jour/index

Manuscripts are to be submitted to the editorial office in electronic form: **vestnikfinu@mail.ru**

Minimal size of the manuscript: 4 ths words; optimal — 6 ths words.

The editorial makes a mandatory expertise (review, scientific and stylistic editing) of all the materials to be published in the journal. More information on publishing terms is at: **financetp.fa.ru**

CONTENTS

FINANCE: THEORY AND PRACTICE

Scientific and practical journal

Vol. 25, No. 5, 2021

Editor-in-Chief — **M.A. Fedotova**

Head of Scientific Journals Editorial Department — **V.A. Shadrin**

Managing editor — **I.S. Dovgal**

Translator — **E.V. Logutova**

Reference Manager — **V.M. Alekseev**

Proofreader — **S.F. Mihaylova**

Design, make up — **S.M. Vetrov**

Editorial address:

53, Leningradsky prospekt, office 5.4

Moscow, 125993

tel.: **+7 (499) 553-10-71**

(internal 10-79)

E-mail: **vestnikfinu@mail.ru**

Site: **financetp.fa.ru**

Subscription in editorial office

tel: **+7 (499) 553-10-71**

(internal 10-80)

e-mail: **sfmihajlova@fa.ru**

S.F. Mihaylova

Signed for press on 18.10.2021

Format 60 x 84 1/8.

Size 29,25 printer sheets.

Order № 818.

Printed by Publishing House of the Financial University (51, Leningradsky prospekt)

ORIGINAL PAPER

DOI: 10.26794/2587-5671-2021-25-5-6-23
UDC 330.117(045)
JEL D72, F63, G01, G33, H12

Coronomics, Financial Support for the Economy and its Zombie-ing (In the Context of the Fifth Factor of Production)

V. Papava[a] ✉, **M. Chkuaseli**[b]
Ivane Javakhishvili Tbilisi State University, Tbilisi, Georgia
[a] https://orcid.org/0000-0001-7835-662X; [b] https://orcid.org/0000-0002-4898-4999
✉ Corresponding author

ABSTRACT

The paper examines the impact of the COVID-19 pandemic on the economy and the corresponding atypical economic crisis, the role of the economic ability of the government during this crisis, aspects of financial support for the economy and the peculiarities of the zombie economy. The **aim** of the study is to research the actions of the economic ability of the government as an independent factor of production in the context of the COVID-19 pandemic, contributing to the unfolding of the process of zombie-ing the economy. The research uses **the methods** of deduction and induction, analysis and synthesis, analogy and abstraction. The special functions of the government are considered within the context of the economic crisis caused by the COVID-19 pandemic; particularly, we refer to the recognition of the fifth factor of production of the economic ability of the government. The main features of this atypical crisis are characterized. It is shown that the process of deglobalization during the COVID-19 pandemic characterizes the deglobalization of the economic ability of the government and that this process is temporary, since overcoming the global phenomenon of the pandemic and the economic crisis caused by it requires exclusively global efforts and measures. Particular attention is focused on the financial support of the economy from the economic ability of the government within the context of this economic crisis. **The conclusion** is that this support contributes to the process of zombie-ing the economy which took on a global character during the global financial and economic crisis of 2007–2009 and continued after its completion. Zombie-ing the economy is the result of a conflict between the political interests of the government and its economic ability when the latter is not able to overcome the barrier created by the former. A solution to this problem is possible through changes in bankruptcy legislation when its main principle of avoiding the unwanted bankruptcy of firms will be replaced by the principle of liquidation of unviable firms. Such a change in bankruptcy legislation can be implemented only during the economic upswing.

Keywords: COVID-19 pandemic; economic crisis; factors of production; economic ability of the government; globalization; deglobalization; financial support for the economy; zombie economy; political interests; bankruptcy

For citation: **Papava V., Chkuaseli M. Coronomics, financial support for the economy and its zombie-ing (in the context of the fifth factor of production).** ***Finance: Theory and Practice.*** **2021;25(5):6-23. DOI: 10.26794/2587-5671-2021-25-5-6-23**

INTRODUCTION

2020 will go down in history as the year of the COVID-19 pandemic [1], which triggered a new global economic crisis (for example, [2]). In other words, mankind is experiencing the consequences of the coronavirus and the economic crisis at the same time [3].

The economic crisis was caused by the impact of severe restrictions on social contacts in response to the rapid spread of the virus, as a result of which many sectors of the economy were forced to suspend their economic activities (for example, [4]).

Considering the impact of the COVID-19 pandemic on the economy, or rather, on the economic crisis, a new term "coronomics" was invented. It was coined by combining the terms "corona" and "economics" and denotes a sub-sector of economics that studies the impact of the coronavirus pandemic on the economy [5]. In a similar way, the term "coronanomics" was later introduced [6]. Using these terms, the economic crisis caused by the COVID-19 pandemic is referred to as the "coronomic crisis" [7].

It is noteworthy that the coronomic crisis is not only the result of mistakes made in the economy (or in its management), but its end does not depend on the anti-crisis measures imposed by economists. Ending the COVID-19 pandemic will help overcome the coronomic crisis, through effective coronavirus disease treatment and vaccination. However, some issues of the coronomic crisis are the subject of economic science (for example, [8–10]).

If the end of the coronomic crisis depends on the success of medicine in the fight against the COVID-19 pandemic, it can be concluded that in the context of this crisis, the economy is a hostage to medicine [7].

Based on the experience of dealing with the pandemic, as well as developing and implementing anti-crisis measures, the role of national governments with the support of international organizations is of paramount importance. Thus, the aim of this article is not only to understand the actions of the government as an independent factor of production [11] amid the COVID-19 pandemic, but also to identify the most undesirable potential consequences of financial support measures for the economy during the coronomic crisis, by launching and promoting the process of zombie-ing the economy. In other words, the aim of the article is to comprehensively explore the issues related to the impact of the economic ability of the government during the coronomic crisis, which ultimately contributes to the zombie-ing of the economy.

THE ECONOMIC ABILITY OF THE GOVERNMENT AS AN INDEPENDENT FACTOR OF PRODUCTION

Many economists believe that the economic activity of the government is not an integral part of the market economy, since it solves the problems in front of which the market is powerless. In other words, the economic activity of the government is seen as an inevitable addition to the market economy.

Despite this explanation of the economic activity of the government, according to a non-traditional approach to factors of production, some of these activities are an immanent part of the market [12].

As of the generally accepted theory of factors of production, there are four factors of production: land, labor, capital, and entrepreneurial ability. The respective factor incomes are rent, wages interest, and profit.

It is noteworthy that economists occasionally discuss issues related to the traditional theory of factors of production (for example, [12–17]).

Income from sales of the results of production includes the specified factor incomes (rent, wages, interest, and profit), as well as depreciation and indirect business taxes (IBT). It is believed that IBTs (i.e. VAT, general sales tax, excise taxes, etc.) are received by the government as unearned income [18, p. 140; 19, p. 119]. Unlike IBTs, direct taxes are levied directly on the aforementioned factor incomes — rent, wages, interest, and profits.

As known, the economic meaning of depreciation lies in the gradual accumulation of

value transferred by fixed capital to products for the purpose of its simple reproduction, and does not contradict the generally accepted theory of factors of production. At the same time, the explanation of the government receiving IBTs as an unearned income clearly contradicts the principle of unity of the theory of factors of production, since, unlike other factor incomes, the government receives IBTs "for no reason".

Assuming that the *economic ability of the government* is an independent fifth factor of production, IBT qualifies as the corresponding factor income [11, 12, 17, 20].[1]

In terms of its content, the economic ability of the government among other factors of production is similar to entrepreneurial ability, since for both factors the organization of production is an integral function, although the difference lies in its scale. Thus, entrepreneurial ability organizes the production process of a certain good (or goods) by combining such factors of production as land, labor, and capital. As for the economic ability of the government, it organizes production at the level of the national economy, creating the necessary conditions for entrepreneurial ability, which organizes the production of a certain product (or goods). In this case, the goal of entrepreneurial ability is to obtain a larger corresponding factor income, i.e. profits, and the goal of the economic ability of the government is to increase IBT revenue. These goals are quite compatible, since profits are part of the added value, and the larger the profits, the higher the VAT will be.

The functional purpose of the economic ability of the government as an independent factor of production is as follows:

1. Establish an economic environment for entrepreneurs in which entrepreneurial ability as a factor of production can best combine factors such as land, labor, and capital in the production process.
2. Develop and adopt decisions that will have a positive impact on the development strategy of firms operating in the national economy.
3. Implement innovative solutions for the development of monetary and fiscal instruments and improve the institutional environment for entrepreneurial ability.
4. Predict and prevent all kinds of risks that may pose a threat to the development of the national economy.

Since the traditional factors of production are divided into material and human (material — land and capital, and human factors — labor and entrepreneurial ability [18, p. 37]), and economic decisions are made by certain people, the economic ability of the government also belongs to the group of human factors of production.

It should be recognized that the economic ability of the government is not identical with the very concept of the government, since the latter has significantly more functions than the fifth factor of production as such. In particular, these functions include the management of political processes (for example, holding elections at various levels of government), the implementation of international relations, strengthening the country's defense, etc.

In this context, the fact that it is necessary to avoid any confrontation (let alone conflict) between the economic ability of the government and its other functions is of great importance. The ideal situation is when the economic ability of the government and its other functions mutally complement each other.

Unfortunately, the цopposition of the economic ability of the government to any of its functions is possible. An example of this will be discussed below.

While recognizing the economic ability of the government as a separate factor of production, it is necessary to clearly stipulate that international financial and economic institutions, although they are to some extent supranational institutions, perform the same function as the economic ability of the government. In particular, in the context of globalization, a certain expansion of the framework of the national economy takes place, and international financial and economic institutions, together with national governments,

[1] This approach is presented in [21, p. 358].

organize production within these expanded frameworks on the basis of creating the necessary conditions for entrepreneurial ability that also operates in this expanded framework of the economy. In other words, international financial and economic institutions are a private manifestation of the economic ability of the government at the international level in the context of globalization.

It should be emphasized that the role of the government significantly increases in overcoming economic crises, as well as in the post-crisis development of the economy (for example, [22–24]). In other words, during an economic crisis, the fifth factor of production — the economic ability of the government — becomes the most important of all five factors of production. It is understandable assuming that this factor organizes production within the framework of a crisis national economy, on the one hand, supporting firms in crisis, and on the other, developing and implementing anti-crisis measures to end an economic crisis.

In the context of the economic crisis caused by the COVID-19 pandemic, a special role is assigned to the economic ability of the government, which depends entirely on the characteristics of this crisis.

SPECIFIC FEATURES OF THE CORONOMIC CRISIS

As noted in the introduction, during the COVID-19 pandemic, the economy in general, and the way out of the crisis in particular, is completely dependent on medicine. In addition, the onset of the coronomic crisis was due to the inability of medicine to prevent the spread of the coronavirus, other than by temporarily closing many sectors of the economy. Consequently, the causes for the coronomic crisis in the economy are *exogenous*, not *endogenous* [7].

Based on the experience of economic crises accumulated over the past decades, and especially the global financial and economic crisis of 2007–2009, economists and medical professionals have studied the impact of these crises on the healthcare system [25] or on public mental health during economic crises,[2] as well as the spread of infectious diseases during crises [26], etc. The COVID-19 pandemic has fundamentally changed this situation, now economists need to study the impact of the pandemic on the economy.

In the history of mankind, such economic crises are known, which also did not occur in the economy itself, but were introduced into it from the outside. In other words, such crises are not typical, but so-called *atypical* economic crises.

Atypical economic crises include, for example, the economic crises that started after World War I and II, as well as caused by the collapse of the Communist system in Eastern Europe and the USSR. Atypicality as such suggests that these crises differ not only from typical economic crises but may also differ from some other atypical economic crises.

Thus, the economic crises of the post-war period were primarily the result of damages caused by military operations. The most important task of the post-war period was the repair, and sometimes full reconstruction of damaged buildings and facilities. As opposed to this situation, the coronomic crisis has nothing to do with damages to buildings and facilities; on the contrary, everything is safe and sound, but many facilities are temporarily closed and do not function.

The economic crisis caused by the collapse of the Communist system in the countries of Eastern Europe and the USSR was due to the transformation of the command economy into a market economy. Unlike this atypical economic crisis, the coronomic crisis has nothing to do with any transformation of the foundations of the economic system.

At the same time, such economic crises are known in world history and were caused by pandemics of various diseases (for example, [27]).

Particularly noteworthy is the study of the experience of the economic crisis caused by the

[2] WHO. Impact of economic crises on mental health. Copenhagen: World Health Organization; 2011. 34 p. URL: http://www.euro.who.int/__data/assets/pdf_file/0008/134999/e94837.pdf?ua=1 (accessed on 31.03.2021).

well-known 1918 influenza pandemic ("Spanish flu"), which broke out in 1918 (for example, [28–31]), since this crisis has much in common with the modern coronomic crisis: a decline in economic activity, decrease in production volumes and incomes of the population, etc.

However, these economic crises are different (for example, [32]). First, if the Spanish flu pandemic began shortly after the end of World War I, leading to an economic crisis due to military damages, then fortunately, such dramatic events did not precede the onset of the COVID-19 pandemic. Second, during the Spanish flu pandemic, the world was not as globalized as it is today, supply chains and value chains spread to many countries of the world, and in the context of the coronomic crisis, in most cases, they began to disintegrate (for example, [33]). Third, by the start of the Spanish flu pandemic, tourism, and international transport links were not as developed as they are today, resulting in greater economic damage to these sectors of the economy during the coronomic crisis.

Thus, the coronomic crisis is not only atypical [34], but also unique in nature [35].

FEATURES OF THE ECONOMIC ABILITY OF THE GOVERNMENT DURING THE CORONOMIC CRISIS

As known, the role of the government increases during economic crises. This is fully applicable to the conditions of the coronomic crisis, which is quite natural, since not only overcoming an epidemic (within one country) or a pandemic (on a global scale) but also bringing the country out of the crisis is impossible without an active role of the government [36]. In other words, both during economic crises in general and during a coronomic crisis, in particular, the economic ability of the government acquires a dominated role [37, p. 64–66] among the factors of production [38].

The highest priority for the functioning of the economic ability of the government during the coronomic crisis is the maximum support and development of the healthcare system, without which it is impossible to treat the coronavirus and prevent its spread. At the same time, the activity of the economic ability of the government is a necessary condition for overcoming the coronomic crisis.

Additionally, it is important for the economic ability of the government not only to maintain the healthcare system but also make it more accessible to the public [39].

In the context of the coronomic crisis, it seems necessary to revise some of the generally accepted rules that are legislatively enshrined in the economic ability of the government. In particular, we are talking about the process of vaccination against coronavirus, which started at the end of 2020, and more specifically, the use of patent and copyright mechanisms, which, by their content, create legal barriers to the mass distribution of vaccines registered by the World Health Organization (WHO) [40, 41].

The suspension of patent and copyright protection mechanisms is an effective way for ensuring the availability of mass vaccination against coronavirus disease for almost all countries [39, 42]. In other words, vaccines against coronavirus should become a public goods, which fits into the scheme of expanding the "boundaries" of these goods when the economic ability of the government is recognizing new technologies as a public goods. This will qualitatively expand the possibilities of a technological breakthrough in the economy [43, p. 91].

It should be noted that even the presence of high-quality vaccines against coronavirus in the required quantity does not mean that mass vaccination will take place without hindrance, which is primarily related to the issues of the possible consequences of the vaccination [44].

Thus, one of the primary tasks of the economic ability of the government, along with providing the public with high-quality vaccines in the required quantity, is not only to minimize all possible risks of vaccination but also to raise public awareness on the issue.

With regard to the COVID-19 pandemic, one cannot but agree with the opinion that this is the "price of globalization" [45]. However, the global phenomenon of the COVID-19 pandemic was

accompanied by a process of de-globalization, which was stimulated by US President Donald Trump (for example, [46]) and Brexit (for example, [47]) even before the pandemic started.

When it comes to de-globalization in the context of the fifth factor of production, it should be noted that we are talking about the de-globalization of the economic ability of the government, which had a clear trend towards globalization before the COVID-19 pandemic.

The process of de-globalization in the context of the COVID-19 pandemic was facilitated by the unpreparedness of the economic ability of the government, represented by national governments, as well as international organizations (primarily WHO) for the rapid and uncontrolled spread of coronavirus. This, in turn, forced the governments of different countries, at their own peril and risk, to take certain anti-epidemic measures. Individual approaches to tackle pandemic risks and decision-making, especially at the initial stage of the crisis, can best be described by the following words: "all countries are almost equally happy during the period of economic rise, but they suffer differently during crises" [48, p. 5].

The rapid spread of the coronavirus has forced the economic ability of governments to suspend businesses like tourism and passenger transport. The aforementioned gap in international supply and value chains was added to this. As a result, these phenomena, and the inconsistency with each other of anti-epidemic measures taken by national governments, not to mention the confusion of WHO and other international organizations at the beginning of the pandemic, were interpreted as the beginning of the "crisis of globalization" and the transition to isolationism, and in particular, the isolationism of the economic ability of the government. In turn, isolationism negatively affects both economic growth [49] and social, political, and environmental spheres [50].

Due to the global nature of the pandemic, isolationism is a dead-end direction not only for overcoming it [36] but also for post-pandemic economic development [51, 52]. Maximum coordination on a global scale, carried out at the local level within national economies at the expense of the economic ability of the government, can lead to success in the fight against the COVID-19 pandemic [53].

The accumulated experience of using Internet technologies in the context of the coronomic crisis also highlights the "benefits" of globalization. These technologies rescued some sectors of the economy (for example, education, trade, etc.), which was reflected in the fact that they did not suspend their functioning, but transformed their activities based on these technologies. At the same time, it was the COVID-19 pandemic that exposed the gap in the level of Internet connectivity between developed and developing countries [54].

Based on the global nature of the pandemic itself, its overcoming is possible only with a global approach (for example, [55]).

It follows from what has been said that the process of de-globalization of the economic ability of the government is temporary. At the same time, the conclusion suggests itself that countries should not waste time in vain and make the most of the current situation for the timely adoption of appropriate measures to prepare for a truly impending new wave of globalization of the economic ability of the government, i.e. a qualitatively higher level of globalization [56]. The complexity of the problem is caused by the fact that new contours of globalization at this stage of the COVID-19 pandemic and coronomic crisis have not yet emerged [57].

The experience gained during the COVID-19 pandemic has clearly prioritized the prevention of economic security risks. The risks associated with maximizing food security are particularly relevant [58].

Among the challenges facing the economic ability of the government, those related to economic security are of particular importance and are likely to remain relevant in the context of the renewed process of globalization.

It is theoretically possible that a new virus will emerge in the more or less foreseeable future that could trigger a new pandemic

similar to the current one, and the experience gained during the COVID-19 pandemic will be invaluable. Therefore, based on this experience, it is necessary for the economic ability of the government and entrepreneurial ability, as well as for all of humanity, to learn how to live and act in a pandemic. [59] And this, in turn, directly suggests that for such factors of production as the economic ability of the government and entrepreneurial ability, it is advisable to adopt the experience of the so-called "pandemic behavior" for possible cases of new economic constraints during a pandemic.

THE NATURE OF ANTI–CRISIS MEASURES UNDER THE COVID-19 PANDEMIC

It was noted above that any comparison of the coronomic crisis with typical economic crises, including the global financial and economic crisis of 2007–2009, is extremely superficial [60]. Despite this, it should be recognized that the economic instruments that served the economic ability of the government since the onset of the coronomic crisis have not been different from those used relatively successfully during the 2007–2009 global financial crisis [61].

From a theoretical point of view, almost all economic crises after the Great Depression of 1929–1939 clearly express the need to return to well-known Keynesian ideas. Unsurprisingly, this approach has fully retained its relevance during the coronomic crisis [62, 63].

However, there is a fundamental difference in anti-crisis measures during typical economic crises and coronary crises. In particular, in the context of typical economic crises, these measures are designed to perform two functions: to support the population and business, and also to get out of the crisis. In contrast to this case, the completion of the coronary crisis depends solely on overcoming the pandemic, which, as noted above, is the immediate task of medicine. Consequently, there remains only one function of anti-crisis measures — to support the population and business.

Based on this feature of the economic measures taken by the economic ability of the government in connection with the coronomic crisis, they can be divided into two groups: anti-crisis measures as "survival measures" and post-crisis measures as "recovery measures" for economy. And the latter should precede the necessary post-crisis economic reforms [62].

The question of the effectiveness of various programs of financial support for the economy is the subject of a separate study (for example, [64, 65]).

Anti-crisis measures taken by the economic ability of the government have three goals:[3]

1. Financial support and development of the healthcare system for the prevention (vaccination) and treatment of coronavirus.
2. Financial assistance for vulnerable groups impacted by the coronomic crisis.
3. Financial measures to support companies that had to partially or completely suspend their activities due to the coronomic crisis.

All these three target areas of the economic ability of the government during the coronomic crisis fully fit into the above functional purpose of this factor of production. Namely: without healthcare system financial support, it will be impossible to end both the pandemic and the coronomic crisis. At the same time, financial assistance to support vulnerable groups is necessary not only for humane reasons, but also for purely economic reasons, in order to maintain a sufficiently capable workforce for the post-pandemic period. Finally, financial support for companies is required for keeping them in the post-pandemic market.

It is obvious that these anti-crisis measures, taken by the economic ability of the government, by their nature are based on an increase in national budget expenditures for the specified purposes of financial support. At the same time, an increase in the expenditure of national budgets of various countries is accompanied by a decrease in tax revenues, which is the result of a partial or complete suspension of the

[3] IMF. Policy responses to COVID-19. International Monetary Fund. 2021. URL: https://www.imf.org/en/Topics/imf-and-covid19/Policy-Responses-to-COVID-19 (accessed on 31.03.2021).

functioning of individual firms. As a result, the national budget deficit is growing, which, in turn, forces the economic ability of the government to increase borrowing. It directly follows from this that not only during the coronomic crisis[4] [66], but also to a no lesser extent in the post-pandemic period, the global problem of public debt servicing will become urgent [67–70]. It should also be emphasized that this problem arose before the coronomic crisis (for example, [71–74]), although this crisis, in turn, contributed to its relevance and acuteness.

During the coronomic crisis, as expected, the subject of independent research, or rather foresight, is the understanding of the post-pandemic world (for example, [45, 62, 75–78]).

In the context of financial assistance to support companies, there is a real threat of zombie-ing the economy [79].

ZOMBIE-ING THE ECONOMY UNDER THE COVID-19 PANDEMIC

The zombie economy originated in the 1990s in Japan (for example, [80]). In particular, the zombie economy was born in the bowels of a financial crisis (for example, [81, p. 368]).

The zombie economy includes zombie firms and zombie banks. The former, despite their insolvency, continue to function by lending to banks [82]. Moreover, the latter are these lenders, and they provide loans to zombie firms on favorable terms [83]. The mechanism that supports this clearly non-commercial activity of banks is based on the provision of government guarantees to zombie firms [84, p. 301], on the basis of which zombie banks create a win-win situation for themselves, despite the inability of these firms to service and repay loans. As a result, this entire mechanism is carried out at the expense of taxpayers [85, p. 164], and firms and banks that use it turn into zombies [80]. They generally make up the "unviable" part of the economy — the zombie economy [86].

As noted above, the zombie economy is usually formed in the bowels of a financial crisis, which is easily explained. In conditions of stagnation, among other negative consequences, the number of unemployed increases, the wages of workers fall and, as a result, the living standards decrease. Governments, as a rule, tend to avoid initiating bankruptcy proceedings for insolvent firms, either by supporting them with direct budget funding or by providing government guarantees that allow these insolvent firms to continue operating at the expense of a preferential bank loans.

Japan's economy was partially non-viable due to the financial crisis. After the end of this crisis, the government continued to use the described mechanism of zombie-ing the economy, since, in the event of liquidating the zombie economy with the help of bankruptcy legislation, the authorities feared losing the support of voters in the upcoming elections.

Obviously, this action of the government is based on political considerations and, in general, contradicts the functional purpose of the economic ability of the government as an independent factor of production. In particular, for the latter, the priority is to maintain and develop a healthy economic climate for the successful functioning of business, while the politically motivated process of zombie-ing the economy, on the contrary, in every possible way prevents the liquidation of these non-viable firms through bankruptcy procedures.

The Japanese phenomenon of the zombie economy in the context of the global financial crisis of 2007–2009 acquired an exclusively global character [87–92]. In particular, under the conditions of this crisis, most countries within the framework of special anti-crisis programs operating through "privatizing profits and nationalizing losses" [93, p. 10], provided financial support not only to private financial institutions but also to individual firms in the real sector [93, p. 22–23].

This was during the 2007–2009 global crisis when the process of zombie-ing the economy in the US (for example, [94, 95]) and some

[4] IMF. COVID-19 financial assistance and debt service relief. International Monetary Fund. March 4, 2021. URL: https://www.imf.org/en/Topics/imf-and-covid19/COVID-Lending-Tracker#ftn (accessed on 31.03.2021).

EU countries started (for example, [96, 97]). The zombie economy also affected the post-Communist countries [98, 99].

It should be emphasized that the process of zombie-ing the economy continued after the end of the global financial crisis of 2007–2009 (for example, [100–104]).

It was noted above that in the conditions of the coronomic crisis, as expected, the same methods of financial support for the population and the economy were used during the global financial crisis of 2007–2009. The main difference is that anti-crisis measures in the context of the latter, in addition to supporting the population and business, were aimed at completing it, and measures of a similar nature in the context of the coronomic crisis have an exclusively additional function to support the population and business. And the way out of this crisis is directly related to the end of the COVID-19 pandemic, which can only be achieved with the help of the success of medicine to prevent and treat the coronavirus.

As noted above, the Japanese experience of the zombie economy, as well as a similar experience of the global financial crisis of 2007–2009, shows that direct budget financing, as well as tax incentives and concessional lending, are becoming available for the firms in need. The same business support tools are used during the coronomic crisis. Since the formation of zombie firms has almost never stopped since the global financial crisis of 2007–2009, such firms in the context of the coronomic crisis include not only "healthy" (i.e. financially solvent) firms, but also existing zombie firms.

It should be borne in mind that, according to economics, government concessional lending to business, as a rule, not so much solves, but further exacerbates the accumulated economic problems (for example, [105, pp. 2–28]). At the same time, the experience of the zombie economy shows that many countries resort to this financial mechanism, during the financial and economic crisis.

During the coronomic crisis, the economic ability of the government cannot determine whether a particular firm was solvent before the crisis. As a result, the process of zombie-ing the economy in the context of the coronomic crisis is progressing [106].

In fact, the zombie-ing process has affected such giants as Boeing Co., Carnival Corp., Delta Air Lines Inc., Exxon Mobil Corp. Macy's Inc., etc., which can remain zombie companies in the post-pandemic period. But this does not mean that, according to some optimistic expectations, zombie companies will still be able to recover from this unhealthy zombie syndrome [107]. It should also be emphasized that even with successful vaccination, the zombie process can become irreversible [108].

As emphasized above, the zombie-ing of the economy is the result of the fact that the conflict between the political interests of the government and the economic ability of the government, as the global experience shows, is resolved exclusively in favor of the former. This is understandable within the framework of the "public choice" theory [109] when political decisions are not always economically rational [110].

To resolve the conflict between the political interests and economic ability of the government in favor of the latter, it is necessary to change the basic principle of bankruptcy legislation, aimed at avoiding unwanted bankruptcy (for example, [111]). The main principle of bankruptcy should strictly ensure not the preservation, but the liquidation of non-viable firms [112, 113]. Such a change in bankruptcy legislation requires a firm reformatory attitude of those directly "representing" the economic ability of the government and "setting in motion" this factor of production.

For a reform breakthrough in bankruptcy legislation, all other things being equal, it is necessary to choose the most appropriate time for this. This can be considered a non-crisis period of economic development, when economy is on the growth.

During economic crises, making such decisions is not only impossible but also inappropriate, so as not to aggravate the crisis

political situation. This provision is confirmed by the approach to bankruptcy legislation in the context of the COVID-19 pandemic, aimed at avoiding the initiation of appropriate procedures at all costs [114].

Thus, in the post-pandemic period of economic recovery and reforms, one of the priority areas of the economic ability of the government as a factor of production will be the development and implementation of such an economic policy, which will be aimed at overcoming the protracted process of zombie-ing the economy.

CONCLUSIONS

The COVID-19 pandemic and the resulting economic crisis have particularly exacerbated the question of the government's role in solving many purely pandemic and economic problems. In this context, it is advisable to consider the economic ability of the government as an independent fifth factor of production along with such factors as land, labor, capital, and entrepreneurial ability.

The economic ability of the government organizes production at the level of the national economy, creating the necessary conditions for entrepreneurial ability, which combines land, labor, and capital into production in order to create a specific good.

The economic ability of the government is not identical to the very concept of the government. In fact, the latter, in addition to economic ability, performs other functions (for example, political, international, defensive, etc.). The most desirable situation is when the economic ability of the government and its other functions do not contradict each other.

The economic crisis assigns a special anti-crisis function to the economic ability of the government.

To prevent the rapid and massive spread of the coronavirus, many countries had to temporarily restrict, and in many cases even suspend the functioning of most sectors of the economy, which triggered an economic crisis. In other words, the economic crisis under the COVID-19 pandemic is not typical, since its causes are not endogenous to the economy, but exogenous. It defines the nature of this economic crisis as atypical. And atypicality determines the dissimilarity of almost all atypical economic crises.

The economic crisis caused by the spread of the coronavirus is the coronomic crisis. Under the latter, the economic ability of the government naturally acquires a leading role among the factors of production.

From the outset, the COVID-19 pandemic has exacerbated the issue of de-globalization. The latter, in the context of factors of production, means the de-globalization of the economic ability of the government, which was characterized by a globalization trend before the COVID-19 pandemic. The process of de-globalization was facilitated by the unpreparedness of the economic ability of the government at the level of international organizations (primarily WHO) for the rapid and uncontrolled spread of the coronavirus.

At the same time, the global nature of the pandemic and the resulting coronomic crisis, all other things being equal, call for a globally coordinated response. Consequently, the de-globalization of the economic ability of the government is temporary.

Anti-crisis measures taken during typical economic crises are not fundamentally different from those taken during the coronomic crisis. The difference lies in the fact that the measures of a typical economic crises have both a supporting (population and business) and an ending (crisis) function. In addition, during a coronomic crisis, only one supportive function is performed, since the duration of this crisis depends entirely on the end of the pandemic.

The main directions of enhancing the economic ability of the government in the context of the coronomic crisis are priority support for the healthcare system; financial assistance to support vulnerable groups and those firms that had to completely or at least partially locked their activities. The implementation of these measures requires an increase in state budget expenditures.

The financial support of firms contributes to the zombie economy.

The zombie economy phenomenon occurred in the 1990s in Japan during the financial crisis.

Zombie firms are insolvent firms that continue to operate on concessional loans from zombie banks. The win-win of such an operation for the latter is ensured by government guarantees issued to zombie firms.

During the global financial crisis of 2007–2009, the process of zombie-ing the economy acquired a global character. This process continued after the end of the crisis.

Financial support instruments for businesses in the context of the coronomic crisis continue the process of zombie-ing the economy. Unfortunately, the giant companies have been gripped by this process, and there is no guarantee that they will be able to get rid of the zombie syndrome after the coronomic crisis. This is due to the political interests of the ruling parties, which fear losing the support of voters in upcoming elections, who may lose their jobs in the event of the legal bankruptcy of zombie firms.

The zombie economy occurs due to the conflict between the political interests of the government and the economic ability of the government. This conflict, as a rule, is resolved in favor of the former, which is explained by the well-known "public choice" theory.

In order for the economic ability of the government to be able to overcome the barrier of the political interests of the government, it is necessary to radically change the basic principle of bankruptcy legislation. Instead of applying the principle of preventing unwanted bankruptcy of firms, the principle of liquidating non-viable firms should be applied. Such a revolutionary change in bankruptcy law can only be implemented in an environment when the economy is booming.

In the post-pandemic period, the economic ability of a government to fulfill its primary function of efficiently organizing production both in a particular country and globally will be critical.

REFERENCE

1. Ghebreyesus T. A. WHO Director-General's opening remarks at the media briefing on COVID-19–11 March 2020. World Health Organization. Mar. 11, 2020. URL: https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19—-11-march-2020 (accessed on 31.03.2021).
2. Baldwin R., di Mauro B. W., eds. Mitigating the COVID economic crisis: Act fast and do whatever it takes. London: CEPR Press; 2020. 219 p. URL: https://voxeu.org/content/mitigating-covid-economic-crisis-act-fast-and-do-whatever-it-takes?fbclid=IwAR 2tO7kRFEGS 1_3J88oedtd1G3CARE 4S 0PFDSmOFJeSzH5tfEi6Odu55Fx8 (accessed on 31.03.2021).
3. Grigoryev L. M. Global social drama of pandemic and recession. *Naselenie i ekonomika = Population and Economics*. 2020;4(2):18–25. DOI: 10.3897/popecon.4.e53325
4. Geller A., Wiseman P., Rugaber C. Outbreak starts to look more like worldwide economic crisis. Herald Tribune. Feb. 28, 2020. URL: https://www.heraldtribune.com/business/20200228/outbreak-starts-to-look-more-like-worldwide-economic-crisis (accessed on 31.03.2021).
5. De Alwis A. Coronomics — Plan your eggs and the basket! Daily FT. Feb. 06, 2020. URL: http://www.ft.lk/columns/Coronomics-%E 2%80%93-Plan-your-eggs-and-the-basket-/4–695109 (accessed on 31.03.2021).
6. Eichengreen B. Coronanomics 101. Project Syndicate. Mar. 10, 2020. URL: https://www.project-syndicate.org/commentary/limits-macroeconomic-tools-coronavirus-pandemic-by-barry-eichengreen-2020–03?utm_source=Project+Syndicate+Newsletter&utm_campaign=cba7e1c6a1-sunday_newsletter_15_03_2020&utm_medium=email&utm_term=0_73bad5b7d8-cba7e1c6a1–93567601&mc_cid=cba7e1c6a1&mc_eid=e9fb6cbcc0 (accessed on 31.03.2021).

7. Papava V. Coronomic crisis: When the economy is a hostage to medicine. Eurasia Review. Mar. 29, 2020. URL: https://www.eurasiareview.com/29032020-coronomic-crisis-when-the-economy-is-a-hostage-to-medicine-oped/ (accessed on 31.03.2021).
8. Papava V. New challenges of economic science under the COVID-19 pandemic. *Ekonomisti*. 2020; XVI(4):20–35. (In Russ.). DOI: 10.36172/EKONOMISTI.2020.XVI.04.Papava
9. Basu K. How the pandemic should shake up economics. Project Syndicate. June 22, 2020. URL: https://www.project-syndicate.org/commentary/covid19-pandemic-shows-markets-depend-on-tacit-social-norms-by-kaushik-basu-2020–06?utm_source=Project%20Syndicate%20Newsletter&utm_campaign=4bba15cfe5-sunday_newsletter_06_28_2020&utm_medium=email&utm_term=0_73bad5b7d8–4bba15cfe5–93567601&mc_cid=4bba15cfe5&mc_eid=e9fb6cbcc0&barrier=accesspaylog (accessed on 31.03.2021).
10. Hamada K. Epidemics, economics, and externalities. Project Syndicate. Aug. 27, 2020. URL: https://www.project-syndicate.org/commentary/covid19-epidemics-economics-externalities-social-justice-by-koichi-hamada-2020–08?utm_source=Project+Syndicate+Newsletter&utm_campaign=219b01f4ff-covid_newsletter_03_09_2020&utm_medium=email&utm_term=0_73bad5b7d8–219b01f4ff-93567601&mc_cid=219b01f4ff&mc_eid=e9fb6cbcc0 (accessed on 31.03.2021).
11. Papava V. The role of the state in the modern economic system. *Voprosy ekonomiki.* 1993;(11):33–41. (In Russ.).
12. Papava V. On some controversial issues in the theory of factors of production. *Teoreticheskaya i prikladnaya ekonomika = Theoretical and Applied Economics*. 2017;(3):106–118. (In Russ.). DOI: 10.25136/2409–8647.2017.3.23890
13. Grebnev L. Factors and resources: Identity, difference or opposition? *Voprosy ekonomiki.* 2010;(7):135–150. (In Russ.). DOI: 10.32609/0042–8736–2010–7–135–150
14. Brynjolfsson E., Hitt L. Information technology as a factor of production: The role of differences among firms. *Economics of Innovation and New Technology*. 1995;3(3–4):183–200. DOI: 10.1080/10438599500000002
15. Gentile B. The new factors of production and the rise of data-driven applications. Forbes. Oct. 31, 2011. URL: https://www.forbes.com/sites/ciocentral/2011/10/31/the-new-factors-of-production-and-the-rise-of-data-driven-applications/#4264220317da (accessed on 31.03.2021).
16. Kendall W.R., Scott C.R. Information as a factor of production. *Journal of Information Technology Management*. 1990;1(2):39–43. URL: http://jitm.ubalt.edu/I-2/JITM%20Vol%20I%20No.2–5.pdf (accessed on 31.03.2021).
17. Papava V. On production factors. *Bulletin of the Georgian National Academy of Sciences*. 2017;11(4):145–149. URL: http://science.org.ge/bnas/t11-n4/22_Papava.pdf
18. McConnell C.R., Brue S.L. Economics: Principles, problems, and policies. New York: McGraw-Hill Book Co.; 1990. 866 p. (Russ. ed.: McConnell C.R., Brue S.L. Ekonomiks: printsipy, problemy i politika (in 2 vols.). Vol. 1. Moscow: Respublika; 1992. 399 p.).
19. McConnell C.R., Brue S.L. Economics: Principles, problems, and policies. 16th ed. Boston, MA: McGraw-Hill/Irwin; 2005. 733 p.
20. Papava V. A new view of the economic ability of the government, egalitarian goods and GNP. *International Journal of Social Economics*. 1993;20(8):56–62. DOI: 10.1108/03068299310044425
21. Griffiths A., Wall S., eds. Applied economics: An introductory course. Sixth edition. London: Longman; 1997. 808 p.
22. Krugman P. The return of depression economics and the crisis of 2008. New York: W.W. Norton & Co.; 2009. 207 p.
23. Shiller R.J. The subprime solution: How today's global financial crisis happened, and what to do about it. Princeton, Oxford: Princeton University Press; 2008. 208 p.
24. Stiglitz J.E. Freefall: America, free markets, and the sinking of the world economy. New York: W.W. Norton & Co.; 2010. 480 p.
25. Maresso A., Mladovsky P., Thomson S., Sagan A., Karanikolos M., Richardson E., Cylus J., Evetovits T., Jowett M., Figueras J., Kluge H., eds. Economic crisis, health systems and health in Europe: Country experience.

Copenhagen: World Health Organization; 2015. 554 p. URL: http://www.euro.who.int/__data/assets/pdf_file/0010/279820/Web-economic-crisis-health-systems-and-health-web.pdf?ua=1 (accessed on 31.03.2021).
26. Suhrcke M., Stuckler D., Suk J.E., Desai M., Senek M., McKee M., Tsolova S., Basu S., Abubakar I., Hunter P., Rechel B., Semenza J.C. The impact of economic crises on communicable disease transmission and control: A systematic review of the evidence. *PLoS ONE.* 2011;6(6): e20724. DOI: 10.1371/journal.pone.0020724
27. Roach S.S. The pandemic's long economic shadow. Project Syndicate. Dec. 21, 2020. URL: https://www.project-syndicate.org/commentary/pandemics-long-economic-shadow-by-stephen-s-roach-2020–12 (accessed on 31.03.2021).
28. Bishop J. Economic effects of the Spanish flu. Reserve Bank of Australia. June 18, 2020. URL: https://www.rba.gov.au/publications/bulletin/2020/jun/economic-effects-of-the-spanish-flu.html (accessed on 31.03.2021).
29. De Santis R., Van der Veken W. Economic expected losses and downside risks due to the Spanish flu. VoxEU-CEPR Policy Portal. Nov. 11, 2020. URL: https://voxeu.org/article/economic-expected-losses-and-downside-risks-due-spanish-flu (accessed on 31.03.2021).
30. Maas S. Social and economic impacts of the 1918 influenza epidemic. National Bureau of Economic Research. The Digest. 2020;(5). URL: https://www.nber.org/digest/may20/social-and-economic-impacts-1918-influenza-epidemic (accessed on 31.03.2021).
31. Ullman H. Economic recovery from coronavirus: Lessons from 1918–1923. Atlantic Council. May 01, 2020. URL: https://www.atlanticcouncil.org/blogs/new-atlanticist/economic-recovery-from-coronavirus-lessons-from-1918–1923/ (accessed on 31.03.2021).
32. Scheidel W. The Spanish flu didn't wreck the global economy: What is different about the coronavirus pandemic? Foreign Affairs. May 28, 2020. URL: https://www.foreignaffairs.com/articles/united-states/2020–05–28/spanish-flu-didnt-wreck-global-economy (accessed on 31.03.2021).
33. Derviş K., Strauss S. What COVID-19 means for international cooperation. Project Syndicate. Mar. 06, 2020. URL: https://www.project-syndicate.org/commentary/global-cooperation-can-prevent-next-pandemic-by-kemal-dervis-and-sebasti-n-strauss-2020–03?barrier=accesspaylog (accessed on 31.03.2021).
34. Papava V. On the atypical economic crisis under the COVID-19 pandemic. *Economics and Business*. 2020; XII(4):9–16. URL: https://www.researchgate.net/publication/349098628_On_the_Atypical_Economic_Crisis_under_the_COVID-19_Pandemic
35. Ajili W. Pourquoi la crise Covid-19 est-elle aussi inédite? *L'Economiste*. 1 mai, 2020. URL: https://www.leconomistemaghrebin.com/2020/05/01/pourquoi-crise-covid-19-est-elle-aussi-inedite/ (accessed on 31.03.2021).
36. Stiglitz J.E. Plagued by Trumpism. Project Syndicate, Mar. 09, 2020. URL: https://www.project-syndicate.org/commentary/trump-coronavirus-failure-of-small-government-by-joseph-e-stiglitz-2020–03?utm_source=Project+Syndicate+Newsletter&utm_campaign=cba7e1c6a1-sunday_newsletter_15_03_2020&utm_medium=email&utm_term=0_73bad5b7d8-cba7e1c6a1–93567601&mc_cid=cba7e1c6a1&mc_eid=e9fb6cbcc0 (accessed on 31.03.2021).
37. Elion S., Gold B., Soesan J. Applied productivity analysis for industry. Oxford: Pergamon Press Ltd; 1976. 151 p. (Russ. ed.: Elion S., Gold B., Soesan J. Sistema pokazatelei effektivnosti proizvodstva (prikladnoi analiz). Moscow: Ekonomika; 1980. 191 p.).
38. Rodrik D. Making the best of a post-pandemic World. Project Syndicate. May 12, 2020. URL: https://www.project-syndicate.org/commentary/three-trends-shaping-post-pandemic-global-economy-by-dani-rodrik-2020–05?utm_source=Project%20Syndicate%20Newsletter&utm_campaign=3ce69c95d3-sunday_newsletter_17_05_2020&utm_medium=email&utm_term=0_73bad5b7d8–3ce69c95d3–93567601&mc_cid=3ce69c95d3&mc_eid=e9fb6cbcc0&barrier=accesspaylog (accessed on 31.03.2021).
39. Stiglitz J.E., Jayadev A., Prabhala A. Patents vs. the pandemic. Project Syndicate. Apr. 23, 2020. URL: https://www.project-syndicate.org/commentary/covid19-drugs-and-vaccine-demand-patent-reform-by-joseph-e-stiglitz-et-al-2020–04 (accessed on 31.03.2021).

40. Penteado A. Uncertainty and intellectual property rights. *NUJS Journal of Regulatory Studies*. 2020;(April):1–5. URL: https://nujs.edu/crsgpp/crsgpp-journal-april2020.pdf (accessed on 31.03.2021).
41. Woods N. The green shoots of COVID solidarity. Project Syndicate. Mar. 02, 2021. URL: https://www.project-syndicate.org/commentary/rich-countries-must-show-covid19-vaccine-solidarity-by-ngaire-woods-2021–03?utm_source=Project+Syndicate+Newsletter&utm_campaign=49ad427ef0-sunday_newsletter_03_07_2021&utm_medium=email&utm_term=0_73bad5b7d8–49ad427ef0–93567601&mc_cid=49ad427ef0&mc_eid=e9fb6cbcc0 (accessed on 31.03.2021).
42. Spence M., Stiglitz J.E., Ghosh J. Avoiding a K-shaped global recovery. Project Syndicate. Mar. 24, 2021. URL: https://www.project-syndicate.org/commentary/global-economy-avoiding-k-shaped-recovery-by-michael-spence-et-al-2021–03?utm_source=Project+Syndicate+Newsletter&utm_campaign=4161ffd8c1-sunday_newsletter_03_28_2021&utm_medium=email&utm_term=0_73bad5b7d8–4161ffd8c1–93567601&mc_cid=4161ffd8c1&mc_eid=e9fb6cbcc0 (accessed on 31.03.2021).
43. Sachs J.F. Building the new American economy: Smart, fair, and sustainable. New York: Columbia University Press; 2017; 152 p.
44. Papava V. Is the vaccine a panacea? Eurasia Review. Sept. 30, 2020. URL: https://www.eurasiareview.com/30092020-is-the-vaccine-a-panacea-oped/?fbclid=IwAR 0A1A6aQRGpC-6SfhcjjtneRU 34HGm920joNg HsnZMIO4raEsLWO8l5Jrs (accessed on 31.03.2021).
45. Auzan A.A. The economy under the pandemic and afterwards. *Naselenie i ekonomika = Population and Economics*. 2020;4(2):4–12. DOI: 10.3897/popecon.4.e53403
46. Sachs J.D. Global cooperation is the only way forward for the US. World Economic Forum. Jan. 06, 2017. URL: https://www.weforum.org/agenda/2017/01/jeffrey-sachs-global-cooperation-is-the-only-way-forward-for-the-us/ (accessed on: 31.03.2021).
47. O'Rourke K. A short history of Brexit: From Brentry to backstop. London: Pelican; 2019, 384 p.
48. Grigoryev L.M., Pavlyushina V.A., Muzychenko E.E. The fall into 2020 recession… *Voprosy ekonomiki*. 2020;(5):5–24. (In Russ.). DOI: 10.32609/0042–8736–2020–5–5–24
49. Rogoff K. Deglobalization will hurt growth everywhere. Project Syndicate. June 03, 2020. URL: https://www.project-syndicate.org/commentary/deglobalization-threat-to-world-economy-and-united-states-by-kenneth-rogoff-2020–06?utm_source=Project%20Syndicate%20Newsletter&utm_campaign=56f4462bc8-sunday_newsletter_07_06_2020&utm_medium=email&utm_term=0_73bad5b7d8–56f4462bc8–93567601&mc_cid=56f4462bc8&mc_eid=e9fb6cbcc0&barrier=accesspaylog (accessed on 31.03.2021).
50. Haass R.N. Deglobalization and its discontents. Project Syndicate. May 12, 2020. URL: https://www.project-syndicate.org/commentary/deglobalizaton-discontents-by-richard-n-haass-2020–05?utm_source=Project%20Syndicate%20Newsletter&utm_campaign=3ce69c95d3-sunday_newsletter_17_05_2020&utm_medium=email&utm_term=0_73bad5b7d8–3ce69c95d3–93567601&mc_cid=3ce69c95d3&mc_eid=e9fb6cbcc0&barrier=accesspaylog (accessed on 31.03.2021).
51. Åslund A. Trump's global recession. Project Syndicate. Mar. 13, 2020. URL: https://www.project-syndicate.org/commentary/donald-trump-covid19-global-recession-by-anders-aslund-2020–03 (accessed on 31.03.2021).
52. Fung V.K. The trade cure for the global economy. Project Syndicate. Apr. 22, 2020. URL: https://www.project-syndicate.org/commentary/covid19-crisis-revive-multilateralism-open-trade-by-victor-k-fung-2020–04?utm_source=Project%20Syndicate%20Newsletter&utm_campaign=871db40e9f-sunday_newsletter_26_04_2020&utm_medium=email&utm_term=0_73bad5b7d8–871db40e9f-93567601&mc_cid=871db40e9f&mc_eid=e9fb6cbcc0&barrier=accesspaylog (accessed on 31.03.2021).
53. Mazzucato M., Torreele E. How to develop a COVID-19 vaccine for all. Project Syndicate. Apr. 27, 2020. URL: https://www.project-syndicate.org/commentary/universal-free-covid19-vaccine-by-mariana-mazzucato-and-els-torreele-2020–04?barrier=accesspaylog (accessed on 25.03.2021).

54. Passaris C. E. The moral dilemma and asymmetric economic impact of COVID-19. *Real-world economics review*. 2021;(95):62–70. URL: http://www.paecon.net/PAEReview/issue95/Passaris95.pdf (accessed on 25.03.2021).
55. Abesadze R. Globalization and the economic problems of the pandemic. *Ekonomisti*. 2020; XVI(2):14–20. (In Russ.).
56. El-Erian M. A. Navigating deglobalization. Project Syndicate. May 11, 2020. URL: https://www.project-syndicate.org/commentary/covid19-deglobalization-two-priorities-by-mohamed-a-el-erian-2020–05?utm_source=Project%20Syndicate%20Newsletter&utm_campaign=3ce69c95d3-sunday_newsletter_17_05_2020&utm_medium=email&utm_term=0_73bad5b7d8–3ce69c95d3–93567601&mc_cid=3ce69c95d3&mc_eid=e9fb6cbcc0&barrier=accesspaylog (accessed on 31.03.2021).
57. Mau V. Coronavirus pandemic and trends of economic policy. *Voprosy ekonomiki.* 2021;(3):5–30. (In Russ.). DOI: 10.32609/0042–8736–2021–3–5–30
58. Blair T., Kalibata A. Building food security during the pandemic. Project Syndicate. May 07, 2020. URL: https://www.project-syndicate.org/commentary/four-ways-to-boost-food-security-during-covid19-pandemic-by-tony-blair-and-agnes-kalibata-2020–05?utm_source=Project%20Syndicate%20Newsletter&utm_campaign=2ad6876daf-sunday_newsletter_10_05_2020&utm_medium=email&utm_term=0_73bad5b7d8–2ad6876daf-93567601&mc_cid=2ad6876daf&mc_eid=e9fb6cbcc0&barrier=accesspaylog (accessed on 31.03.2021).
59. Gigerenzer G. Why what does not kill us makes us panic. Project Syndicate. Mar. 12, 2020. URL: https://www.project-syndicate.org/commentary/greater-risk-literacy-can-reduce-coronavirus-fear-by-gerd-gigerenzer-2020–03 (accessed on 31.03.2021).
60. Roach S. S. The false crisis comparison. Project Syndicate. Mar. 19, 2020. URL: https://www.project-syndicate.org/commentary/covid-19-crisis-nothing-like-2008-by-stephen-s-roach-2020–03 (accessed on 31.03.2021).
61. Hatheway L. A COVID-19 emergency response plan. Project Syndicate. Feb. 27, 2020. URL: https://www.project-syndicate.org/commentary/covid-19-economy-response-plan-by-larry-hatheway-2020–02 (accessed on 31.03.2021).
62. Skidelsky R. Sequencing the post-COVID recovery. Project Syndicate. Mar. 16, 2021. URL: https://www.project-syndicate.org/commentary/keynes-criticism-of-new-deal-relevant-to-covid19-by-robert-skidelsky-2021–03?utm_source=Project+Syndicate+Newsletter&utm_campaign=8d2c6792d0-sunday_newsletter_03_21_2021&utm_medium=email&utm_term=0_73bad5b7d8–8d2c6792d0–93567601&mc_cid=8d2c6792d0&mc_eid=e9fb6cbcc0 (accessed on 31.03.2021).
63. Velasco A. Are we all Keynesians again? Project Syndicate. Aug. 25, 2020. URL: https://www.project-syndicate.org/commentary/states-must-be-insurer-of-last-resort-against-aggregate-risks-by-andres-velasco-2020–08?utm_source=Project+Syndicate+Newsletter&utm_campaign=84fdc5db75-sunday_newsletter_30_08_2020&utm_medium=email&utm_term=0_73bad5b7d8–84fdc5db75–93567601&mc_cid=84fdc5db75&mc_eid=e9fb6cbcc0 (accessed on 31.03.2021).
64. Zaitsev Yu. K. Monetary and fiscal policy measures during the COVID-19 economic crisis in Russia. *Finansy: teoriya i praktika = Finance: Theory and Practice*. 2020;24(6):6–18. (In Russ.). DOI: 10.26794/2587–5671–2020–24–6–6–18
65. Jiang M., Hu Y., Li X. Financial support for small and medium-sized enterprises in China amid COVID-19. *Finansy: teoriya i praktika = Finance: Theory and Practice*. 2020;24(5):6–14. DOI: 10.26794/2587–5671–2020–24–5–6–14
66. Gros D. Fiscal follies in the COVID recovery. Project Syndicate. Mar. 05, 2021. URL: https://www.project-syndicate.org/commentary/folly-of-additional-deficit-financed-fiscal-stimulus-in-2021-by-daniel-gros-2021–03?utm_source=Project+Syndicate+Newsletter&utm_campaign=4110556ba0-sunday_newsletter_03_14_2021&utm_medium=email&utm_term=0_73bad5b7d8–4110556ba0–93567601&mc_cid=4110556ba0&mc_eid=e9fb6cbcc0 (accessed on 31.03.2021).

67. Stiglitz J.E., Rashid H. How to prevent the looming sovereign-debt crisis. Project Syndicate. July 31, 2020. URL: https://www.project-syndicate.org/commentary/how-to-prevent-looming-debt-crisis-developing-countries-by-joseph-e-stiglitz-and-hamid-rashid-2020–07?barrier=accesspaylog (accessed on 31.03.2021).
68. Spence M., Leipziger D. The pandemic public-debt dilemma. Project Syndicate. Dec. 08, 2020. URL: https://www.project-syndicate.org/commentary/pandemic-spending-debt-dilemma-by-michael-spence-and-danny-leipziger-2020–12?utm_source=Project%20Syndicate%20Newsletter&utm_campaign=4f0dca62b8-sunday_newsletter_12_13_2020&utm_medium=email&utm_term=0_73bad5b7d8–4f0dca62b8–93567601&mc_cid=4f0dca62b8&mc_eid=e9fb6cbcc0&barrier=accesspaylog (accessed on 31.03.2021).
69. Rajan R.G. How much debt is too much? Project Syndicate. Nov. 30, 2020. URL: https://www.project-syndicate.org/commentary/borrowing-and-spending-limits-in-ultra-low-interest-rate-environment-by-raghuram-rajan-2020–11 (accessed on 31.03.2021).
70. Lee A. Global public debt to rise 'modestly' after US$ 14 trillion spent to tackle coronavirus economic damage, IMF says. China Macro Economy. Jan. 28, 2021. URL: https://www.scmp.com/economy/global-economy/article/3119649/global-public-debt-rise-modestly-after-us14-trillion-spent (accessed on 31.03.2021).
71. Newman F.N. Freedom from national debt. Minneapolis, MN: Two Harbors Press; 2013. 104 p.
72. Hager S. Public debt, inequality, and power: The making of a modern debt state. Oakland, CA: University of California Press; 2016. 174 p.
73. Dalio R. Big debt crises. Westport, CT: Bridgewater; 2018. 472 p.
74. Abbas S., Pienkowski A., Rogoff K., eds. Sovereign debt: A guide for economists and practitioners. Oxford: Oxford University Press; 2019. 464 p.
75. Kolodko G.W. After. Economics and politics of the post-pandemic world. *Voprosy ekonomiki.* 2020;(5):25–44. (In Russ.). DOI: 10.32609/0042–8736–2020–5–25–44
76. Gardini G.L., ed. The world before and after COVID-19: Intellectual reflections on politics, diplomacy and international relations. Salamanca-Stockholm: European Institute of International Studies Press; 2020. 153 p. URL: https://www.ieeiweb.eu/wp-content/uploads/2020/06/Full_book_FINAL_EN 2.0-UNIDO.pdf (accessed on 25.03.2021).
77. Harrington K. The risk of post-pandemic instability. Project Syndicate. Mar. 25, 2021. URL: https://www.project-syndicate.org/commentary/post-covid-instability-sources-of-unrest-by-kent-harrington-2021–03 (accessed on 31.03.2021).
78. Zakaria F. Ten lessons for a post-pandemic world. New York: W.W. Norton & Co.; 2020. 320 p.
79. Stiglitz J.E. Priorities for the COVID-19 economy. Project Syndicate. July 01, 2020. URL: https://www.project-syndicate.org/commentary/covid-2020-recession-how-to-respond-by-joseph-e-stiglitz-2020–06?utm_source=Project+Syndicate+Newsletter&utm_campaign=67133fbc7b-covid_newsletter_02_07_2020&utm_medium=email&utm_term=0_73bad5b7d8–67133fbc7b-93567601&mc_cid=67133fbc7b&mc_eid=e9fb6cbcc0 (accessed on 31.03.2021).
80. Hoshi T. Economics of the living dead. *The Japanese Economic Review*. 2006;57(1):30–49. DOI: 10.1111/j.1468–5876.2006.00354.x
81. Ahearne A.G., Shinada N. Zombie firms and economic stagnation in Japan. *International Economics and Economic Policy*. 2005;2(4):363–381. DOI: 10.1007/s10368–005–0041–1
82. Smith D.C. Loans to Japanese borrowers. *Journal of the Japanese and International Economies*. 2003;17(3):283–304. DOI: 10.1016/S 0889–1583(03)00043–1
83. Hoshi T., Kashyap A. Solutions to Japan's banking problems: What might work and what definitely will fail. In: Ito T., Patrick H., Weinstein D.E., eds. Reviving Japan's economy: Problems and prescriptions. Cambridge, MA: The MIT Press: 2005:147–195.
84. Kane E.J. The dialectical role of information and disinformation in regulation-induced banking crises. *Pacific-Basin Finance Journal*. 2000;8(3–4):285–308. DOI: 10.1016/S 0927–538X(00)00014–7

85. Kane E. J. Capital movements, banking insolvency, and silent runs in the Asian financial crisis. *Pacific-Basin Finance Journal*. 2000;8(2):153–175. DOI: 10.1016/S 0927–538X(00)00009–3
86. LeLaulu L. Zombie economics? Devex. Jan. 12, 2009. URL: https://www.devex.com/news/zombie-economics-58420 (дата обращения: 25.03.2021).
87. Constable S., Wright R. E. The Wall Street Journal guide to the 50 economic indicators that really matter: From Big Macs to "zombie banks", the indicators smart investors watch to beat the market. New York: Harper Business; 2011. 281 p.
88. Desjardins L., Emerson R. Zombie economics: A guide to personal finance. New York: AVERY; 2011. 304 p.
89. Harman C. Zombie capitalism: Global crisis and the relevance of Marx. Chicago, IL: Haymarket Books; 2010. 425 p.
90. Marrs J. The trillion-dollar conspiracy: How the new world order, man-made diseases, and zombie banks are destroying America. New York: HarperCollins Publishers; 2011. 496 p.
91. Onaran Y. Zombie banks: How broken banks and debtor nations are crippling the global economy. Hoboken, NJ: John Wiley & Sons; 2012. 184 p.
92. Quiggin J. Zombie economics: How dead ideas still walk among us. Princeton, Oxford: Princeton University Press; 2010. 288 p.
93. Mau V. The drama of 2008: From economic miracle to economic crisis. *Voprosy ekonomiki.* 2009;(2):4–23. (In Russ.). DOI: 10.32609/0042–8736–2009–2–4–23
94. Coy P. A new menace to the economy: 'Zombie' debtors. Bloomberg Businessweek. Jan. 15, 2009. URL: https://www.bloomberg.com/news/articles/2009–01–14/a-new-menace-to-the-economy-zombie-debtors (accessed on 25.03.2021).
95. Krugman P. Wall Street Voodoo. The New York Times. Jan. 18, 2009. URL: http://www.nytimes.com/2009/01/19/opinion/19krugman.html?_r=2&partner=rssnyt&emc=rss (accessed on 25.03.2021).
96. Kelly M. Our zombie nation and zombie banks. Machine Nation. Oct. 29, 2008. URL: https://machinenation.forumakers.com/t1496-morgan-kelly-bank-guarantee-likely-to-deal-a-crippling-blow-to-the-economy#43586 (accessed on 25.03.2021).
97. Schnittger F. Ireland's zombie economy. European Tribune. Jan. 14, 2009. URL: https://www.eurotrib.com/?op=displaystory; sid=2009/1/14/113437/798 (accessed on 25.03.2021).
98. Papava V. The problem of zombie-ing the post-communist necroeconomy. *Vestnik Instituta Kennana v Rossii*. 2009;(15):37–48. URL: https://www.wilsoncenter.org/sites/default/files/media/documents/publication/Vestnik_15.pdf (In Russ.).
99. Papava V. Economy of post-Communist capitalism under the financial crisis. *Studies in Economics and Finance*. 2010;27(2):135–147. DOI: 10.1108/10867371011048625
100. Andrews D., McGowan M.A., Millot V. Confronting the zombies: Policies for productivity revival. OECD Economic Policy Paper. 2017;(21). URL: https://www.oecd-ilibrary.org/docserver/f14fd801-en.pdf?expires=1616400907&id=id&accname=guest&checksum=0FFA916B 03477B 73B 1977631281D 9DA5 (accessed on 25.03.2021).
101. Banerjee R., Hofmann B. The rise of zombie firms: Causes and consequences. *BIS Quarterly Review*. 2018;(Sept.):67–78. URL: https://www.bis.org/publ/qtrpdf/r_qt1809g.pdf (accessed on 25.03.2021).
102. Blažková I., Dvouletý O. Zombies: Who are they and how do firms become zombies? *Journal of Small Business Management*. 2020. DOI: 10.1080/00472778.2019.1696100
103. Liang J. Can "zombie enterprises" find self-help road through technological innovation? *Chinese Studies*. 2017;6(3):173–180. DOI: 10.4236/chnstd.2017.63017
104. Krugman P. Arguing with zombies: Economics, politics, and the fight for a better future. New York: W.W Norton & Co.; 2020. 461 p.
105. Hazlitt H. Economics in one lesson: The shortest and surest way to understand basic economics. New York: Three Rivers Press; 1988. 218 p. (Russ. ed.: Hazlitt H. Tipichnye oshibki gosudarstvennogo regulirovaniya ekonomiki. Moscow: Serebryanye niti; 2000. 160 p.).

106. Papava V. Features of the economic crisis under the COVID-19 pandemic and the threat of the zombie-ing of the economy. *Bulletin of the Georgian National Academy of Sciences*. 2020;14(3):128–134.
107. Lee L., Contiliano T. America's zombie companies rack up $ 2 trillion of debt. Bloomberg. Nov. 17, 2020. URL: https://www.bloomberg.com/news/articles/2020–11–17/america-s-zombie-companies-have-racked-up-1–4-trillion-of-debt (accessed on 25.03.2021).
108. Donnan S. America's economy faces a zombie recovery, even with vaccine. Bloomberg. Dec. 15, 2020. URL: https://www.bloomberg.com/news/articles/2020–12–15/covid-pandemic-u-s-economy-in-zombie-recovery-without-government-stimulus (accessed on 25.03.2021).
109. Buchanan J.M., Tullock G. The calculus of consent: Logical foundations of constitutional democracy. Ann Arbor, MI: University of Michigan Press; 1962. 361 p.
110. Papava V. On the non-economic policy and the post-Communist experience of Georgia. *European Journal of Economic Studies*. 2019;8(2):143–151. DOI: 10.13187/es.2019.2.143
111. Stiglitz J.E. Bankruptcy laws: Basic economic principles. In: Claessens S., Djankov S., Mody A., eds. Resolution of financial distress: An international perspective on the design of bankruptcy laws. Washington, DC: The World Bank; 2001:1–23. URL: https://documents1.worldbank.org/curated/en/872461468766246801/pdf/multi0page.pdf
112. Papava V. On retroeconomy. *Voprosy ekonomiki*. 2017;(10):148–159. (In Russ.). DOI: 10.32609/0042–8736–2017–10–148–159
113. Papava V. Retroeconomics — moving from dying to brisk economy. *Journal of Reviews on Global Economics*. 2017;6:455–462. DOI: 10.6000/1929–7092.2017.06.46
114. Boon G.-J. Amending insolvency legislation in response to the COVID-19 crisis. Harvard Law School Bankruptcy Roundtable. May 12, 2020. URL: https://blogs.harvard.edu/bankruptcyroundtable/2020/05/12/amending-insolvency-legislation-in-response-to-the-covid-19-crisis/ (accessed on 25.03.2021).

ABOUT THE AUTHORS

Vladimer Papava — Dr. Sci. (Econ.), Prof., Department of Theoretical Economics, Faculty of Economics and Business, Ivane Javakhishvili Tbilisi State University, Tbilisi, Georgia; Academician, National Academy of Sciences of Georgia, Tbilisi, Georgia
vladimer.papava@tsu.ge

Mikheil Chkuaseli — PhD student, Department of Theoretical Economics, Faculty of Economics and Business, Ivane Javakhishvili Tbilisi State University, Tbilisi, Georgia
mikheil.chkuaseli@tsu.ge

The article was submitted on 05.04.2021; revised on 19.04.2021 and accepted for publication on 27.06.2021.
The authos read and approved the final version of the manuscript.

ORIGINAL PAPER

DOI: 10.26794/2587-5671-2020-25-5-24-44
UDC 336:553.98(045)
JEL G32, F30, M21, Q01, Q40

Trends in Russia's GDP Growth under Environmental Constraints

Z.V. Bragina[a] ✉, **A.R. Denisov**[b], **N.N. Masyuk**[c], **N.V. Steblyanskii**[d]
[a, b] Kostroma State University, Kostroma, Russia;
[c] Vladivostok State University of Economics and Service, Vladivostok, Russia;
[d] Russian University of Transport (MIIT), Moscow, Russia; Institute of Economics and Finance of Russian University of Transport (MIIT), Moscow, Russia,
Corporate University of Russian Railways, Moscow, Russia
[a] https://orcid.org/0000-0003-3457-4574; [b] https://orcid.org/0000-0003-2676-8862;
[c] https://orcid.org/ 0000-0001-8055-8597; [d] https://orcid.org/ 0000-0001-8557-9370
✉ Corresponding author

ABSTRACT

The paper illustrates an approach to GDP growth in the context of an ecological economy. The **subject** of the research is the establishment of the interdependence of the state of the ecology of the environment and the results of human activity. The **aim** of the study is to determine the presence or absence of a relationship between pollutants in each type of environmental pollutants and the level of economic development of the country, represented by GDP per capita indicators. The **relevance** of the study is due to the ecologically unbalanced growth of GDP, which is accompanied by an increase in disproportions between the volume of pollutants emitted by the extractive, processing, processing, agricultural and infrastructure sectors of the economy, and the conditions of human life due to the deterioration of the "ecological quality" of the environment, which limits the possibilities for further development of human capital. The scientific **novelty** of the research lies in the development of economic and mathematical models, methods, and numerical algorithms for assessing and analyzing the state of air, water, and environmental pollution under the influence of the country's economic growth. **Methods** used: empirical and statistical analysis, building regression models, algorithmic and predictions, building time trends, etc. The authors based the methodology of substantiating the method for assessing the environmental constraints on GDP growth on an empirical study of the state of the environment and the state of the Russian economy in 2000–2018. **Results:** the authors have determined a set of indicators reflecting the state and trends of changes in environmental pollutants in Russia (carbon dioxide emissions, wastewater, production, and consumption waste) and their interdependence with economic development, which predetermine long-term social, environmental, and energy consequences. An algorithm has been developed to substantiate environmental restrictions on Russia's GDP growth in the period 2000–2018. The algorithm is based on a modified Kaya equation, through which the relationship between each type of pollutant and indicators of GDP per capita, energy resources, and industrial production is checked. In accordance with GDP growth, the forecast of environmental restrictions was developed according to scenarios of 10–40% and showed the inevitability of implementing a plan to prevent environmental pollution in Russia. It is **concluded** that Russia must promote environmental and low-carbon policies, reduce emissions, waste, and energy consumption over the next few decades to achieve sustainable development. The country is faced with the task of moving away from a nature-destroying economy, thereby saving natural capital, minimizing the costs of eliminating the negative environmental consequences of technogenic economic development in the future.

Keywords: ecological economics; Russia; GDP growth; sustainability; environmental constraints; wastewater; production and consumption waste; CO_2 emissions; Kaya's equation

For citation: **Bragina Z.V., Denisov A.R., Masyuk N.N., Steblyanskii N.V. Trends in Russia's GDP growth under environmental constraints. *Finance: Theory and Practice.* 2021;25(5):24-44. DOI: 10.26794/2587-5671-2021-25-5-24-44**

INTRODUCTION

GDP growth rates are the primary indicator of economic progress worldwide [1–4]. However, nowadays, the "benefit" for the economy has become inextricably linked with the "harm" to the environment.[1] It reinforces the illusion that the economy and the environment are separate and leads to the fact that politicians ignore environmental problems or contribute to their destruction for the sake of economic growth, even though there have been some justifications for a close interaction of economic and environmental factors [1]. Almost all modern researchers agree on one thing: economic growth is impossible without taking into account the impact on the environment. These and related issues have become the subject of ecological economics. R. Costanza has developed the meta-paradigm of ecological economics where he has concluded that a sustainable, desirable future is more critical than unsustainable GDP growth [5]. People need to recognize the limitedness of GDP growth by the quality of the environment that is promoted by the followers of the ecological economics direction [5–7]. The concept of ecological economics considers a person not as a consumer of natural resources, but as an essential component of an integral ecological-economic system, responsible for understanding his role in the overall global network of the biosphere, in preserving and managing it to achieve sustainability [8, 9]. In Russian practice, since the mid-80s of the 20th century, the introduction of the environmental restrictions on economic growth was actively discussed [10, 11]. E.A. Zhalsaraeva et al. (2019) have argued that environmental restrictions arise under the influence of human will and the stage of the region's socio-economic development. The authors have concluded, that environmental restrictions should be agreed upon at the level of states, region, and municipality levels, but in Russian's regions, it is not such an optimistic situation with such things [12]. The mechanism for managing the potential ecological production reserves should be developed with limitations according to the green passport system as a system of maximum permissible concentration (MPC) of pollutants.[2] Nowadays there is a need to find a balance between the interests of the Russian economy and the reduction of pollution. These things should be balanced with ecologically-oriented economic growth in terms of GDP[3] [14].

The authors' logic for investigating the environmental constraints to Russia's GDP growth is the following: (1) To understand the state of the problem: trends in environmental restrictions and targets; (2) To analyze the impact of environmental restrictions on targets, to ensure whether there is a close relationship between them; (3) To develop an algorithm for predicting the impacts of environmental restrictions on the Russian economic growth until 2030.

In this study, we have analyzed the Russian GDP growth for the period of 2000–2018 and have made a forecast until 2030. The authors agree that all types of pollutants resulted in production and consumption play an incredible role in the sustainable ecologically oriented economy. The authors refer to the volume of industrial production and the volume of consumed natural energy resources as targets since the level achieved by them predetermines the improvement of the ecological situation.

The research includes three blocks. The first block concerns the awareness of "environmental constraints". The variety of environmental restrictions is not universal for all states and even for all regions of one country. It is associated with natural geophysical features, natural resource availability, the level of development and specialization of the economy, and other objectively determined features. Therefore, the list of pollutants was substantiated and determined carefully. In the second block, the authors investigate the presence or absence of a relationship between pollutants, GDPPC, industrial production, and energy consumption. The authors calculated regression models, evaluating the measure and nature of their interdependence. The third block of research

[1] OECD. The Economy of Well-being: Creating Opportunities for People's Well-being and Economic Growth, Organization for Economic Co-operation and Working paper. 2019;33(102):1–54.

[2] Global Footprint Network Standards Committee, Ecological Footprint Standards 2009, Executive Editor Kitzes J. URL: https://www.footprintnetwork.org/content/images/uploads/Ecological_Footprint_Standards_2009.pdf (accessed on 26.08.2021).

[3] Decree of the President of the Russian Federation of 19.04.2017 No. 176 "On the Strategy of Environmental Safety of the Russian Federation for the Period until 2025", 2017 (In Russ.). URL: http://www.kremlin.ru/acts/bank/41879 (accessed on 26.08.2021).

assessment is environmental pollution under the influence of GDP growth. The authors have modified the Kaya identity formula, where emissions of pollutants are determined by the restriction into the atmosphere, polluted wastewater, industrial solid waste, and energy consumption.

The scientific novelty of the research lies in the development of economic and mathematical models, methods, and numerical algorithms for assessing and analyzing the state of air, water, and environmental pollution under the influence of the country's economic growth. Following Robert Costanza and his ideas, the authors have recognized that GDP growth, in the long run, could be decoupled with natural resource consumption.

The authors begin the paper with an overview of Russia's annual economic losses caused by the deterioration of the environment and related economic factors. The second part represents the sample data and methodology. The third part is the presentation of the obtained results of Russia's sustainability modeling.

METHODOLOGY

Data

The authors have developed a methodology of justification for the environmental constraints on Russian GDP growth between 2000–2018. The indicators have included emissions of pollutants, wastewater, production, and consumption wastes. The Russian economy has been represented by GDP, population, energy consumption, and industrial production indicators. The authors have used data from the Russian Statistical Yearbook, 2019 from the Federal State Statistics Service (Rosstat)[4] [15], where actual data concerning emissions of sulfur dioxide (SO_2), nitrogen dioxide (NO), carbon dioxide (CO_2), volatile organic compounds (VOC), ammonia emissions (NH_3) (thousand tons), volumes of waste generated production and consumption (million tons), volumes of contaminated wastewater (billion cubic metres), GDP (million rubles), and population indicators could be found. Industrial Production Index (IPI) and already spent natural energy resources expressed in million tons could be found on the Rosstat website — www.gks.ru. The full list of the research data can be found in Appendix A.

Methodological base

One of the most popular ways to assess the environmental constraints of GDP growth has been discussed in Kaya's paper. He has proposed a model of the GDP identity with key determinants, with relative values as crucial factors. Kaya identity is an identity that indicates that the total level of carbon dioxide emissions can be expressed as a product of four factors: population, GDPPC, energy intensity (per unit of GDP), and carbon intensity,[5] i.e. carbon energy footprint[6] [16, 17] (see Eq. 1–5).

$$F = P \times \frac{GDP}{P} \times \frac{E}{GDP} \times \frac{F}{E}, \quad (1)$$

where, F — CO_2 emissions from human-made sources; P — Population; GDP — Gross Domestic Product; E — Energy consumed. For the research purpose, the authors modified Kaya formula following way:

$$Y = P \times \frac{X}{GDP} \times \frac{Y}{X} \times \frac{GDP}{P}, \quad (2)$$

where Y is the factor that we want to test as a limitation (waste, emissions, resource consumption…), X is some factor with properties: (1) we can identify either trend or targets for the indicator $\frac{Y}{X}$; (2) we can identify either trend or targets for the indicator $\frac{X}{GDP}$. For example, for a CO_2 limiting indicator, X is the energy resource (E)

[4] Decree of the President of the Russian Federation dated 01.12.2016 No. 642 "On the Strategy of Scientific and Technological Development of the Russian Federation", 2016. URL: http://kremlin.ru/acts/bank/41449 (accessed on 26.08.2021).

[5] Energy Strategy of the Russian Federation till 2035 (in Russ.), 2017. URL: https://minenergo.gov.ru/node/18038 (accessed on 26.08.2021).

[6] State annual report "About ecological protection in Russian Federation" (in Russ.). 2018. URL: https://www.mnr.gov.ru/docs/o_sostoyanii_i_ob_okhrane_okruzhayushchey_sredy_rossiyskoy_federatsii/gosudarstvennyy_doklad_o_sostoyanii_i_ob_okhrane_okruzhayushchey_sredy_rossiyskoy_federatsii_v_2018_/ (accessed on 26.08.2021).

consumed. Since P, $\frac{Y}{X}$, $\frac{X}{GDP}$ are predictable, we can present the formula for Y as:

$$Y_f = \left(P \times \frac{X}{GDP} \times \frac{Y}{X} \right)_f \times \left(\frac{GDP}{P} \right)_f, \quad (3)$$

where Y is a factor that we want to check as a constraint (waste, emissions, consumed resources ...), X is some factor with the following properties: (1) we can determine either trends or target values for the $\frac{Y}{X}$ indicator; (2) we can determine either trends or target values for the indicator $\frac{X}{GDP}$. Thus, for the limiting indicator CO_2, the indicator X is the consumed energy resources (E). Indicator P, $\frac{Y}{X}$, $\frac{X}{GDP}$ could be forecasted, thus, the formula for Y could be written in the following form:

$$Y_f = \left(P \cdot \frac{X}{GDP} \cdot \frac{Y}{X} \right)_f \cdot \left(\frac{GDP}{P} \right)_f \quad (4)$$

or:

$$Y_f = \left(P \cdot \frac{X}{GDP} \cdot \frac{Y}{X} \right)_f \cdot \left(\frac{GDP}{P} \right)_b \cdot \left(1 + K_f \right), \quad (5)$$

where Y_f is a forecasting factor that we want to test as a limitation (waste, emissions, resource consumption...), $\left(P \cdot \frac{X}{GDP} \cdot \frac{Y}{X} \right)_f$ is some factor with properties, b — base year (in our case-2018), K_f — relative change in the indicator $\frac{GDP}{P}$ in the forecast year in comparing with the base year 2018. Eq. 5 helps to find the maximum possible value of GDP growth under given constraints. We can assume that Kf equals 10% and 20% and this would directly affect the value of Y. This approach makes it possible to predict the value of the limiting indicator at different growth rates $\frac{GDP}{P}$. Thus, we set the limit values for the limiting indicator and determine the growth limits of the indicator $\frac{GDP}{P}$. The model allowed us to develop an algorithm for assessing Russia's GDP growth under the environmental constraints, presented in *Fig. 1*. Y has a maximum permissible value [Y]. Accordingly, a Kf needs to be found so that Y is equal to [Y]. This is the maximum possible Kf (max).

RESULTS

Environmental constraint analysis results

During the study period, the state of the environment was unstable. Emissions of air pollutants from 2000 to 2018 show that the maximum level of emissions took place from 2004 to 2007, significantly decreased in 2014 with a slight increase in 2018. The total volume of emissions of air pollutants in 2018 amounted to 32.3 million tons: 17.1 million tons were emitted by stationary sources and 15.3 million tons by mobile sources (vehicles) [18]. Such dynamics were developed under the influence of a sharp increase in emissions of Carbon Dioxide (CO_2) from stationary and mobile sources in 2003–2007. CO_2 accounts for more than half of the total volume of gas emissions into the atmosphere. Therefore, assessing the environmental restrictions on Russia's GDP growth deserves special attention. The specific gravity of all other air pollutants in the total volume of emissions is in the range of 1 to 11%. In the same way, there was an increase in the amount of waste production and consumption by 4.5 times (from 1603 thousand tons up to 7,266.1 billion tons).

According to Russian State Statistics, the volume of wastes annually increases by more than five billion tons. This is twice as many as in all EU countries in terms of comparable accounting. The waste dynamics

are provoked by the growth of industrial production and retail turnover; weak development of the waste management and recycling industry, and non-effective legal regulation of waste disposal[7] [19].

In recent years, Russia has seen relatively stable CO_2 emissions. The energy sector accounts for the majority of greenhouse gas emissions. For example, 78.9% in 2017. Simultaneously, in Russia, the land-use change and forestry sector is a significant net sink of greenhouse gases, offsetting about 26.8% of emissions occurring in other industries. The volume of discharge of contaminated wastewater decreased significantly during the study period from 55.6 billion cubic metres to 40.1, i.e. 28% as a result of reduced pollutant emissions of all species except nitrates. The effect is also amplified by the fact that GDP grew by 76% during this period, and the withdrawal of freshwater decreased by 19%. Electricity and heat were the primary sources of discharge of contaminated wastewater[8] [20]. Emissions of nitrates doubled from 2000 to 2013. The growth was caused by a change in economic structure in terms of reducing high-tech production and increasing the growth of production, the waste of which are nitrates: components of rocket fuel, production of explosives, pyrotechnics, drug production, and glass production.

The analysis of the state of the Russian economy's environment made it possible to understand trends in pollutants (emissions), in which energy resources were used during the study period and achieved useful indicators: GDP, industrial production, volumes of natural energy resources (spent), expressed in million tones of conventional fuel and how to consider them. The decline in the population of 2005–2012 was due to the economic crisis and institutional economic regulation problems. The social support since 2012 and some stabilization of financial mechanisms have contributed to population growth as well [14, 15]. Despite the fluctuations in population, GDPPC in Russia is characterized by a positive trend. The results of the economic processes that have a substantial impact on the environment were represented by the volume of industrial production and the number of energy resources spent is presented in *Fig. 2, 3*. Both graphs show a persistently positive growth trend beyond the exclusion of some recession during the 2008–2009 crisis.

However, in terms of environmental constraints on the development of the economy, these results cannot be considered positive, as emissions into the atmosphere, wastewater pollution, and solid waste of production and consumption have increased. For determining the values of environmental constraints on GDP growth, we need to understand the quality of the relationships, the nature of the impact between pollutants and GDP, and the results of economic processes that have an intense effect on pollution. Based on the concept of an environmental economy, we analyze the existence or absence of a relationship between pollutants and Russia's level of economic development represented by GDPPC, industrial production, and consumption of natural energy resources. We calculated regression patterns of GDPPC dependence and pollutants of each species (see *Fig. 2, 3, Tabl. 1, 2*).

Table 1 highlights the close relationship between GDPPC and Sulfur Dioxide (SO_2) and Ammonia (NH_3). Both of these substances are captured in the atmosphere and can be reused in production. Of the three remaining elements, only CO_2 has a significant impact. Two types of pollutants are closely related to the Russian Federation level of economic development: wastes from production and consumption and wastewater growing in proportion to GDP growth.

The authors observed a high correlation between CO_2 and GDPPC. It is not clear if this is a false correlation or a real relationship from 19 annual datasets. However, there are no more annual official data. Moreover, if we take a more extended period, then during it the conditions will change, in particular, the technology, which will make the dependence invalid, since the conditions at the beginning of the period will differ from the conditions at the end. However, the research task is urgent, the ability to trace the links between GDP and environmental impact is a prerequisite for a green economy. Sustainability cannot be ensured without this. So, the paper research technique helps to solve this problem. The solution is based on the Kaya formula. In fact, in the classical

[7] Bulletin on current trends in the Russian economy. Ecology and economics: dynamics of air pollution in the country on the eve of the ratification of the Paris Agreement (in Russ.), 2019, p. 1–226. URL: https://ac.gov.ru/files/publication/a/23719.pdf (accessed on 26.08.2021).

[8] Federal State Statistics Service (Rosstat), Russian Statistical Yearbook, 2019. URL: https://gks.ru (accessed on 26.08.2021).

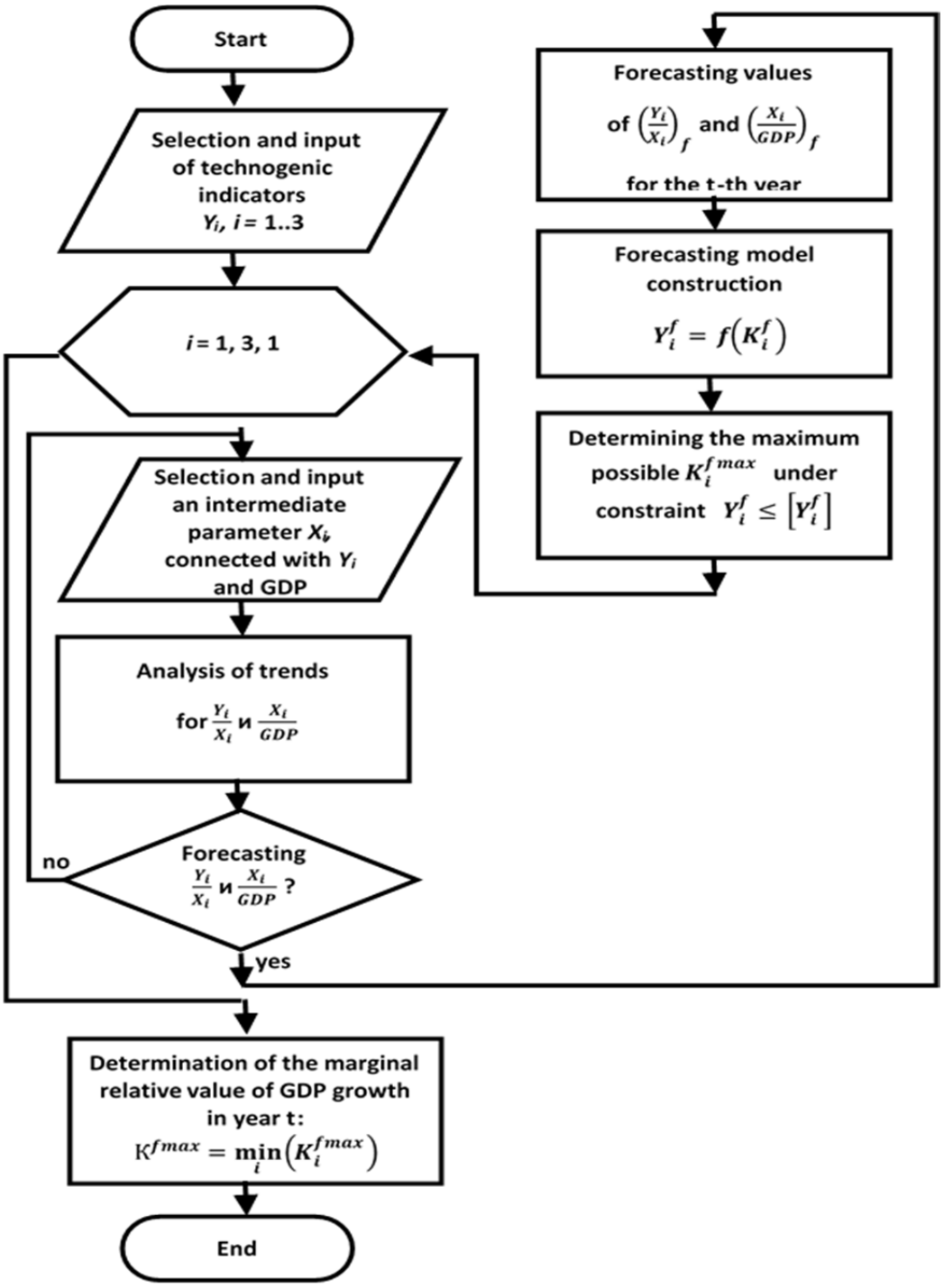

Fig. 1. **Assessment of Russia's GDP growth environmental limits**

Source: authors' methodology.

form, it allows to present CO_2 emissions as the product of four indicators, three of which (population, carbon footprint (CO_2/Energy consumed) and energy intensity) are spelled out in the strategic documents of the country's development and, accordingly, limit values can be determined for them. The author does the same for other emissions by selecting an X indicator. The autoregressions presented in the work are needed for experts to simplify the task of determining values. It is also proposed to take into account not only the identified regressions but also the declared state goals, as, for example, we do it with garbage, when we reduce the predicted value of the indicator by 14%, as indicated in the National Project "Ecology".

Table 1

Regression models of pollutants in emissions to the environment and their extent are related to the level of GDPPC

Waste	Abbr	Function	R^2
Sulphur dioxide	SO_2	$-2.18X + 5314$	0.92
Nitrogen dioxide	NO_2	$0.13X + 3460$	0.03
Carbon Dioxide	CO_2	$-1.91X + 17041$	0.19
Volatile Organic Compounds	VOC	$-0.29X + 2996$	0.05
Ammonia	NH_3	$0.095X + 35.99$	0.97
Waste from production and consumption	W	$6.84492X + 1725.75$	0.95
Wastewater discharge	WD	$0.02114X + 55.5165$	0.93

Source: authors' calculations.

Table 1 and *Fig. 2* show that not all substances polluting Russian airspace have a considerable effect on the level of economic development: nitrogen dioxide and volatile organic compounds do not have a significant impact. Besides, Sulfur Dioxide (SO_2) and Ammonia (NH_3) are easily caught and can be reused in production. This fact explains their high closeness to the indicator of the level of economic development. However, the proportion of substances in total emissions ranges from 1% to 50–53%. Carbon Dioxide accounts for more than 50% of the total emissions into the atmosphere. Therefore, in forecasting the value of GDPPC by 2030, under the influence of polluters, it is advisable to take into account trends in the development of CO_2 emissions. This statement is justified by the fact that the strategy of socio-economic development of Russia until 2030 does not provide a sharp change in the structure of the economic complex. Consequently, changes in pollutant emissions should be proportionate to changes in production volumes.

Although wastewater discharges have decreased from 2000 to 2018, we have analysed the behaviour of pollutants. *Table 2* shows the components that contaminate succulent waters and their relationship to GDP.

Table 2 shows that all kinds of pollutants in wastewater have a significant impact on Russia's economic development level. However, the measure of this influence is different but relatively high (*R* 2 over 0.5). However, *Fig. 3* shows that pollutants are reduced in wastewater. The only exceptions are nitrates. The elasticity of the effect of each wastewater pollutant on the level of economic development is not significant. Therefore, in predicting the trend of Russia's economic growth by 2030, under the influence of environmental pollutants, it is reasonable to take into account (use) the cumulative value of wastewater.

Comparative analysis of the impact on the level of economic development of pollutant types is presented in *Table 3*.

According to R 2 coefficients, the relationship between pollutant types and GDP is significant. The most considerable GDP changes coincide with a change in the mass of waste production and consumption (*R* 2 q0.95), with no less significant impact on the GDP of wastewater (*R* 2 q0.93).

The impact of gas emissions by stationary and mobile sources on GDP per capita is the smallest of all pollutant types (*R* 2. 0.45). Such a significant correlation between all types of pollutants and the state of GDP per capita updates the assessment of environmental constraints for GDP growth by 2030. Regression models of pollutants and the measure of their connection with the natural energy resources spent, expressed in millions of tons' conventional fuel can be seen in *Appendix A*. Full calculation results see in the *Tables 4–6, Fig. 4–6*.

Analysis results

The authors have verified the interrelationship

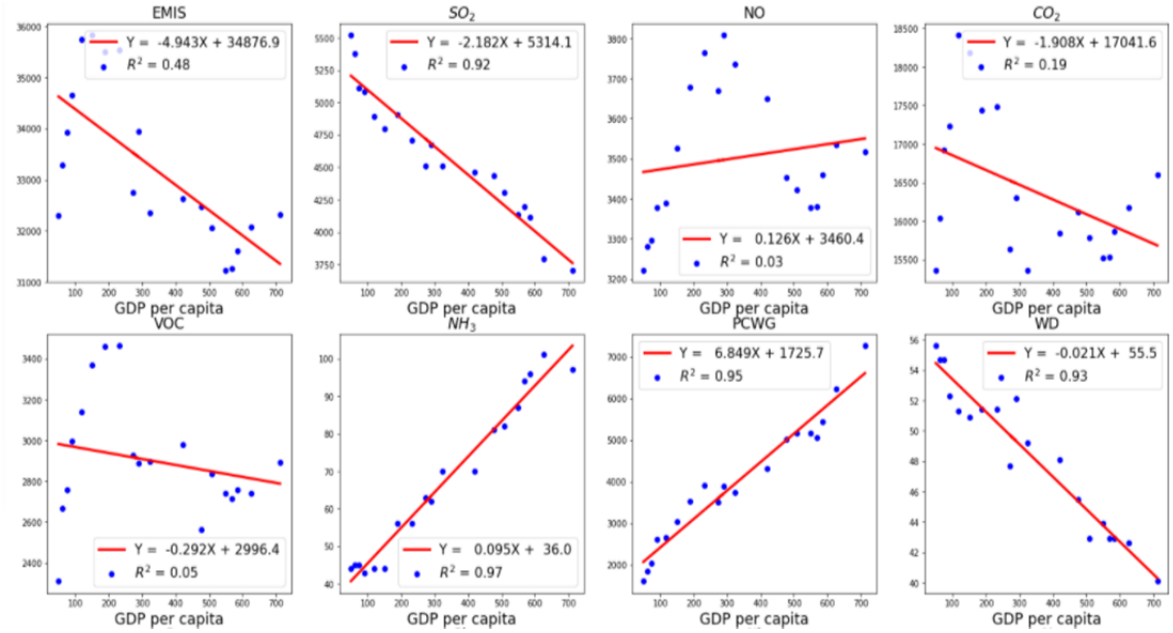

Fig. 2. **Dependencies between the number of pollutants and the level of Russia GDPPC**

Source: authors' calculations.

Table 2

Emissions of pollutants and their ratio to GDPPC regression models (thousand rubles)

Substances that pollute water drains	Abbr	Function	R^2
Sulphates	S	−0.0012*X* + 2.55	0.55
Chlorides	Ch	−0.0028*X* + 7.12	0.28
Nitrogen	Ni	−0.018*X* + 41.03	0.53
Nitrates	N	0.28*X* + 269	0.6
Fats, oils	FAO	−0.020*X* + 12.83	0.81
Phenol	Ph	−0.064*X* + 53.92	0.84
Plumbum	Pb	−0.035*X* + 24.86	0.76
Hydrargyrum	Hg	-0.0003*X* + 0.172	0.74

Source: authors' calculations.

between every type of pollutant and the next indicators:

GDPPC is the country's economic development level (GDP billion rubles divided by P-population (million people)

E/GDP is the energy intensity of the GDP unit (E — natural energy resources spent (mln.t.) divided by GDP (billion rubles)

F/E is a carbon energy footprint (F — CO_2 emissions from human-made sources (thousand tons) divided by consumed natural energy resources, expressed in millions of tons of fuel equivalent (million tons)

W/Y is an environmental pollution indicator (W — waste production and consumption per unit of industrial production (where W is the volume of waste production and consumption (billion tons)

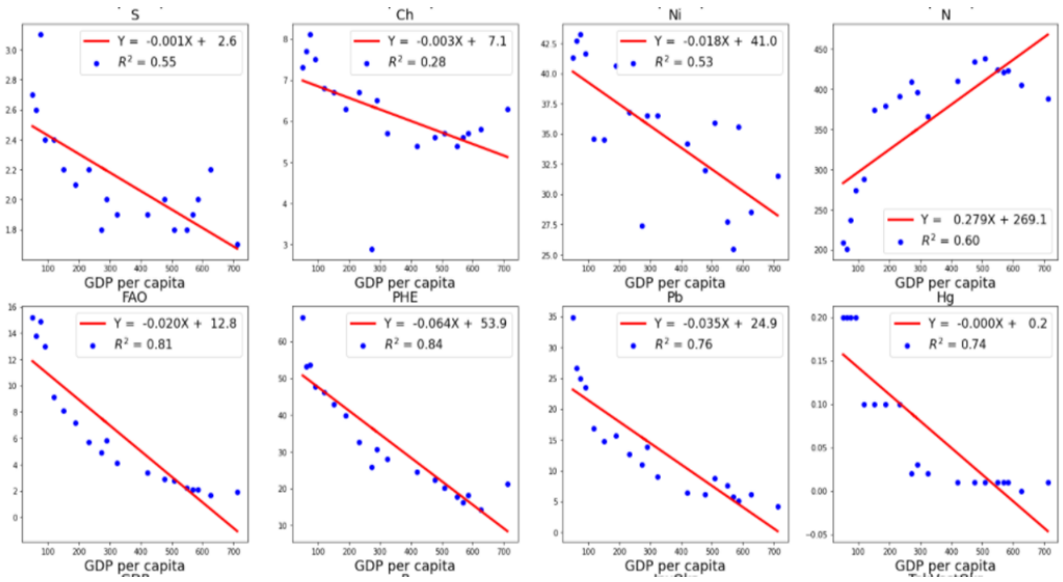

Fig. 3. **Dependence between pollutants in runoff and the development of the Russian economy (GDP per capita) (1–8)**

Source: authors' calculations.

Table 3

Impact of pollutants on the level of economic development

Types of pollutants	Abbr	Function	R^2	Quadrant upper fig
Emissions	EMIS	$-4.94X + 34877$	0.48	No. 1
Waste	W	$6.85X + 1726$	0.95	No. 7
Wastewater discharge	WD	$-0.0214X + 55.52$	0.93	No. 8

Source: authors' calculations.

divided by Y — the volume of industrial production (billion rubles)

IPI/GDP — Industrial Production Index per unit of GDP

F/IPI — F — CO_2 emissions from human-made sources (thousand tons) to Industrial Production Index (%)

W/IPI — Waste of production and consumption (billion tons) relative to the Industrial Production Index (%).

An analysis of the relationship between indicators reflecting the environmental constraints of Russia's GDPPC is presented in *Table 4* and *Fig. 4*.

Table 4 provides regression models of the indicators' interdependence reflecting the environmental constraints of GDPPC growth with a fairly high link: 0.56; 0.63; 0.87; 0.88.

The correlation between elements of the Kaya formula was analysed. In the carbon footprint of the population, 0.1 of the P. GDPPC dependence is 87% dependent on energy consumption E/GDP, and the energy consumption is explained by 87% energy intensity. At the same time, carbon energy footprint is 88% dependent on energy intensity.

Fig. 4 shows the trend of regression dependence. Thus, the following trends are characteristic of the Russian economy during the study period: with the growth of the population, the level of GDPPC is growing, while the energy capacity and carbon footprint are decreasing; As economic development increases, energy intensity and carbon footprint are reduced; Energy intensity is also increasing as the carbon footprint grows.

Thus, all the received dependencies are not logically inconsistent and statistically reliable, which gives us the right to use indicators reflecting the environmental

Table 4

Relationship of the indicators reflecting the environmental limits of GDPPC Growth (for the GDPPC forecasting algorithm till 2030)

	P	GDPPC	E/GDP	F/E
P		79.62X – 1053.2	–0.0059X + 0.884	–0.139X + 28.796
		R^2 = 0.56	R^2 = 0.28	R^2 = 0.10
GDPPC	0.007X + 141.13		–0.0001X + 0.078	–0.003X + 10.16
	R^2 = 0.56		R^2= 0.87	R^2 = 0.63
E/GDP	47.85X + 145.9	8918.4X + 754.363	5689X + 7.567	36.25X + 7.455
	R^2 = 0.28	R^2 = 0.87	R^2 = 0.67	R^2 = 0.88
F/E	0.756X + 150.8	196.4X + 2151.7	0.024X – 0.17	0.013X – 0.15
	R^2 = 0.10	R^2 = 0.63	R^2 = 0.88	R^2 = 0.65

Source: authors' calculations.

limitations of Russia's GDPPC growth to calculate the GDPPC forecast by 2030.

To determine every species pollutants' ecological limits: emissions into the atmosphere; wastewater discharge; solid waste of economic activity and the population should be aware of their limits, which were achieved in the country's economy in 2018. For this purpose, the authors built various scenarios of every parameter that characterize indicators' conditions. The authors accepted the value of the parameter reached in 2018 as its limit and then used the formula (Eq. 3) to assess environmental constraints. Then, the authors accepted the assumption of the intensity of GDPPC growth by 10–20–30–40% until 2030.

Analysis of the CO_2 emissions into the atmosphere

For the prediction of the carbon dioxide value as a limiting environmental indicator of energy consumption by 2030, the authors extrapolated the energy intensity functions of the GDP until 2030 (*Fig. 7*) and the function of the carbon footprint (*Fig. 8*).

To predict the ecological limit for carbon dioxide emissions, the per capita energy intensity limit is taken as 0.017, as the best value achieved in 2018 (*Fig. 7*). The carbon footprint limit is shown in *Fig. 8*. The best carbon footprint was achieved in 2014 at 8 million cubic meters. m. carbon dioxide emissions per unit volume of consumed natural energy resources.

In the study, we use the advantage of the Kaya model, which we have converted into a modified formula (*Eq. 5*). The result of the calculation is given in *Fig. 9*. It is clear from the figure that with the planned GDPPC growth from 0 to 40% while maintaining the existing feasibility study level, CO_2 emissions increase from the actual level of 2018 by 25% and reach 19,500 thousand. If GDPPC growth increases by 10%, CO_2 emissions would decrease by 296,000 tonnes. If CO_2 emissions increase by 25% by 2030, GDPPC will increase by 40% to RUB 1,000 billion; 30% — RUB 910 billion; at 20% — RUB 870 billion; 10% — RUB 800 billion.

Wastewater discharge analyses

To predict the value of wastewater discharge as an environmental limiter of GDP growth by 2030, the authors extrapolated the functions of industrial production per unit of GDP until 2030 (*Fig. 10*) and the function of wastewater emissions / per unit of industrial production (*Fig. 11*).

To predict an environmental limit, "the amount of contaminated wastewater" is the limit of the industrial output per unit of GDP (expressed by the index) of 0.0015. *Fig. 11* shows that the limit for wastewater emissions per unit of industrial

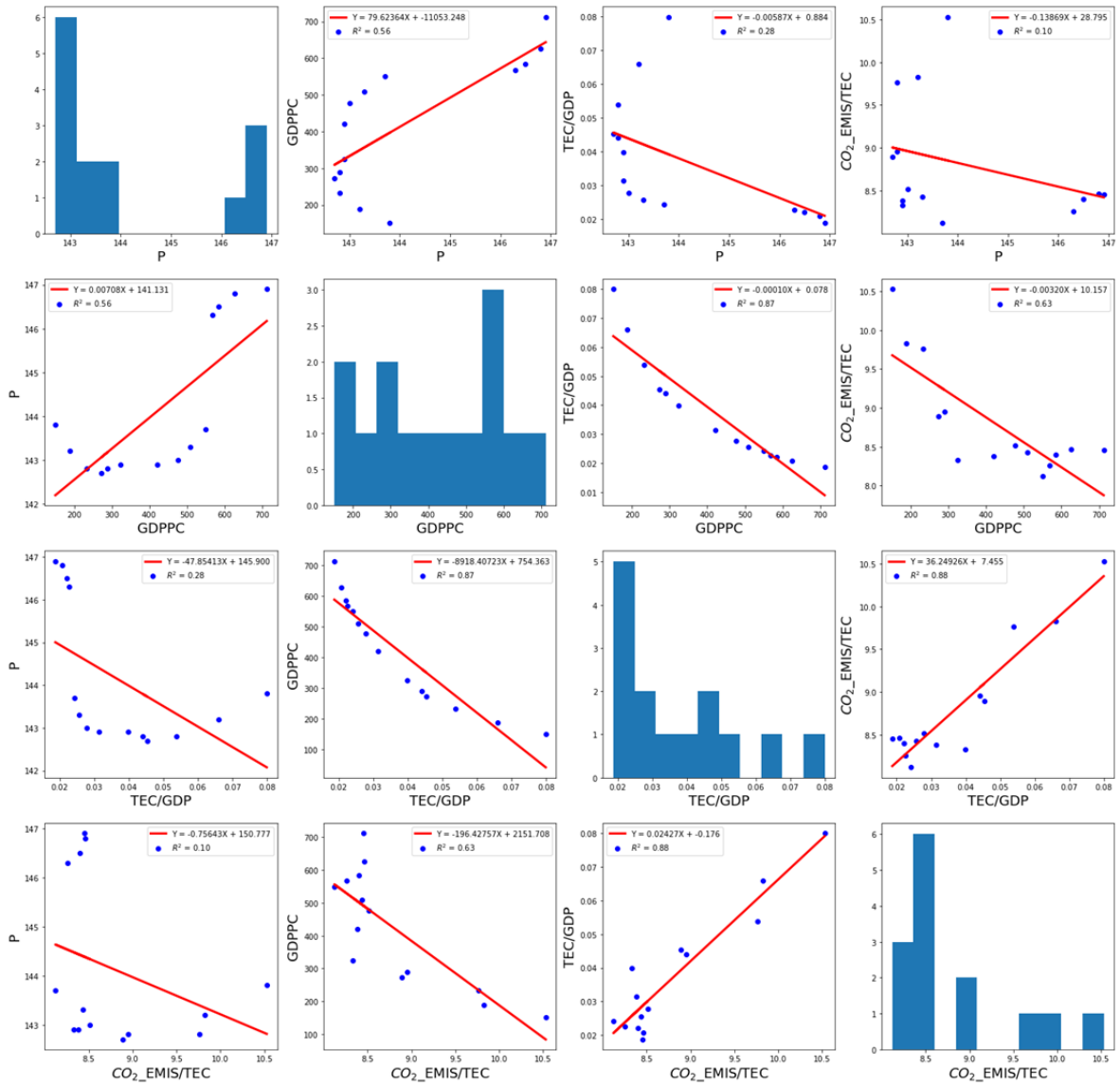

Fig. 4. **The nature of the relationship between environmental constraints (CO_2 and the number of natural energy resources spent) on Russia's GDPPC growth**

Source: authors' calculations.

Table 5

Models of the relationship of indicators reflecting environmental constraints (wastewater volume) and industrial output per GDPPC growth are required for the GDP forecasting algorithm by 2030

	P	GDPPC	IPI/ GDP	F/IPI
P		$79.62X - 1053.2$	$-0.0004X + 0.066$	$-0.021X + 3{,}351$
		$R^2 = 0.56$	$R^2 = 0.28$	$R^2 = 0.53$
GDPPC	$0.007X + 141.13$		$-0.00001X + 0.006$	$-0.0003X + 0.423$
	$R^2 = 0.56$		$R^2 = 0.86$	$R^2 = 0.98$
IPI/GDP	$-638.4X + 146.04$	$-119633X + 781.6$		$32.03 + 0.213$
	$R^2 = 0.28$	$R^2 = 0.86$		$R^2 = 0.84$
F/IPI	$-25.3X + 151.95$	$-3636.3X + 1547.3$	$0.026X - 0.005$	$0.021X - 0.04$
	$R^2 = 0.53$	$R^2 = 0.98$	$R^2 = 0.84$	$R^2 = 0.75$

Source: authors' calculations.

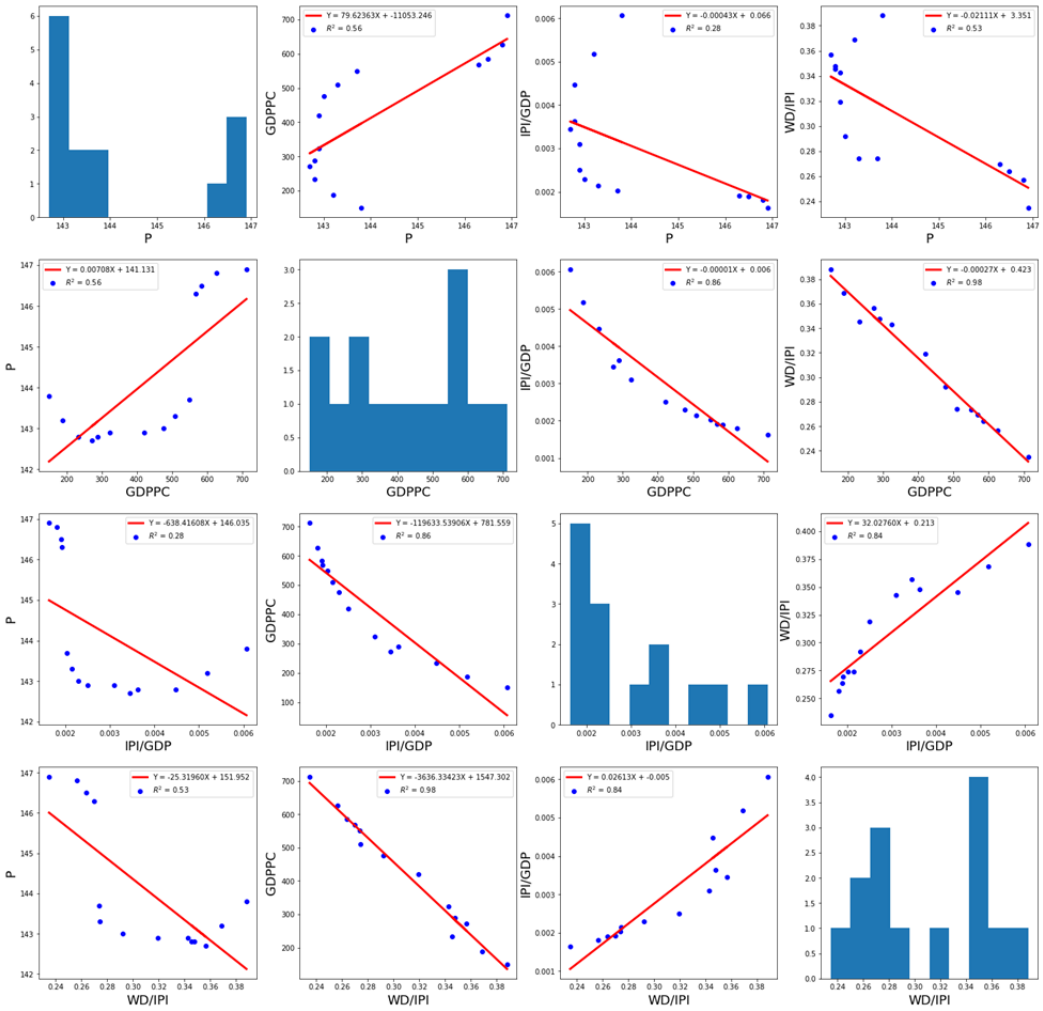

Fig. 5. **The nature of the relationship between environmental constraints (wastewater volume) and the size of industrial production and GDPPC growth required for the GDP forecasting algorithm by 2030**

Source: authors' calculations.

Table 6

Models of the relationship of indicators reflecting environmental constraints (the volume of waste production and consumption) and the volume of the industrial production per GDP growth required for the GDP forecasting algorithm by 2030

	P	GDPPC	IPI/GDP	W/IPI
P		79.62X – 1053.2	–0.0004X + 0.066	2.454X + –323.3
		R^2 = 0.56	R^2 = 0.28	R^2 = 0.59
GDPPC	0.007X + 141.13		–0.00001X + 0.006	0.029X + 18.22
	R^2 = 0.56		R^2 = 0.86	R^2 = 0.89
IPI/GDP	–638.4X + 146.04	–119633X + 781.6		–3155. 8X + 39.77
	R^2 = 0.28	R^2 = 0.86		R^2 = 0.66
W/IPI	0.239X + 136.9	31.289X – 525.7	–0.00021X + 0.009	23.289X – 435,8
	R^2 = 0.59	R^2 = 0.89	R^2 = 0.66	R^2 = 0.78

Source: authors' calculations.

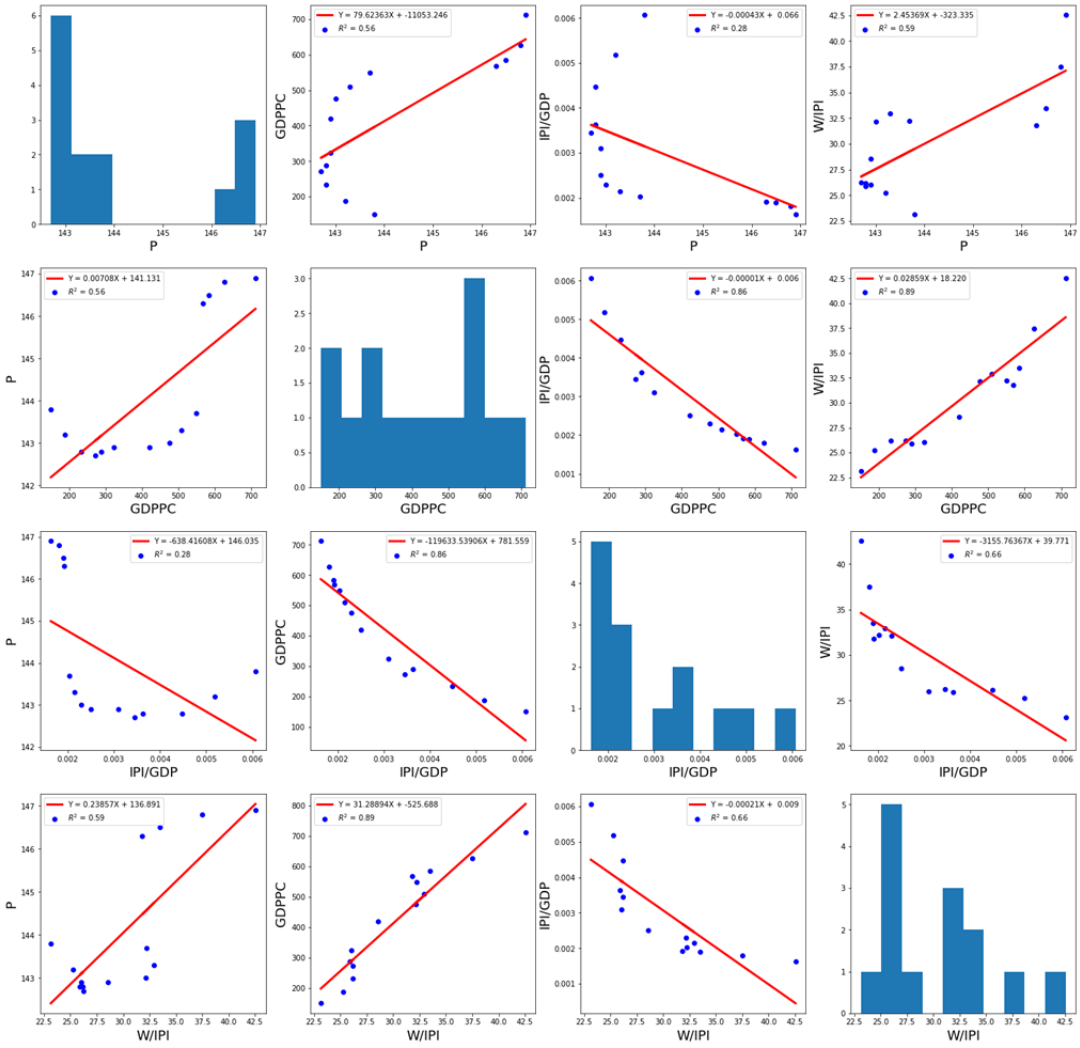

Fig. 6. **The nature of the relationship between environmental constraints (the volume of waste production and consumption and the volume of industrial production) on Russia's GDP growth**

Source: authors' calculations.

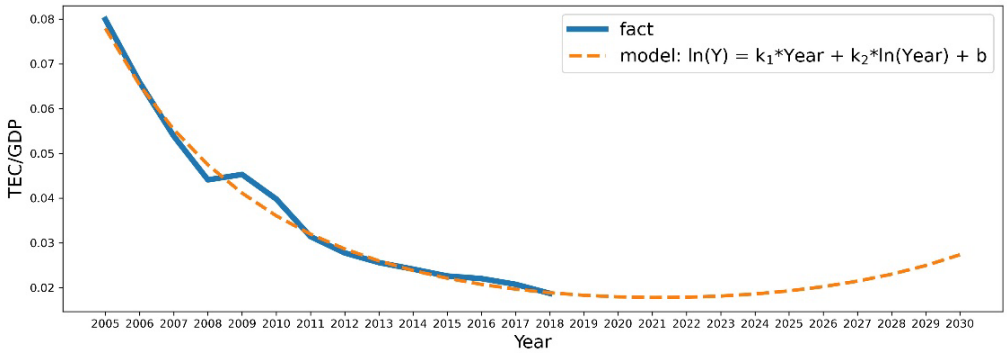

Fig. 7. **The trend of changing energy intensity of a unit of GDP until 2030 (the amount of natural energy resources spent is a million tons of conventional fuel divided by billion rubles of GDP)**

Source: authors' calculations.

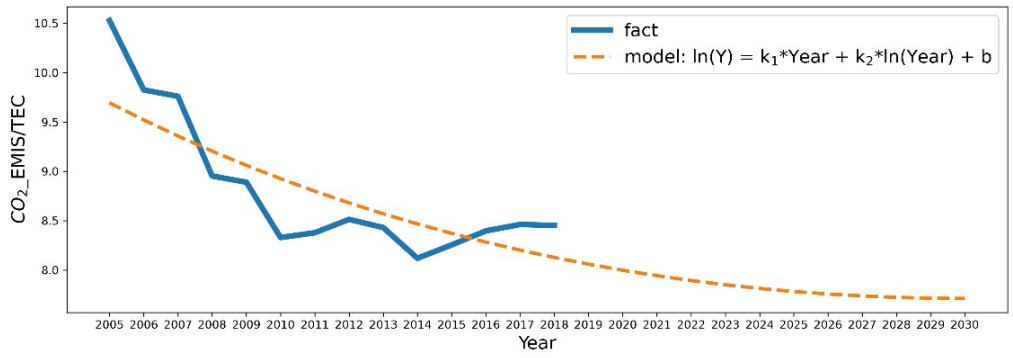

Fig. 8. **Carbon footprint trend to 2030**

Source: authors' calculations.

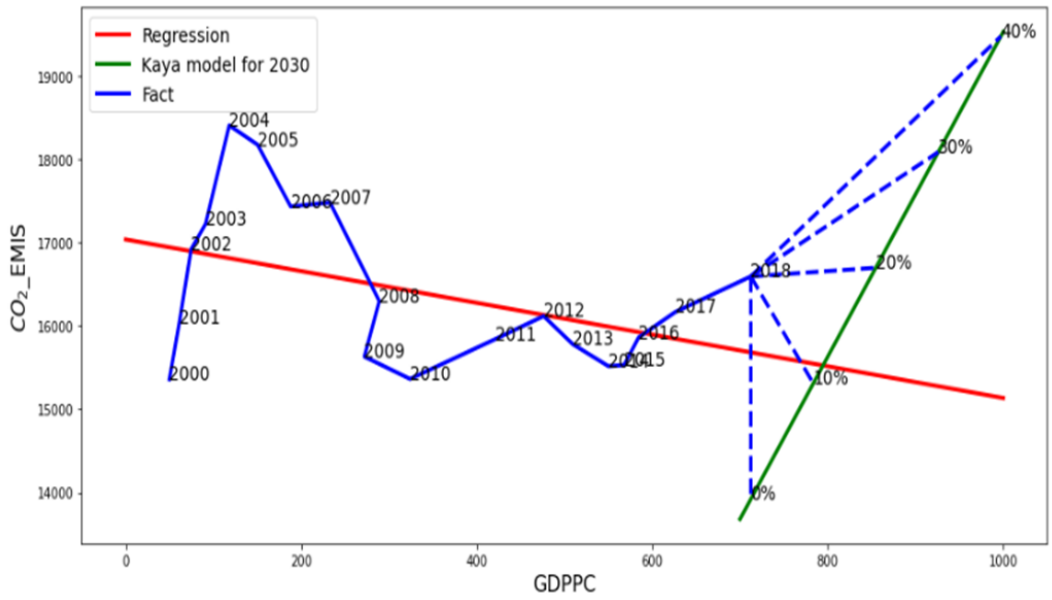

Fig. 9. **Dynamics of CO_2 emissions with 10–20–30–40% of Russia's GDPPC growth scenario by 2030**

Source: authors' calculations.

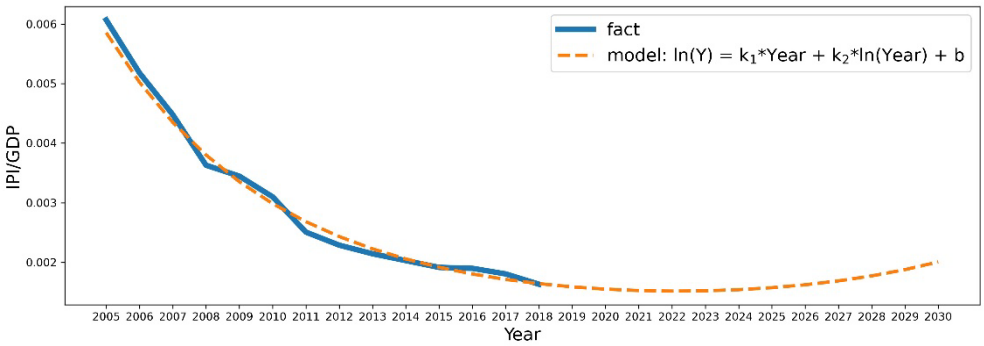

Fig. 10. **IPI/GDP trends until 2030**

Source: authors' calculations.

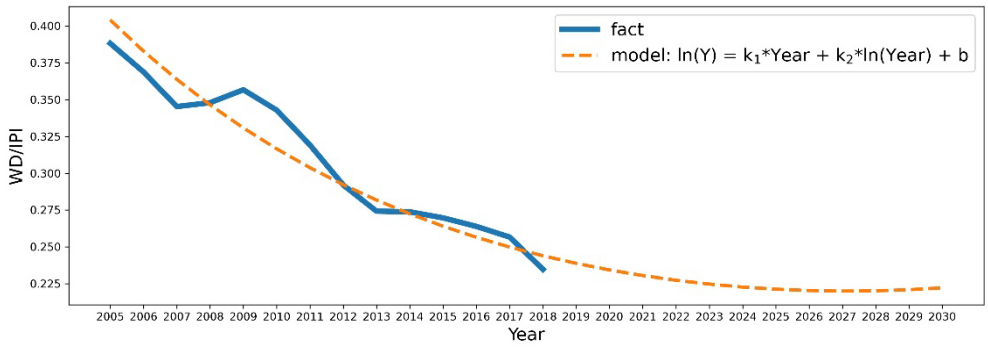

Fig. 11. **The trend of changes in wastewater emissions/per unit of industrial production until 2030**
Source: authors' calculations.

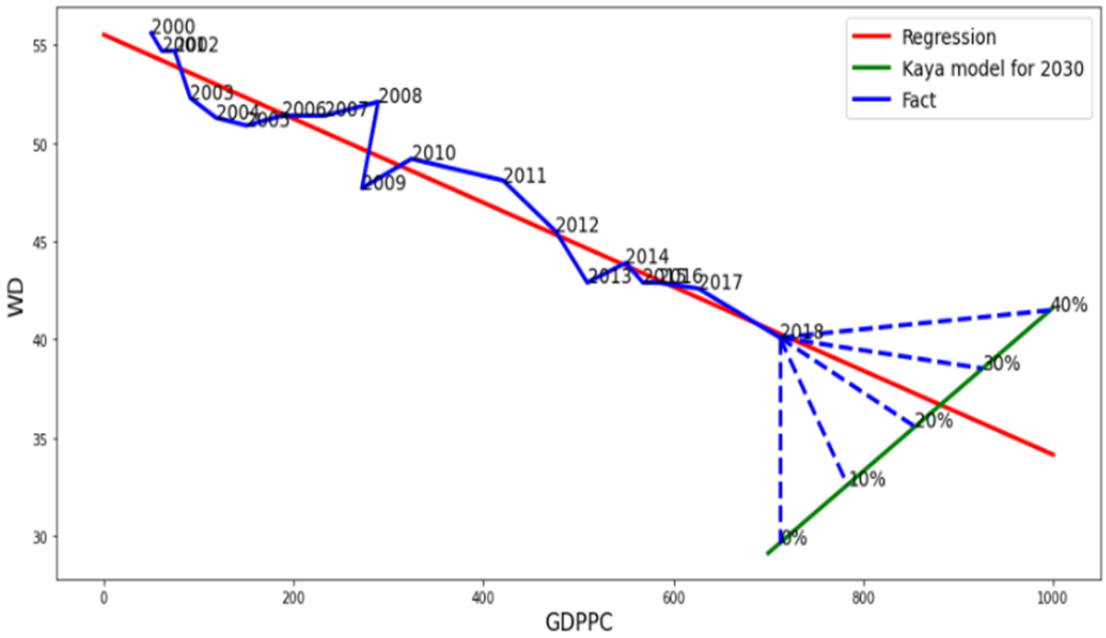

Fig. 12. **Emissions forecast in case of GDP growth per capita by 0, 10, 20, 30 and 40% concerning 2018**
Source: authors' calculations.

production has fluctuated from 0.30 to 0.2. Both figures show that the lowest value has achieved in 2018. It is clear from *Fig. 11* that with the planned GDPPC growth from 0 to 40%, the amount of contaminated wastewater would increase from the level of 2018 by 2% and reach 41 billion m^3 in 2030. With GDPPC growing by 30% by 2030 compared to 2018, emissions of contaminated wastewater would decrease by 3%.

Fig. 12 shows a reduction in GDPPC depending on wastewater discharge under the 10–40% scenario. Thus, with an increase in wastewater emissions by 40% in 2030, GDPPC would reach RUB 1000 thousand; 30% — RUB 910 thousand; 20% — RUB 870 thousand; 10% — RUB 800 thousand. At 20% — 870; at 30% — 910 and at 40% — RUB 1000 thousand.

To predict the value of solid waste in production and consumption, the authors extrapolated the functions of production pollution (the volume of waste production and consumption divided by industrial production) (see *Fig. 13*) and the volume of industrial production per unit of GDPPC until 2030 (*Fig. 14*).

The limit of industrial production per unit of GDPPC and pollution of production (waste of production and consumption per unit of industrial production) is 55 (maximum) and 0.0015, as the lowest level achieved in 2018.

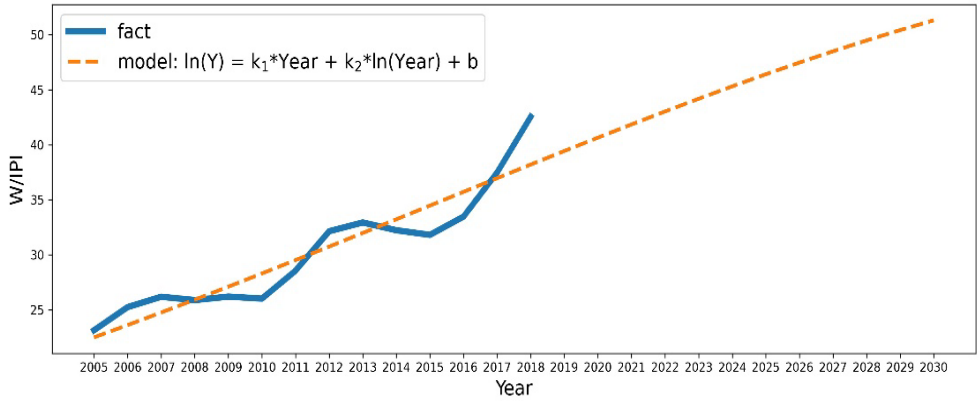

Fig. 13. **Waste production and consumption divided by industrial output, trend until 2030**

Source: authors' calculations.

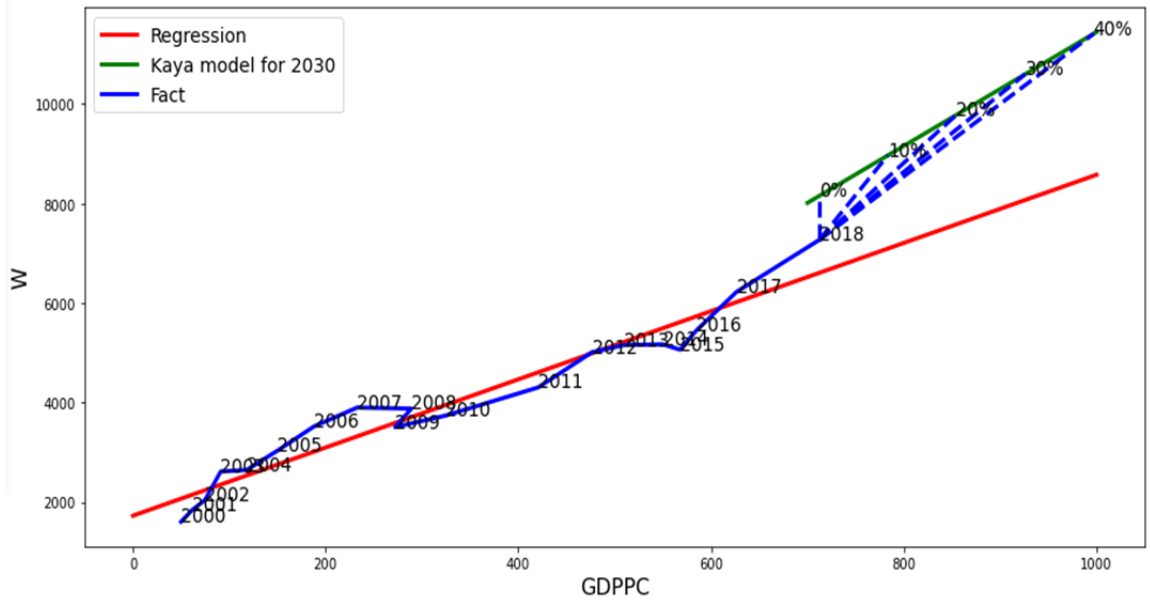

Fig. 14. **Dynamics of changes in waste production and consumption volumes, while GDP growth by 40% billion tons**

Source: authors' calculations.

Then, we can observe the wastes products forecast until 2030.

Fig. 14 shows that if the current technological production level is maintained, the volume of waste production and consumption will grow faster than GDP pc. If national projects are implemented to increase the recycling rate from 60% to 86%, GDP growth options will change as presented in *Fig. 15*. The trend of GDP pc changes and changes in wastes would be almost parallel.

If the carbon footprint is maintained at the level of 2018, economic growth (GDP per capita) could be increased by another 10%. If the country needs to allow only 30 million cubic metres wastes per year, to curb the deterioration of the environment, Russia should be satisfied with GDPPC at the level of 2018.

DISCUSSION

Environmental sustainability should be an essential feature of the new sustainable economic growth model [16–18]. Congrong Yao et al (2015) emphasized that a better understanding of driving forces of every country's change in CO_2 emissions is to develop a broadly acceptable agenda for sustainable growth.[9]

[9] Bulletin on current trends in the Russian economy. Ecology and economics: dynamics of air pollution in the country on the eve of the ratification of the Paris Agreement (In Russ.), 2019, pp. 1–226. URL: https://ac.gov.ru/files/publication/a/23719.pdf.

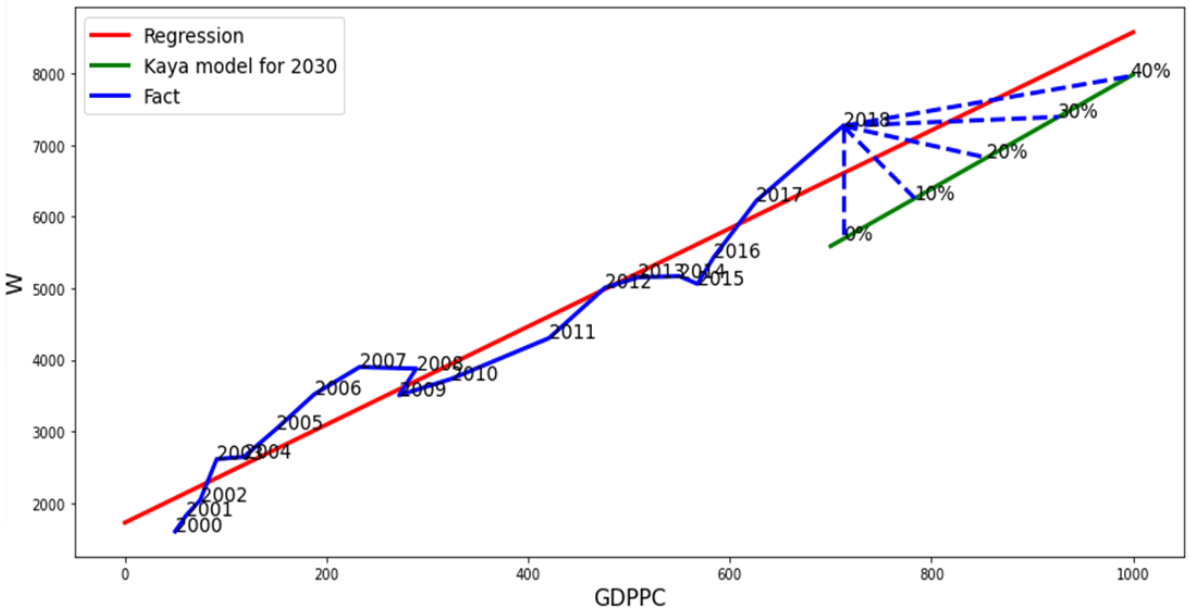

Fig. 15. **Dynamics of changes in waste production and consumption provided that national**

Source: authors' calculations.

Ecologically unbalanced GDP growth is accompanied by an increase in disproportions between the volume of pollutants emitted by the extractive, processing, agricultural and infrastructure sectors of the economy, and the conditions of human life. It is necessary to study the dynamics of changes in environmental restrictions and their impact on the quality of life [19]. The (IPCC) Intergovernmental Group of Experts on Climate Change (Mitigation of Consequences) also gave great attention to the methodology for studying the problems of the economic growth environmental constraints [20].

The governments of all countries are concerned about the quality of life. Moreover, usually, this estimate is justified by economic growth, expressed in GDP. However, economic growth is based on natural resources usage and wastes production. The most important thing is how are the two processes interconnected: the production of vital products and the production of pollution. Nowadays, is less attention paid to the production of pollutants, and as a result, the growing environmental threat. To comprehend and solve this problem, the authors propose a model for assessing the interdependence of the GDPPC and the environmental pollutants production volumes. In this study, the authors built the scenarios for GDPPC growth under environmental constraints by using the idea of Kaya identity. Kaya identity states that total CO_2 emissions are driven by four factors: population size; GDPPC; energy intensity per unit of GDP; and carbon intensity (carbon footprint). This paper analyzed the set of indicators that characterize the state of environmental restrictions and their impact on Russia's GDPPC growth. The authors proved James B. Ang's (2007) findings that pollutants, energy consumption, and outputs are strongly interrelated and therefore their relationship should be further examined under the sustainable framework [21]. The authors agree with I. Korhonen and A. Lyakin, who emphasized in their research that although the current debate focuses on the problems of short-term growth and its stimulation, the problems of long-term growth, taking into account environmental factors, are more significant [22]. The GDP losses in recent years could be mitigated by introducing the following environmental policies: enhancement of environmental investment, improvement of waste management technology, taxation reform for the introduction of waste power generation, and changes in consumption patterns [12].

Similarly, water drains component trends were built-in forecasting the influence of pollutant constraints on the level of Russia's economic development. Their limits are based on the analysis of functions that reflect their relationship and trends for every indicator from 2000 to 2018. For the "wastes" indicators, the value of the limit is taken from the national sustainable goals,

aiming to increase the level of waste recycling from 60% to 86%. Regression models have been built to link indicators reflecting the environmental constraints of GDPPC growth, which have shown a reasonably high level of communication (*R* 2–0.56).

CONCLUSION

It is established that the following trends are characteristic of the Russian economy study period:

(1) With the growth of the population, the level of GDPPC increased, while the energy intensity and carbon footprint decreased;

(2) While economic development increased, energy intensity and carbon footprint are reduced;

(3) Energy intensity was growing when the carbon footprint has grown.

Thus, all the received dependencies are logically not contradictory and statistically reliable. Thus, the authors use indicators reflecting the environmental limitations of Russia's GDP growth and forecasting environmental restrictions for GDPPC until 2030. The use of a research model allowed to manage the level of investments in waste-free production and environmental restoration. The study aimed to understand the structure of conditions and trends in environmental improvement/deterioration. Measuring the ecological footprint as a quantitative assessment of its impact on the growth of the Russian economy is a fundamental condition for understanding the prospects for environmental hazards, and therefore, understanding the sequence of economic and technological measures to preserve the environment.

Research limitations are seen by the authors in the

Appendix A

Name	Abbr	Measure
Emissions (Total emitted by stationary and mobile sources)	EMIS	thsnd. ton
Sulfur dioxide	SO_2	thsnd. ton
Nitric Oxide	NO	thsnd. ton
Carbon dioxide	CO_2	thsnd. ton
CO_2 emissions from human-made sources	F	thsnd. ton
Volatile Organic Compounds	VOC	thsnd. ton
Ammonia	NH_3	thsnd. ton
Production and consumption waste generation	PCWG	thsnd. ton
Wastes from production and consumption	W	thsnd. ton
Wastewater discharge	WD	mln. cub.m.
Sulfates	S	mln.ton
Chlorides	Ch	mln.ton
Nitrogen	Ni	thsnd. ton
Nitrates	N	thsnd. ton
Fats and Oils	FAO	thsnd. ton
Phenol	PHE	ton
Plumbum	Pb	ton
Hydrargyrum	Hg	ton
Gross Domestic Product	GDP	RUB bn
Population	P	mln. people
Gross Domestic Product per capita	GDPPC	RUB

Appendix 1 (continued)

Name	Abbr	Measure
Energy consumption	EC	mln. t. of fuel equivalent
incl. Fuel (natural fuel for production)	Fuel	mln. t. of fuel equivalent
incl. Oil	Oil	mln. t. of fuel equivalent
incl. Gas	Gas	mln. t. of fuel equivalent
incl. Coal	Coal	mln. t. of fuel equivalent
incl. Fuel products	FP	mln. t. of fuel equivalent
incl. Combustible by-product energy resources	CER	mln. t. of fuel equivalent
incl. Electric energy	EE	mln. t. of fuel equivalent
incl. Boiler and Heating Fuel	BHF	mln. t. of fuel equivalent
Industrial Production Index	IPI	%
Natural fuel	NF	mln.ton

following way: (1) the authors use data for the 2000–2018 period, cause wastes statistics were not full before the 2000s. The study of the product that accompanies pollution emissions deserves further theoretical and practical consideration. The results obtained based on the proposed research model could be clarified if, along with statistical information for an extended period, could also be used expert assessments of the indicators limits for better predicting the dynamics of environmental restrictions. The research model for assessing and predicting environmental restrictions should be continued in terms of the initial data reliability; (2) In the system of state statistics, all types of pollutants are estimated in physical and value units of measurement, which limits the possibility of cross-country comparisons; (3) The Russian practice of working with environmental restrictions differs from the practice of developed countries with long-developed market economies, where, along with the numerical values of pollutants, risks of situations that generate the production of pollutants are also recorded. This approach creates an opportunity to prepare and make management decisions about the ecological well-being of the economy to prevent emissions into the atmosphere, polluted water stocks, and production and consumption wastes.

REFERENCES

1. Daly H.E. Ecological economics and sustainable development, selected essays of Herman Daly. Cheltenham: Edward Elgar Publishing Ltd.; 2007. 288 p. (Advances in Ecological Economics Series).
2. Anielski M. Measure the sustainability of nations: The genuine progress indicator system of sustainable well-being accounts. In: The 4th Biennial conf. of the Canadian Society for Ecological Economics: Ecological sustainability of the global market place. Montreal, Quebec. 2001:1–52.
3. Costanza R., Liu S. Ecosystem services and environmental governance: Comparing China and the U.S. *Asia & the Pacific Policy Studies*. 2014;1(1):160–170. DOI: 10.1002/app5.16
4. Denisov A.R., Bragina Z.V., Masyuk N.N., Chalova M.V. Assessment of environmental limitations to Russia's GDP growth: Growth prospects. In: Possible future scenarios of Russia and the World: Interdisciplinary discourse. Proc. 11th Int. Kondratieff conf. (Moscow: Oct. 20–21, 2020). Moscow: Uchitel'; 2020:522–523. (In Russ.).
5. Costanza R., de Groot R., Sutton P., van der Ploeg S., Anderson S.J., Kubiszewski I. et al. Changes in the global value of ecosystem services. *Global Environmental Change*. 2014;26:152–158. DOI: 10.1016/j.gloenvcha.2014.04.002

6. Costanza R. What is ecological economics? *Ecological Economics*. 1989:1(1):1–7. DOI: 10.1016/0921–8009(89)90020–7
7. Chou S.K., Costanza R., Earis P., Hubacek K., Li B.L., Lu Y., Span R. et al. Priority areas at the frontiers of ecology and energy. *Ecosystem Health and Sustainability.* 2018;4(10):243–246. DOI: 10.1080/20964129.2018.1538665
8. Costanza R., de Groot R., Braat L., Kubiszewski I., Fioramonti L., Sutton P., Farber S., Grasso M. Twenty years of ecosystem services: How far have we come and how far do we still need to go? *Ecosystem Services*. 2017;28(Pt.A):1–16. DOI: 10.1016/j.ecoser.2017.09.008
9. Costanza R. Time to leave GDP behind. *Nature.* 2014;505:283–285. URL: http://www.idakub.com/academics/wp-content/uploads/2017/02/2014_Costanza_Nature_GDP.pdf
10. Ivanov D., Kuzyk M., Simachev Y. Fostering innovation performance of Russian manufacturing enterprises: New opportunities and limitations. *Forsait = Foresight and GTI governance.* 2012;6(2):18–42. (In Russ.). DOI: 10.17323/1995–459x.2012.2.18.41
11. Bobylev S., Perelet R., eds. Sustainable development in Russia. Berlin, St. Petersburg: Russian-German Bureau for Environmental Information; 2013. 224 p. URL: https://www.rnei.de/wp-content/uploads/2017/05/Ustoichivoe-Razvitie_gro-.pdf (In Russ.).
12. Zhalsaraeva E., Shangina A., Dugarzhapova M. Ecological restrictions of spatial development in practice of Russian regions. *Vestnik Rossiiskogo ekonomicheskogo universiteta imeni G.V. Plekhanova = Vestnik of the Plekhanov Russian University of Economics.* 2019;(6):32–42. (In Russ.). DOI: 10.21686/2413–2829–2019–6–32–42
13. Proskuryakova L. Foresight for the 'energy' priority of the Russian Science and Technology Strategy. *Energy Strategy Reviews.* 2019;26:100378. DOI: 10.1016/j.esr.2019.100378
14. Kaya Y. Impact of carbon dioxide emission control on GNP growth: Interpretation of proposed scenarios. Paper presented to the IPCC Energy and Industry Subgroup, Response Strategies Working Group. Paris. 1990.
15. Oberheitmann A. Long-term Kaya-identity analysis and prerequisites of a sustainable and green economic growth in a 2 °C world. ISPSW Strategy Series: Focus on Defense and International Security. 2013;(236). URL: https://www.files.ethz.ch/isn/167156/236_Oberheitmann.pdf
16. Steblyanskaya A., Wang Z.; Bragina Z. Financial sustainable growth theory as a result of interaction with energy, environmental and social processes (evidence from oil and gas industry). *Finansy: teoriya i praktika = Finance: Theory and Practice.* 2019;23(2):134–152. (In Russ.). DOI: 10.26794/2587–5671–2019–23–2–134–152
17. Bedritskiy A. Report on implementing the principles of sustainable development in the Russian Federation. Russian outlook on the new paradigm for sustainable development. Preparing for "Rio + 20". Moscow, 2012. 70 p. URL: https://sustainabledevelopment.un.org/content/documents/1043natrepeng.pdf
18. Nabeeh N.A., Abdel-Basset M., Soliman G. A model for evaluating green credit rating and its impact on sustainability performance. *Journal of Cleaner Production.* 2021;280(Pt.1):124299. DOI: 10.1016/j.jclepro.2020.124299
19. Yan J., Feng L., Denisov A., Steblyanskaya A., Oosterom J.P. Correction: Complexity theory for the modern Chinese economy from an information entropy perspective: Modeling of economic efficiency and growth potential. *PLoS One*. 2020;15(3):e0230165. DOI: 10.1371/journal.pone.0230165
20. Fleurbaey M., Kartha S., Bolwig S., Chee Y.L., Chen Y., Corbera E. et al. Sustainable development and equity. In: Edenhofer O., Pichs-Madruga R., Sokona Y. et al., eds. Climate change 2014: Mitigation of climate change. Working Group III contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, New York: Cambridge University Press; 2014:283–350. URL: https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_full.pdf
21. Ang J.B. CO_2 emissions, energy consumption, and output in France. *Energy Policy.* 2007;35(10):4772–4778. DOI: 10.1016/j.enpol.2007.03.032
22. Korhonen I., Lyakin A.N. Problems and prospects of Russia's economic growth. *Vestnik Sankt-Peterburgskogo*

universiteta. Ekonomika = St Petersburg University Journal of Economic Studies (SUJES). 2017;33(1):36–50. DOI: 10.21638/11701/spbu05.2017.103

ABOUT THE AUTHORS

Zinaida V. Bragina — Dr. Sci. (Eng.), Prof., Kostroma State University, Kostroma, Russia
bragzv@yandex.ru

Artem R. Denisov — Dr. Sci. (Eng.), Prof., Kostroma State University, Kostroma, Russia
iptema@yandex.ru

Natal'ya N. Masyuk — Dr. Sci. (Econ.), Prof., Vladivostok State University of Economics and Service, Vladivostok city, Russia
masyukn@gmail.com

Nikolai V. Steblyanskii — Cand. Sci. (Econ.), Assoc. Prof., Institute of Economics and Finance, Russian University of Transport (MIIT), ANO DPO "Corporate University of Russian Railways", Moscow, Russia
steblyanskiy@curzd.ru, stebliansky.nv@edu.rut-miit.ru

Authors' declared contribution:
Bragina Z.V. — developed methodological basis.
Denisov A.R. — modeling processes in the Python program.
Masyuk N.N. — wrote the abstract, general conclusions and recommendations, performed data analysis.
Steblyanskii N.V. — wrote the theoretical part, performed data analysis.

The article was submitted on 17.05.2021; revised on 31.05.2021 and accepted for publication on 27.08.2021.
The authors read and approved the final version of the manuscript.

ORIGINAL PAPER

DOI: 10.26794/2587-5671-2021-25-4-45-58
UDC 339.72(045)
JEL F33

Military and Political Influence on the Portfolio of Global Reserve Currencies

M.Yu. Alekseev[a] ✉, **P.A. Kolyandra**[b], **B.M. Cheskidov**[c]
[a, c] Financial University, Moscow, Russia;
[b] Bauman Moscow State Technical University, Moscow, Russia
✉ Corresponding author

ABSTRACT

This paper analyses a new concept presented in the works of B. Eichengreen, A.J. Mehl, L. Chitu "Mars or Mercury? The Geopolitics of International Currency Choice", according to which the state's possession of nuclear weapons is linked to its possession of reserve currency. The paper **aims** to provide a detailed assessment of how gaining reserve currency status depends on the military and political potential of the state issuer. The research **method** is an analysis of the historical material and the current state of the issue under discussion. The study shows the relationship between the global military and political leadership and control over the global financial infrastructure, which increases its importance as a space for interstate conflicts. It has been proven that neither the presence of military power nor the ability and willingness to provide partners with security guarantees do not predetermine the acquisition of the reserve status by the national currency. This status is acquired as a result of control over global investment processes, in the implementation of which military power plays a significant, but not exclusive role. This power, as the potential for economic and financial dominance, is a derivative of the scale and level of development of the national economy, with a key factor in its deep involvement in international trade. From the point of view of practical forecasting of economic, military and political development, the authors **conclude** that in the foreseeable future, despite the strengthening of its military potential, the PRC will not be able and, most likely, will not try to obtain the status of the yuan as a reserve currency. The United States, in turn, will increasingly use its dominance in the capital market and control over the global financial infrastructure as a tool to maintain global leadership. Further study of the considered issues will significantly increase the efficiency of forecasting economic processes in relation to the military and political situation.

Keywords: reserve currency; the cost of financing the budget deficit; international trade; global financial infrastructure; economic, military and political domination; nuclear weapon; "Mars hypothesis"; "Mercury hypothesis"; "Athena hypothesis"

For citation: **Alekseev M. Yu., Kolyandra P.A., Cheskidov B.M. Military and political influence on the portfolio of global reserve currencies.** ***Finance: Theory and Practice.*** **2021;25(5):45-58. DOI: 10.26794/2587-5671-2021-25-5-45-58**

INTRODUCTION

The paper "Mars or Mercury? The Geopolitics of International Currency Choice" by B. Eichengreen, A. J. Mehl, L. Chitu from the National Bureau of Economic Research [1], is particularly valuable and relevant now in a situation of simultaneous multilateral exacerbation of contradictions between states. With regard to assessments of long-term reserves and the state of international trade, the material collected by these authors is more than complete. However, when assessing the military-political interaction and the processes of capital movement and international trade associated with it, they demonstrate the limited data used and the lack of experience in economic analysis of such problems. Compensation for such incompleteness will make it possible to more accurately assess the dependence of the acquisition of the reserve currency status by the national currency on the military-political potential of the issuing state.

THE INCOMPLETE SCOPE OF RESEARCH

The mention of the nuclear weapons as a factor providing greater security and, as a consequence, facilitating the choice of a reserve currency, rests

on the incompleteness of the list of states provided by B. Eichengreen, A. J. Mehl, and L. Chitu for which the presence of a nuclear missile potential cannot be unambiguously attributed to the tightness of economic relations with the United States. Countries like Germany, Japan, and Saudi Arabia are non-nuclear powers, but for the first two countries, the US market is of paramount importance, and Saudi Arabia initially looked for markets to place its giant financial assets, which meant turning to the largest of these markets — the United States. However, this thesis makes the list of countries cited by the authors much more controversial due to the changing factors affecting their security. Chronologically, the gap between the analyzed data from a military-political point of view is too large — between 2004 (data for the UK) and 2016 (data for Russia), a whole epoch passed, including the relations between these two powers, which directly influenced their security, and their economic (including trade and financial) policies.

The assessment of the nuclear potential for all the states under consideration clearly does not reflect the real situation with ensuring security, including on the ground of an independent nuclear missile potential. The UK, although a nuclear-weapon state, is at the same time the closest military ally of the United States and critically depends on them in the production of both thermonuclear charges and their carriers. Thus, in the ranking of nuclear powers, it has the least independence, which should have put it in first place in terms of the share of the US dollar in reserves, but in practice, it is in last place.

Israel's nuclear weapons program is independent, but its dependence on the United States for security, both in the provision of concessional loans for the purchase of U.S.-made weapons and military equipment and in the direct security guarantees, is very high and cannot be compensated for the possession of nuclear missile weapons due to the small size of the territory.

India is not officially an ally of the United States, but as of 2015, analyzed by the authors in relation to this country, it was rapidly moving closer to Washington in security matters. Political-military relations between the United States and China in 2008 were rather wary, with the Russian Federation in 2016 — obviously unfriendly.

Based on the concept proposed by the authors of the dependence of the choice of the reserve currency on the country — the guarantor of security, the less the country depends on the security guarantees of the United States, the less is the share of the currency of the guarantor country in its reserves. Accordingly, the rating for nuclear-weapon states should look as follows (in descending order of dependence):

- United Kingdom.
- Israel.
- India.
- China.
- Russia.

The figure presented by the authors looks different (in descending order of the share of the US dollar in the foreign reserves), which does not allow us to reveal the correlation of the two factors:

- Israel.
- India.
- China.
- Russia.
- United Kingdom.

The indicators on the share of the US dollar in the reserves of Russia and the UK are very close, as well as China and India, with a completely incomparable level of their military and political contradictions with the United States, make a hypothesis about the role of nuclear weapons vulnerable. The lack of data on such nuclear powers as France (as the authors point out) and Pakistan (they do not mention it) should be considered.

Non-nuclear powers are more homogeneous because the United States plays a key role in ensuring their security. However, the authors are faced with the problem of the anachronism of their data. They argue that the United States initially guaranteed the safety of Germany from the USSR and Japan from China. For 2006 and 2004, according to the authors, this is true, but before the collapse of the USSR, it was considered the main threat to Japan both by this country and by the United States. China did not have the potential and ground for an invasion of the Japanese archipelago.

At the same time, from 1987 to 2014, Germany did not consider the threat from the Russian Federation to be real not only for itself but also for the stability of its allies and partners. The threat to South Korea (from North Korea) and Taiwan (from China) seems constant and very serious. The threat to Saudi Arabia has less opportunity, given the potential of the Islamic Republic of Iran (IRI), to develop into an open full-scale military conflict. Thus, if the size of the reserves in the currency of the guarantor country (USA) was directly dependent on the role of this country in ensuring security, the list of non-nuclear states would look in descending order of dependence on ensuring security, as follows:

- Taiwan.
- South Korea.
- Japan.
- Saudi Arabia.
- Germany.[1]

The list presented by the authors looks as follows (in descending order of the US dollar's share in foreign reserves):

- Saudi Arabia.
- Germany.
- Taiwan.
- Japan.
- South Korea.

There is no correlation either; rather the opposite. Thus, from the point of view of the role of the issuer of the reserve currency in ensuring security, the hypothesis also looks unconvincing. The ranking of the US role in the trade of the states under consideration, in our opinion, is more clearly related to the choice of the reserve currency.

Regarding the choice of currencies, conditionally claiming reserve status before World War I, the currencies of the leading Entente countries (except for Russia), Germany and Holland are mentioned. The latter remained neutral and, most importantly, did not have significant military weight. Its neutrality ensured the well-being of the Dutch economy and the strength of its currency *after* the war, but *before* the war it weighed no more than the neutrality of Belgium and Luxembourg, which Germany violated in the first hours of the war. Moreover, during the next world war, Holland shared the fate of Belgium, although even then it counted on maintaining its neutrality. Thus, the choice of the Dutch guilder is not obvious — from a military-political point of view, Russia, Austria-Hungary, Italy, and Turkey had immeasurably greater military weight among the belligerent powers (in descending order). Among the neutral countries are Switzerland and Sweden, which could ensure their neutrality and ensured it during both world wars. Thus, the Dutch guilder can act as an element of comparison in relation to the "Mercury hypothesis", but not to the "Mars hypothesis", while the task of the study is a comparison of both hypotheses.

In general, the choice of the analyzed countries from the point of view of both economic and political realities before the World War I is doubtful. Among the dominions, Australia and Canada did have noticeable economic independence, and Canada was already clearly showing a tendency to move towards the US economic influence. The forces of the dominions were small from a military point of view. However, India, Indonesia, Sri Lanka were full-fledged colonies. It will be shown below that the key importance for the formation of military-political alliances of that time was played not so much by international trade itself as by the movement of capital. Britain took the lead in this process and from 1870 to 1914 invested abroad almost half of its domestic savings, interest, and dividends, which were 1/10 of its national income. At the same time, the ratio of British investments in the territory of the empire (including formally independent Egypt) to investments in other countries was approximately 6 to 5 [2, p. 243]. Obviously, with such a massive inflow of capital denominated in pounds sterling, the reserves of the colonies in full, and of the dominions — to varying degrees — were ultimately formed on the basis of the policy of the metropolis, which also determined their foreign trade activity.

The same applies to Finland, which was part of the Russian Empire. The Philippines in the analyzed period ceased to be a colony of Spain

[1] Saudi Arabia and Japan can switch places if we assess not the potential of a potential adversary, but the likelihood of deteriorated relations.

and, having formally gained independence, in fact, remained a protectorate of the United States. Even Norway remained in union with Sweden until the middle of the period under consideration. With the approach applied by the authors, they should have separately considered Austria and Hungary (as part of a two-pronged monarchy) and, possibly, the Czech Republic.

Thus, out of 19 countries under consideration, 6 cannot be considered in the "Mars hypothesis" at all (without having an independent military potential, but enhancing the potential of the metropolis) and to varying degrees, can only be partially considered in the "Mercury hypothesis" (without having a sovereign economic, let alone financial policy). If we add two dominions to their number, then the number of non-representative territories (which in one way or another were not subjects of politics) increases to 7. As for Brazil and Chile, they had no interest in World War I.

Of the remaining 10 states, Japan's accession to the Entente was predetermined precisely by the "Mars hypothesis", since the country's navy was largely staffed with ships built by Britain and the United States. In addition, Japan had no interests in Europe, where the main theater of military operations was located, and could reasonably count on easily seizing isolated German colonies in China (which it successfully carried out). Japan's military efforts ultimately remained minimal.

As a result, from the above list, the following countries could *independently* influence the course of World War I: Austria (more precisely, Austria-Hungary), Germany (as the Axis powers); Russia, Italy, Romania, and Greece (as the Entente powers); Sweden, Norway, and Switzerland (as neutral powers). The choice is clearly incomplete in terms of the importance of states for the military-political situation before and during the First World War (primarily due to the absence of its important participants — Serbia, Belgium, and Turkey, as well as neutral Denmark, which played a significant economic role). This is no less illogical from the point of view of the security (as an influence on the choice of the reserve currency). For colonies and protectorates, this was predetermined and was not a choice by itself. Japan had serious treaty guarantees from Britain but did not have them from other major powers of the Entente until the very beginning of the war. Moreover, relations with Russia were very complicated by the relatively recent war of 1905. The guarantees of Austria-Hungary and Germany were mutual, although the superiority of the latter (both economic and military) was noticeable, until 1916 the role of Vienna in military plans of allies was independent. Italy had guarantees not from the Entente, but from the Axis powers before the war, of which it was a formal member, and its entry into the war in 1915 was viewed by Vienna and Berlin as a betrayal of its obligations. Romania did not join the Triple Alliance[2] just because Bismarck considered it unnecessary, but according to the 1889 agreement (extended in 1892 and expanded in 1900), it was allied with Austria-Hungary, to which Germany joined in a separate act.

Greece joined the Entente in June 1917, but in reality, it was a desire to work its way towards the implementation of territorial claims against a weakened Turkey. By that time, if not defeat, then the impossibility of victory for the Axis powers had already become obvious.

Norway, while not participating in the war, actually acted as a non-belligerent British ally due to its vulnerability to the British navy and its dependence on exports to the UK.

Sweden experienced some pro-German hesitation at the start of the war but quickly opted for neutrality. Switzerland did not even doubt its neutrality. Of these neutral countries, only Norway received any guarantees during the war. In general, the foreign and defense policy of the three Scandinavian countries before World War I exactly reflected the state of their investment markets. Relying on foreign investment, Denmark tossed between the Axis and the Entente powers, completely oblivious to the possibility of resisting potential aggression. Norway, where foreign investment played an important role, relied on a strong ally, hoping with its help to repel any aggression attempt if any. Sweden, with little

[2] Pointing out that it was a formal, albeit secret, member, the authors are not entirely correct, with regard to Romania, there was a system of separate bilateral agreements.

foreign investment, was self-reliant and willing to play an independent role in a future conflict.

With regard to the analyzed countries, the pound sterling, if we proceed from the position of the authors, should have dominated purely quantitatively, since out of the total number of them, 4 of these territories were under the direct political control of Britain (albeit with very different degrees of autonomy), and only one was controlled by the Netherlands, the United States (formally independent Philippines), Sweden (Norway until 1905) and Russia (Finland until 1918). The territories on this list controlled by Britain were immeasurably superior to those controlled by the other countries mentioned in terms of population, area, and volume of production. At the same time, the currencies of Russia and Sweden are not considered by the authors as reserve ones. Probably, if the list had included the overseas territories that Germany and France had at that time, the conclusions made by the authors would have changed. The authors themselves point out the importance of colonial status for the choice of a reserve currency, but the very concepts of choice and reserves are questioned — the choice was clearly not free, and the goals of the reservation were fundamentally different from those of sovereign states. Likewise, the functions performed by the colonial authorities responsible for financial regulation were different.

Nevertheless, the great merit and observation of the authors lie in the choice of the pre-World War I period for the analysis. This period demonstrates the direct dependence of military-political alliances on the international movement of capital, but not in terms of the choice of a reserve currency or international trade in general, but in terms of ensuring public loans and international trade in in arms and military equipment.

FINANCIAL ASPECT OF INTERSTATE ALLIENCES

The direct connection between state loans and the formation of military-political alliances before World War I is especially noticeable in the example of France, which acted as the center of Entente alliance, which was based on the two concluded agreements — with Russia and Britain, only later they were formalized into a general alliance. Its formation was largely facilitated by France's special position in the international borrowing market. It is characteristic that this leadership ultimately led both to the militarization of the national economy and a relative lag in the development of the industry. In 1872, France exported capital in the amount of 10–12 billion francs, in 1900–30 billion, in 1914–60 billion, i.e., the export of capital increased 6 times, and industrial production — in 3 times [3, p. 518]. According to 1908 data, 9.5 billion francs were invested in French industry and trade, and 10.4 billion francs in bonds and other foreign stocks, i.e. 10 times more. At the same time, taking the military expenditures of France in 1913 per capita as 100%, for Britain this figure was 82%; Germany — 72%; Italy — 40%; Austria-Hungary — 22%; Russia — 32% [3, p. 341]. If, as noted above, British investments were mainly productive, then the French were directly focused on public debt. In 1902, 55% of French capital invested abroad was invested in state and municipal loans, and only 25% was invested in the industry and transport of foreign countries (while 40% of French capital investment in Europe was in Russia) [3, p. 519]. Undoubtedly, the main impetus in France's military preparations was the desire to avenge the results of the Franco-Prussian war and fears (which motivated its future allies) of the strengthening of Germany, but this was precisely an exceptional opportunity, including infrastructure, in providing government loans that put Paris at the center of the future coalition.

The very beginning of the formation of two opposing coalitions in Europe was directly related not only to trade contradictions but also to direct government pressure on the possibility of borrowing a negotiating partner. Thus, the agreement between Russia and Germany, known as the "reinsurance contract", concluded in June 1887 and providing for three-year mutual neutrality (except for cases of aggression against Austria-Hungary and France), was not extended and did not turn into an alliance largely because that the greatest irritation in Russia was caused not by openly provocative attempts to push Russia into

a war with Great Britain for the Black Sea Straits, but by Bismarck's "advice" to German banks to ease the burden of Russian assets motivated by the instability of Russian finances. Bismarck's financial pressure not only failed to achieve its goal, but also had the exact opposite result — the Russian government turned to France for support, and in 1888 French banks provided Russia with the first loan in the amount of 200 million francs. The strengthening of the Franco-Russian alliance was accompanied by a grandiose operation of 1888–1889 on the conversion of Russian public debt on the Parisian money market [4, p. 97]. And when at the initial stage the Russian government showed hesitation, the French Rothschilds immediately refused it a loan. 75% of government loans from Serbia, Bulgaria, Romania, and Greece were also placed on the Paris Stock Exchange [3, p. 520]. Of the four indicated countries, three, despite hesitations, ended up in the Triple Entente, and Russia, together with France, became the first participants in this bloc at the stage of its formation.[3] In 1913, at a meeting of the General Staff, representatives of France announced that the Russian government could provide annual loans on the Paris Stock Exchange only if the construction of strategic railways began immediately [5, p. 309].

The formation of an alliance around Germany was also directly accompanied by a sharp increase in the expansion of German capital. After a German military mission aimed at reorganizing the Turkish army, the German capital began to infiltrate Turkey in 1880. In 1888, German banks received a concession for the construction of the Anatolian railway with a length of 500 km (this branch was the beginning of the famous Baghdad railway, the construction of which finally connected Turkey with Germany) [6, p. 428]. Nevertheless, Germany's potential was significantly inferior to the capabilities of its future adversaries — in 1914 German foreign investment was already 35 billion marks — this was half the corresponding figure for Britain and 2/3 for France [7, p. 86]), which predetermined, despite diplomatic successes, the gradual reduction in the number of its future allies.

Although Italy was initially an open member of the Triple Alliance, gradually it was economic, and primarily financial pressure from Britain and France, which forced it to change its position. Since the Italian economy was highly dependent on imports (in particular, up to 25% of consumed raw materials and almost all coal was imported), Britain quickly demonstrated to Italy that it had no choice by stopping coal exports to the Apennines for only a few weeks, which led to the collapse of the industry, panic in the banking sector and rising prices [8, p. 421]. The instruction to the French ambassador in Rome from Foreign Minister Ribot contains a direct indication of the inextricable link between interstate borrowings of that time and the formation of military-political alliances: "Our policy is to be good with Italy without harming her, but no loans to her until she is convinced of the futility of her alliance with Germany and Austria-Hungary".[4]

The situation in Russia before World War I is worth mentioning separately since there was a serious contradiction between the level of military power and the provision of capital. The dependence of the military-political course of St. Petersburg on external funding manifested itself already in 1905, when Germany, taking advantage of the exacerbation of Russian-British relations, tried to separate Russia from the Entente and form a military alliance with it. Although Germany managed to impose a much more favorable trade agreement on Russia, the conclusion of an alliance, which Nicholas II personally spoke about a lot, was rejected because of the report of the Minister of Finance Kokovtsev, presented at the very moment of negotiations [9, p. 605]. It said that the use of three money markets available to Russia — Paris, Berlin and Amsterdam — would allow borrowing up to 500 million rubles during 1905, which would cover the needs of 8 months of the war. Of these, the Berlin market could give 231 million rubles, for which they have already begun to sell a loan (funds in small portions were received throughout the next year). The remaining 270 million could

[3] This treaty (from French "entente" — meaning "friendship, understanding, agreement") was originally built upon the Franco-Russian alliance and the Entente Cordiale of 1904 between Paris and London later.

[4] Documents diplomatigues français, série I, Vol. VIII, No. 183.

be obtained only in Paris. At the same time, the usual budget was planned with a deficit of 400 million rubles. Paris responded to all attempts at rapprochement with Germany with blows to Russian finances, and immediately compensated for the conclusion of the above trade agreement with an agreement on the transfer of Russian military orders to France, and they were carried out at prices higher than German ones.

In 1900, 1,736.8 million rubles of Russian share capital, 911 million rubles were accounted for by foreign investors. Of the total amount of foreign capital invested in Russian industry, Belgium, France, and Britain (i.e., the Entente countries) accounted for 660.7 million rubles, and German capital — 97.9 million rubles. [5, p. 170]. The capital of the Entente countries was concentrated in strategic industries — mining and metals production and oil.

The above figures very well explain the hesitation of Russia between Germany, to which it was pushed by dynastic considerations and personal sympathies of the emperor Nicholas II, as well as the very noticeable interests of both exporters and importers of industrial and agricultural products, and France to which it was pushed in the first place by the interest of capital imports, mainly in the form of government loans. The final choice of St. Petersburg explains these figures. Germany could supply Russia with any goods — consumer goods, machinery, equipment, weapons, and military equipment, and could buy a significant part of Russian raw materials. Russia needed it to a much greater extent than France, and especially Great Britain, which had huge empires. But Germany, which itself experienced (albeit for other reasons) a relative lack of capital, was physically unable to finance the Russian public debt in the required amount. This forces us to look at both the "Mars hypothesis" and the "Mercury hypothesis" from a slightly different angle than the authors.

Separately, United States should be mentioned, whose accession to the Entente powers[5] finally deprived Germany not only of hopes of victory but also of the opportunity to conclude peace on the basis of the pre-war status quo. The United States was not a major exporter of capital until World War I, and its investment presence in Europe was negligible. If British foreign investment amounted to $ 20 billion, French — $ 10 billion, German — $ 5 billion, the United States — only $ 500 million. More than 88% of them were in the countries of the North American continent (mainly Canada and Mexico.), in Europe (without Russia) — only 2%, i.e. only 2 times more than for Japan and China combined [10, p. 566]. But this by no means refutes the above assumptions about the key role of government loans both in the process of forming military-political alliances and in obtaining the status of a reserve national currency. While not a major exporter of capital, the United States was a major importer of capital until World War I. By 1899, foreign investment in the US economy reached $ 3.3 billion, of which $ 2.5 billion fell on British banks [10, p. 566]. That is, just as government loans pushed St. Petersburg to Paris, private investment pushed Washington to London. In the course of the war, the situation changed, and the United States began to turn into a creditor and supplier of the Entente (since the delivery of goods to Germany would require a challenge to the superior forces of the British fleet blocking it, as well as a preference for a less solvent partner). In total, during the period of United States neutrality, Britain, France, Italy, and Russia received about $ 2 billion from the United States, and Germany — $ 20 million [10, p. 566]. In this case, as we can see, the movement of capital, as in relation to Russia, fully explains the choice of a military-political alliance. However, the different nature of interstate economic relations leads to the fact that with a smaller purely military potential, the United States received an incomparably higher status of the national currency as a reserve than in the case of Russia.

From the above, it can be seen that security guarantees hardly predetermine the choice of the reserve currency. Quite the opposite. In an effort to provide security guarantees through the creation of military-political alliances, states with

[5] The United States was not an official member of the Entente powers, acting as an "associated member".

significant capital (especially if their infrastructure was focused on the export of capital with a specialization in investing in foreign public debt) provided loans to countries in their own currencies, for purely military reasons, which sought to involve them in the alliance. As a result of the need to service these loans, the preconditions were formed for the accumulation of such a currency as a reserve. If we exclude the neglect of the factor of interstate movement of capital, in particular the external financing of public debt, which is mainly spent on military preparations, the "Mars hypothesis" before World War I becomes obvious.

In the analysis of statistical material B. Eichengreen, A. J. Mehl, L. Chitu came close to this factor. They rightly note the increase in the share of the French franc, especially in the reserves of Russia, while maintaining the stability of the share of the German mark. They also note the maximum role of the pound sterling at the beginning of the last decade of the 19th century. However, the authors state that it is impossible to determine whether this situation is the result of economic or political factors. In practice, as shown above, using the example of historical material, these factors are identifiable and economic in nature (since at that time government loans on concessional terms were almost not provided), but politically motivated. Thus, the authors provide data confirming the role of international capital movement in the formation of the status of a reserve currency, which in the period under review acquired the character of government loans in the lender's currency, due to which forced preparations for war were ensured within the framework of emerging military alliances.

Similarly, when considering the economic justification of the "Mercury hypothesis", the authors, although they do not ignore interstate borrowing and foreign investment, hardly link them with the real needs of military development. Directly speaking about the connection between military alliances and borrowing, the authors do not specify the purpose of such borrowing, and also separate interstate loans and private investments, which in practice are closely connected, especially in the pre-war period, when investors faced a real threat of at least freezing access to their property in a hostile state. In addition, the special investment attractiveness for private capital of investments in the military-industrial complex, supported by the state as a customer of products and as an investor, especially noticeable in the period preceding the world wars and the interval between them, is not considered. Meanwhile, if today the supply of weapons, especially to less economically developed countries, is often carried out at the expense of loans issued on the most favorable terms by the country — the manufacturer of weapons and military equipment, then in the period preceding the First World War, the situation looked different. Concessional lending could be called conditional, and the link between the loan and the purchase of specific types of weapons existed rather at the level of agreements than formal contracts. The classification of creditors as public and private is very confusing. For example, after the October Revolution and the refusal of the Bolsheviks to pay foreign debts, and then at the stage of restoring diplomatic relations with France and repaying some of them, it turned out that many French investors, sincerely considering themselves creditors of the imperial government, in practice acquired bonds of private issuers. Thus, when accounting for the movement of capital, attributing it exclusively to supporting the "Mercury hypothesis" for the period under review is the least justified and confusing in terms of the pre-war existence of the metal standard, the inflation caused by the war, and the complete rejection of the obligations assumed by the losing states (including Russia).

CORRELATION OF DIPLOMATIC MISSIONS WITH ALLIED RELATIONS AS A RATIONALE FOR THE CHOICE OF A RESERVE CURRENCY

Within the framework of the mathematical analysis of the "Mars hypothesis", the quantitative assessment of diplomatic representation as correlated with allied relations is extremely vulnerable. Such a concept is not true today, all the more it was incorrect at the turn of the 19th and 20th centuries when the level of diplomatic contacts in many respects still bore an echo of

the old dynastic relations. The level and scale of diplomatic representation were regulated by traditions, including those based on the feudal hierarchy. Representation at the court of the monarch could not be below a certain level under any circumstances (except for a complete break in relations) and, moreover, it had to be headed by a person whose status allowed him to be admitted to the court and received with respect not only because of his diplomatic rank but also because of the origin (even if the diplomat represented the republic). As a result, the mutual diplomatic representation of the leading European states, as today, was based on the "mirroring" principles.

Regarding both the registration and the maintenance of allied relations (the level of which is analyzed by the authors), these activities were mainly carried out by individual delegations, since the diplomatic missions did not have the appropriate authority or qualified personnel in sufficient numbers. As an example, it is enough to cite the visit to St. Petersburg of the Deputy Chief of the French General Staff, during which a draft military convention was signed by military representatives of the two countries. The permanent French diplomatic mission was engaged only in the technical support of these negotiations, and later — in the technical implementation of the agreements [4, p. 105]. It follows from this that the level of diplomatic representation as an indicator of the closeness of allied ties in relation to that historical one, although carefully analyzed by the authors, cannot influence the final conclusion on the problem under study.

GENERAL CONCLUSIONS OF EICHENGREEN, MEHL AND CHITU

The main conclusion of the authors is that the dominance of the US dollar as a world reserve currency is supported by the status of the issuing country as a superpower guaranteeing the security of the allied states. The issuance of such a currency, in turn, reduces the cost of financing the budget deficit. Further, the authors conclude that if the US policy is more isolationist, the attractiveness of their currency will also decrease, and funds to implement such a scenario will be invested in yen, euro, and renminbi. As a result, the long-term debt interest rates will increase by 80 points, which will be equivalent to an increase in annual interest rate payments (applied to 2016) by $ 115 billion. The US dollar will depreciate by 5%. The authors compare these losses with the costs of supporting the U.S.'s military presence overseas estimated at $ 10 billion per year, 70% of which is spent in Germany, Korea, and Japan (US Senate, 2013). The independent estimate is significantly higher at $ 100 billion per year (Vine 2015).

At the same time, the authors' concept suggests that the loss of security guarantees provided by the United States will increase the global military-political tension. In turn, the states will need to increase the share of more reliable currencies in their reserve holdings, by turning to the US dollars. As a result, on the one hand, getting rid of dollars due to the loss of American security guarantees and, on the other hand, acquiring dollars in an effort to have large reserve holdings, long-term interest rates on the US public debt still increase by 30 percentage points.

REALISTIC SCENARIOS OF THE LOSS OF THE RESERVE CURRENCY STATUS BY THE US DOLLAR DUE TO THE INABILITY TO GUARANTEE THE SECURITY OF ALLIES AND THE APPEARANCE OF NEW SECURITY GUARANTORS

The last statement does not quite fit into the framework of the concept proposed by the authors. First, it is highly unlikely that the US currency will remain attractive as the country moves to a policy of isolationism. Such a transition can occur either as a result of the loss of the ability to guarantee the security of the allies due to the decline in the country's military potential or as a result of a break with the allies due to the intensification of insurmountable contradictions. The first arises either as an outcome of military (diplomatic) defeat and changes in the global balance of power, or as a result of significant degradation of the national economy, which does not allow maintaining the military potential at the same level. In both cases, the attractiveness of the reserve currency of a country that has suffered such a heavy defeat or

plunged into the abyss of a large-scale economic crisis will sharply decrease. The second option is more realistic and presupposes the gradual development of economic contradictions to a level at which the costs of allied relations become unacceptable. However, even then, the willingness to abandon the US dollar as a reserve currency among countries disintegrated by trade wars will outpace the abandonment of the union itself, which, while remaining more formal and ineffective, may continue to exist for quite some time.

Moreover, this logic of choosing a reserve currency is obvious for countries that are not directly in allied relations with the United States. For them, the reasons for the US withdrawal from the position of the world military-political hegemon will either determine the decline in interest in their currency even before the fact of such a withdrawal is stated, or coincide with it in the course of a large-scale crisis caused by their military and diplomatic defeat.

The consequences of the US's refusal to provide security guarantees to its allies are important, but the authors ignore them. The resulting vacuum will be filled either by a system of regional alliances or, more likely over a longer period of time, by a new hegemon. Since we are talking about the choice of a reserve currency by each individual country (and not all countries can guarantee their own security), such guarantees after the US withdrawal will be obtained rather quickly — either in the form of a voluntary alliance or under pressure — the use or threat to use power to turn the country into a satellite. The question arises about the connection in this hypothetical situation of the possibility of providing military-political guarantees and the potential of the national currency of the guarantor country. It should also be considered that if currencies of states opposing each other are present in the composition of reserves, hypothetically, in approximately equal shares, the security guarantees of such states, if given simultaneously to one country, are in the nature of a temporary compromise, ending in the triumph of one of the opposing forces. We will consider the situation with potential guarantor countries in the case of a hypothetical withdrawal of the United States, analyzed by the authors.

China is undoubtedly capable of acting as a guarantor of security, although today the ability of the country, given the relative weakness of its navy, to project power beyond the Indo-Pacific region is seriously questioned. It will be all the more difficult for China to wage two major military conflicts overseas at the same time, which is a distinctive feature of the military-technical base of the current great power of the United States. The military potential of Japan is of purely regional importance and today is sufficient for the proper defense of the Japanese archipelago in the event of a non-nuclear conflict.

The military-technical potential of a united Europe is significant and in the long term may be equal to the potential of the United States. However, this is just the potential of an economic-political, not a military-political alliance. The military planning bodies of the EU are in their infancy, the military-industrial complex of the EU countries is integrated, but they retain their national specifics, their cooperation does not yet surpass similar interaction with the military-industrial complex of the United Kingdom (which has already left the union) and the United States. In general, we can only consider separate programs and a specific list of intentions to create a unified defense space. At the same time, due to the significant differences in foreign policies outside the European continent, there is no doubt about the ability and readiness of the integrated military component of the EU to guarantee the security of its members and a number of neighbors on a continent (possibly in the Mediterranean area) in some indefinite future. However, it is difficult to imagine that the willingness of the union would entail additional costs in building the capacity to project global power.

On the other hand, the authors did not mention the British pound sterling in the list of currencies that could challenge the US dollar, within the framework of their hypothetical scenario. This is all the more strange because the United Kingdom has nuclear weapons and a powerful balanced navy (according to various estimates — the second or third in the world), capable of operating in all

Table

Providing security guarantees in connection with the reserve currency

Countries	Ability to provide security guarantees	Assessment of a currency as a reserve currency	Role in the global financial infrastructure
China	High	Low	Absent
Japan	Absent	High	High
EU	Regional	Global	High
Russia	Global	Low	Absent
UK	Absent	High	Global
India	Regional	Low	Absent

Source: compiled by the authors.

corners of the globe. The absence of the Indian rupee on the list is also not entirely clear — from the point of view of problems with convertibility and freedom of movement of capital, it is slightly inferior to the Chinese yuan, as well as the military power of India in the regional aspect somewhat, but not radically inferior to the Chinese. Finally, it is not at all clear whether the list includes the Russian Federation, the economy of which is much inferior to that of China, Japan, or the common European, but the Armed Forces are comparable in the potential to the former and surpass the last and third. In terms of regulation, the Russian ruble is at least as good as the Chinese yuan. The *Table* shows the possibilities for providing security guarantees in relation to the reserve currency.

The research method is the analysis of historical material, as well as the current state of the issue under consideration.

As we can see, at the level of scenarios, the authors' concept is vulnerable — it is easy to assume a weakening of the United States and its transition to a policy of isolationism, accompanied by a reduction in military spending (which, by the way, will save significantly more than the aforementioned $ 750 billion). Likewise, it is easy to allow the US dollar to lose its position in favor of the currencies of other powerful economies. However, this series does not in any way integrate military security guarantees that support the claims of the currencies of such states for the status of reserve ones. Based on this, it seems logical to assume that the military dominance of the United States is predetermined by the same economic considerations as the dominance of its national currency.

Indeed, the history of the United States confirms this thesis. Considering the fact that the United States, before the Nazi occupation of France in 1940, did not even give secret and vague security guarantees to any European country, and in Asia, these guarantees extended only to formally independent states (primarily the Philippines), where the American military contingents were deployed, the "Mars hypothesis" in the interpretation proposed by the authors remains unconvincing. In a logical chain, they quote: military power; security guarantees; the presence of a reserve currency — in relation to the situation in the United States in the period from 1875 to 1940, the first component is not exhaustive and does not allow providing the second (which, in fact, is absent), and the third is not only happening but is also consistently strengthening.

A vivid example is the USSR, which obviously possessed both global military power and the largest (along with the United States) nuclear missile potential, which allowed it to provide comprehensive security guarantees in any corner of the globe. However, none of these prerequisites in any way predetermined even a limited interest in the Soviet currency.

THE INEVITABLE COMBINATION OF MILITARY HEGEMONY AND THE OWNERSHIP OF RESERVE CURRENCY

As a result, we come to the conclusion that a large modern economy producing a wide range of

products, including high-tech and integrated into world trade, will inevitably have either available military power or the potential to create it in a short time, as well as a reserve currency that has already become global or able to become it. The question, therefore, boils down to one thing: is it inevitable, upon the achievement of military superiority, which makes it possible to become a hegemon within the framework of a military alliance, the acquisition of the status of a reserve currency by the national currency?

After World War II, as the authors rightly point out, security was guaranteed by the presence of nuclear weapons. However, of the two powers that originally possessed it, only one — the United States — issued the world reserve currency. Great Britain had a reserve currency before gaining access to nuclear weapons, the popularity of the French franc since the 1960s inferior to the popularity of the West German brand, despite the *presence* of nuclear weapons in France and their *absence* in Germany. The China currency aroused interest in the world *half a century* later after the country received nuclear status. The unofficial members of the "nuclear club" obviously do not apply for the status of the owner of the reserve currency.

At the same time, it is difficult to deny the fact that military power and security considerations cannot but serve as a weighty argument both in economic disputes and in economic cooperation.

The authors' general conclusion that the loss of the United States' role as a global leader, guaranteeing the security of numerous allies, will lead to higher American interest rates, is not in doubt, but the question remains open about the reasons for such changes. Since, as shown above, such a loss may be the result of either large-scale military-diplomatic defeats, or a sharp exacerbation of the situation in the national economy, and it is very likely both at the same time, the authors' assessment seems excessively optimistic. On the other hand, there is no reason to believe that with the preservation of the economic and military status quo or its slow natural transformation, the United States will radically change its global status. Thus, it is impossible to determine the choice between the "Mars hypotheses" and "Mercury hypotheses" simply because military power is based on economic power, and its configuration is largely determined by considerations of ensuring economic activity.

ATHENA HYPOTHESIS

And here we return to the problem identified by the authors when considering the state of foreign exchange reserves prior to World War I. It seems reasonable to ask the question: if the connection between military leadership and the role of the currency as a reserve currency is refuted by a number of notable exceptions, which casts doubt on the "Mars hypothesis" and, at the same time, the military-political factor is present in the context of economic leadership, which does not allow taking the side of the "Mercury hypothesis", why not consider the issues of trade in relation to the military component, that is, trade (including the cross-border movement of capital), which provides military construction? This hypothesis could be called the "Armed Mercury hypothesis", but the name "Athena hypothesis"[6] looks more attractive.

The essence of this hypothesis is that military power is based on economic potential, and if the former is superior to the latter, then it is neither sustainable nor long-term, nor provides economic preferences in international trade. Military power does not create any additional investment attractiveness, including the attractiveness of the national currency, as well as a reserve one. The exception established by the authors for nuclear missile power is seeming since in practice this is confirmed only by the example of the Russian Federation, for which the corresponding potential significantly exceeds the economic one. However, in this case, this does not cause any incentives to obtain security guarantees from its owner in connection with a number of economic

[6] Pallas Athena (among the Romans — Minerva) — the ancient Greek goddess of wisdom, the patron of states both in days of peace and during the war. This is the goddess of a just and reasonable war, in contrast to Ares (Mars), who patronized a cruel and bloody war. In addition, this goddess bestowed laws on people, patronized sciences, agriculture, and crafts.

concessions, as well as to obtain the status of a reserve currency for the national currency.

A direct link between military and economic potential arises mainly to ensure stable international trade, and, based on this, its naval component is of particular importance. Military power by itself, with the exception of cases of obvious inequality in the general potential of neighboring states, is not capable of providing its holder with significant economic preferences, including foreign exchange.

At the same time, the global capital market, which forms a complex system of interconnections and interdependencies in various spheres of interaction between states, plays a significant role in military-political alliances and the status of a currency as a reserve one. Since the pre-World War I period, this interaction has spread from providing loans to the state, which is planned to be involved in a military-political alliance, to providing such a state with the widest possible access to its own government borrowing instruments. The preferences in this process of attracting and distributing funds are indeed broadly, but not exclusively, predetermined by the military potential of the state. This potential, in turn, is supported by operations in the global money market, restricting access to which through sanctions is becoming an increasingly important form of interstate confrontation and a way to maintain global leadership.

Thus, neither the presence of military power nor the ability to provide partners with security guarantees predetermines the acquisition of the reserve currency status by a national currency. This status is being acquired as a result of control over global investment processes in their broadest sense, in the implementation of which military power plays a significant role. However, this power itself, as the potential for economic and financial domination, is a derivative of the scale and level of development of the national economy with a key factor of its deep involvement in international trade, which, in turn, generates an objective demand for long and stable existence of such power.

This implies the controversy of the theses about the a priori advantage for the emerging centers of power in the form of China and the EU of the interconnected spread of their military-political influence and the role of national currencies since both of these goals exist independently and in each case are determined by separate considerations. This, in fact, is confirmed by the absence of a direct correlation between the rather sharp strengthening (starting from the middle of the second decade of the 21st century) of the military potential of China with the role of the Chinese yuan in international settlements. At the same time, the reduction in the military potential of the EU during the first two decades of the 21st century was accompanied by the emergence of the euro, not without success claiming the role of a reserve currency.

CONCLUSIONS

It seems logical to conclude that in the foreseeable future, despite the strengthening of its military potential, China will not be able and, most likely, will not try to significantly raise the status of the yuan to the level of a reserve currency, implying accompanying costs in the form of the need for liberalization of financial system inadequate benefits. The United States, in turn, will increasingly use its dominance in the capital market and control over the global financial infrastructure as a tool to maintain global leadership.

Presumably, the noted relationships and interdependencies still exist separately. Thus, the military power of a state is considered when assessing the attractiveness of its currency, although, as the experience of modern Russia shows, it is by no means decisive. Political-military alliances affect the attractiveness of the currencies of their members as a reserve, but this influence becomes direct, mainly based on considerations of military-technical cooperation, which is a separate and very specific area of economic activity. Military power is only partially formed from considerations of interstate economic cooperation, while for the latter, not a nuclear missile, but naval power still has a special and almost exclusive significance (at the moment they are basically the same, but not identical).

REFERENCES

1. Eichengreen B., Mehl A.J., Chitu L. Mars or Mercury? The geopolitics of international currency choice. NBER Working Paper. 2017;(24145). URL: https://www.nber.org/system/files/working_papers/w24145/w24145.pdf
2. Blaug M. Economic theory in retrospect. Cambridge: Cambridge University Press; 1978. 750 p. (Russ. ed.: Blaug M. Ekonomicheskaya mysl' v retrospektive. Moscow: Delo Ltd; 1994. 720 p.).
3. Manfred A.Z., ed. History of France (in 3 vols.). Vol. 2. Moscow: Nauka; 1973. 658 p. (In Russ.).
4. Potemkin V.P., ed. History of diplomacy (in 3 vols.). Vol. 2: Diplomacy in modern times (1872–1919). Moscow, Leningrad: OGIZ; 1945. 423 p. (In Russ.).
5. Lutskii E.A. History of the USSR. 1861–1917. Moscow: Ministry of Education of the RSFSR; 1956. 376 p. (In Russ.).
6. Skazkin S.D. et al., eds. German history in new and modern times (in 2 vols.). Vol. 1. Moscow: Nauka; 1970. 510 p. (In Russ.).
7. Kuczynski J. Die Geschichte der Lage der Arbeiter unter dem Kapitalismus. T.I. Bd. 4: Darstellung der Lage der Arbeiter in Deutschland von 1900 bis 1917/18. Berlin: Akademie-Verlag; 1967.
8. Miziano K.F. et al., eds. History of Italy (in 3 vols.). Vol. 2. Moscow: Nauka; 1970. 607 p. (In Russ.).
9. Romanov B.A. Russia in Manchuria (1892–1906): Essays on the history of the foreign policy of the autocracy in the era of imperialism. Leningrad: Leningrad Oriental Institute; 1928. 607 p. (In Russ.).
10. Faulkner H.U. American economic history. New York, London: Harper; 1943. 784 p.

ABOUT THE AUTHORS

Mikhail Yu. Alekseev — Dr. Sci. (Econ.), Prof., Dean of the Faculty of International Economic Relations, Financial University, Moscow, Russia
mikh.alekseev@gmail.com

Pavel A. Kolyandra — Cand. Sci. (Eng.), Assoc. Prof., Senior Lecturer, Bauman Moscow State Technical University, Moscow, Russia

Boris M. Cheskidov — Dr. Sci (Econ.), Financial University, Moscow, Russia
state2017@icloud.com

Authors' declared contribution:
Alekseev M. Yu.— statement of the problem, development of the concept of the research, critical analysis of the literature.
Kolyandra P.A.— collection of statistical data, presentation of results.
Cheskidov B.M.— description of the results and formation of conclusions of the study.

The article was submitted on 15.04.2021; revised on 29.04.2021 and accepted for publication on 27.08.2021.
The authors read and approved the final version of the manuscript.

ORIGINAL PAPER

DOI: 10.26794/2587-5671-2021-25-5-59-78
UDC 336.71(045)
JEL G21

Key Trends and Regulations of the Development of Digital Business Models of Banking Services in Industry 4.0

M. N. Dudin[a] ✉, **S. V. Shkodinskii**[b], **D. I. Usmanov**[c]
[a, b, c] Market Economy Institute of the Russian Academy of Sciences, Moscow, Russia;
[b] Financial Research Institute, Moscow, Russia
[a] http://orcid.org/0000-0001-6317-2916;[b] http://orcid.org/0000-0002-5853-3585;
[c] http://orcid.org/0000-0002-0357-1584
✉ Corresponding author

ABSTRACT

The **subject** of the research is trends in the implementation of digital technologies in the banking sector. The **relevance** of the paper is due to the objective processes of global digital intervention of technologies in all spheres of human life and society. The research **aims** to identify, systematize and generalize key trends and regulations in the development of digital business models of banking services in Industry 4.0. For the first time, the authors identified and systematized modern trends and regulations in the development of digital business models of banking services in Industry 4.0, offered their own conceptual vision of the concept of "digital business model of banking services". The authors apply general scientific, philosophical, analytical, statistical, problem-chronological and historical-genetic **methods,** as well as methods of expert assessments. The article summarizes the main stages of the evolution of business models of the banking sector, reveals substantive and methodological differences between traditional remote banking services and digital banking, highlights the main business models for organizing digital banking; provides up-to-date data on the level of development of digital banking in the main geographic zones of the world; shows the dynamics and key areas of investment in the fintech industry in 2014–2019 and provides a critical analysis of their conditions; identifies problematic aspects of the development of digital business models of banking; describes the functionality of the main digital business models of Russian banks with the author's assessment of their capabilities and examples of their use in Russian practice. The authors **conclude** that the main drivers of digitalization of the banking sector are stable growth of non-cash payments in the world and in Russia; stable growth of the global digital banking market; the impact of the COVID-19 pandemic on the active demand of consumers of remote financial services; increased competition in the retail banking market; and a significant decrease in margins for traditional banking products. Identification and systematization of trends and regulations in the implementation of digital business models of banking services can form the basis for further analysis of the specifics of digitalization and personalization of digital banking in Industry 4.0 for the sustainable socio-economic development of the country in terms of possible advantages and threats to the security of financial resources and personal data of customers.

Keywords: digital banking; banking products; business models; Industry 4.0; cybersecurity; digitization; financial market

***For citation*: Dudin M. N., Shkodinskii S. V., Usmanov D. I. Key trends and regulations of the development of digital business models of banking services in Industry 4.0. *Finance: Theory and Practice*. 2021;25(5):59-78. DOI: 10.26794/2587-5671-2021-25-5-59-78**

INTRODUCTION

The digital economy inevitably affects all spheres of life of the socio-economic system, changing the traditional rules and mechanisms of its functioning, considering the global trends of digitalization. The banking system is one of the most receptive areas of the national economy to the introduction of innovations and the use of new digital solutions. This is due to a number of internal and external reasons. The internal reasons include:

- stable growth of non-cash payments in the world and in Russia (the share of non-cash transactions using bank cards in Russia in 2015–2019 increased from 38 to 64.7%[1]);
- the development of competition in the payment services market on the part of non-banking organizations (in 2019, more than 6 non-bank payment services operated in Russia — direct competitors of banks, and the share of e-money as a settlement instrument was 77.6%) (for comparison, bank cards accounted for 90.5%).

The external reasons include:

- stable growth of the global digital banking market (according to GlobalMarketInsight, in 2019 its volume amounted to US $ 8 trillion, and by 2026 it is expected to grow to US $ 12 trillion[2]);
- the impact of the COVID-19 pandemic on the active demand of consumers of remote financial services (according to Fidelity National Information Services (FIS), since April 2020, the number of new unique customers in mobile banking increased by 200%, and traffic increased by 85%[3]).

In addition, the expansion of the range of digitalization of banking services is due to the trend towards the development of personalized banking. On the one hand, personalization today is a key competitive advantage of a modern bank that relies on meeting the unique needs of its customers. On the other hand, a personified approach in the banking sector is an adequate response to the personal economic, and psychological expectations of consumers of banking products. These expectations are associated, firstly, with an increase in the level of well-being of the population (according to the IMF and UN data, incomes are expected to grow by 3.0–10.0% by 2025, depending on the region), secondly, with the expansion of the middle class — the main driver of innovation for individuals (according to WorldDataLab, by 2030, the size of the global middle class will reach 5.3 billion people[4]), thirdly, with a change in personal motives for organizing financial services based on lifestyle and needs (life-style-banking). These facts are a breeding ground for the development of digital services for the personalization of banking products, considering the national characteristics of Industry 4.0.[5]

All of the above determines the relevance of the topic of this scientific research, since the banking sector is most actively introducing new digital technologies due to the need, on the one hand, to ensure that the costs of conducting banking operations are minimized for both clients and for your own business, and on the other, to improve security, the speed and convenience of such transactions for retail and corporate clients. In addition, in the context of the COVID-19 pandemic, not only the transition to

[1] Melnikova Y. Non-cash is taking over cash. (16.10.2020). URL: https://www.comnews.ru/content/211038/2020–10–16/2020-w42/beznal-pobezhdaet-kesh (accessed on 18.01.2021).

[2] Digital banking market size by type. (October 2020). URL: https://www.gminsights.com/industry-analysis/digital-banking-market (accessed on 17.01.2021).

[3] Matsiborska T. How the pandemic impacted banks: the digital revolution and new trends. (02.06.2020). URL: https://psm7.com/bank/kak-pandemiya-izmenila-banki-cifrovaya-revolyuciya-i-novye-trendy.html (accessed on 17.01.2021).

[4] Kharas H. The Unprecedented Expansion of the Global Middle Class: An Update: Global Economy & Development Working Paper 100. 2017 (February). Brookings Institution, 14. UN World Population Prospects. P. 14.

[5] Kirakasyants A. Fintech: Brief history. (19.11.2019). URL: https://frankrg.com/8732 (accessed on 18.01.2021).

remote forms of service in various spheres of society has intensified, but the problem of the vulnerability of virtual services and services offered by Russian banks has also intensified, in connection with which the task of forming viable digital business models of banking services especially relevant and of practical value.[6]

The purpose of the scientific article is to identify, systematize and summarize the key trends and patterns in the implementation of digital business models of banking services in Industry 4.0. It seems that the results of the study can form the basis for further analysis of the specifics of digitalization and personalization of banking products and services in Industry 4.0 in the direction of summarizing data on financial effects for initiating banks, assessing the significance of banking innovations for sustainable socio-economic development of the country with positions of possible benefits and threats to the security of financial resources and personal data of clients.

MATERIALS AND METHODS

This scientific paper is of an interdisciplinary nature. We applied both general scientific and philosophical methods of cognition, as well as special economic, analytical, and statistical research methods based on them. To study the process of introducing digital business models in the banking sector, we used problem-chronological and historical-genetic methods of scientific knowledge, as well as methods of expert assessments.

The study is based on materials from open sources of thematic reviews of the VC.RU consulting agencies, the Skolkovo Research Center, Digital IQ, PWC, Delloite, and the Bank of Russia.

LITERATURE REVIEW

In recent years, there has been a rapid increase in the interest of the scientific community in the problems of digital transformation of the banking sector. A number of researchers, for example, L. Magomayev [1], V. Zakshevski, A. Pashuta [2], T. Yu. Popova [3], A. A. Timchenko [4], and others in their works pay attention to the problems of introducing banking innovations.

The issues of transforming business models of banks into a digital economy are reflected in the works of Yu. B. Bubnova [5], A. P. Belous, S. Yu. Lyal'kov [6], S. Yu. Pertseva [7] and others.

F. T. Aleskerov[7] and his colleagues from the Higher School of Economics presented a typology of business models for Russian banks.

At the same time, the issues of the formation and development of digital business models of banking services were poorly studied in domestic and foreign literature, which served as an additional motivation for the authors to study this scientific area in more detail. At the same time, banking services should be regarded as well-established electronic technologies for servicing and supporting customers, for example, online banking, mobile banking, a virtual account in an electronic payment system, online banking services, etc.

It seems that at the beginning of this study, it is important to understand the conceptual apparatus. For this, the author managed to systematize various approaches to the content of the concept of "digital business models of banking services"

[6] Bank losses due to cybercrime. (29.10.2020). URL: https://www.tadviser.ru/index.php/Статья:Потери_банков_от_киберпреступности (accessed on 24.02.2021); How the post-Covid-19 reality will change banks and fintech services. (12.05.2020). URL: https://vc.ru/finance/125294-kak-novaya-realnost-posle-covid-19-izmenit-banki-i-finteh-servisy (accessed on 24.02.2021).

[7] Aleskerov F.T., Belousova V. Yu., Bondarchuk P.K., Popova E.S. Russian banking business models: Typology, structure and loyalty. National Research University Higher School of Economics. URL: https://www.hse.ru/data/2012/12/04/1268905426/бизнес-модели%20рос%20банков%20статья.pdf (accessed on 22.02.2021).

presented in domestic and foreign literature (*Table 1*).

Summarizing the material presented in *Table 1*, the authors propose their own interpretation of the concept of *"digital business model of banking services"* — this is a way of digital interaction of a bank with customers, focused on creating new value using the latest digital technologies in a virtual mechanism to create and promote personalized banking products and services. This interpretation summarizes all modern patterns and trends in the development of digital banking both in Russia and abroad.

It should be emphasized that an important feature of the banking system in terms of identifying the stages of its integration into the digital economy is the inalienability of digital technologies in banking sector processes. Thus, the first mention of "Industry 4.0" as an evolutionary stage of the world economy belongs to the American computer scientist N. Negroponte, but the genesis of digitalization should be sought much earlier [14].

According to I. A. Sedykh, the first successful example of digitalization of banking services was the creation of a stable operating ATM of Barclays Bank in London in 1969, which laid the foundation for the development of a new segment of the banking market — bank card products, and in 1970 Bank Americard was issued in the USA, which later transformed into international system Visa International [15].

The second stage is considered to be the period from 1980 to 2000. The "client-bank" methodology of remote banking services was formed at this stage, which is the basis of modern digital solutions and services.

The third stage covers the period from 2001 to 2010 when there was an active filling of the previously created client-banking platform with various services and products [16].

From 2011 to the present, the era of an open banking system has begun, which is gradually forming large-scale digital spaces with the involvement of an increasing number of representatives of the non-financial sector within the framework of thematic partnerships: businesses in FMCG, HoReCa, airlines, taxis (the most common examples), which most often are the sphere of interests of leading banks [17].

The COVID-19 outbreak in 2019–2020 became one of the most active catalysts in the entire history of the formation of remote banking services and, like spring, rapidly pushed the development of banking services, forcing to rethink traditional strategies and models of communication with customers. It should be noted that at present, the effect of a sharp start is still preserved, and in the next 2–3 years it will act as one of the key drivers of the intellectual development of digital banking in the world and in Russia.

Critical analysis of scientific and applied research of such foreign scientists as R. Amit, C. Zott [8], C. Burmeister, D. Lüttgens [9], J. Björkdahl, M. Holmen [18], streamline the development and implementation of innovations in the business models of the banking sector date back to the 1970s. In general, the evolution of the stages of transformation of business models in the banking sector can be represented as follows (*Table 2*).

Table 2 shows that the transition from a physical to a digital business model took place in a fairly short period of time, and recent years have demonstrated literally rapid development of the banking sector in the direction of digital optimization and personalization of virtual bank-client interaction.

RESULTS AND DISCUSSION

The key signal for the revolutionary transformation by banks of existing business models for organizing and promoting banking services for retail and corporate clients was the adoption in September 2015 by the government regulator of the UK banking system of an initiative to switch to the

Table 1

The content of the concept of "digital business model of banking services" in domestic and foreign literature

Author (s) / reference	Content of the concept
I. Foreign authors	
1. Amit R., Zott C. [8, p. 43]	Maximum use of the potential of digital technologies for the sale of banking products and services exclusively in a remote format
2. Burmeister C., Lüttgens D., Piller F. [9, p. 67]	A large-scale transformation of the architecture and infrastructure of banking sector processes to provide a product (service) to the client, in which his communication with the bank takes place in a virtual environment
3. Parker G., Van Alstyne M., Choudary S. [10, p. 145]	A new organization of banking services, which allows increasing the performance of all banking systems and personalizing the product (service), considering client's preferences
4. PWC Analytical reports*	The bank's work format is based on the use of social, mobile, and other digital technologies in order to reduce transaction costs and personalize banking services to increase its own competitiveness
II. Domestic authors	
1. Borovkov A.I., Ryabov Yu.A., Maruseva V.M.**	Strategy for the digital transformation of banking sector processes by transferring the mechanism for selling products (services) into a virtual format
2. Gaisina D.V.***	A conceptual vision of the implementation of a portfolio of banking products and services in the format of start-end digital chains on the Internet
3. Orekhova S.V. [12, p. 85]	A new stage in the development of the architecture of banking processes for the creation, management, implementation, and maintenance of banking products and services with the dominant use of innovative digital technologies
4. Melenkin V.L. [13, p. 45]	Conceptual implementation of the digital architecture of the future mechanism for the provision of banking products and services, reflecting the vision and interests of its functional stakeholders
5. IFRS "Financial Instruments" ****	The way an entity manages its financial assets to generate cash flows

Source: compiled by the authors based on the research of the specialized domestic and foreign scientific literature.

* Financial Services Technologies in 2020 and Beyond: Revolutionizing Change. Analytical report. PWC. (published on 14.12.2020). URL: https://www.pwc.ru/ru/banking/publications/_FinTech2020_Rus.pdf (accessed on 24.02.2021); Blurring the Boundaries: How FinTech Companies Are Impacting the Financial Services Sector: A Worldwide View of the FinTech Segment. PWC. (published on 09.05.2016). URL: https://www.pwc.ru/ru/banking/publications/fintech-global-report-rus.pdf (accessed on 24.02.2021).

** Digital Manufacturing: Methods, Ecosystems, Technologies. Skolkovo. URL: http://tpp74.ru/storage/tsifrovoe_proizvodstvo_112017.pdf (accessed on 12.02.2021).

*** Gaisina D.V. *Transformation* of modern business models towards ecosystems: Report at the conference "Designing business structures". *Business studio.* (16.09.2017). URL: https://www.businessstudio.ru/upload/iblock/7e6/Гайсина.pdf (accessed on 24.02.2021).

**** International Financial Reporting Standard (IFRS) 9 "Financial Instruments" (put into effect in the Russian Federation by order of the Ministry of Finance of Russia dated August 26, 2015, No. 133n). URL: http://www.consultant.ru/document/cons_doc_LAW_186221/ (accessed on 24.02.2021).

Table 2

Key stages of the evolution of the banking sector business models

The stage of development of business models in the banking sector	Stage description
1. Stage of the physical business model	*Chronological boundaries:* 1950–1970. *Stage content:* the banking sector is focused on the active development of a physical presence in the widest possible geographical area. Time of rapid growth of branches and representative offices of the bank in foreign countries. The use of remote services (radio, telephone, television) is of a targeted operational nature and, as a rule, is concentrated in the marketing block of the banking sector
2. Stage of the technocratic business model	*Chronological boundaries:* 1980–1990. *Features of methodological paradigms:* the banking sector is actively developing the technical side of its activities through the use of telephone tools, the emerging Internet connection for managing remote branches, as well as the formation of a new direction of activity — a remote banking service system as an independent business unit
3. Stage of the model of cross-border communications	*Chronological boundaries:* 1990–2000. *Stage content:* as the banking sector scales and goes beyond the national financial markets, a request arises to include in the business model the factor of foreign influence of stakeholders and the need for predictive management of their economic interests. Active development of the concept of accumulation of personal information, the first attempts to form a digital portrait of the client
4. Stage of the synergy model between banking and non-financial enterprises	Chronological boundaries: 2001–2011. Stage content: in order to increase its own competitive positions in the market, as well as develop a portfolio of cross-functional products and services, the banking sector is increasingly involving non-financial enterprises in its sphere of activity on the principles of partnership and technical collaboration (for example, cooperation of the bank with fintech companies, creation on the basis of the bank of venture funds to support innovations)
5. Stage of the digital business model of financial ecosystems and marketplaces	*Chronological boundaries:* 2011 — present. *Stage content:* the rapid growth of digital technologies and their rapid scaling led to the orientation of the bank's management towards the formation of digital markets that unite many independent physical and virtual enterprises, connected by partner contracts and operating in an autonomous zone of mutual non-competition, and since 2015 the market has formed a new message for the formation of business -models in the form of ecosystems — autonomous socio-economic systems that implement packages of products and services in one space via the Internet of Things (IoT)*

Source: compiled by the authors based on the data [19; 20, p. 3].

* Gaisina D.V. Transformation of modern business models towards ecosystems. URL: https://www.business studio.ru/upload/iblock/7e6/Гайсина.pdf (accessed on 24.02.2021).

Table 3

Characteristics of informative and methodological differences between traditional remote banking and digital banking

Comparison criterion	Traditional remote banking	Digital banking
1. Chronological boundaries	? — 2015 (for the EU — 2018)	2015 (2018) — present
2. Business model	Violent (a rigid vertical structure created by a bank based on a portfolio of services and the services it offers	Customer-oriented (banking is a constructor that responds flexibly to customers' requests and can adapt to their behavior)
3. The main source of information	Client's personal data constituting a bank secret	Open customer data, BigData about customer transactions, data from social networks, thematic discount cards, available to a certain scope of persons
3. Tools for the implementation of services	Package solutions or tariff plans that are strictly defined by the bank and are offered to the client (as a rule, it is difficult to change their functional composition)	Marketing, behavioral (software products are smart and capable of self-adaptation, considering the behavioral characteristics or lifestyle of the clients, their professional preferences)
4. Source of income for the bank	Commission for the client's performance of certain transactions based on the banking infrastructure	Commission fee for managing the client's personal data, ensuring the cybersecurity of his interaction on the Internet
5. Format of the banking service	Physically focused on its own infrastructure and specialists of a particular bank (the same service may differ qualitatively depending on the competencies of the bank's specialists)	Virtually focused on special infrastructure solutions of an open type (regardless of the bank, the client receives a service that is almost identical in quality and safety)
6. Tools for competition and customer acquisition	Pricing. Banks offer flexible rates and discount schemes, as well as loyalty programs in exchange for attracting customers	Technical. Banks attract customers with the convenience of solutions, availability, and a wide range of means of individualization of financial instruments

Source: compiled by the authors based on the data [15, p. 49; 22, p. 50–51].

application of open API standards (developed by the Open Banking Working Group[8]). This allowed banks to use data on customers of other organizations, considering the requirements of the privacy policy, to improve banking services and proactively respond to changing customer needs and requests. We emphasize that since January 13, 2018, the use of open API standards in the UK has become mandatory for the 9 largest banks in the country [21, p. 80].

Independently of the UK, in January 2016, the EU payment directive PSD 2 was adopted, which provided the client with the right to transfer the rights to manage financial transactions to third parties based on the open API standard [15, p. 22–23].

These two events became a bifurcation point in the development of banking services: everything that was in force before the adoption of the open API standard is called traditional remote banking, and everything that was later is called digital banking. *Table 3* presents substantive and methodological differences between traditional remote banking and digital banking in more detail.

The information summarized in *Table 3* allows us to conclude that digital banking is a qualitatively new technical and functional add-on, which is a free designer for the formation of unique financial marketplaces, considering the needs of a particular retail client or corporate business needs.

The trends analysis of digitalization in the banking sector allowed us to identify three main business models for organizing digital banking that are currently used in world practice: Anglo-American, European and Russian. A more detailed description of each of them is given in *Table 4*.

It is noteworthy that the patterns of digital banking development are directly related to the concept of Fintech — a market segment that combines pure financial services and high technologies into original products for implementation in virtual reality without reference to a specific physical location of the bank. This means that it is fair to analyze the development of new digital business models for the sale of banking products precisely from the position of the Fintech market [24].

To assess the scale of the development of digital banking as a key product of the Fintech market, let us present the dynamics of its penetration into the banking systems of the main geographic zones of the world (*Fig. 1*).

The *Fig. 1* data show that the UK was the most developed geographic center of digital banking in 2019–71.0% of all financial transactions in the country were carried out through digital banking mechanisms. The Asian region (Singapore and Hong Kong) ranked second — 67.0% each, third — Australia — 58.0%. It is interesting to note that in the United States, despite the highest level of development of digital technologies, the share of digital banking was only 46.0%.[9]

Based on the data of the E&YGlobal Fin Tech Adoption Index-2019, we will consider the most promising banking services for digitalization (the rating is based on the volume of transactions made by customers) (*Fig. 2*).

According to *Fig. 2*, we can conclude that in 2015–2019 the main development was received by the least regulated instruments of banking services: P2P, P2B money transfers — 75.0%, in second place — investments and savings — 48.0%, in third place — services for household budgeting and planning — 34.0%. The least widespread are complex products with a high level of risk of losses for banks or non-financial companies: insurance — 29%, borrowing — 27%.

[8] Information and analytical review "The Russian banking system today" (September 2019). URL: https://asros.ru/upload/iblock/c30/20397_informatsionnoanaliticheskoeobozreniesentyabr2019.pdf (accessed on 17.01.2021).

[9] Omelchuk N. Fin Tech conquered the world: EY research (25.10.2019). URL: https://psm7.com/fintech/fintech-zavoeval-mir-issledovanie-ey.html (accessed on 18.01.2021).

Table 4

Main business models of digital banking and their characteristics

Business model	Business model description
1. Anglo-American	*Formation factors:* – the highest level of Internet access in the world (95.0%)*; – growth of public and business confidence in digital providers in terms of personal data (in the UK, the cybersecurity index was 0.931, in the USA – 0.926)**; – the formation of a large-scale integrated market for services due to the technical cooperation of the companies of the FAMGA group (Facebook, Apple, Microsoft, Google, and Amazon) and BAT (BAIDU, ANTFINANCIAL, TENCENT)***; – policy of strict isolation and quarantine during the COVID-19 pandemic in the United States, China. *Description of the business model.* Creation of autonomous platforms for the integration of banking services into gadgets and other personal digital devices in order to create a barrier-free environment for obtaining banking services "here and now". The business model is distinguished by the active integration of banks into the non-financial sphere of clients' lives and its seamless integration into the client's life rhythm, as well as the tools for developing their own financial solutions
2. Russian	*Formation factors:* – active innovation policy of the Big Three Russian banks (Sberbank, Tinkoff Bank, Alfa-Bank); – the policy of protectionism on the part of the banking regulator (Bank of Russia) and strategic goals for the creation of domestic digital banking systems; – large-scale state programs for digitalization of the economy (National Program "Digital Economy of the Russian Federation" dated 04.06.2019 No. 7); – reaching a ceiling on market growth on the part of the largest Internet providers (Rostelecom, MTS). *Description of the business model.* In the Russian digital banking business model, individual banking players are developing standalone solutions that are not yet ready to combine their customers' data into a single transparent library for sharing. Due to strong competitive sentiment, banks are producing similar products, spending money on solving the same problems many times, instead of productive cooperation within the framework of national projects to digitalize the economy
3. European (EU countries)	*Formation factors:* – the need to create cross-border solutions in the field of financial services for the convenience of making retail and corporate transactions between the countries of the union; – active growth of customer interest and the need to unify requirements for working with personal data, cybersecurity, and countering fraudulent transactions; – moral and physical obsolescence of traditional banking portfolios of services. *Description of the business model.* The EU countries form digital banking based on the adoption of uniform standards for the processing of personal data of clients and the granting of the right to the client to distribute personal information among certain persons, for example, business structures, taking into account the provision of an appropriate level of cybersecurity. As a rule, each country individually develops its own innovative direction, considering the specifics of the banking sector and national priorities

Source: compiled by the authors based on data [14, 17, 23].

* Sergeeva Y. Internet statistics in 2019 – in the world and in Russia. (11.02.2019). URL: https://www.web-canape.ru/business/vsya-statistika-interneta-na-2019-god-v-mire-i-v-rossii/ (accessed on 18.01.2021).

** Public confidence in network technologies and services. (20.06.2019). URL: https://issek.hse.ru/data/2019/06/20/1488856771/NTI_N_133_20062019.pdf (accessed on 17.01.2021).

*** FINTECH World Market (2019). URL: https://innoagency.ru/files/FinTech_StartupCafe_2020.pdf (accessed on 18.01.2021).

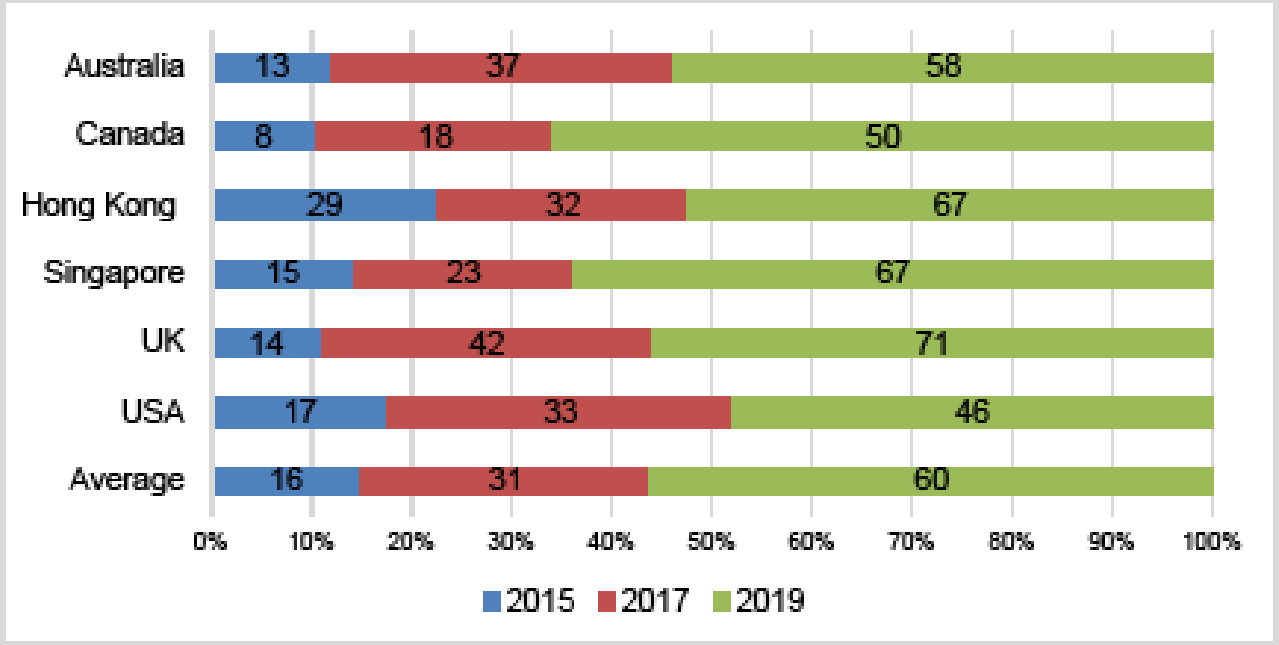

Fig. 1. **The level of development of digital banking in the main geographical zones of the world, %**

Source: Global Fin Tech Adoption Index 2019 (2019). URL: https://assets.ey.com/content/dam/ey-sites/ey-com/en_gl/topics/banking-and-capital-markets/ey-global-fintech-adoption-index.pdf (accessed on 17.01.2021).

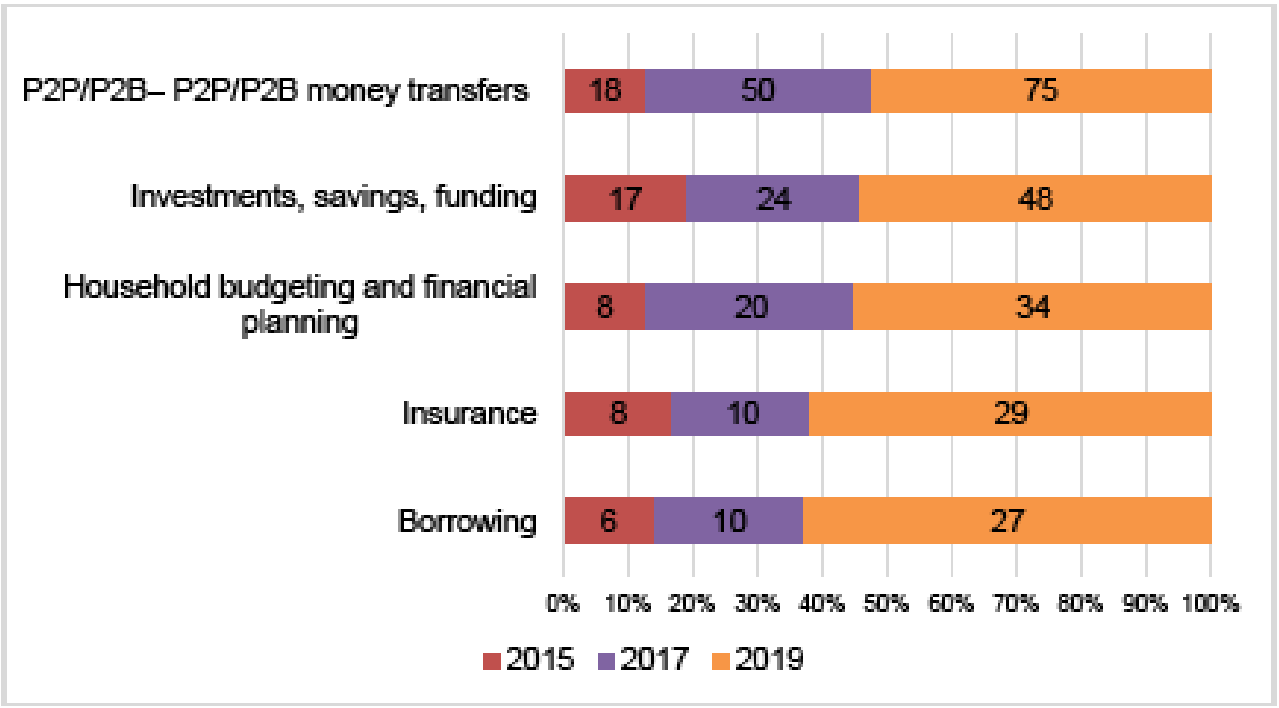

Fig. 2. **The most promising bank services for digitalization (world practice), %**

Source: Global Fin Tech Adoption Index 2019 (2019). URL: https://assets.ey.com/content/dam/ey-sites/ey-com/en_gl/topics/banking-and-capital-markets/ey-global-fintech-adoption-index.pdf (accessed on 17.01.2021).

Table 5

General dynamics and key areas of investment in the fintech industry in 2014–2019 (I and II quarters)

Indicator	2014	2015	2016	2017	2018	2019 (1/2 of the year)
1. Total investment in the Fintech industry market, total, USD billion *Including:*	70.4	92.1	141.1	148.1	270.2	109.4
1.1. Blockchain and cryptocurrency investments	0.7	0.5	0.7	4.9	5.0	1.0
1.2. Cybersecurity investment	60.1	78.9	120.0	128.9	250.5	102.6
1.3. Investment in regulatory technology	3.9	1.2	3.7	1.3	3.9	1.5
1.4. Insurance investments (innovative insurance products)	3.7	3.1	12.1	10.0	7.6	1.1
1.5. Digital management solutions investments	1.7	8.0	3.6	2.5	1.8	2.2
1.6. Development and real estate investments (in terms of financing the construction industry)	0.3	0.4	1.0	0.5	1.4	1.0

Source: The Pulse of Fintech 2019. Biannual global analysis of investment in fintech (31 July 2019). URL: https://assets.kpmg/content/dam/kpmg/xx/pdf/2019/07/pulse-of-fintech-h1–2019.pdf (accessed on 19.01.2021).

To understand the development trends of the global Fintech industry market, let us consider the general dynamics of investments in this segment of the financial market and, in particular, key areas for 2014–2019 (data are available for the 1st half of the year) (*Table 5*).

According to *Table 5* data, the key place in the object-thematic direction of investment was taken by cybersecurity — on average, this area accounted for US $ 123.5 billion per year (88.3% of the total investment), in second place — insurance investment — US $ 6.3 billion per year (4.6%), in third place — investments in digital solutions in the field of investment management — US $ 3.3 billion per year (3.0%). At the same time, such popular technologies as blockchain accounted for 1.4% of all investments in Fintech. Practical technologies in development finance also accounted for a very small share — 0.6%.

The reasons for this investment "unpopularity" of the two indicated areas are the legal unsettledness of the status of the first object (currently only 10 countries officially recognize the blockchain technology and bitcoin as a financial instrument and means of payment, respectively[10]) and the absence of a single regulatory act or a single mechanism for bank financing of development projects

[10] Top 10 countries where cryptocurrency is allowed (05.01.2021). URL: https://bitexpert.io/wiki/cryptocurrencies/top-10-stran-gde-razreshena-kriptovalyuta/ (accessed on 18.01.2021).

Table 6

Dynamics of indicators of driver factors in the formation of digital business models of banking in the Russian Federation in 2015–2019

Indicator	2015	2016	2017	2018	2019
1. The share of citizens with Internet access, %	72.1	74.8	76.3	76.6	76.9
1.1. Including broadband internet	66.8	70.7	72.6	73.2	73.6
2. The share of financial sector enterprises using high-tech services, % (for 2019, data are estimated)	18.4	20.1	30.1	33.8	36.2
3. Index of digitalization and intensity of use of digital technologies in the financial sector, %	29.8	33.6	34.7	40.0	41.6

Source: compiled by the authors. Gorodnikova N.V., Gokhberg L.M., Ditkovsky K.A. and others. Indicators of innovation: 2018. Statistical collection. Moscow: National Research University Higher School of Economics; 2018.p. 13, 146, 149. Gokhberg L.M., Ditkovsky K.A., Kuznetsova I.A. and others. Indicators of innovation: 2019. Statistical collection. Moscow: National Research University Higher School of Economics; 2019. p. 13, 14, 166.

and real estate (in the world there are at least 3 different models of organization of mortgage lending and more than 20 different laws on mortgages) [25].

In Russia, digital banking business models are developing rather unevenly and contradictory. At the same time, experts note the following key trends:

• the active development of Internet traffic in the Russian Federation has become a key driver of growth in the Fintech market: according to the All-Russian Omnibus GfK, by the beginning of 2019 the number of Internet users aged 16+ amounted to 90 million people or 75% of the total adult population of the country.[11] The share of financial organizations using cloud services (as an integral element of the digital business model of a banking organization) amounted to 33.8% at the beginning of 2019 [26];

• stable growth of e-commerce and services in e-commerce, which is objectively impossible without the corresponding development of P2B and P2P bank transfer services. At the same time, the share of entrepreneurial organizations using high-tech services for doing business online amounted to 30.1% at the beginning of 2019 [10, 15];

• the index of digitalization and the intensity of the use of digital technologies in the financial sector at the beginning of 2019 amounted to 40.0%, which also significantly hinders the development of digital business models of banking since only the largest players in the banking sector allow the implementation of large infrastructure projects for the transition to full-fledged digital banking.

[11] GfK Research: Internet Penetration in Russia (15.01.2019). URL: https://www.gfk.com/ru/press/issledovanie-gfk-proniknovenie-interneta-v-rossii (accessed on 19.01.2021).

Table 7

Main business models of digital banking implementation in the Russian Federation

Business model	Business model description
1. Digital banking brand	*Types of banks using a business model* Classic banks with a rigid vertical architecture and a large-scale physical presence in the market. *Drivers of digitalization:* – a large client base of various ages, lifestyles, social and professional statuses; – the need to maintain a loyal attitude of customers to the existing line of banking products, while at the same time the impossibility and (or) reluctance of management to revolutionize the product portfolio; – large-scale infrastructure and proprietary software systems that require maintenance costs. *Features of the business model* Old-school banks, due to the reluctance and (or) impossibility of large-scale changes in the portfolio of banking products, create branded versions based on traditional products with options available only to certain categories of customers or under certain conditions (for example, placing a deposit in the amount of at least US $ 100 thousand). *Examples of banks*: Tochka, Delobank, Rocket-Bank
2. Bank with digital channels	*Types of banks using a business model* Banks create separate divisions or subsidiaries that operate on the basis of a parent license and implement separate, as a rule, specialized digital products or services. *Drivers of digitalization:* – the need to diversify the banking portfolio of service products; – decrease in marginality for regular banking products; – the need to consolidate or expand the client base (usually the market for such banks is limited to a specific region or even a city). *Features of the business model* The bank's management finances and forms a turnkey new structural business unit that provides specialized services or sells assistance products under the parent license. In the future, a procedure for separating a business structure into an independent Fintech business or carrying out a buyback procedure (the subsidiary buys control over the parent bank) is possible. *Examples of banks:* Sphere, Prosto Bank, Megafon Bank
3. Digital branch of the bank	*Types of banks using a business model* Medium and large banks that are developing a long-term strategy for digitalizing business processes by reforming the parent business model based on a pilot project — a digital branch, which is actually a twin of the bank, but whose products and services are based on the digital economy. In the future, this experience can be extended to the entire bank, or the parent bank can be liquidated as unprofitable. *Drivers of digitalization:* – increasing the competitive position in the rating of banks; – participation in the management of a promising startup project; – testing the possibilities of restructuring the business model on the example of a separate branch. *Features of the business model* Features of the business model. As part of the parent business model, a separate branch, or a new branch created from scratch, is organized according to the latest achievements of Industry 4.0. The bank's management evaluates the performance of the branch, and in case of satisfactory performance, the model is scaled to the entire bank. *Examples of banks:* Elba Bank, TalkBank.

Table 7 (continued)

Business model	Business model description
4. Completely digital bank	*Types of banks using a business model* Large and super-large banks, which, as part of the restructuring strategy, decided to completely reformat the business model of organizing banking services, or were initially distinguished by the maximum interest in innovative solutions. *Drivers of digitalization:* – strengthening the position of market leadership in the banking services market; – obtaining unique competitive and technological advantages that can be used for banking expansion in other countries; – increasing the credibility and business reputation of the bank as a market expert in the field of innovations; – participation of the bank in complex non-standard projects and government programs requiring the development of innovative tools. *Features of the business model* Banks with such a model are digital twins of real banks with a request to form a banking ecosystem by involving non-financial market agents in the orbit of their influence and forming partnership agreements with them on a joint work strategy. *Examples of banks:* Sberbank, Bank 131, Tinkoff Bank

Source: compiled by the authors based on data [24, 26, 27, 33].

The dynamics of indicators of driver factors in the formation of digital business models of banking in Russia for 2015–2019 are summarized in *Table 6*.

Compared to the indicators of the leading countries, the Russian digital banking market is distinguished by the concentration of technological competencies directly in the banking system, or rather in a number of super-large banks from the Big Three and a number of innovative and active banks. According to experts, this is due either to the weakness of Fintech projects or to their absence in statistical accounting [15].

Our analysis allows us to conclude that Russian banks are currently implementing digital banking in the following business models (*Table 7*).

Another trend in the implementation of digital business models of banking products in Russia is the uneven distribution of digital services: for example, according to KPMG, 86% of Russian banks in the top 20 have their own programs for the development of digital technologies, and there is no information on the rest of the banks. It can be concluded that less than 20 domestic banks are the driving force behind digitalization, and out of the top 20, only 3 allocate regular budgets to finance projects in the field of digitalization of banking services and products (*Fig. 3*).

Fig. 3 shows that Sberbank is leading in the digital development of the banking sector — on average, its annual budget for financing projects in the field of digitalization of banking services and products was 91.4 billion rubles in 2014–2018 (for full years). VTB Bank is in second place — 9.6 billion rubles, Rosselkhozbank is in third place — 4.4 billion rubles.

Russian banks have different visions of strategies for the further development of digital business models of banking services,[12]

[12] Banking UX Trends 2020: Artificial Intelligence, Voice Assistants, and Hyperpersonalization (30.01.2020). URL: https://vc.ru/design/102910-ux-trendy-bankinga-2020-goda-iskusstvennyy-intellekt-golosovye-pomoshchniki-i-giperpersonalizaciya (accessed on 19.01.2021); Financial Services Technologies in 2020 and Beyond: A Revolutionary Change (2020). URL: https://www.pwc.ru/ru/banking/publications/_FinTech2020_Rus.pdf (accessed on 17.01.2021).

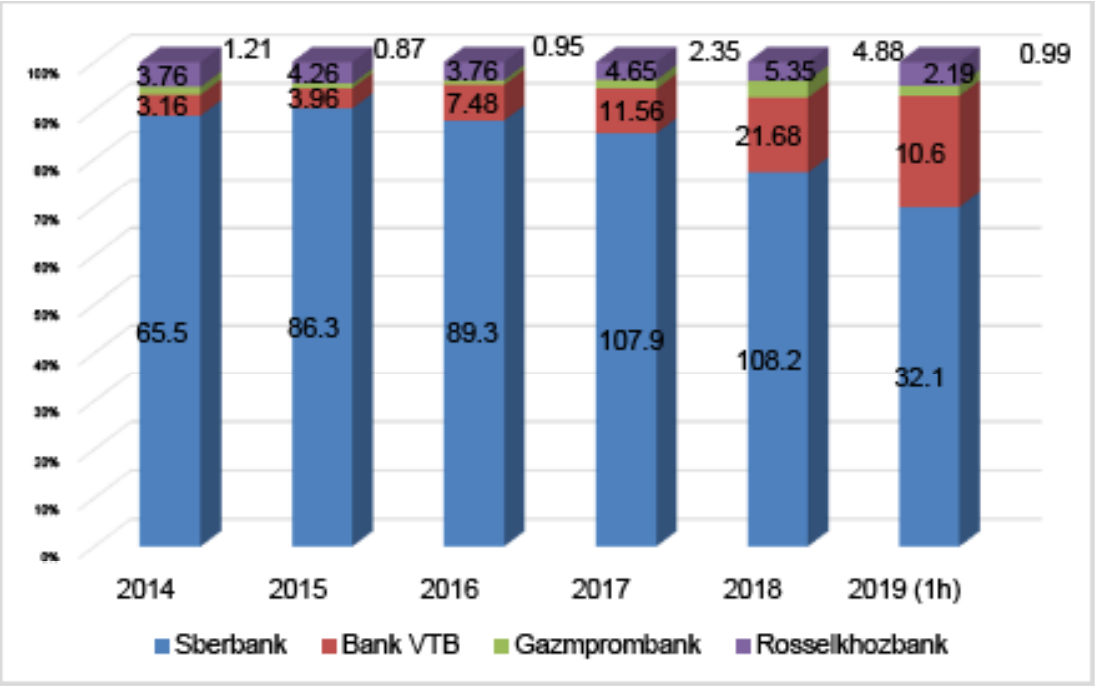

Fig. 3. **The volume of budgets for financing projects in the field of digitalization of banking services and products, billion rubles**

Source: FINTECH 2019 annual research of the financial technology market in Russia (2019). URL: https://ict.moscow/static/f1c840b8–468c-5a33-b94b-f15ee9f66230.pdf (accessed on 18.01.2021).

but in general, they can be structured into the following groups:

1. **The de facto standard** — the bank develops norms and criteria for the implementation of a banking product, which are mandatory for all customers [27, 28]. The innovativeness and personification of such a model, as a rule, is low and limited by the framework of the legislation. These include, for example, money transfer instruments:

- U-Money (formerly Yandex.Money) has been successfully integrated into the system of the Unified and Regional Portal of State and Municipal Services, but the possibility of forming an individual set of services is limited by the functionality of partner portals;
- the practice of transfers by phone number both between the accounts of one client and different clients, including abroad: from June 29, 2020, the Mir payment system launched cross-border transfers to cards of national payment systems of the CIS countries, which imposes restrictions on transfers to bank cards of local payment systems;
- the use of QR codes for making payments in the e-commerce system (such a service is provided by TalkBank in the format of the "Paylastic.me" product). The convenience of this product is encrypted storage of data about the user of the bank account and increased security of the money transfer operation, but its functionality depends on the beneficiary of the payment and its technical equipment [32].

2. **Switch** — development of individual and digital solutions based on proprietary technologies and infrastructure [29]. Thus, Tinkoff Bank offers the client to build their own banking platform, considering the age, needs, professional status of clients.

3. **Pyramid of products** — providing customers with the opportunity to create their portfolio of products or services from independent digital blocks based on the use of smart contracts [30].

Currently, such a model is available only for corporate clients of Sberbank, VTB Bank, and Rosselkhozbank when carrying out factoring and leasing operations, as well as when receiving subsidies for a farm. As part of the corporate cabinet, the client collects a diagram of connections between business partners, describes their functions, and determines financial flows, then this model is agreed with all participants and, with their common consent, a chain of smart contracts is created, within which financial transactions.

4. **Blockbuster model** — a high-tech company brings together, within a certain project or platform, various business agents from Fintech, physical business, and IT to create a cross-industry product (for example, a remote fare payment system, video surveillance system, and perimeter security, including "smart home", "smart factory" systems from CELENO, Euro Mobile, Wo Master) [27, 29].

5. **Customization model** — platforms for social engineering and implementation of systems of invisible indicators to ensure the personal and public safety of large industrial, transport projects of corporate clients [29, 30]. Solutions are developed exclusively individually for the requests of specific projects, for example:

- artificial intelligence systems for assessing the risk of fraud in the implementation of multilateral investment projects;
- predictive analytics systems for online tariff adjustment for toll motorways, for example, Western High-Speed Diameter in St. Petersburg, considering the peculiarities of the user's social status, for example, disability;
- systems for blocking card accounts when a client visits prohibited or restricted places to visit, for example, a casino;
- "invisible payments" — VisionLab offers the installation of a special chip in electric cars linked to the owner's bank account, which will allow him to remotely pay for charging the car using a bank card. This solution is relevant to ensure the safety of both the owner and the operator of gas stations in areas with dense development.

It should be noted that there are very few independent Fintech projects with a full-cycle digital personalization business model in the country, although experts note that, according to various estimates, the number of potential applicants for the status of digital banks among Fintech companies ranges from 200 to 300. However, there is not a single unicorn startup in Russia yet, although the neobank segment is actively growing (for example, Tinkoff Bank is a full-fledged online bank with multifunctional digital services without a network of its own branches).[13]

As for traditional banks, the most prepared for digitalization and integration of financial technologies are: Tinkoff Bank, Sberbank, Alfa-Bank, Raiffeisenbank, AK Bars, Rosbank, VTB Bank, Russian Standard Bank, Bank Saint Petersburg, and Uralsib Bank [24, 31].

CONCLUSIONS

The processes of digitalization of the economy are rapidly penetrating all aspects of the life of society and the socio-economic system, changing both the mental attitude to electronic and virtual technologies that have entered our reality and the purely pragmatic perception, due to the driving forces of competitiveness, optimization, and comfort. This is directly related to the banking sector. The result is the transformation of services, infrastructure, mobile and electronic technologies.

Despite a significant amount of research by domestic and foreign authors devoted to the digital transformation of banks, the introduction of new banking technologies,

[13] Digital Banking Maturity — 2020. How banks are responding to the digital revolution/evolution? (September 2020). URL: https://www2.deloitte.com/content/dam/Deloitte/ru/Documents/research-center/DBM_2020_rus.pdf (accessed on 19.01.2021).

the formation, and development of modern banking infrastructure, the development of digital business models of banking services have not been deeply studied.

In this regard, the value of this scientific study lies in the fact that the authors for the first time identified and systematized modern trends and patterns in the development of digital business models of banking services in Industry 4.0. Based on the latest scientific works of Russian and foreign scientists, this study proposes its own conceptual vision of the concept of "digital business model of banking services", which is distinguished by originality and depth of presentation of the features of new electronic interaction technologies between the bank and customers.

The authors have summarized the main stages of the evolution of business models of the banking sector, identified substantive and methodological differences between traditional remote and digital banking, identified the main business models for organizing digital banking.

The article presents relevant data on the level of development of digital banking in the main geographic areas of the world, the dynamics of investments, and key areas of investment in the Fintech industry in 2014–2019 and a critical analysis of its condition is given. In addition, the authors identified problematic aspects of the development of digital business models of banking, as well as described the functionality of the main digital business models of Russian banks with the author's assessment of their capabilities and examples of their use in Russia.

The article makes a significant theoretical and practical contribution to the generalization and systematization of the processes of digitalization of the banking sector in Russia and the development of promising business models of banking services in Industry 4.0, taking into account the national goals and objectives of sustainable development.

We believe that identifying and systematizing trends and patterns in the implementation of digital business models of banking services can form the basis for further analysis of the specifics of digitalization and personalization of digital banking in Industry 4.0 in the context of summarizing data on financial effects for initiating banks, updating the significance of innovative digital services and products for the sustainable socio-economic development of the country in terms of possible advantages and threats to the security of financial resources and personal data of customers.

ACKNOWLEDGMENT

The article was written within the framework of the state assignment of the Market Economy Institute of the Russian Academy of Sciences, the topic of the research is "Institutional transformation of economic security in solving socio-economic problems of sustainable development of the national economy of Russia". Market Economy Institute of the Russian Academy of Sciences, Moscow, Russia.

REFERENCES

1. Magomaeva L.R. Banking innovations in the digital economy: Theory and practice. Doct. econ. sci. diss. Vladikavkaz: Khetagurov North Ossetian State University; 2020. 367 p. (In Russ.).
2. Zakshevski V., Pashuta A. Theoretical aspects of innovative banking products at the present stage. *Vestnik Voronezhskogo gosudarstvennogo agrarnogo universiteta = Vestnik of Voronezh State Agrarian University*. 2015;(3):214–220. (In Russ.).
3. Popova T. Yu. Evaluation of the effectiveness of financial innovations implemented by banks with state participation. *Finansovaya analitika: problemy i resheniya = Financial Analytics: Science and Experience*. 2011;(6):21–28. (In Russ.).

4. Timchenko A. A. The modern directions of development of financial innovations in banking. *Politematicheskii setevoi elektronnyi nauchnyi zhurnal Kubanskogo gosudarstvennogo agrarnogo universiteta = Scientific Journal of KubSAU*. 2012;(83):596–605. (In Russ.).
5. Bubnova Yu. B. Transformation of bank's business model in terms of digital economy. *Izvestiya Baikal'skogo gosudarstvennogo universiteta = Bulletin of Baikal State University*. 2019;29(3):425–433. (In Russ.). DOI: 10.17150/2500–2759.2019.29(3).425–433
6. Belous A. P., Lyal'kov S. Yu. The vector of development of banks in the stream of the digital revolution. *Bankovskoe delo = Banking*. 2017;(10):16–19. (In Russ.).
7. Pertseva S. Yu. Digital transformation of the financial sector. *Innovatsii v menedzhmente = Innovations in Management*. 2018;(4):48–52. (In Russ.).
8. Amit R., Zott C. Creating value through business model innovation. *MIT Sloan Management Review*. 2012;53(3):41–49. URL: http://aproaingenieria.com/intranet/uploads/creating-value-through-business-model-innovation.pdf
9. Burmeister C., Lüttgens D., Piller F. T. Business model innovation for Industrie 4.0: Why the "Industrial Internet" mandates a new perspective on innovation. *Die Unternehmung*. 2016;72(2):124–152. DOI: 10.5771/0042–059X-2016–2–124
10. Parker G. G., Van Alstyne M. W., Choudary S. P. Platform revolution: How networked markets are transforming the economy — and how to make them work for you. New York: W. W. Norton & Co.; 2016. 352 p. (Russ. ed.: Parker G., Van Alstyne M., Choudary S. Revolyutsiya platform. Kak setevyye rynki menyayut ekonomiku — i kak zastavit' ikh rabotat' na vas. Moscow: Mann, Ivanov and Ferber; 2017. 304 p.).
11. Orekhova S. V. Industrial enterprises: electronic vs traditional business model. *Terra Economicus*. 2018;16(4):77–94. (In Russ.). DOI: 10.23683/2073–6606–2018–16–4–77–94
12. Melenkin V. L. Social innovations: Essential content and forms of manifestation in the post-coronavirus era. *Ekonomika i ekologiya territorial'nykh obrazovanii = Economy and Ecology of Territorial Formations*. 2020;4(2):43–49. (In Russ.). DOI: 10.23947/2413–1474–2020–4–2–43–49
13. Ruchkina G. F. Banking activity: Transfer to new operation model, or Fintech as new reality. *Bankovskoe parvo = Banking Law*. 2017;(4):55–62. (In Russ.).
14. Sedykh I. A. Market of innovative financial technologies and services. Moscow: NRU HSE; 2019. 76 p. (In Russ.).
15. Alontseva V. R. Assessment of digital banking in the Russia. *Mezhdunarodnyi zhurnal gumanitarnykh i estestvennykh nauk = International Journal of Humanities and Natural Sciences*. 2018;(5–2):88–91. (In Russ.).
16. Dolgushina A. Ya. Evolution of types and models of banking services. *Finansy i kredit = Finance and Credit*. 2016;(36):34–49. (In Russ.).
17. Björkdahl J., Holmen M. Business model innovation — the challenges ahead. *International Journal of Product Development*. 2013;18(3–4):213–225. URL: http://www.businessmodelcommunity.com/fs/Root/azvr9-Bjorkdahl_and_Holmen_Business_Model_Innovati_on_The_challenges_ahead.pdf
18. Ramdani B., Rothwell B., Boukrami E. Open banking: The emergence of new digital business models. *International Journal of Innovation and Technology Management*. 2020;17(5):2050033. DOI: 10.1142/S 0219877020500339
19. Dvoeglazova I. A. Banks of the future: Integration with IT services or multi-format business. *Molodoi issledovatel' Dona*. 2018;(3):161–164. (In Russ.).
20. Sulimenko O. V., Ryabova K. A. Development of digital banking and fintech companies. *Finansovye issledovaniya*. 2019;(4):78–83. (In Russ.).
21. Dmitrieva G. S. Digital technologies in the banking sector of economy. *Izvestiya Sankt-Peterburgskogo gosudarstvennogo ekonomicheskogo universiteta*. 2020;(1):49–53. (In Russ.).

22. Rekha I.S., Basri S., Kavitha T.C. Acceptance of internet banking: Comparing six theoretical models. *Indian Journal of Finance*. 2020;14(3):7–21. DOI: 10.17010/ijf/2020/v14i3/151073
23. Kokh L., Kokh Yu. Banks and fintech companies: Competitors or partners. *Vestnik Zabaikal'skogo gosudarstvennogo universiteta = Transbaikal State University Journal*. 2019;25(6):111–121. (In Russ.). DOI: 10.21209/2227–9245–2019–25–6–111–121
24. Povetkina N.A., Ledneva Yu.V. Fintech and regtech: Boundaries of legal regulation. *Pravo. Zhurnal Vysshei shkoly ekonomiki = Law. Journal of the Higher School of Economics*. 2018;(2):46–67. (In Russ.). DOI: 10.17323/2072–8166.2018.2.46.67. (In Russ.)
25. Yusupova O.A. Online banking as an area of banking digitalization: The conditions, issues, prospects. *Finansovaya analitika: problemy i resheniya = Financial Analytics: Science and Experience*. 2016;(34):12–25. (In Russ.).
26. Slobodenyuk D.D., Pavlova A.M. Innovative banking products. *Ekonomika i biznes: teoriya i praktika = Economy and Business: Theory and Practice*. 2020;(5–2):184–188. (In Russ.). DOI: 10.24411/2411–0450–2020–10455
27. Shikhiev A.A. Digitalization of payment services on the example of "open banking". *StudNet*. 2020;3(9):938–950. (In Russ.). DOI: 10.24411/2658–4964–2020–10227
28. Dhote T., Pathak P., Kulkarni P. Coping with the challenges posed by GAFA and other digital disruptors: Can advanced technologies help the banking sector? *International Journal of Scientific and Technology Research*. 2020;9(2):2196–2199. URL: http://www.ijstr.org/final-print/feb2020/Coping-With-The-Challenges-Posed-By-Gafa-And-Other-Digital-Disruptors-Can-Advanced-Technologies-Help-The-Banking-Sector.pdf
29. Gandolfo A. Content shared between banks and users on the social ecosystem: An inductive exploratory inquiry. *Electronic Commerce Research*. 2020;20(4):679–712. DOI: 10.1007/s10660–019–09340-z
30. Sergeeva A.D., Zakharova O.V. Neobanks in Russia: Features and their influence on the economy. *Mezhdunarodnyi zhurnal gumanitarnykh i estestvennykh nauk = International Journal of Humanities and Natural Sciences*. 2019;(12–3):146–150. (In Russ.). DOI: 10.24411/2500–1000–2019–11953
31. Nikonets O.E., Popova K.A. Remote banking as an element of the modern bank ecosystem. *Vestnik Volzhskogo universiteta im. V.N. Tatishcheva = Vestnik of Volzhsky University named after V.N. Tatischev*. 2020;2(1):280–292. (In Russ.).
32. Westermeier C. Money is data — the platformization of financial transactions. *Information Communication and Society*. 2020;23(14):2047–2063. DOI: 10.1080/1369118X.2020.1770833

ABOUT THE AUTHORS

Mikhail N. Dudin — Dr. Sci. (Econ.), Prof., Deputy Director for Science, Market Economy Institute, Russian Academy of Sciences, Moscow, Russia
dudinmn@mail.ru

Sergei V. Shkodinskii — Dr. Sci. (Econ.), Prof., Head of the Laboratory of Industrial Policy and Economic Security, Market Economy Institute, Russian Academy of Sciences, Moscow, Russia; Chief Researcher at the Center for Sectoral Economics, Financial Research Institute, Moscow, Russia
sh-serg@bk.ru

Daler I. Usmanov — Cand. Sci. (Econ.), Assoc. Prof., Senior Researcher of the Laboratory of Problems of Spatial Development, Market Economy Institute, Russian Academy of Sciences, Moscow, Russia
us.dali@mail.ru

Authors' declared contribution:
Dudin M.N. — statement of the problem, development of the concept of the article, generalization of the results on the problems of the development of digital banking.
Shkodinskii S.V. — description of the results, formation of research conclusions, critical analysis of the literature.
Usmanov D.I. — collection of statistical data, tabular and graphical presentation of the results.

The article was submitted on 05.03.2021; revised on 20.03.2021 and accepted for publication on 27.08.2021.
The authors read and approved the final version of the manuscript.

ORIGINAL PAPER

DOI: 10.26794/2587-5671-2020-25-5-79-91
UDC 336.018(045)
JEL C30, D12, Q41, Q48

Analysis of Energy Projects Financial Efficiency and Renewable Energy Generation in Russia

J. An[a], A.Yu. Mikhaylov[b]
[a] College of Business, Hankuk University of Foreign Studies; Seoul, South Korea;
[b] Financial University, Moscow, Russia
[a] https://orcid.org/0000-0001-5410-7506; [b] https://orcid.org/0000-0003-2478-0307

ABSTRACT

The authors study the development of the oil and gas industry and assess the financial efficiency of the use of renewable energy sources, which determine the **relevance** of the research topic. **The purpose** of this work is to study the effectiveness of the development of the Russian energy sector and its contribution to the world economy. The main question to which this article should give an answer is that how the Russian power industry will develop in corresponding to the global trends in energy consumption. This paper **uses a method** for finding the parameters of the efficiency of renewable energy sources using exponential smoothing. The paper uses data from the analytical report of British Petroleum and the Bloomberg system for the period from January 2012 to December 2019. **The result** of the study shows an improvement in the accuracy of the predicted values, while previous models had higher standard error estimates. **The novelty** of the study is to achieve accurate results of the forecast of fossil-fuel consumption for 3 years ahead (the forecast accuracy is 80.5). The article **concludes** that while Russian oil and gas projects are very important for the Russian economy until now, renewable energy projects are more beneficial. In addition, Russia does not seem to support the global trend towards a renewable and sustainable economy. Although oil and gas prices remain acceptable, unforeseen changes in the behavior of real buyers can hinder the efficiency of the Russian economy and lead to a disruption of Russia's economic growth if Russia does not decisively steer towards renewable energy from now on. The growth of the Russian power industry corresponds to the global trends in fossil energy consumption (while fossil prices, thus incomes keep worsening), and thus innovative solutions for enhancing renewable energies must be adopted. The article proves that many pipeline projects (South Stream, Turkish Stream, Nord Stream 2) move the Russian energy sector back to the past because they just contradict existing trends.

Keywords: Power consumption; Energy resources; Natural gas; Hydropower; Electrical grids; Stock quotes movement

For citation: **An J., Mikhaylov A.Yu. Analysis of energy projects financial efficiency and renewable energy generation in Russia. *Finance: Theory and Practice.* 2021;25(5):79-91. DOI: 10.26794/2587-5671-2021-25-5-79-91**

INTRODUCTION

The development of the oil and gas industry financial efficiency determines the relevance of the research topic. The purpose of this article is to study the development of Russia's energy sector and its contribution to the global economy. The tasks included are the analysis of the biggest and most important projects of the Russian energy industry that have an impact on a global scale. Furthermore, the article analyzes activities of large market participants such as Gazprom, which is actively working in Europe, and giving the opportunity to reduce the consumption of coal. It allows to reduce emissions into the atmosphere. Secondly, the wide use of renewable energy sources (RES), like solar and wind energy, becomes possible.

The article novelty consists in the analysis of modern Russian Oil and Gas projects using a modified random forest ensemble model [1–3]. This research paper is the first to include these analytical methods.

The power industry in Russia is under state control. In other words, the government owns over 50% of stocks of Gazprom, RusHydro and the Federal Grid Company of Unified Energy System. This allows them to plan the work of the three monopolies exclusively in the interests of the state and of their own company interests. The investment activities of Gazprom particularly should be emphasized. Their large-scale plans will offer resources that are additionally needed by the Chinese economy, as many of their projects are located in the general area of these countries. Projects in Yamal and especially the Amur oil refinery are accompanied by multi-million-dollar credits from European and Asian banks [4, 5].

The main hypothesis is that recent trends, which are manifested as a slowdown in global economic growth and an excess of the aggregate supply of hydrocarbons over their demand, lead to a drop in energy prices and increased cross-country tensions, both for producing and recipient countries. This leads to toughening cross-country competition [6, 7]. This research result proves the main hypothesis.

The paper analyses the trends in the Russian electric power industry corresponding to the global trends in energy consumption. Its development is impossible without the adoption of innovative solutions. In general, the Russian energy sector is not stagnating, and new projects are accompanied by innovative solutions.

The main question to which this article should give an answer is that how the Russian power industry will develop in corresponding to the global trends in energy consumption.

The article proves that so many pipeline projects (South Stream, Turkish Stream, Nord Stream 2) move the Russian energy sector to the past. It will increase the share of fossil fuel energy in the next 10–20 years until oil sources will become weak.

The conclusion includes results of gas flows analysis from Russia. The choice of this method is most appropriate from the point of view of risk diversification in gas supplies to Europe.

LITERATURE REVIEW

The reduction of consumed fuels and energy resources through innovative technologies is a prominent task that needs solving. The increase of energy efficiency of the power supply system requires reduction of power loss during energy transfers [7–10].

In 2017 the environmental effects of Russian energy systems were already studied by the International Renewable Energy Agency (IRENA) and in last 5 years a revolution took place regarding the efficiency of many renewable energy sources around the world (in solar energy, for example) [11].

A review of studies in the field of logical assessment of energy projects in Russia allows us to identify four main areas of use of quantitative methods for analyzing information. Firstly, a formal analysis of the projects can be carried out to assess the energy policy of Russia and to compare energy projects with each other. The use of renewable energy sources promises to improve the situation according to international studies. Furthermore, it should be noted that the energy supply system can use not only solar and wind energy, but also the heat of the earth [12].

This makes the task of determining the cost-efficiency of heat supply systems using renewable energy sources difficult. The study aims to determine the impacts of oil price on the markets and the possibility of using renewable energy sources [13–15].

In connection with the novelty of the topic, this study prioritizes conducting research. The focus of the study was given to the development of new gas projects and the interaction between governments and national energy companies [16–19]. Unfortunately, the economic side of the development of the energy sector is also influenced

by political aspects — such as sanctions from the USA. It is necessary to analyze methods of eliminating the sanctions in the best interests of European countries. Price movements of successfully developing companies should be confirmed by relevant trends.

METHODS

While looking for new methodological approaches and methods for mathematical modeling of complex systems, researchers are increasingly paying attention to the world around Random Forest model.

Random Forest models are currently one of the most well-known and effective tools for intelligent data analysis, which is being developed thanks to advances in the theory of artificial intelligence and computer science [19]. Since the rapid development of computer technology creates the prerequisites for the emergence of neurocomputers, which, according to experts, will process information according to the same principles as the human brain [2, 3], the interest in neural network technologies is gradually covering an increasingly wide range of users.

At the same time, despite the considerable scientific development, the tough market requirements and increased competition, as well as the dynamism of the geo-economic environment as a whole, provide an additional impetus for conducting both fundamental and applied research in the direction of development of such intelligent modeling technologies as fuzzy sets and identification of the features of their use in the economy. The fuzzy set concept depends on the assumption that the characteristic function of the set (the membership function for a fuzzy set) can take any values in the range [0, 1]. It is not just the values 0 or 1. It is a major concept of fuzzy logic [1, 2].

To determine the trend, technical analysis may be used, examining peaks and troughs. Also, the article considers a model of pricing energy, which is as follows:

$$Energy\ cost = \sum A + B + C + D, \quad (1)$$

where A is the costs incurred by the infrastructure dependent on the annuity factor and related CAPEX costs; B is the operational costs of plant technology; C is the supply chain costs, collection, and treatment; D is the transport cost.

The first step is the selection of the initial features in the data set. Then, it is constructed for each of the group. Furthermore, its performance and feature importance are calculated. In other words, there is a number of separate and interconnected models for the time period, to evaluate their accuracy and influence of their parameters on the metrics. The modified random forest ensemble model is appropriate for datasets with not so long a time period for fossil-fuel power plant efficiency from 2020 until 2022. Many researchers found that fossil-fuel power will not be a crucial share in the next 20–30 years [5, 11, 18]. The fundamental analysis shows that the renewable energy share in Russia is stable in 2003–2019. There is no trend to rise like in global energy generation (*Fig. 1, 2*).

The paper uses the data selection approaches for modified random forest ensemble model:

1. Total gas flow from Russia, GWh/d.
2. Electricity generation in Russia, TWh.
3. Line length and electricity output.

The base number of fossil-fuel power plant efficiency from 2020 until 2022: horizon for the forecasting model is n = 730 days. It was tested for other n = 365, 1095 and 1460 days in order to estimate the significance of chosen features and potential of forecast and time influence on the model accuracy.

The paper uses the Random Forest model which is a class of artificial neural networks in which connections between nodes form a directed graph along a time sequence. For example, the renewable energy efficiency can be calculated:

$$Ts = k * I / E * C * V, \quad (2)$$

where I is the share of investments in solar panels in the total of investments in installations; k is the coefficient of investments, that depends on the type of installation; E is the specific annual amount of solar energy that installations receive, GJ/(m^2*year); C is the renewable energy efficiency of the solar establishment; V is the cost of the replaced heat energy, rub/GJ.

It can be used such formula too:

$$Tw = ki / U * T * P, \quad (3)$$

where ki is the average capital cost in renewable energy; U is the coefficient of renewable power consumption; T is the annual operating time of installments, hours per year; P is the cost of the replaced energy, USD/(kW·hour). The following universal formula can determine the payback period of power plants:

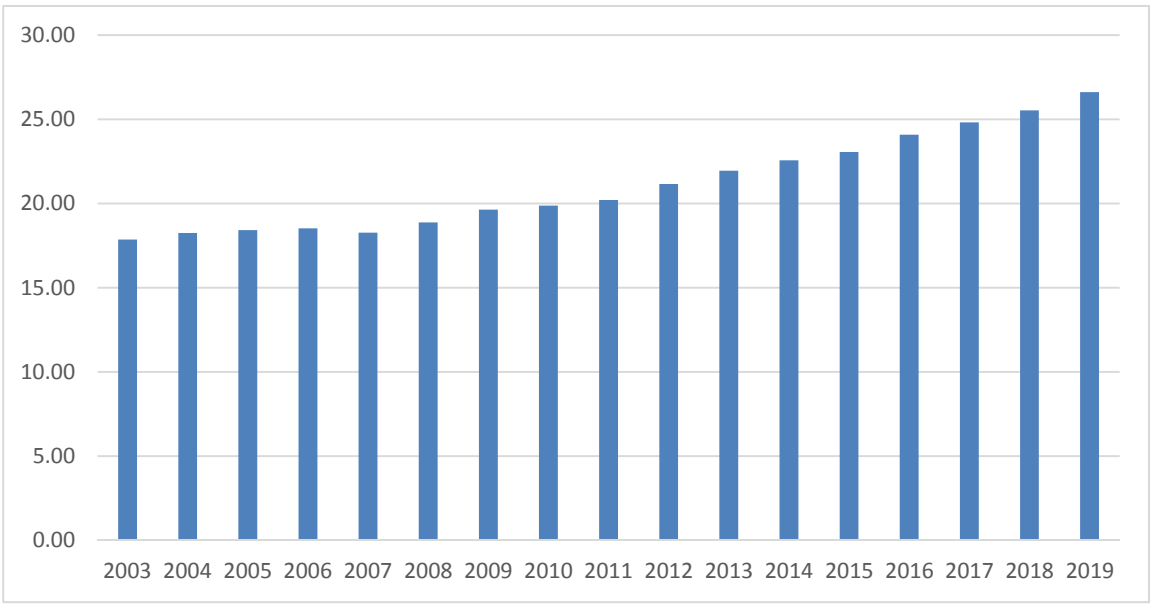

Fig. 1. **Renewable energy share in global generation, %**

Source: Bloomberg, BP Statistical Review (2020). URL: https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/downloads.html (accessed on 10.08.2021).

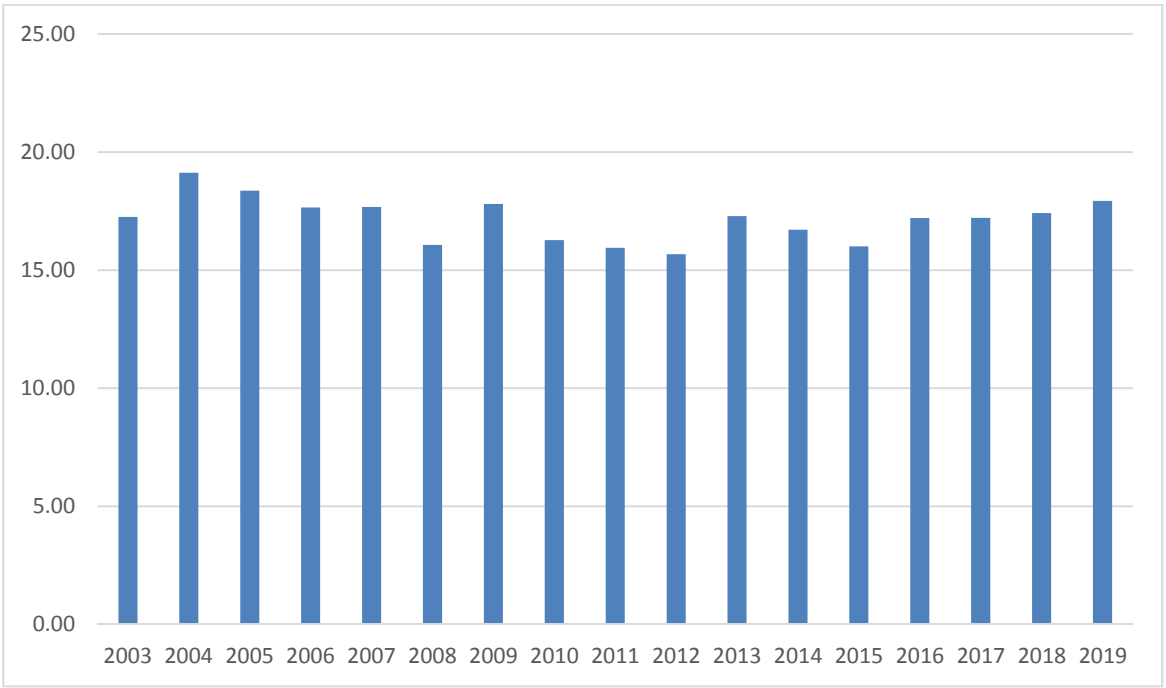

Fig. 2. **Renewable energy share in Russia, %**

Source: Bloomberg, BP Statistical Review (2020). URL: https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/downloads.html (accessed on 10.08.2021).

$$Tb = kb / Vb\,, \qquad (4)$$

where kb is the average capital expenditures; Vb is the volume of the reactor, м^3.

Initially, the performance of each model is calculated using metrics provided by NumPy and Scikit-learn. Out of which the paper uses Root Mean Squared Error, Mean Absolute Percent Error (MAPE), Accuracy (provided by

Scikit-learn), Pearson Correlation Coefficient (PCC) and Mean Squared Error (MSE). RMSE is a standard deviation of the difference between actual data and the forecasted result.

Models are evaluated as a whole with a particular focus on Accuracy:

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN}, \quad (5)$$

where *TP* is true positives, *TN* is true negatives, *FP* is false positives and *FN* is false negatives;

$$RMSE = \sqrt{\frac{\sum_{t=1}^{n} (g_t - f_t)^2}{n}}, \quad (6)$$

where g_t = actual value, f_t = forecasted value, n = = number of data points;

MAE measures the difference between two continuous variables.

$$MAE = \frac{\sum_{t=1}^{n} |g_t - f_t|}{n}; \quad (7)$$

MAPE is a measurement of accuracy based on the percentage error.

$$MAPE = \left[\frac{1}{n} \sum \frac{|g_t - f_t|}{g_t} \right] * 100; \quad (8)$$

PCC is a measurement of relationship strength between to variables.

$$PCC = \frac{n \sum g_t f_t - (\sum g_t)(\sum f_t)}{\sqrt{\left[n \sum g_t^2 - (\sum g_t)^2 \right] \left[n \sum f_t^2 - (\sum f_t)^2 \right]}}. \quad (9)$$

In order to estimate the impact of each group on the prediction by the Scikit-learn tools for future importance calculation. For each decision tree, the Scikit-learn computes a node`s importance using Gini with two child nodes.

RESULTS

Traditional energy generation projects of Russia

The research paper explores some achievements and successes of several Russian energy companies and compares them with a foreign corporation (Gazprom, RusHydro, Federal Grid Company of Unified Energy System and transnational oil and gas and petrochemical company British Petroleum).

Table 1

Design and power of main Oil and Gas projects

	Billions of cubic meters	
	Number of threads	Power
Nord Stream-2	2	55
The power of Siberia	1	38
Turkish stream	2	31.5

Source: BP Statistical Review 2020.

Table 2

Energy consumption share by Fuel in Russia and China

Energy consumption share by Fuel	Russia, %	China, %
Gas	55	4
Oil	21	18
Nuclear power	6	1
Hydroelectricity	2	7
Coal	15	70

Source: Bloomberg.

Let us examine the activities of these companies in further detail. The number of threads is a relevant parameter for decision-making and choosing between energy strategies because a number of threads of more than 1 shows that the delivery of resources can be long in the case of problems with the main tube. Recent projects in development or operation are presented below in *Table 1*.

The volume and sizes of deliveries are also presented, confirming the company's activity, price charts of growing stocks over the past year, along with some other formulas indicators of technical analysis. Successful projects of the company and the dividend policy that Gazprom can afford significantly affect its price quotes.

1. The Nord Stream-2 is a gas pipeline that exits the Russian Ust-Luga and is over 1200 km long. At the end of December 2019, all participants removed its pipe layers from the site of the construction of Nord Stream-2 and, due

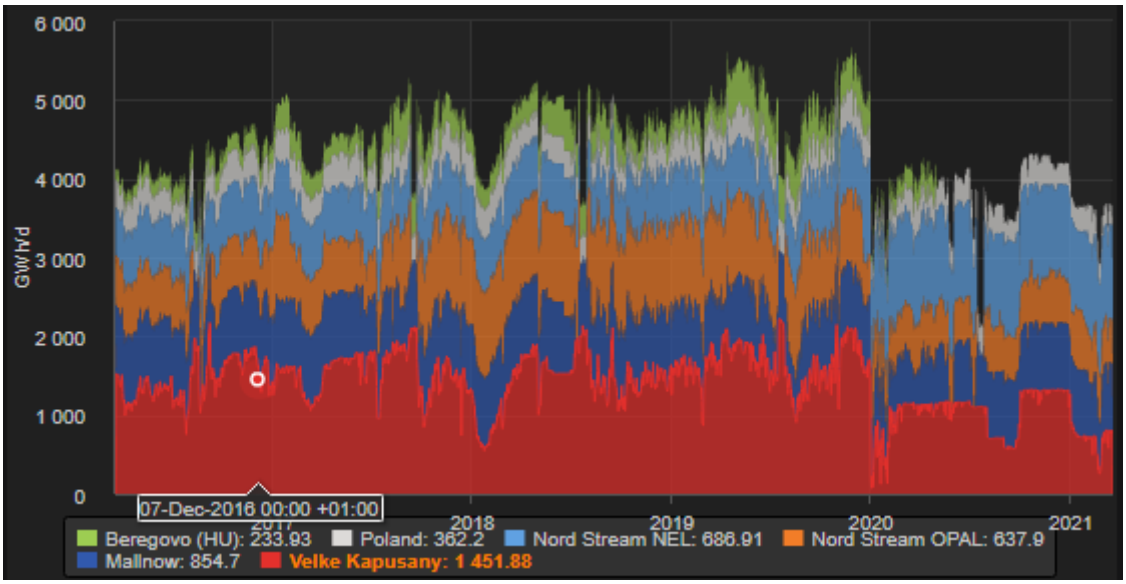

Fig. 3. **Total gas flow from Russia, GWh/d**

Source: Bloomberg, BP Statistical Review (2020). URL: https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/downloads.html (accessed on 10.08.2021).

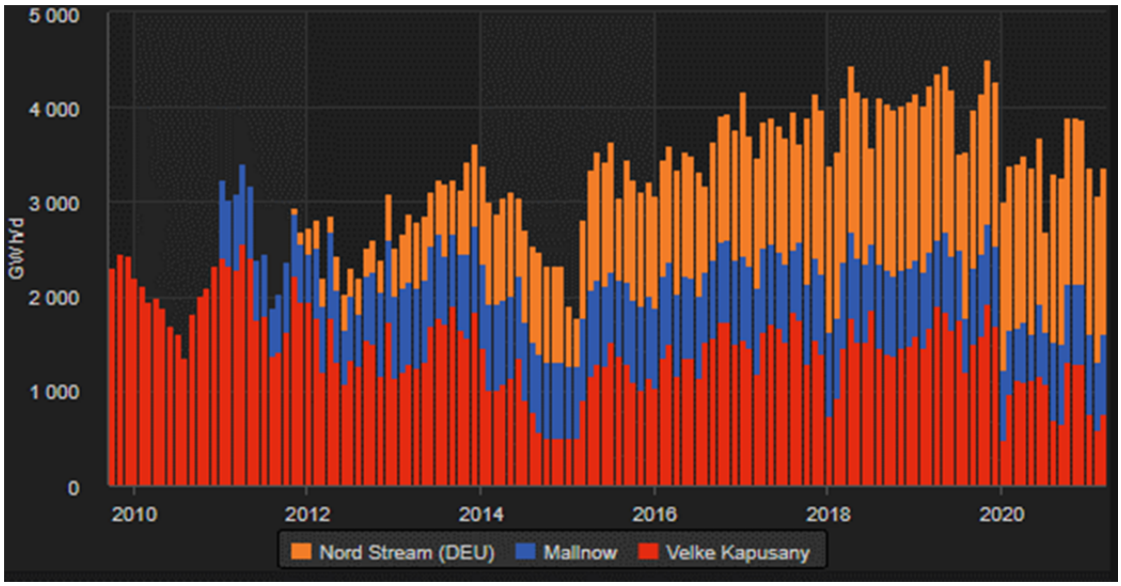

Fig. 4. **Main Gas flow from Russia, GWh/d**

Source: Bloomberg, BP Statistical Review (2020). URL: https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/downloads.html (accessed on 10.08.2021).

to U.S. sanctions, the project was completely abandoned. But at the end of 2020, the Nord Stream-2 was reopened again. Many authors proved that this pipeline is not needed because it only distracts gas from existing pipelines but adds no new or additional gas to the market. Moreover, in an increasingly carbon-free global economy, this gas is just not needed any more [18–22].

2. The Power of Siberia. In May 2014, Gazprom and the China National Petroleum Corporation (CNPC) signed an agreement on the supply of Russian gas via an eastern route. It was finished after 30 years and assumes an annual supply of 38 billion cubic meters of gas after reaching its design capacity. In September 2016, Gazprom and CNPC signed a contract for the construction of an underwater crossing over the Amur River.

On December 2, 2019, Russian gas supplies to China were launched through the Power of Siberia gas pipeline. This project will allow the Russian party to reduce the risks

accompanied with European gas supplies, and will reduce coal consumption in China, which will have a significant impact on the environment and energy market, *Table 2*.

3. Turkish stream. The offshore section of the gas pipeline running along the bottom of the Black Sea was built in 2019 and consists of two threads. The first line is intended for Turkish consumers, the second — for gas supply to the countries of Southern and Southeast Europe. In November, both lines were filled with gas, and in early January 2020, Northern Macedonia and Greece received the first volumes of Russian gas. Main current gas flow from Russia are illustrated below. The initiation of reverse-flow natural gas scheduling at Slovakian-Ukrainian interconnection Veľké Kapušany, has provided Russian gas supply via transport system of Ukraine. The Mallnow station was constructed for Gazprom gas transporting in November 2012. Mallnow compressor station near Frankfurt an der Oder in the vicinity of the German-Polish border. The extension of the Mallnow station improved a capacity for receiving up to 600,000 m3/h (*Fig. 3, 4*).

Electronic trading platform "Gazprom export" (ETP) with delivery a month in advance. Now customers can buy gas with one day delivery in advance, on weekends, until the end of the month. Most of the sales through ETP in 2019 were accounted for by Germany — 8.5 billion cubic meters, Slovakia — 2.3 billion cubic meters, Austria — 1.5 billion cubic meters. *Table 3* shows the breakdown of trading by month.

4. The prospects of building a giant gas chemical complex on the Yamal Peninsula and raising funds for project financing for the construction of the Amur Gas Processing Plant (GPP). This chemical complex allows to produce ethylene and propylene from dry gas with a design capacity of 3 million tons as part of the consortium. The cost of this project is about 1 trillion rubles. The connection Amur GPP project with the rest of the article is that Russian gas needs a market for conversion into other goods because gas demand is too low on the back of renewable energy transition around the world. The main client for this ethylene and propylene can be Europe and China like it was mentioned in the previous research [4, 5].

Amur GPP would be the second largest in the world. On December 23, 2019, the company entered a package of transactions for a total of 11.4 billion euros. Funds were provided by European, Chinese, Japanese and Russian credit organizations. The total cost of the project is estimated to be about 20 billion euros.

Table 3

Average ETP trading volumes in 2017–2020

Month	Billion m3 sales
Nov.	0.64
Oct.	1.3
Sept.	1.39
Aug.	1.54
July	2.79
June	1.27
May	1.37
Apr.	1.1
March	0.89

Source: Bloomberg.

In relation to the projects discussed above, it is appropriate to compare the movement of stock prices for Gazprom with respect to the stock price of British Petroleum (BP) — one of the leading oil, gas and petrochemical Transnational companies. Moreover, BP is a major shareholder (~19.5% of the authorized capital) of Rosneft.

BP has released its annual statistical data, concerning the study of the global energy market. Natural gas has a share of about 24% in the world energy market now. This share will decrease not so quickly as the oil share as a result of efficiency growth in renewable energy generation around the world.

Oil retains its position in the total energy sum compared to last year. Coal, which is second in the fuel mix, is at 27% and this is the lowest result since 2015. The share of natural gas has increased. The contribution of hydroelectricity and nuclear energy has not changed significantly in recent years. Strong growth is observed in RES (renewable energy sources). The energy picture of Russia is as follows. Oil consumption has increased (+2.1%). Gas remains to be the primary source of fuel — 55% of energy consumption. Coal consumption fell by 5.5% due to an increase in electricity generation (+9.5%). RES at the moment is in its infancy and occupies an insignificant place.

The Federal Grid Company is the largest hydro-energy-generating company in Russia and the third largest in the world. It has electricity generation growth in Russia (*Table 4*).

Table 4

Electricity generation in Russia, TWh

Year	2011	2012	2013	2014	2015	2016	2017	2018
Production	77	81.2	124.1	113.6	114.3	124.8	127	130.6

Source: URL: https://www.fsk-ees.ru/about (accessed on 10.08.2021).

The Federal Grid Company (FGC) is a Russian energy company whose main activity is the transmission of electricity through the Russian electrical grid. Moreover, this is one of the largest companies in the world in terms of thread length. The main production indicators can prove the idea of electricity generation growth in 2014–2018 on the back of stable export volumes from Russia to Europe (*Table 5–7*).

The cost of gas production in Norway is more than twice as high as in Russia and is about $ 1.04 per million British thermal units (MMBtu). Norway can provide all oil and gas demand in Europe in the future. In this case, Russia's oil and gas export can become insufficient for European countries.

Norway provides about 25 percent of Europe's consumption (115 billion cubic meters) and is Russia's main competitor. The movement of Norwegian and Russian gas flows reflects that Gazprom's export became dependent on the export facilities of Norway (*Fig. 5*).

Efficiency of renewable energy generation in Russia

The study was able to achieve results with a prediction of fuel consumption for 3 years ahead (RMSE 5 to 25 MAPE, average MAPE = 16.52) because of using the Random Forest model. The paper exactly computed the fossil-fuel power generation forecast (by plant) from 2021 until 2023. The relevance of such computation is important for the future study. But there are a few caveats. The neural network must be trained on the data for each fossil-fuel power plant throughout its work separately each time, i.e. only after the formation of a new image of this model can predict the indicators of this particular power plants, otherwise predicted values differ too greatly from the actual.

To increase the accuracy in future studies, you can use a vector model, but it is a little more complex and requires more time to train. You can also take a lot of power plants for all years, or one power plant, but with all the other indicators (vacation, expenditure by category, cost). Unfortunately, Random Forest models do not support the same flexibility in time series sets as simpler algorithms. Fossil-fuel power generation forecast (by plant) from 2021 until 2023 shows that most energy plants in Russia will have the same efficiency in the next 3 years (*Fig. 6*).

Also, this model does not support multivariability, which means that it only takes fuel consumption as the basis for predictions. The accuracy of previous models is about 0.5 but the modified random forest model has an accuracy of more than 0.8. MAPE, MSE, MAE and PCC are at the high-level tuning of hyperparameters (*Table 8, 9*).

It can be concluded that for the indicator of power generation of renewable plants, thousand kWh, the model gives a more accurate result than in the earlier works (MSE is about 272 MWh) [1–3].

A comprehensive assessment of the efficiency of power plants using renewable energy sources in Russia allows us to make the following conclusions.

DISCUSSION

This is due to states' high activity levels in the energy industry. Furthermore, it is important to analyze alternatives in management techniques, and possible use for by-products in order to sustain effective production and consumption. This is the reason for a detailed study on the environmental aspects of Russian projects and the supply chain that it provides, as well as the evaluation of potential sources [2, 20–22].

The reason for researching the environmental aspects of Russian projects and evaluating its potential resources is to determine a sustainable and efficient chain of life in production [23, 24].

These results can be achieved only under the conditions of certain actions, including changes in social behavior, vehicle technologies and the introduction of biofuel innovations. Infrastructure projects have been hampered by market uncertainty and other fuel supply problems in the last few years [25, 26].

Projects are concentrated in a wide variety of areas. It is important to be attentive regarding accessibility and

Table 5

Line length and electricity output

Year	2014	2015	2016	2017	2018
Length of power lines, thousand km	138.8	139.1	140.3	142.4	146
Electricity supply to consumers, kWh	515.3	525.8	540.5	547.4	557.7

Source: URL: https://www.fsk-ees.ru/about (accessed on 10.08.2021).

Table 6

Main Gas flows from Russia, GWh/d

Name	2020, 1	2020, 2	2020, 3	2020, 4	2020, 5	2020, 6	2020, 7	2020, 8	2020, 9	2020, 10	2020, 11	2020, 12
Greifswald (OPAL)	559	567	582	583	631	638	533	529	552	560	541	562
Greifswald (NEL)	1195	1213	1190	1142	1123	1195	1226	1202	1199	1210	1192	1192
Mallnow	860	859	858	859	859	859	868	773	772	827	870	868
Velke Kapusany	777	646	787	810	810	811	811	625	578	736	803	803
Polish Offtake	261	261	261	261	261	262	253	253	252	252	252	251
Net VIP Bereg (HU)	105	97	98	100	95	101	101	108	103	80	281	272
Romania	29	29	29	29	29	29	29	29	29	29	29	29
Total	3786	3672	3805	3784	3808	3895	3821	3519	3485	3694	3968	3977

Source: Bloomberg, author calculations.

Table 7

Analysis Summary

	Greifswald (OPAL)	Greifswald (NEL)	Mallnow	Velke Kapusany
Average	567.6471	1192.88	851.18	760.688
Standard error	7.297734	6.08148	7.5767	18.8328
Median	562	1198	860	801.5
Standard deviation	30.08933	25.0746	31.239	75.331
Sample variance	905.3676	628.735	975.9	5674.76
Excess	1.399464	3.74782	3.7712	1.44661
Asymmetry	1.238365	−1.865	−2.199	−1.6474
Interval	109	103	98	233
Minimum	529	1123	772	578
Maximum	638	1226	870	811
Amount	9650	20279	14470	12171
Greatest (1)	638	1226	870	811
Smallest (1)	529	1123	772	578
Reliability level (95.0%)	15.4705	12.8922	16.062	40.1411

Source: Bloomberg, authors' calculations.

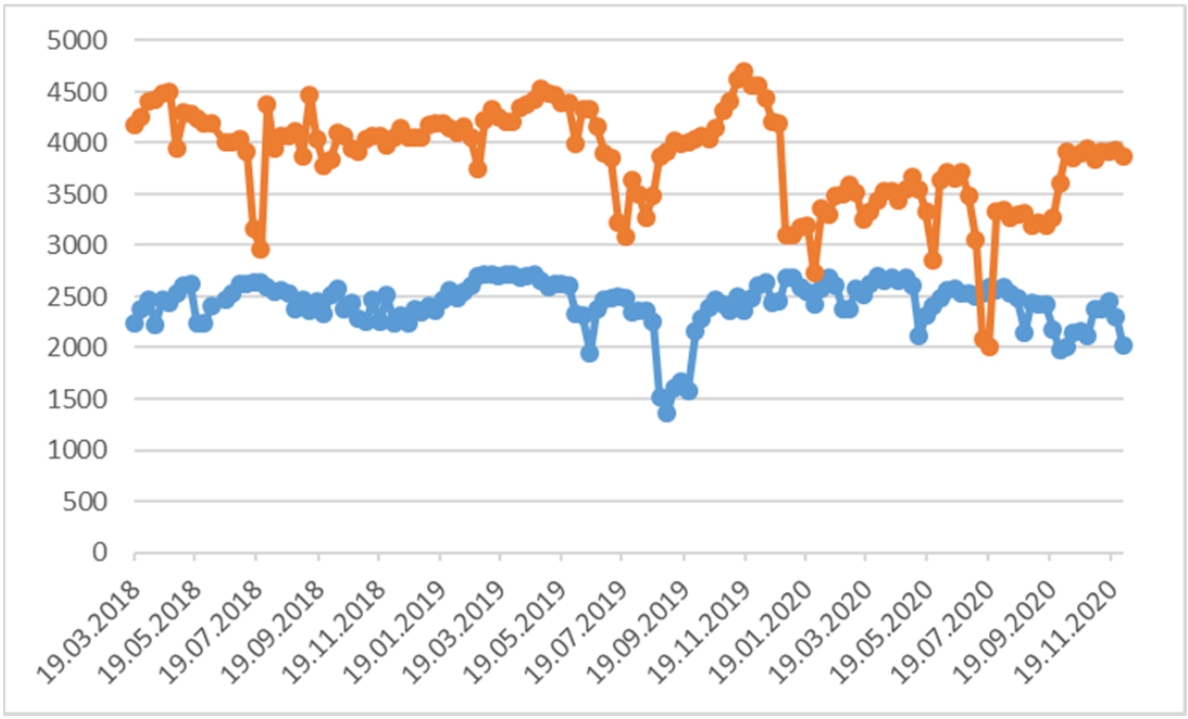

Fig. 5. **Gas flows from Norway (blue) and Russia (orange), GWh/d**

Source: Bloomberg.

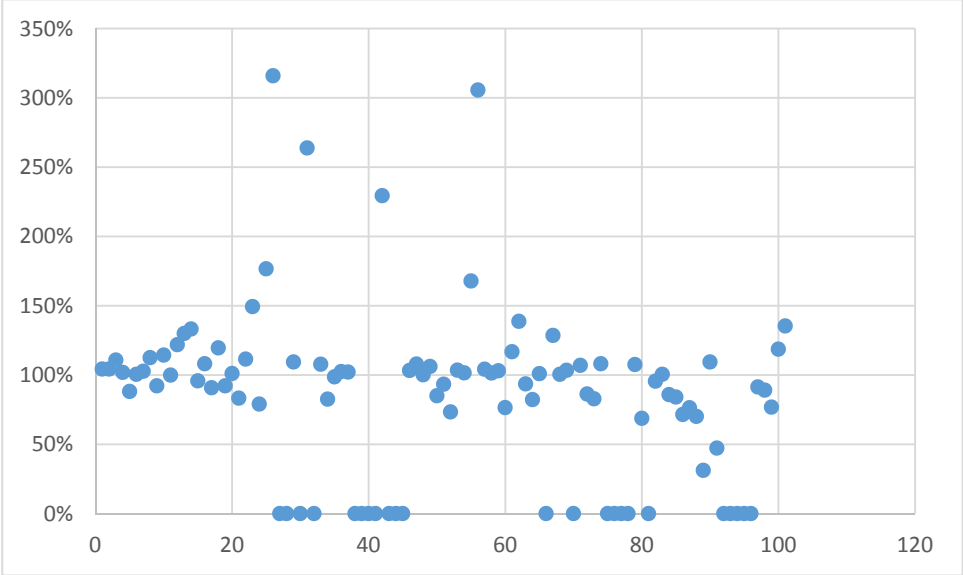

Fig. 6. **Fossil-fuel power generation forecast (by plant) from 2021 until 2023, MWh/t**

Source: Bloomberg.

the usage of raw material in such projects. This is the reason for this study to include proof of sustainable energy production from Russian companies [27–29].

In the realization of projects, there is a large number of components that are divided into two classes: 1) those that come from foreign companies' operations, 2) those that are produced in the domestic industry from the process of production.

Unlike other industries, the oil and gas sector has the advantage of a significant and useful place, which can be applied during different stages of the production of goods [19–21]. The study was able to achieve accurate results

Table 8

Analysis Summary

RMSE	MAPE	MSE	MAE	PCC	Accuracy (%)	Horizon
16.52	1.945	272	157	0.49	80.11	3 years

Source: authors' calculation.

Table 9

Analysis Summary

Models	LSTM	RNN	ARIMA	Modified random forest model
Accuracy	0.528	0.502	0.512	0.811

Source: authors' calculation.

with a prediction of fuel consumption for 3 years ahead (RMSE 5 to 25 MAPE, average MAPE = 16.52), but there are a few caveats.

CONCLUSIONS

The study includes the development of Russia's energy sector and its contribution to the global economy. The tasks and goals of the biggest and most important projects of the Russian energy industry that have an impact on a global scale are researched in this paper as well. The article's novelty is renewable energy analysis by modification of random forest ensemble model for fossil-fuel power plant efficiency from 2020 until 2022.

This is the first research paper to consider this method. The article reviewed major projects of Gazprom, which contribute to the economic development of Russia, as well as Europe and Asia (the most important partners among which are Germany and China). The presence of the latter is most appropriate from the point of view of risk diversification in gas supplies to Europe. The creation and completion of the Turkish Stream gas pipeline aids in assessing this problem.

The diversification of the activities of Gazprom in Russia should also be noted. This refers to the development of the market of power engineering. In general, Russian energy is not stagnant and is accompanied by innovative solutions. It is worth noting that the creation of a new electronic trading platform, Gazprom export and the development of renewable energy sources of RusHydro contribute significantly to economic growth of the national economy. Currently, the last paragraph illustrates a backlog in comparison with advanced countries of the world, which must be reduced in the next few years.

To increase the accuracy in future studies, a vector model can be used, but it is more complex and requires more time to be developed. A lot of renewable power plants for all years, or one renewable power plant, but with all the other indicators (vacation, expenditure by category, cost). Unfortunately, Random Forest models do not support the same flexibility in time series sets as simpler algorithms.

The physically existing pipelines will not help the Russian gas industry if worldwide trust in Russian institutions and respectful democratic institutions keeps crumbling and its reliable democratic functioning and de-escalating policy-making are not perceived by Russia's economic and business partners. Therefore, any calculation of gas volume flows in various geographic directions is using a far too short horizon because such analysis does not touch on the essence of any business, which is mutual trust. Europe now tries to become independent of a Russia slipping more and more into authoritarian rule; in the same way as Europe became independent from Middle East gas governed by authoritarian regimes and It is described by a "gas flows analysis". Global demand will decrease anyhow because of efficiency improvements and the greening of economies.

The main conclusions are that: (1) The random forest model proves the financial efficiency of renewable energy production and (2) the accuracy of this model is very higher (0.81) and (3) it is highly relevant, since Russia does not seem to support the global trend towards a renewable and sustainable economy.

Although oil and gas prices remain acceptable, unforeseen changes in the behavior of real buyers can hinder the efficiency of the Russian economy and lead to disruption of Russia's economic growth. The growth of the Russian electric power industry corresponds to the global trends in energy consumption, and its development is impossible without the adoption of innovative solutions. In general, the Russian energy sector is not stagnating, and new projects should therefore drastically increase renewables by using sustainable technologies which represent innovative solutions.

ACKNOWLEDGEMENTS

The first author was supported by the Hankuk University of Foreign Studies Research Fund.

REFERENCES

1. Lohrmann C., Luukka P. Classification of intraday S&P500 returns with a Random Forest. *International Journal of Forecasting*. 2019;35(1):390–407. DOI: 10.1016/j.ijforecast.2018.08.004
2. Louppe G. Understanding Random Forest: From theory to practice. PhD diss. Liège: University of Liège; 2014. 211 p. URL: https://arxiv.org/pdf/1407.7502.pdf
3. Krauss C., Do X.A., Huck N. Deep neural networks, gradient-boosted trees, random forests: Statistical arbitrage on the S&P 500. *European Journal of Operational Research*. 2017;259(2):689–702. DOI: 10.1016/j.ejor.2016.10.031
4. Klyuev N.N. Current changes on the industrial map of Russia. *Regional Research of Russia*. 2020;10(4):494–505. DOI: 10.1134/S 2079970520040140
5. Wang X., Liu Q. The evolution of the Sino-Russian oil and gas partnership: From structure-centred to actor-centred engagement. *Chinese Political Science Review*. 2021. DOI: 10.1007/s41111–021–00176–3
6. Hamilton J.D. This is what happened to the oil price-macroeconomy relationship. *Journal of Monetary Economics*. 1996;38(2):215–220. DOI: 10.1016/S 0304–3932(96)01282–2
7. An J., Mikhaylov A., Jung S.-U. The strategy of South Korea in the global oil market. *Energies*. 2020;13(10):2491. DOI: 10.3390/en13102491
8. Branch E.R. Short run income elasticity of demand for residential electricity using consumer expenditure survey data. *The Energy Journal*. 1993;14(4):111–121. DOI: 10.5547/ISSN 0195–6574-EJ-Vol14-No4–7
9. Brown M. Market failures and barriers as a basis for clean energy policies. *Energy Policy*. 2001;29(14):1197–1207. DOI: 10.1016/S 0301–4215(01)00067–2
10. Basher S.A., Sadorsky P. Oil price risk and emerging stock markets. *Global Finance Journal*. 2006;17(2):224–251. DOI: 10.1016/j.gfj.2006.04.001
11. Gielen D., Saygin D. REMAP 2030: Renewable energy prospects for Russian Federation. IRENA Working Paper. Abu Dhabi: IRENA; 2017. 92 p. URL: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/Apr/IRENA_REmap_Russia_paper_2017.pdf
12. Milbrandt A.R., Heimiller D.M., Perry A.D., Field C.B. Renewable energy potential on marginal lands in the United States. *Renewable and Sustainable Energy Review*. 2014;29:473–481. DOI: 10.1016/j.rser.2013.08.079
13. Aloui C., Nguyen D.K., Njeh H. Assessing the impacts of oil price fluctuations on stock returns in emerging markets. *Economic Modelling*. 2012;29(6):2686–2695. DOI: 10.1016/j.econmod.2012.08.010
14. Kilian L., Park C. The impact of oil price shocks on the U.S. stock market. *International Economic Review*. 2009;50(4):1267–1287. DOI: 10.1111/j.1468–2354.2009.00568.x
15. Balestra P., Nerlove M. Pooling gross section and time series data in the estimation of a dynamic model: The demand for natural gas. *Econometrica*. 1966;34(3):585–612. DOI: 10.2307/1909771
16. Hecking H., Weiser F. Impacts of Nord Stream 2 on the EU natural gas market. Cologne: ewi Energy Research & Scenarios gGmbH; 2017. 48 p. URL: https://www.ewi.research-scenarios.de/cms/wp-content/uploads/2017/09/EWI-1163–17-Studie-Impacts-of-Nord-Stream-2-web.compressed.pdf
17. Riley A. Nord Stream 2: A legal and policy analysis. CEPS Special Report. 2016;(151). URL: http://aei.pitt.edu/81693/1/SR 151AR_Nordstream2.pdf

18. Rogers H.V. The impact of lower gas and oil prices on global gas and LNG markets. The Oxford Institute for Energy Studies. OIES Paper. 2015;(NG 99). URL: https://www.oxfordenergy.org/wpcms/wp-content/uploads/2015/07/NG-99.pdf
19. Zolfaghari M., Golabi M.R. Modeling and predicting the electricity production in hydropower using conjunction of wavelet transform, long short-term memory and random forest models. *Renewable Energy*. 2021;170:1367–1381. DOI: 10.1016/j.renene.2021.02.017
20. Meynkhard A. Priorities of Russian energy policy in Russian-Chinese relations. *International Journal of Energy Economics and Policy*. 2020;10(1):65–71. DOI: 10.32479/ijeep.8507
21. Morgan S.M., Yang Q. Use of landfill gas for electricity generation. *Practice Periodical of Hazardous, Toxic, and Radio Waste Management*. 2001;5(1):14–24. DOI: 10.1061/(ASCE)1090–025X(2001)5:1(14)
22. Meynkhard A. Fair market value of bitcoin: Halving effect. *Investment Management and Financial Innovations*. 2019;16(4):72–85. DOI: 10.21511/imfi.16(4).2019.07
23. Tazvinga H., Hove T. Technical model for optimising PV/diesel/battery hybrid power systems. In: 3rd CSIR Biennial conf.: Science real and relevant (Pretoria, Aug. 31, 2010). Pretoria: CSIR; 2010. URL: http://researchspace.csir.co.za/dspace/handle/10204/4229
24. Nord Stream 2 — Divide et impera again? Avoiding a zero-sum game. Brussels: European Political Strategy Centre, European Commission; 2016. 14 p. URL: https://www.nabu.de/imperia/md/content/nabude/meeresschutz/180703_papier_epsc_nordstream2.pdf
25. Fischer S. Nord Stream 2: Trust in Europe. *Policy Perspectives*. 2016;4(4):1–4. URL: https://ethz.ch/content/dam/ethz/special-interest/gess/cis/center-for-securities-studies/pdfs/PP4–4.pdf
26. Goldthau A. Assessing Nord Stream 2: Regulation, geopolitics & energy security in the EU, Central Eastern Europe & the UK. London: EUCERS; 2016. 40 p. URL: https://www.asktheeu.org/en/request/7115/response/23365/attach/2/Goldthau%20July%202016.pdf
27. Rogers D., Nelson R., Howell N. LNG in Europe 2018: An overview of LNG import terminals in Europe. Atlanta, GA: King & Spalding LLP; 2018. 36 p. URL: https://www.kslaw.com/attachments/000/006/010/original/LNG_in_Europe_2018_-_An_Overview_of_LNG_Import_Terminals_in_Europe.pdf?1530031152
28. An J., Mikhaylov A., Richter U.H. Trade war effects: Evidence from sectors of energy and resources in Africa. *Heliyon*. 2020;6(12): e05693. DOI: 10.1016/j.heliyon.2020.e05693
29. Roson R., Hubert F. Bargaining power and value sharing in distribution networks: A cooperative game theory approach. *Networks and Spatial Economics*. 2015;15(1):71–87. DOI: 10.1007/s11067–014–9270–6

ABOUT THE AUTHORS

Jaehyung An — Cand. Sci. (Econ.), College of Business, Hankuk University of Foreign Studies, 02450, Seoul, South Korea
jaehyung.an@yahoo.com

Alexey Yu. Mikhaylov — Cand. Sci. (Econ.), Deputy Director Research Center of Monetary Relations, Financial University, Moscow, Russia
AYUMihajlov@fa.ru

The article was submitted on 26.02.2021; revised on 14.03.2021 and accepted for publication on 27.04.2021.
The authors read and approved the final version of the manuscript.

ORIGINAL PAPER

DOI: 10.26794/2587-5671-2021-25-5-92-116
UDC 336.63(045)
JEL G11, G18, G24, O16, O31

The Venture Capital Market in a Pandemic: Realities of Time and Future Prospects

I.A. Ezangina[a] ✉, **A.E. Malovichko**[b]
Volgograd State Technical University, Volgograd, Russia
[a] https://orcid.org/0000-0002-9441-4401; [b] https://orcid.org/0000-0002-2040-0584
✉ Corresponding author

ABSTRACT

The **subject** of the research is the financial mechanism of the modern venture investment market under conditions of uncertainty and the requirements of accelerated innovative development. The study **aims** to analyze the impact of the pandemic on the sustainability of the institutional behavior of venture capital investment in the global and Russian markets. The authors apply such scientific **methods** as sampling, grouping, comparison, analogy, analysis, generalization, systemic-structural approach to assessing the development of the subject of research. The paper analyses the role of venture investment in the successful promotion of innovations using the example of the world's leading companies in 2016–2021. Successful examples of venture investment are presented. The study investigates the impact of the pandemic and lockdown on the level of volatility, composition and dynamics of venture capital investments in 2020–2021. The authors **conclude** that the pandemic has an impact on the sectoral redistribution of investments in favor of venture investments in medicine, biotechnology, the sector of information and communication technologies and solutions for business, education, healthcare, on market polarization (covid-negative, covid-positive, covid-neutral), on reducing the role of state funds and Russian accelerators, while increasing the interest and scale of participation of private institutions (foreign investors, business angels, syndicated angel investment), to increase of the volume of the Russian venture capital market by increasing the average ticket size despite the reduction in their number, to strengthen the practice reproduction of their own ecosystems by corporate institutions, to popularize venture capital investment deals in terms of mergers and acquisitions. **Prospects** for researching the venture capital market are associated with the constant attention to high-tech covid-positive projects, with the growth of transactions in the early stages, due to the increase in the number of professional communities, with the pinpoint development of specific tasks of an investor or corporation by accelerators, with venture investment of companies with the subsequent entry of the project into their own ecosystem, with the improvement of the state's restrictive measures aimed at a clear institutionalization of professional activities and increasing the financial stability of participants in the investment and innovation markets, with the stimulation of mechanisms for regional innovative development to attract capital to high-risk projects in the regions.

Keywords: pandemic; venture investment; venture market; startup; unicorn company; first public offering; state fund; investment portfolio; corporate investment; accelerator; business angel

For citation: **Ezangina I.A., Malovichko A.E. The venture capital market in a pandemic: Realities of time and future prospects. *Finance: Theory and Practice.* 2021;25(5):92-116. DOI: 10.26794/2587-5671-2021-25-5-92-116**

INTRODUCTION

Innovation is the result of intellectual activity in the form of development, invention, innovation, implying an increase in efficiency, rationalization of existing or the emergence of new processes or a specific object aimed at solving the urgent needs of society. Often innovations are the result of investments, focused on the implementation of the resulting developments, subsequent scaling, accompanied by the receipt of a commercial result in the form of profit [1, p. 24–25].

Innovation, inextricably linked with the concept of "investment", allows an object of intellectual activity to become a final product or service. Since innovation involves a high degree of novelty, significant technical isolation, and an increased likelihood of negative research progress, projects with similar characteristics are accompanied by venture capital investments [2].

In this context, venture investment is understood as long-term financing (5–10 years) of a science-intensive project at the initial stage of development by providing private capital in exchange for a share of the company (innovator) or investment in high-risk securities characterized by a high degree of risk and attractive potential yield [3; 4, p. 29].

The role of venture capital investments in the successful promotion of innovations can be assessed by the example of the world famous companies created and developed by venture capital (Intel, Microsoft, Google, Facebook, Alibaba, Apple, WhatsApp, Yandex, Mail.Ru) (*Table 1)* [5, p. 44].

The companies listed in *Table 1* have a successful track record of attracting venture capital investments to create startups and subsequent developments, provide access to new markets, diversify regions of presence and expand the business. Some of them are "unicorns" that have a significant financial and technological impact on both the Russian economy and the world as a whole (the emergence of social networks, payment systems, computers, phones, search engines, etc.) [6, p. 431].

The first public offering in different periods of time, regardless of the level of development of the venture capital market, contributed to large-scale capital raising (Apple's largest exit in 1980 — $ 101.2 million, Alibaba in 1999 — $ 21.8 billion), an increase in the company's capitalization on the day of placement (Alibaba — an increase of 40%, Apple — an increase of 32%, Yandex — an increase of 40%). The attracted venture capital has provided companies with incredible opportunities for development, as evidenced by the systematic increase in the capitalization of companies over the years [7].

VENTURE CAPITAL: A DILEMMA OF HIGH RISK AND HIGH RETURN

Despite the impressive profitability, venture investment is not the most popular way to invest money, which is to some extent associated with risks: a long investment period, the presence of a complex (phased) investment mechanism (*Table 2*) [8, p. 94].

The investment conditions, presented in *Table 2*, are difficult for many owners of financial capital since the culture of venture investment involves not only investing in a potential project but also the constant participation of the investor in its development [9]. We refer to the operational management of the company, the provision, along with material, intangible resources [10, p. 144]. On the other hand, the difficulty of choosing a project for financing is noted: a startup assessment in a general sense at the seed stage is impossible due to the lack of accounting, financial reporting, economic plans.

Finally, global statistics on venture projects do not attract market participants: 0.01% of projects reach a public offer or final sale of the project. Venture capital investments are associated with high risks of investment loss: on average, a venture capital fund invests in

Table 1

The role of venture capital in the creation and growth of capitalization of the world's leading companies in the dynamics of 2016–2021

Company, venture capital recipient	Year of the deal	The amount of capital raised in the IPO	Company capitalization based on IPO results	Company capitalization, USD billion					
				2016	2017	2018	2019	2020	2021*
Intel Corporation	1968	$ 2.5 million	N/a	172	215	219	279	213	261
Apple	1980	$ 101.2 million	$ 1.778 billion	609	860	794	1458	2269	2071
Microsoft	1986	$ 61 million	$ 780 million	483	662	780	1213	1692	1822
Google (Alphabet)	2004	$ 1.67 billion	$ 23.1 billion	539	729	360	461	526	1431
Mail.ru Group	2010	$ 1 billion	$ 5.71 billion	N/a	N/a	324	235	438	373
Yandex	2011	$ 1.3 billion	$ 9.99 billion	397	615	564	792	1517	1745
Facebook	2012	$ 16 billion	$ 104 billion	332	516	380	594	657	846
Alibaba	2014	$ 21.8 billion	$ 168 billion	217	441	441	544	625	609

Source: compiled by the authors according to RBC Investments, a reference portal for calculating the capitalization of companies, Portals: TAdadviser, Goldman Sachs, Celebrity net worth, Seoded.ru, Vedomosti, Repub-lic, EDN, Cnews, Forbes.

* Data provided as of 03.04.2021.

30 startups, of which a smaller part receives refinancing, and only one company becomes a successful profitable business.[1]

At the same time, overcoming a number of limiting factors, the complexity of the mechanism implies high profitability: in Russia, it is 35% per year,[2] the possible maximum profitability is not limited by anything (for example, Pinterest brought 1900% profitability when it was publicly placed).[3]

The most profitable and at the same time rare investment in the venture capital market is financing a company that later acquires the status of a "unicorn". We refer to a startup with a capitalization of $ 1 billion or more. There are 500 unicorn companies in the world; in 2020, growth was 88 companies compared to 2019 (122 companies).[4] The growth decline in growth is affected by the pandemic and the cancellation of planned first public offerings of companies: as a result, we know about 588 unicorn companies at the beginning of 2021. The largest concentration of highly profitable unicorn

[1] IPO: investment attraction rounds. URL: https://www.rvc.ru/press-service/media-review/rvk/156690/ (accessed on 24.02.2021).

[2] Venture funds. URL: Фонды венчурные | InvestFuture (accessed on 24.02.2021).

[3] The Midas list: which venture capitalist has earned 1,900x returns in the past. URL: «Список Мидаса»: кто из венчурных инвесторов получил в прошлом году 1900-кратную доходность (forbes.ru) (accessed on 24.02.2021).

[4] The number of "unicorns" in the world. URL: https://bloomchain.ru/newsfeed/kolichestvo-edinorogov-v-mire-dostiglo-500-v-2020-godu-jetot-status-obreli-89-startapov#:~: text=Исследования%20(Архив)-, Количество%20«единорогов»%20%D0%B4%D0%B8%D0%BD%D0%BE%D1%80%D0%BE%D0%B3%D0%BE%D0%B2%C2%BB%20 (accessed on 25.02.2021).

Table 2

The main characteristics of the stages of the venture capital investment process

Criterion	Seed stage	Startup	Series A	Series B	Exit
Investor	Environment, business angels, grants, crowdfunding	Business angels, grants, seed funds	Venture funds, early stage funds	Venture funds, private equity funds, bank loans, corporate funds	Strategic, portfolio investors, IPO
Investment amount	Up to $ 250,000	Up to $ 2,000,000	Up to $ 10,000,000	Up to $ 100,000,000	From $ 100,000,000
Investor profitability	No profitability	Possibility of the first income/ significant expenses	Reaching the breakeven point, the first net profit	Possible profit of the company	Profit through the sale of shares (exit)
Risk level	The risk level gradually decreases with each subsequent stage				
Characteristics of the stage	Presence of an idea, conducting R&D, marketing research, drawing up a business plan	Organization of production, creating a prototype of a finished product	Launching on the market, completing R&D, creating a sales network, advertising campaign	Expansion of production and sales, increasing working capital	Issue of shares for exchange
Payback period of investments	Up to 10 years	5–7 years	4–7 years	2–5 years	x
Move on to the next stage, % of companies	10	15	40	30	x
% of projects excluded in relation to the first stage	85–90%	90%	95%	98%	99.9%
Barriers	Weakness of the idea, lack of a full-fledged team, underestimation of the market	Wrong business model, high competition among peers, technological risks	Errors in technology strategy, unreasonable costs, inexperienced leader as a manager	Low demand for a product, high competition, ineffective management decisions	Risk of loss of investment associated with the exit. Economically ineffective exit

Source: compiled by the authors according to the data of the Department of Research of the IIDF. URL: https://www.iidf.ru/upload/iblock/3b5/startup_way_2015.pdf (accessed on 24.02.2020).

Table 3

Presence of unicorn companies by country as of the end of 2020

Number of unicorn companies, pcs.	Country	Capitalization, USD billion	Number of unicorncompanies, pcs.	Country	Capitalization, USD billion
290	United States	911.77	3	Sweden	16.2
139	China	540.81	2	Republic of Columbia	4.65
27	United Kingdom	114.95	2	South Africa	2.59
25	India	86.87	2	Spain	2.4
15	Germany	27.63	2	United Arab Emirates	3.5
11	Brazil	38.45	1	Bermuda	1.6
10	Israel	13.57	1	Estonia	4.3
10	South Korea	21.38	1	Belgium	2.36
9	France	10.99	1	Mexico	1.15
5	Indonesia	26.4	1	Lithuania	1.1
5	Switzerland	6.5	1	Uruguay	1.2
4	Hong Kong	14.35	1	Ireland	1.2
4	Japan	5.2	1	Finland	1
3	Australia	9.01	1	Croatia	1
3	Canada	6.6	1	Philippine Islands	1
3	Netherlands	5	1	Luxembourg	1
3	Singapore	19.1	TOTAL:		1,904.83

Source: compiled by the authors from the full list of unicorn companies. URL: The Complete List Of Unicorn Companies (cbinsights.com) (accessed on 25.02.2021).

companies was noted in the United States and China (290 and 139 business units, respectively), which is associated with a special stable system of financial support for startups in universities, foundations, business angels in Silicon Valley, with a developed culture of entrepreneurship (especially in the USA), advanced technology and manufacturing facilities (in China) [11].

The total capitalization of unicorn companies in the United States and China is $ 1,452.58 billion (1.66% of the total global economy). In total, all unicorn companies own 2.18% of the global GDP (gross domestic product), which indicates the significant potential impact of these companies both on the world economy as a whole and on the economies of individual states [12, p. 9]. The size of the capitalization of unicorn companies, their geographic presence is presented in *Table 3*.

In turn, unicorn companies can be divided into "decacorn" companies worth more than

$ 10 billion and "hectocorn" companies worth more than $ 100 billion, the most popular of which are presented in Table 4. The most important areas were identified as artificial intelligence, financial technology, and logistics — areas designed to keep businesses running in lockdown [13].

One of the most successful "unicorns" in the world of "hectocorn" is the fast-growing technology company Bytedance, which owns a number of popular online services based on the use of artificial intelligence technologies to personalize user interests (TikTok, Toutiao, Doyinee, etc.). The market value of the company at the end of 2020 was $ 140 billion against $ 75 billion in 2017.[5] At the stage of the creation of the company, the financing of its activities was carried out by the owner, and subsequently, venture capital investments from General Atlantic and KKR & Co, Primavera Capital Group and SoftBank Group. Large-scale growth is associated with several venture investment rounds, including the first one aimed at the technological development of developments and their testing, and the subsequent ones were aimed at expanding and popularizing the developed services.[6]

Among the decacorns, the largest company is SpaceX, the first privately-owned US company to compete with government corporations for the development of the space industry. The company specializes in the production of reusable spacecraft, delivery of goods to the ISS, the development of tourist flights, the construction of a colony on Mars, etc. Currently, SpaceX has the status of a non-public organization, develops through venture funding by private and corporate investors. At the same time, the first public offering is planned, which will become one of the largest in the history of venture capital investment.

[5] TikTok parent company gauging $ 180 billion USD valuation. URL: Материнскую компанию TikTok оценят в $ 180 млрд в новом раунде (vctr.media) (accessed on 06.03.2021).

[6] The first Chinese startup without investment. URL: https://vc.ru/story/55229-pervyy-kitayskiy-startap-bez-investiciy-ot-baidu-tencent-ili-alibaba-istoriya-vladelca-tiktok-kompanii-bytedance (accessed on 06.03.2021).

It should be noted that at the moment no Russian company has been able to achieve the status of a unicorn company. The candidates are Yandex, Avito, Telegram, Mail.ru Group. However, it does not seem appropriate to talk about the lack of interest in venture capital investments in Russia, since:

- there are startups actively using venture capital;
- investment platforms, including crowdfunding ones, function;
- the market can be considered harmonious due to the presence of large venture capital investors and communities, in particular, the Russian company is present in the world rating of investors by the number of funded unicorn projects (*Table 5*).

According to *Table 5*, in the world's top-ranking of investors in high-risk projects, the 9th place is taken by the company — a resident of Russia — DST Global, which participates in the investment of 20 unicorn companies. Digital Sky Technologies (DST) is an investment company founded in 2005 by Y. Milner and G. Finger to invest in the Internet sector, including social networks, electronic payment systems, online games, and online trading. The company's investment portfolio includes such large companies as Facebook, Twitter, Spotify, Airbnb, Alibaba Group. During the pandemic, the company conducted active investment activities, the results of which are shown in *Table 6*.

In 2020, the company completed major financing deals for high-tech companies focusing on the online sector and industries that are particularly popular in a difficult epidemiological situation.

Thus, the existing successful examples of venture investing enhance the interest of investors in this market with their profitability, the market is developing dynamically within the framework of world practice, systemic development has been noted in Russia as well. At the same time, the importance of studying the impact of the pandemic and blocking on the level of volatility, composition, and

Table 4

Examples of venture capital unicorn companies "decacorns" and "hectocorns"

Company	Value (USD billion)	Unicorn status year	Country	Scope of the company	Investors
Hectocorns					
Bytedance	140	2017	China	Artificial intelligence	Sequoia Capital China, SIG Asia Investments, Sina Weibo, Softbank Group
Decacorns					
SpaceX	74	2012	United Sates	Aerospace	Founders Fund, Draper Fisher Jurvetson, Rothenberg Ventures
Didi Chuxing	62	2015	China	Auto and transportation	Matrix Partners, Tiger Global Management, Softbank Corp.,
Instacart	39	2014	United States	Supply chain, logistics and delivery	Khosla Ventures, Kleiner Perkins Caufield & Byers, Collaborative Fund
Stripe	36	2014	United States	Fintech	Khosla Ventures, LowercaseCapital, capitalG
UiPath	35	2018	United States	Artificial intelligence	Accel, capitalG, Earlybrid Venture Capital, Seedcamp
Global Switch	31	2016	United Kingdom	Hardware	Aviation Industry Corporation of China, Essence Financial, Jiangsu Sha Steel Group
Databricks	28	2019	United States	Data management and analytics	Andreessen Horowitz, New Enterprise Associates, Battery Ventures
Rivian	27,6	2019	United States	Auto and transportation	Amazon, Ford Motor Company, Cox Automotive
Nubank	25	2018	Brazil	Fintech	Sequoia Capital, Redpoint e.ventures, Kaszek Ventures
Epic Games	17,3	2018	United States	Development of computer games	Tencent Holdings, KKR, Smash Ventures
One97 Communications	16	2015	India	Fintech	Intel Capital, Sapphire Ventures, Alibaba Group
Yuanfudao	15,5	2017	China	Edtech	Tencent Holdings, Warbug Pincus, IDG Capital
DJI Innovations	15	2015	China	Hardware	Accel Partners, Sequoia Capital
SHEIN	15	2018	China E-commerce and direct-to-consumer		Tiger Global Management, Sequoia Capital China, Shunwei Capital Partners

Source: Full list of unicorn companies. URL: The Complete List Of Unicorn Companies (cbinsights.com) (accessed on 25.02.2021).

dynamics of venture capital investments in 2020–2021 is underlined.

GLOBAL VENTURE MARKET: THE IMPACT OF THE PANDEMIC

After peaking in 2018, the activity of the global venture capital market is as follows. In terms of funding, there is a significant reduction in 2019, and the expected crushing drop amid the pandemic can be considered invalid as there is growth over the last year. At the stage of expansion, a significant increase was noted (twofold). On average, the volume of the venture capital market in 2020 reached $ 300 billion, which is 4% more than in the previous period (*Fig. 1*).

At the same time, the number of concluded venture deals (about 30%) significantly decreased at all stages, especially at the late stage. Thus, there is an increase in the average check per deal, since the market volume has grown, and the number of deals has decreased significantly (*Fig. 2*).

Quarterly analysis of data for 2020 allows us to state a drop in volumes in the first quarter of 2020 while reducing investments at all stages. The market recovered in the following quarters; a Comparison of 4 quarters of 2019 and 2020 showed a similar volume of investments, which indicates a complete recovery of the market to average volumes (*Fig. 3*).

When comparing for six months, a decrease in the number of transactions was established (a decrease by 33% in the 1st half of 2020 compared to the 1st half of 2019), a decrease in the monetary volume of transactions (compared to the 1st half of 2019 and 2020 — by 4.1%, which in monetary terms amounts to $ 5.7 billion). The pandemic returned the indicators for the number of transactions to the 1st half of 2014, and in terms of volumes — to the 1st half of 2019 (*Fig. 4*).

According to *Fig. 5*, the most significant drop in the number of transactions in the 1st half of 2020 compared to the same period in 2019 was observed for the seed stage projects (by 1,888 transactions, by 35%). At the beginning of the pandemic, investors were not ready for the most risky investments and were focused on risk reduction in the framework of late-stage projects (Series B, C), including a preference for investing in existing portfolio companies, rather than financing new projects. In terms of the volume of transactions, a decrease was observed, respectively, for all stages, except for the less risky Series B, C (*Fig. 5*).

At the same time, many investors preferred to roll over the promised financing for an indefinite period until the epidemiological situation improves and economic stability is achieved. Projects, startups, and operating companies during the pandemic acquired new status related to the epidemiological situation, in particular:

Table5

Rating of world investors by the number of unicorn projects in 2019

Company	Country	Number of funded unicorn projects, pcs.
Sequoia	United States	92
Tencent	China	46
Softbank	Japan	42
Tiger Fund	United States	36
IDG	China	31
Goldman Sachs	United States	24
Alibaba	China	22
Andreessen Horowitz	United States	20
DST Global	Russia	20
GGV Capital	United States	19

Source: Research of the number of unicorn startups in the world. URL: https://incrussia.ru/news/world-unicorns/ (accessed on 08.03.2021).

Table 6

Investment by DST Global and its co-investors in 2020

Recipient of investment	Investment volume	About the company
Market Kurly	$ 150 million from DST Global and other investors	Delivery of premium goods. Through the service, 3 million orders are served monthly. Capitalization for 2020 — $ 780 million (South Korea)
Airwallex	$ 160 million from DST Global and other investors	A unicorn company, a service that allows managing cross-border transfers, taking into account savings on the exchange rate (China)
Brex	$ 150 million from DST Global and other investors	The unicorn company is engaged in the issue of corporate cards for IT startups with an increased credit limit (20 times) (USA)
Instacart	$ 225 million from DST Global and General Catalyst	The application for the delivery of products, after investment, the company's capitalization is estimated at $ 13.7 billion (USA)
Byju's	$ 122 million from DST Global	During the investment, the company's capitalization amounted to $ 10 billion, it is considered the most expensive educational startup in the world. Byju's designs online school education courses and exam preparation. 57 million users. (India)
Weee!	$ 35 million from DST Global	Online store of Asian goods. The capitalization of the company after investments was $ 500 million. (USA)

Source: Investor's investment DST. URL: https://www.forbes.ru/tehnologii/408399-dostavka-produktov-i-finteh-vo-chto-investiroval-yuriy-milner-v-razgar-pandemii (accessed on 11.03.2021).

- covid-negative — companies significantly affected by the pandemic (restaurant business, tourism, and logistics, entertainment, etc.);
- covid-positive — companies that have received a positive effect from the pandemic and isolation (online education, remote work tools, online entertainment, etc.);
- covid-neutral — companies that have not been affected by the coronavirus.

By company exits, data analysis for 2019–2020 confirmed a similar trend: the number of exits fell by 26.71%, or by 277 deals; the reduction in the volume of exits amounted to 61.42%, or $ 207 billion. In terms of the volume and number of exits, the venture capital market returned to the indicators of 2014 (*Fig. 6*).

A study of the situation in individual sectors allows us to note a significant increase in investment volumes in value terms: IT companies (an increase of 30%, up to 28.4 billion US dollars), payment systems

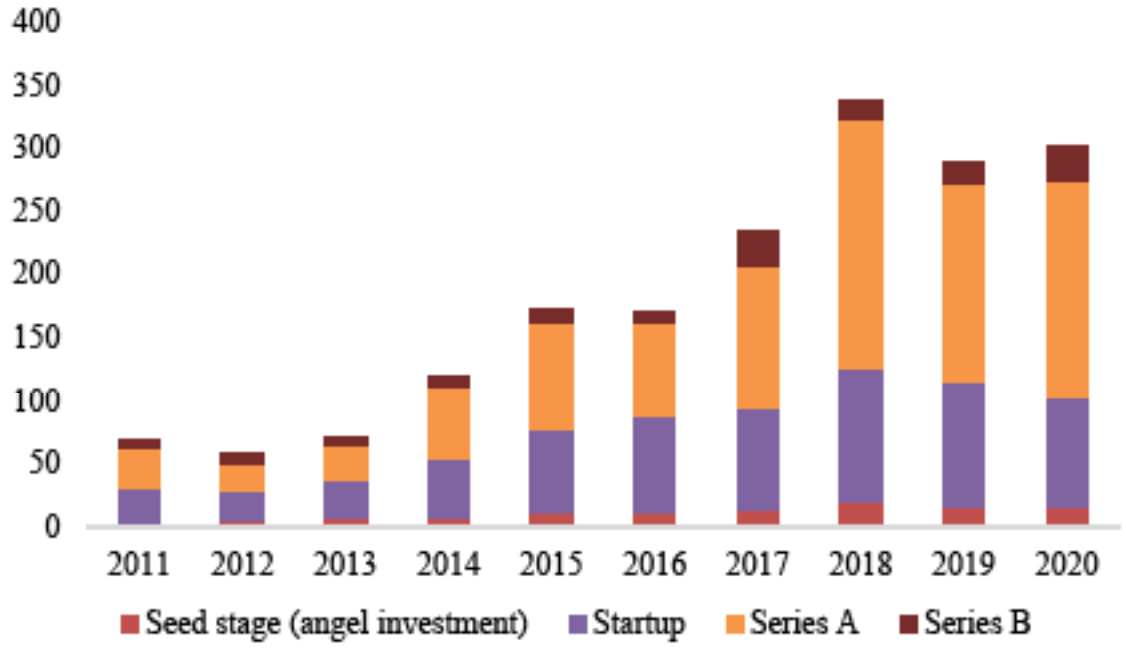

Fig. 1. **The volume of the global venture capital market in dynamics by years, USD billion**

Source: Global *VC Report* 2020: Funding and Exists Blow Past 2019 Despite Pandemic Headwinds. URL: https://news.crunchbase.com/news/global-2020-funding-and-exit/#seed (accessed on 12.04.2021).

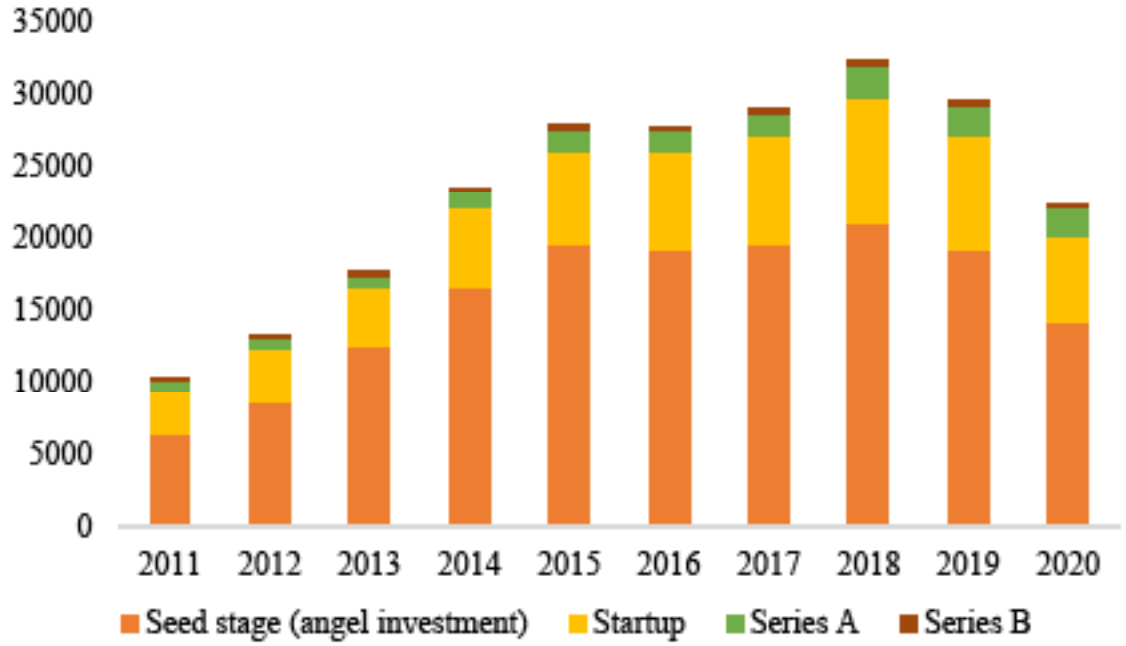

Fig. 2. **The global venture capital market in dynamics by years by the number of deals, pcs.**

Source: Global VC *Report* 2020: Funding and Exists Blow Past 2019 Despite Pandemic Headwinds. URL: https://news.crunchbase.com/news/global-2020-funding-and-exit/#seed (accessed on 12.04.2021).

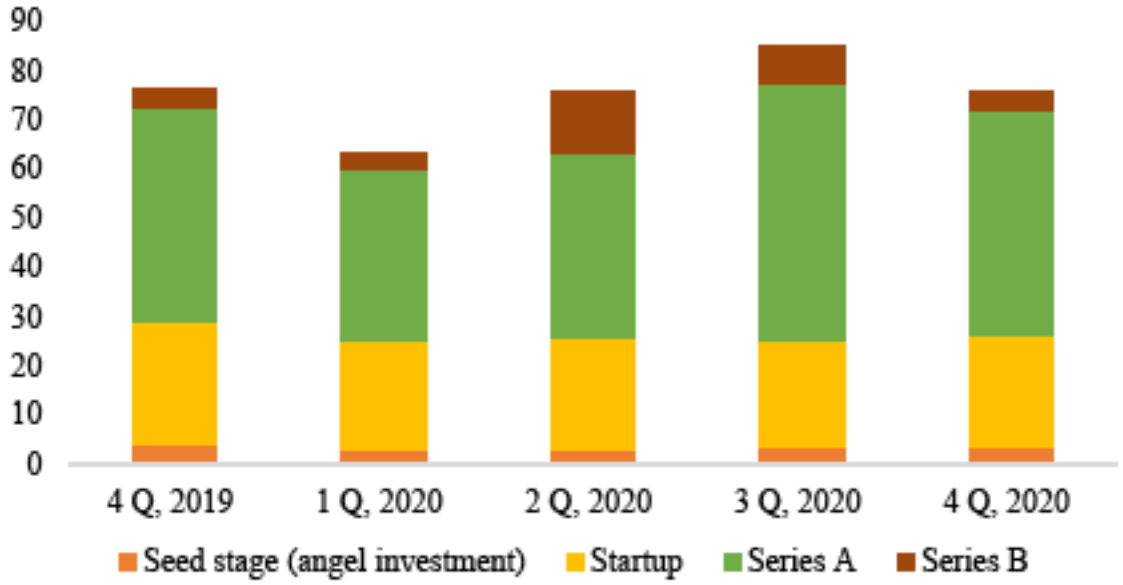

Fig. 3. **Quarterly dynamics of the global venture capital market, USD billion**

Source: Global VC *Report* 2020: Funding and Exists Blow Past 2019 Despite Pandemic Headwinds. URL: https://news.crunchbase.com/news/global-2020-funding-and-exit/#seed (accessed on 12.04.2021).

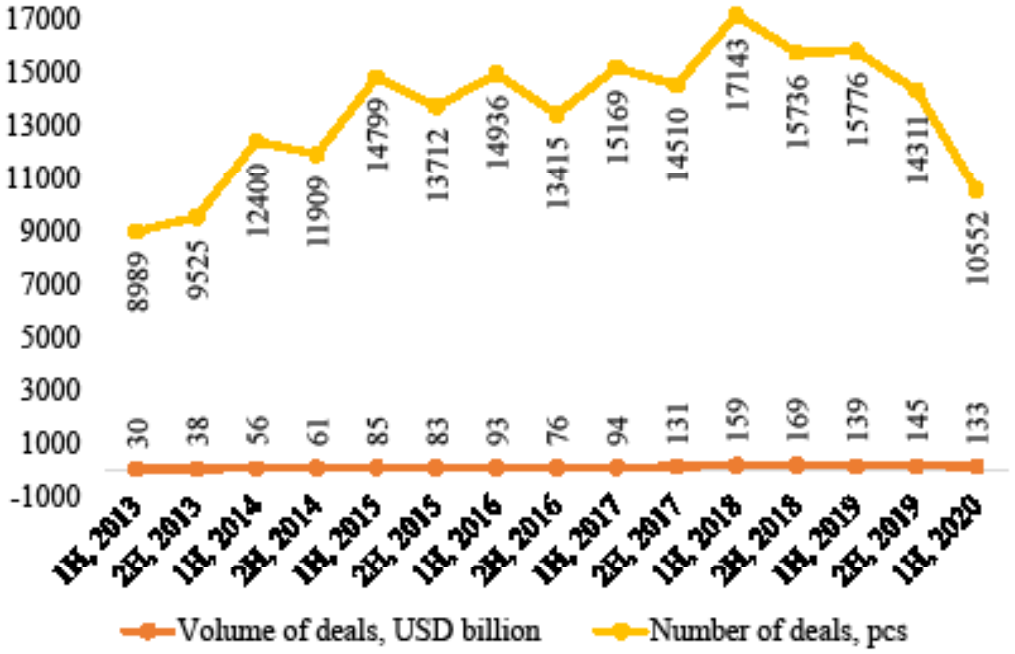

Fig. 4. **Dynamics of indicators of the global venture capital market in 2013–2020**

Source: Venture Russia: 1H 2020 Results. URL: ey-dsight-venture-russia-survey-rus.pdf (accessed on 15.04.2021).

(an increase of 52%, up to 9 billion US dollars), applications for mobile developers (growth by 68% to $ 13 billion).

The participation of government institutions in the recovery of the venture capital market is noted in the United States: since May 2020, there has been a support program related to the provision of government loans at a rate of 1%, the debt for which does not require repayment if the money was used within 24 weeks and 60% of they were covered by the costs of paying employees' salaries [14, p. 1]. The recipients of concessional loans were, among others,

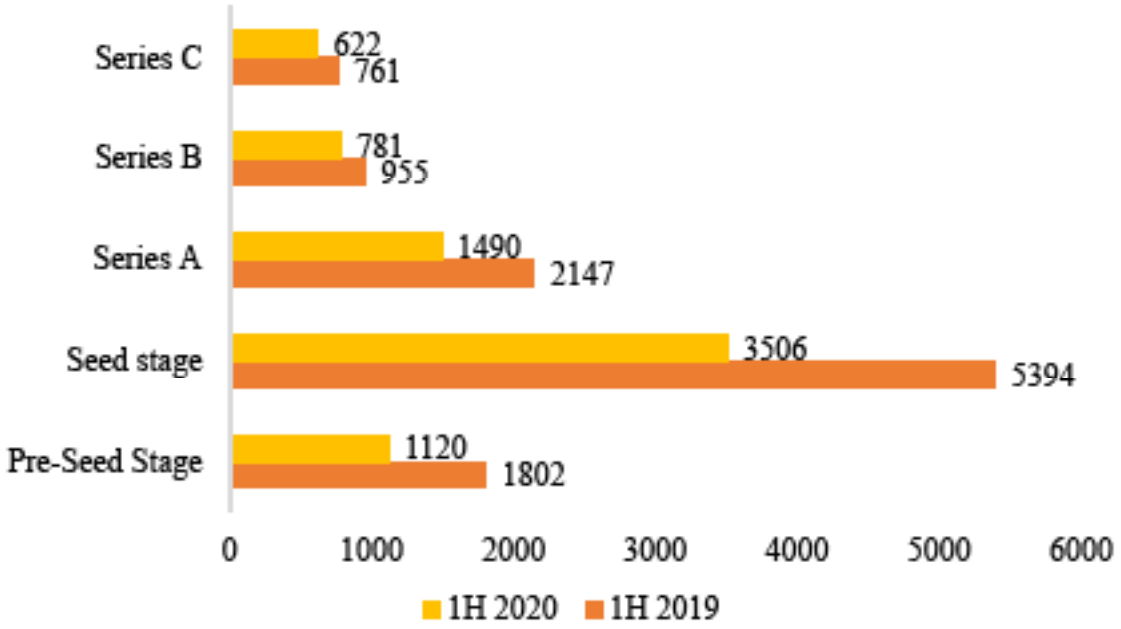

Fig. 5. **Number of deals in the global venture capital market by investment stages in the 1st half of 2019–2020**
Source: Venture Russia: 1H 2020 Results. URL: ey-dsight-venture-russia-survey-rus.pdf (accessed on 15.04.2021).

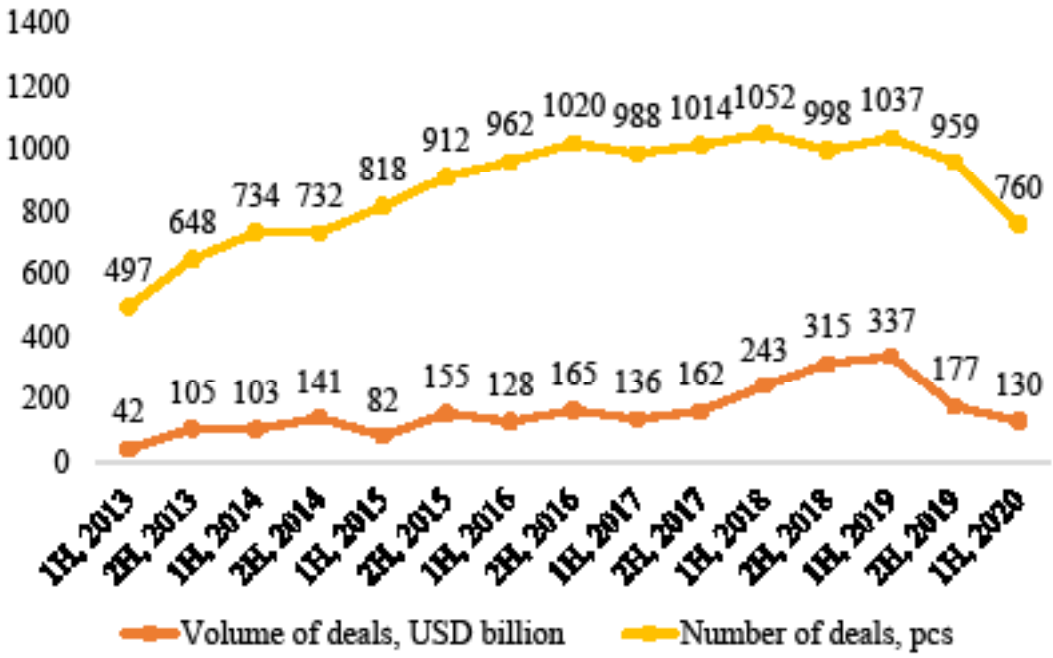

Fig. 6. **Dynamics of the number and volume of exits in the global venture capital market in 2013–2020, USD billion**
Source: Venture Russia: 1H 2020 Results. URL: ey-dsight-venture-russia-survey-rus.pdf (accessed on 15.04.2021).

venture funds — Andreessen Horowitz, Index Ventures and Foundation Capital. In total, 5,650 companies representing the venture capital sector in the United States were granted an estimated $ 5.2 billion in PPP loans.[7]

Most countries interested in developing technology entrepreneurship, innovation potential and venture capital investments have launched various programs to support startups and SMEs. In France, deferrals were introduced for paying taxes and insurance premiums, paying on loans, issuing guarantees to raise loans and canceling utility bills. Italy has abolished taxes for startups with income of less than € 2 million, offers a deferred tax payment for companies with higher incomes, and issues government guarantees. Portugal similarly provides for tax deferral, government guarantees and salaries from the government budget to support business. In general, in European countries, the approach to supporting start-ups and enterprises implementing them is substantially similar. However, there is no direct financing in the form of non-performing loans, as in the United States, and therefore the American approach is considered more effective than the approaches of other countries, since tax deferrals do not eliminate the subsequent need to pay them.[8]

On a global scale, the alleged collapse of the venture capital market did not happen, the pandemic changed the state of the market at the level of correction and nothing more, the volumes did not decrease critically, government agencies provided support, the focus shifted within the priority industries, venture capital investment continues to develop and attract new market participants [15]. Simultaneously with global trends in conditions of extreme instability and uncertainty, the importance of analyzing the venture capital market in Russia is assumed.

MAIN TRENDS OF THE RUSSIAN VENTURE MARKET IN 2020

For the Russian venture capital market, the pandemic has become an impetus for further development. Compared to 2019, the market has doubled: the volume of public deals with the participation of Russian startups in 2020 amounted to 21.9 billion rubles against 11.6 billion rubles in 2019. It should be considered that this indicator was significantly influenced by several large deals. Thus, startup Miro raised $ 50 million from the American fund Iconiq Capital;[9] a venture loan from Alfa-Bank was provided for the creation of an ivi online video streaming service in the amount of 3.7 billion rubles; Investments of VEB Ventures in the Doktor Ryadom project amounted to 1 billion rubles, investments of a private investor R. Abramovich in the gaming service 100 Industries amounted to 20 million dollars. At the same time, the number of deals increased: growth compared to 2019 was 34.33%, or 46 deals. In 2020, compared to the previous year, the growth in the volume of the venture capital market was noted in foreign investment (the highest growth rate — 316.67%), corporate investment (growth rate — 108%), private investment (growth rate — 236.36%). The impact of the pandemic on the public sector was negatively reflected: the decrease in investment volumes of state funds and accelerators is 27.91 and 57.42%, respectively.[10]

Interest on the part of foreign venture investors is mediated by the cost of participating in projects: Russian startups often require less investment, which allows

[7] Over 8,000 privately backed companies got billions in PPP loans, SBA data shows. URL: https://pitchbook.com/news/articles/privately-backed-companies-got-billions-in-ppp-loans-sba-data (accessed on 15.04.2021).

[8] Support measures for startups in Europe during the pandemic. URL: https://vc.ru/finance/118575-kak-v-evrope-podderzhivayut-startapy-v-period-pandemii (accessed on 17.04.2021).

[9] Startup with Russian roots — Miro. URL: https://www.forbes.ru/karera-i-svoy-biznes/398957-rossiyskiy-startap-miro-privlek-50-mln-ot-fonda-s-uchastiem-cukerberga (accessed on 17.04.2021).

[10] Russian venture market in 2020. URL: https://incrussia.ru/understand/vc-2020/ (accessed on 15.04.2021).

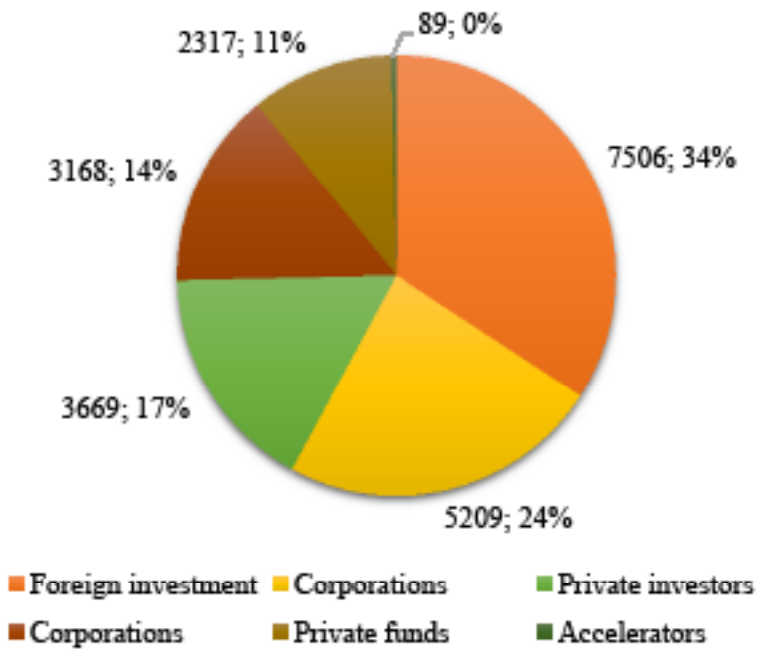

Fig. 7. **Structure and volumes of the Russian venture capital market in 2020**

Source: Russian venture market in 2020. URL: https://incrussia.ru/understand/vc-2020/ (accessed on 15.04.2021).

the investor to differentiate risks by financing a larger number of projects. The institutional structure of the Russian venture capital market for 2020, shown in *Fig. 7*, confirms the interest of the owners of foreign capital.

The aforementioned Miro project is a platform for remote work which helps to conduct online meetings and seminars, exchange photos, videos, and text documents. In 2018, the company raised $ 25 million from the American venture capital company Accel and the AltaiR Capital fund, previously this fund invested $ 1.3 million in a startup. During the pandemic, the startup managed to attract a record amount of investment in its entire history from the Iconiq Capital fund, which previously conducted successful investment deals with such unicorn companies as GitLab, Houzz, Robinhood, Epic Games, SurveyMonkey, Netskope.[11]

The second largest sector (24% of the market, 5,208.6 million rubles) also reached this level due to the concentration of capital in one large deal: a venture loan was provided to the online video streaming service ivi Alfa-Bank in the amount of 3.8 billion rubles. Excluding this deal, the volume of the sector decreased by half compared to the previous year.

The pandemic has made its own adjustments to the corporate investment market: previously created ecosystems continued to develop, more and more corporations began to build their own ecosystems. In particular, in the banking system, this interest is associated with the possibility of expanding the client base for the development of the main line of business through a presence in sectors not related to banking activities. The amendments presuppose the transformation of development vectors: the emergence of significantly "sagging" sectors [services related to the offline activity (ticket booking, travel)] and, conversely, the accelerated development of contactless services, online sales. Market growth is confirmed by the size of the average ticket by segment (*Table 7*) in

[11] Startup with Russian roots — Miro. URL: https://www.forbes.ru/karera-i-svoy-biznes/398957-rossiyskiy-startap-miro-priv-lek-50-mln-ot-fonda-s-uchastiem-cukerberga (accessed on 17.04.2021).

Table7

Average ticket size in the Russian venture capital market by sector in 2019–2020, RUB million

Investor category	2019, average ticket, RUB million	2020, average ticket, RUB million	Relative change, %
Foreign investment	204.3	312.8	+53.1
Corporate investors	115.0	157.8	+37.2
State funds	208.5	117.3	–43.7
Private funds	82.0	92.7	+13.0
Private investors	64.5	66.7	+3.4
Accelerators	4.6	5.6	+21.7

Source: Russian venture market in 2020. URL: https://incrussia.ru/understand/vc-2020/ (accessed on 15.04.2021).

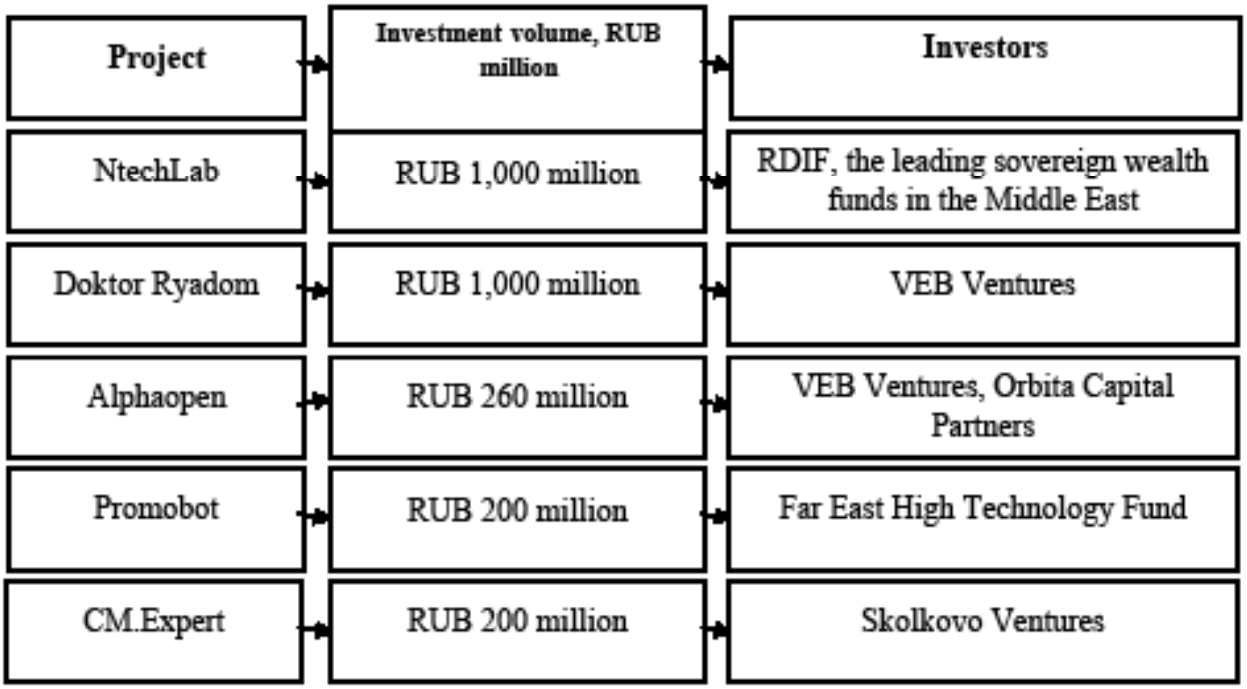

Fig 8. **The largest investment deals by the Russian state funds in 2020**

Source: Russian venture market in 2020. URL: https://incrussia.ru/understand/vc-2020/ (accessed on 15.04.2021).

the main sectors of venture capital investment in Russia.

The state funds are the exception, for which the indicator in 2020 decreased by 43.7% compared to the previous year for the following reasons: the closure of subsidiary funds of JSC Russian Venture Company (JSC RVC); political instability in the management staff of RVC JSC; reforming development institutions — previously, individual development institutions were transferred to the management of VEB (Vnesheconombank) and RDIF (Russian Direct Investment Fund); economic

Project	Investment volume, RUB million	Investors
Magic Kids	9.1.	Starta Ventures
LoyalMe	9.1	Starta Ventures
Slidepage	8.4.	Starta Ventures
NeuraLoom	8.4	Starta Ventures
Everytale	7.6	Starta Ventures

Fig 9. **The largest investment deals by the Russian accelerators in 2020**

Source: Russian venture market in 2020. URL: https://incrussia.ru/understand/vc-2020/ (accessed on 15.04.2021).

downturn, sanctions, devaluation of the ruble, the consequences of COVID-19. The financial resources of the state were redistributed to solve more global problems than to support the venture capital market.

In total, in 2020, at the expense of state funds, 27 deals were carried out for a total amount of 3,167.5 million rubles, of which two (projects NtechLab and Doktor Ryadom) — 2 billion rubles (*Fig. 8*). The most active federal investors are IIDF (Internet Initiatives Development Fund) and VEB Ventures, from regional state funds — Moscow City Venture Investment Development Fund.

As for the activities of corporate accelerators, the decrease in the number of deals is 64.4%, and the volume of completed deals — 57.4% compared to 2019; in 2020, 16 deals were carried out for a total amount of 89.4 million rubles (*Fig. 9*).

In general, the accelerator sector is represented by two active investors who financed the projects — Starta Ventures and Pulsar VC, with the market volume divided by 73.16 and 26.84%, respectively. Currently, the activities of accelerators can be considered insufficiently active, however, there is a wide interest in this institutional investment model from large corporations — Rosselkhozbank, MTC, Gazpromneft, etc., which are interested in expanding their innovative potential through technologies offered by startups.

Projects initiating cooperation with state development institutions, funds, due to the impossibility and significant risks of freezing funding, began to look for other ways to raise funds. The replacement was investment from business angels: this institutional sector tripled in 2020 and, with the exception of the major 110 Industries deal, the segment doubled.

It should be clarified that the gaming company 110 Industries, which has been operating since 2017 as a production center for the creation of the concept of premium games, has previously attracted venture capital investments, in particular, $ 3 million from the founders, and later — $ 1.1 million from private venture investors. In 2020, a subsequent round of investment was held with the attraction of $ 20 million from investment companies Norma Investment, GEM Capital, etc.

The active work of business angels supported investment development in the early stages (pre-seed and seed), which in the future if the trend continues, will change the investment culture in general and increase the influence of angel investments, approaching the US level. At the same time, the practice of business angel communities focused on

Table 8

Syndicated investment deals of the Russian business angels in 2020, RUB million

Investment project-recipient	Amount of investment, RUB million	Investors	Sphere
Fura	160	Svyatoslav Wilde, Alexander Popov, Swiss-Russian Foundation	Logistics and delivery
URent	150	Andrey Vinograd, Andrey Azarov, Mikhail Geisherik	Transport
K-Skai	130	Denis Ilatovsky, Spartak Zabolotsky	Healthcare
Mnogo Lososya	100	Alexander Sysoev, Pavel Dmitriev, Stepan Dmitriev, Maxim Penkin, Peter Sergeev, Alexey Tolokonnikov	Foodtech
Bright Kitchen	100	Stepan Dobrovolsky, Demyan Kudryavtsev, Sergei Anuryev, Ilya Varlamov	Foodtech
Muzlab	77	Andrey Danilov, Sergey Yamshchikov, Eduard Tiktinsky	Video, audio
Карусель	40	Artem Ermolaev, Andrey Belozerov	Transport
Jetlend	37.5	Dmitry Shklyar, Andrey Chernetsov	Finance
Финансист	37	Victor Savyuk, Pavel Orlov, Mikhail Bazhenov, Alexander Sokolov, Mikhail Gavrilov	Finance

Source: Russian venture market in 2020. URL: https://incrussia.ru/understand/vc-2020/ (accessed on 15.04.2021).

joint project financing and risk differentiation is being promoted. In turn, startups have more opportunities to raise funds due to the cooperation of business angels. Examples of syndicated angel investment deals in 2020 are presented in *Table 8*.

Attention should also be paid to the transformation of the sectoral preferences of investors in the venture capital market: the continued popularity of the information and communication technology (ICT) sector and the increased popularity of the healthcare and biotechnology sector in 2020 compared to 2019 *(Fig. 10)*.

At the end of 2020, according to *Fig. 11*, the most popular areas of venture investment in the ICT sector were solutions for business (6507.0 million rubles), video and audio technologies (3854 million rubles), and the healthcare sector (2179.1 million rubles.).

The medical sector has objectively acted as the main beneficiary of changes in the venture capital market: the industry has become a leader in investments in pharmaceuticals, medical equipment, IT platforms, and remote diagnostics. At the same time, serious venture investments have been renewed in this segment. A major deal took place, in which VEB Ventures (a subsidiary of VEB) invested 1 billion rubles to the Doktor Ryadom project,[12] related to online patient consultations. The project is focused on solving the problem of the lack of qualified specialists in remote regions of the country, the availability of health care. At the end of 2020, according to the Doktor Ryadom company, the demand for telemedicine

[12] Investing in the Doktor Ryadom project. URL: «Доктор рядом» получит 1 млрд рублей финансирования от VEB Ventures. ПРАЙМ, 13.05.2020 (1prime.ru) (accessed on 23.03.2021).

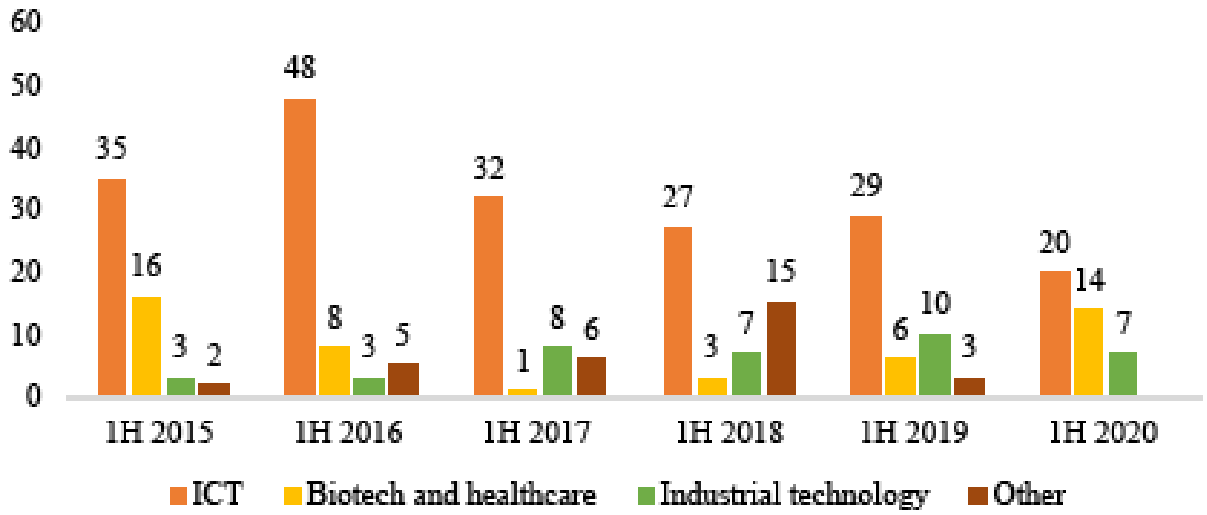

Fig. 10. **Dynamics of the volume of venture capital investment by industry sectors in the 1st half of 2015–2020, USD million**

Source: Overview of the Russian private equity and venture capital market for the 1st half of 2020. URL: RVCA-yearbook-I-2020-Russian-PE-and-VC-market-review-ru.pdf (accessed on 24.03.2021).

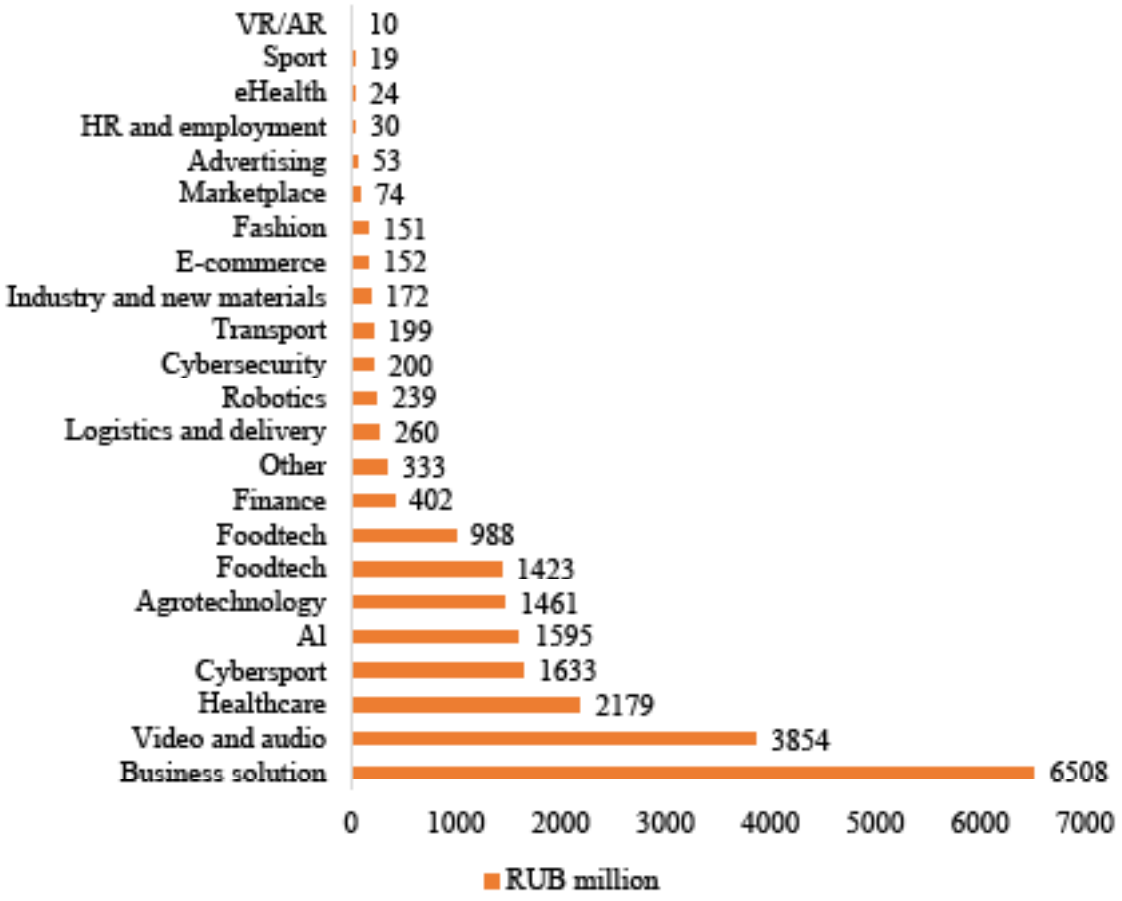

Fig. 11. **Directions of venture capital investment in Russia in 2020, RUB million**

Source: Russian venture capital market in 2020. URL: https://incrussia.ru/understand/vc-2020/ (accessed on 15.04.2021).

services increased 10 times compared to the previous year, which indicates a significant social effect of investments.

Retail is no less important in terms of business decisions. In 2020, Russians spent 3.22 trillion rubles on online shopping, which is 1.6 times more than in 2019. New rounds of investments in Avito and Ozon marketplaces are examples of major deals that confirm the interest of global investors and the attractiveness of Russian companies in the e-commerce sector. The latter held a public offering of American depositary shares on the NASDAQ stock exchange in November 2020, as a result of the placement, $ 990 million was raised, and the company's capitalization exceeded $ 7.4 billion. In addition to these funds, $ 135 million was received from the company's shareholders during a private placement of 67.5 million shares and the sale of Baring Vostok and AFK Sistema.[13]

The third beneficiary of the pandemic is the EdTech sector (educational services). Previously, online education was in its infancy, platforms gradually appeared, including the market leader (Netology Group) and its projects. During the pandemic, the projects "Virtual class" from the company "Uchi.ru" (a resident of Skolkovo), "SberClass" from "Sber", additional interest in existing programs and platforms "InternetUrok", "Foxford" from "Netology-group" were launched. Currently, the problem of introducing high-quality distance education has not been fully resolved and requires further investments in industry innovations.

The relevance of the use of new educational technologies has determined the popularization of the direction of "video and audio". Zoom's conferencing platform has grown 125% since its April 2019 IPO during the pandemic and has been used by over 300 million users daily.[14] The growth in the value of shares in 2020 amounted to 730.86% relative to the maximum value.

In general, the Russian venture capital market underwent a significant transformation without significant losses in market volumes, which was achieved due to the prevalence of the largest deals in industry volumes, attracting foreign capital and significant participation of private investors. At the same time, it should be noted the importance of studying trends at the final stages of the venture capital investment process.

VENTURE CAPITAL STARTUP DEVELOPMENT RESULTS: IPO TRENDS

The logical completion of the development of a startup, its last stage is the exit or IPO (First Public Offering), statistics on exits of companies are of particular importance for the analysis of the venture capital market. Entering a company on the stock exchange is a procedure for increasing capital through private or public offering [16, p. 391].

In 2020, under the influence of the pandemic, a certain transformation of the IPO market took place: there was no significant reduction or increase in the number of deals, but there was a change in investor interest in such securities. Due to the significant volatility of the market, there was a decrease in quotations of oil of all brands, stocks, bonds, as well as a decrease in interest rates on deposits. The forecast for the coming year was broadcasted as extremely pessimistic; the degree of uncertainty grew; investors began to look for ways not only to preserve their savings but also to increase them. One of the most attractive ways to invest in such conditions was investing in an initial public offering since this method provides high

[13] Ozone rose at the opening of US trading. URL: https://www.rbc.ru/technology_and_media/24/11/2020/5fbcf4f39a794716275b7d48 (accessed on 26.03.2021).

[14] End of the Zoom era. URL: https://www.forbes.ru/tehnologii/413573-konec-epohi-zoom-kak-glavnyy-servis-pandemii-perezhivaet-obvineniya-v-utechke (accessed on 28.03.2021).

returns even during periods of significant downturns in the entire market.

The continued growth of the money supply in the country led to a decrease in the refinance rate, interest rates on loans and deposits. In 2020, the officially announced inflation rate was 4.9%.[15]

These changes entailed the transformation of the entire investment market, in particular, the demand for services and products of the securities market has grown significantly [17, p. 55]. According to BCS Express, in 2020 the number of customers increased from 6.5 to 13.4 million, including active customers from 4.1 to 8.1 million.[16] According to the Moscow Exchange, for 11 months of 2020, the inflow of funds from individuals into Russian shares amounted to 300 billion rubles against 47 billion rubles a year earlier. According to the Bank of Russia, by the end of the third quarter of 2020, the total value of securities in the accounts of retail investors in the depositories of the Russian Federation, excluding investments in mutual funds (Mutual investment funds) and securities in trust portfolios, was 4.7 trillion rubles (growth by 45% per year).[17]

For a long time, the government stimulated positive dynamics in the form of growth in the volume of private investments in the stock market by creating comfortable conditions for investors. This is primarily about the introduction of tax incentives, increasing the level of financial literacy of the population through cooperation with large banks in terms of creating educational platforms. However, the interest rate cut had the greatest impact. During the pandemic, government authorities faced not a predicted influx of investors, but an increase in their number at times, which entailed significant difficulties: the market became unpredictable (such investors cannot be considered qualified in investment matters) and unproductive in relation to the national economy (many investors preferred to invest not in the objects of the Russian economy, but in the investment proposals of well-known global companies-giants).

In view of the growing uncertainty in the stock market, a number of decisions were made to regulate it:

- dividing investors into two categories — qualified and unqualified;
- increase in the personal income tax (personal income tax) rate from 13 to 15%;
- introduction of a tax on coupon income on corporate bonds, etc.

The division of investors into categories is aimed at limiting the investment activity of unqualified investors, directing investments in instruments with a low level of risk — securities of Russian issuers, investment units, foreign currency, precious metals, and bonds. On the part of the state, the measures taken are understandable and logical, since the market takes an organized form; the actions of unqualified investors are ordered within the permitted instruments; the market becomes more loyal to forecasts; investment in the national economy is stimulated, and an increase in taxes, considering the growth in the number of investors, can bring additional income to the state budget.

The innovations do not arouse interest among private investors, since most investors are recognized as unqualified, which means that their activities are limited, respectively, and the profitability, which is comparable, without taxes, with the profitability on deposits.

For qualified investors, higher tax rates, tougher procedures for obtaining tax deductions, as well as criteria for obtaining status are additional obstacles to professional activity. Substantially restrictive innovations can eventually lead not only to an outflow of investors to foreign brokers but also to

[15] Rosstat on the assessment of inflation at the end of 2020. URL: https://www.banki.ru/news/lenta/?id=10939826 (accessed on 26.03.2021).

[16] Results of public offerings on the Moscow Exchange in 2020. URL: https://bcs-express.ru/novosti-i-analitika/kto-poiavilsia-na-moskovskoi-birzhe-v-2020 (accessed on 26.03.2021).

[17] Massive stock market disease. URL: https://www.interfax.ru/business/741711 (accessed on 26.03.2021).

Table 9

Largest investment deals by sectors of the Russian economy in 2020

Object of the deal	Customer	Seller	Acquired share, %	Transaction amount, USD million
Innovation and technology				
ICS Holding	USM Telecom	Anton Cherepennikov	100.00	2039.00
Yandex.Market	Yandex	Sberbank	45.00	606.00
Yandex	Alexander Abramov, VTB Capital; Roman Abramovich, Alexander Frolov	Yandex	3.50	600.00
Rostelecom data processing centres	VTB Bank	Rostelecom	44.80	465.00
Yandex	NASDAQ Investors	Yandex	2.30	400.00
Consumer Markets				
OZON Holdings	NASDAQ Investors and Moscow Exchange, Baring Vostok Capital Partners, Sistema	OZON Holdings	20.40	1274.00
Detsky Mir Group	Altus Capital	Existing shareholders	25.00	389.00
Detsky Mir Group	Moscow Exchange Investors	Sistema, RCIF	40.90	438.00
Apteka 36,6	-	Tacticum Capital	14.10	183.00
Barilla Rus	RDIF	Barilla G.e R. Fratelli S.p.A	-	153.00
Transport and infrastructure				
Aeroflot – Russian Airlines	Moscow Exchange Investors	Aeroflot – Russian Airlines	54.60	1048.00
TransContainer	Delo Group	Enisey Capital, VTB Bank	49.60	764.00
Sovcomflot	Moscow Exchange Investors	Sovcomflot	17.20	548.00
Almaty International Airport	TAV Havalimanlari Holding, VPE Capital	Venus Airport Investments, Timur Kulibayev	100.00	415.00
VRK-2	Novaya vagonoremontnaya kompaniya	Russian Railways	100.00	154.00

Table 9 (continued)

Object of the deal	Customer	Seller	Acquired share, %	Transaction amount, USD million
Telecommunications and media				
Turkcell	Turkey Wealth Fund, Группа LetterOne	Telia Company AB, Cukurova Holding	37.80	834.00
MTC	MTC	N/a	2.40	187.00
Akado Group	AVK Investments	Renova Group of Companies	51.00	145.00
Rambler	Sberbank	Alexander Mamut	45.00	136.00
HeadHunter	NASDAQ Investors	Goldman Sachs	9.90	101.00
Banking and insurance				
TCS Group	London Stock Exchange Investors	Oleg Tinkov, Oleg Tinkov Family Trust	5.30	325.00
VTB Bank	Financial corporation "Otkritie"	N/a	4.10	198.00
SOVEST	Sovkombank	QIWI	100.00	86.00
Reserve mutual fund	MTC	Sistema	N/a	77.00
Reserve mutual fund exchange	MTC	Sistema	N/a	50.00

Source: M&A market in Russia in 2020 according to KPMG data. URL: https://www.tadviser.ru/images/4/43/Ru-ru-ma-survey-2020-fin.pdf (accessed on 02.05.2021).

aggressive trading on the exchange in order to achieve the status of a qualified investor (one of the criteria is the presence of assets in the amount of 6 million rubles), which leads to even greater risks on the part of the investor and weakening the state's ability to regulate the market.

The changes were also not welcomed by brokers, many of whom work in the banking group structure, as they stimulate the outflow of existing investors to foreign brokers, while the obligation to provide exams and the complexity of the IT infrastructure increases the volume of their work, requiring additional costs.

Despite the high degree of uncertainty, the suspension of economic activity on a global scale during the pandemic, the introduction of significant changes in the legal framework for the functioning of investment entities, the market volume has increased.

The growth in the number of investors, stabilization in the second half of the year, and high liquidity in the market gave impetus to the public offering of companies' shares, as well as the conduct of investment deals in terms of mergers and acquisitions. The most significant investment deals in 2020 are presented in *Table 9*.

As per *Table 9*, there is an interest in investing both through the stock exchange and through standard speculation on the purchase/sale of shares or companies in general. The most active investors of the

year are Sberbank of Russia (PJSC), VTB Bank (PJSC), and private investors in various exchanges, such as Moscow, London, and the US.

At the same time, it should be noted that the number of deals decreased by 103 in absolute terms and by 15.4% compared to the previous year; in terms of the volume of deals, a 5% decrease is similarly noted, despite the fact that 2019 is considered the most productive year since the imposition of sanctions.[18]

Despite the positive overall dynamics of the market, one cannot fail to note the manifestation of the negative impact of the pandemic. In particular, many companies have started to pursue more conservative short-term development strategies, especially in terms of initial public offerings. Many IPOs planned for 2020 were postponed indefinitely (Pobeda Airlines, VkusVill retail food chain, Yandex.Taxi, FixPrice, Segezha Group, Sibur, ivi, etc.).[19]

In general, venture capital investments during the pandemic have demonstrated significant resilience to the crisis. This is largely due to its key long-term target (5–10 years). Moreover, venture capital funds consider the onset of the crisis in the perspective of the implementation of investments (they consider a mid-term crisis on average 1–2 years).[20] The critical decline of the venture capital market, predicted by analysts, did not happen, and the result of the pandemic was its systematic development. An increase in the volume of the market is noted, however, it is emphasized that the corresponding optimistic result was achieved due to the large deals, incomparable with the volume of the existing market as a whole [18, p. 843]. Accordingly, with the exception of the previously mentioned deals, we see the following trend: in the first half of 2020, there was a decline in all sectors of venture investment, which is objectively mediated by the emerging uncertainty in the market; in the second half of the year the market recovered and, moreover, showed positive dynamics, comparable to the same periods of previous years.[21]

CONCLUSIONS

The research shows that the consequences of the pandemic were significant, but not critical; The venture capital market has transformed in a number of areas, with the following trends emerging:

- increased interest in venture capital investments due to its applicability in conditions of economic uncertainty — absorption of risks through a long investment cycle;
- a decrease in interest in projects of the pre-seed and seed stages in favor of not only more mature projects but also start-ups of large market players, ensuring the stability of their development;
- prolongation of investments in favor of portfolio projects, companies, and not the search for new startups;
- significant growth of the Russian investment market due to the largest deals, incommensurate with the volume of the market as a whole;
- significant interest of foreign investors in Russian companies due to the lower cost of investments;
- a significant increase in the volume of private investment due to angel investments;

[18] M&A market in Russia in 2020 according to KPMG data. URL: https://www.tadviser.ru/images/4/43/Ru-ru-ma-survey-2020-fin.pdf (accessed on 02.05.2021).

[19] The most famous IPOs of the year. URL: https://www.finam.ru/analysis/forecasts/premery-2020-samye-zametnye-ipo-goda-20201221–142531/ (accessed on 04.05.2021).

[20] The economic impact of the pandemic has adjusted investment strategies. URL: https://trends.rbc.ru/trends/innovation/5f44d01a9a79474224070013 (accessed on 17.04.2021).

[21] Global VC Report 2020: Funding and Exists Blow Past 2019 Despite Pandemic Headwinds. URL: https://news.crunchbase.com/news/global-2020-funding-and-exit/#seed (accessed on 12.04.2021); Venture Pulse Q4 2020, Global analysis of venture funding — KPMG Private Enterprise. URL: https://assets.kpmg/content/dam/kpmg/xx/pdf/2021/01/venture-pulse-q4–2020-report-global.pdf (accessed on 05.05.2021).

- a decrease in the role of public funds in connection with a difficult political situation and a change in the organizational structure of the activities of development institutions;
- significant sectoral redistribution of venture capital investments, popularization of medical science and biotechnology, education, video and audio, business solutions that meet the current needs of society;
- maintaining the general indicators of the IPO market with the simultaneous extension or cancellation of the exits of some companies;
- a significant inflow of private investors to the exchange due to the reduction in the key rate of the Central Bank of the Russian Federation (CB), the subsequent institutional and organizational transformation of the market;
- a slight decrease in M&A activity.

However, one cannot speak of the prospect of greater investment growth than in 2020. According to the authors, the reasons for the projected decline in investment activity are as follows:

- in 2020, the inflow of private investors to the exchange is associated with the previously noted decrease in the exchange rate of the Central Bank of the Russian Federation. However, in 2021, for the first time since 2018, an increase in the rate to 4.5% was recorded, which means the likelihood of an increase in interest rates on deposits, which more easily bring financial results and do not require professional knowledge, in contrast to the use of securities market instruments;
- the funds attracted to the stock exchange to a greater extent represent the previously accumulated savings of the population, which cannot be attracted again in the proper volume;
- private corporate investors during the pandemic faced significant difficulties in carrying out their operations on the Internet. Many covid-negative companies suffer significant losses due to a lack of demand for their own products or services. In this regard, the corporate investor will direct resources to restore their own business, and not to the external market and venture investment instruments;
- for some technology companies, financial difficulties are similarly characteristic, which is accompanied by the refusal to conduct exits, the suspension of project financing, a shift in the focus of priority business areas, the reorganization of portfolios considering the optimization of economic costs.

REFERENCES

1. Alekseeva M. B., Vetrenko P. P. Analysis of innovation. Moscow: Yurait; 2021. 302 p. (In Russ.).
2. Pinkow F., Iversen J. Strategic objectives of corporate venture capital as a tool for open innovation. *Journal of Open Innovation Technology Market and Complexity*.2020;6(4):157. DOI: 10.3390/joitmc6040157
3. Spanova L. K., Smagulova Zh.B., Arynova L. D. Features of venture financing in business. *Mezhdunarodnyi zhurnal prikladnykh i fundamental'nykh issledovanii = International Journal of Applied and Fundamental Research.* 2015;(12–7):1297–1299. (In Russ.).
4. Ezangina I. A. Zakharova N. D. Improving project finance tools for the spatial development strategy of Russia (evidence from priority sectors). *Finansy: teoriya i praktika = Finance: Theory and Practice.* 2020;24(2):22–38. (In Russ.). DOI: 10.26794/2587–5671–2020–24–2–22–38
5. Vasilenko O. A. Venture financing of innovations in Russia at the present stage. *European Research.* 2018;(1):43–46. (In Russ.). DOI: 10.20861/2410–2873–2018–44–004
6. Butuzova A. S. Capitalization of international unicorn companies: To what extent is it feasible. *Finansy i kredit = Finance and Credit.* 2018;24(2):430–438. (In Russ.). DOI: 10.24891/fc.24.2.430
7. Ergashev I., Yuldashev S., Alibekova S., Nasimov D. Venture capital financing as the sourse of investment-innovative activities in the field of services. *Journal of Critical Reviews*. 2020;7(7):43–46. DOI: 10.31838/jcr.07.07.08

8. Volkova T. I., Mishcherina T. V. Venture investment of innovation projects: Modern development trends and risks. *Ekonomicheskii analiz: teoriya i praktika = Economic Analysis: Theory and Practice.* 2016;(1):93–103. (In Russ.).
9. Piqué J. M., Berbegal-Mirabent J., Etzkowitz H. The role of universities in shaping the evolution of Silicon Valley's ecosystem of innovation. *Triple Helix.* 2018;5:11. DOI: 10.1186/s40604–018–0060-x
10. Musostov Z. R. Source of development of innovative activities of enterprises: Venture financing. *Ekonomika i biznes: teoriya i praktika = Economy and Business: Theory and Practice.* 2020;(12–2):142–148. (In Russ.). DOI: 10.24411/2411–0450–2020–11091
11. Jeong J., Kim J., Son H., Nam D. The role of venture capital investment in startups sustainable growth and performance: Focusing on absorptive capacity and venture capitalists' reputation. *Sustainbility*. 2020;12(8):3447. DOI: 10.3390/su12083447
12. Humphries J. E., Neilson C. A., Ulyssea G. Information frictions and access to the Paycheck Protection Program. *Journal of Public Economics*. 2020;190:104244. DOI: 10.1016/j.jpubeco.2020.104244
13. Bock C., Hackober C. Unicorns — what drives multibillion-dollar valuations? *Business Research*. 2020;13(3):949–984. DOI: 10.1007/s40685–020–00120–2
14. Karpenko O. A. Initial public offering of shares of Russian venture capital companies. *Voprosy innovatsionnoi ekonomiki = Russian Journal of Innovation Economics*. 2017;7(4):391–406. (In Russ.). DOI: 10.18334/vinec.7.4.38324
15. Standaert T., Knockaert M., Manigart S. Venture capital winners: A configurational approach to high venture capital-backed firm growth. *British Journal of Management.* 2021. DOI: 10.1111/1467–8551.12491
16. Kovalchuk A. I., Razumovskaya E. A. The problem of qualification of novice investors. *Osnovy ekonomiki, upravleniya i prava = Economy, Governance and Law Basis.* 2021;(1):55–58. (In Russ.). DOI: 10.51608/23058641_2021_1_55
17. Minnikova D. A. Venture capital as a factor for increasing of competitive ability of Russian economy. *Vestnik Evraziiskoi nauki = The Eurasian Scientific Journal.* 2020;12(1):56. (In Russ.).
18. Moreva E. Venture capital in Russia and the global evolution of venture capital. *Journal of Reviews on Global Economics.* 2018;7:843–850. DOI: 10.6000/1929–7092.2018.07.82

ABOUT THE AUTHORS

Irina A. Ezangina — Cand. Sci. (Econ.), Assoc. Prof., Department of Management and Finance of Production Systems, Volgograd State Technical University, Volgograd, Russia
ezangirina@rambler.ru

Alina E. Malovichko — Master's student, Department of Management and Finance of Production Systems, Volgograd State Technical University, Volgograd, Russia
malovi4ko.a@gmail.com

The article was submitted on 26.04.2021; revised on 10.05.2021 and accepted for publication on 17.05.2021.
The authors read and approved the final version of the manuscript.

ORIGINAL PAPER

DOI: 10.26794/2587-5671-2020-25-5-117-132
JEL G18, G28

Global Depository Receipts in India: Boon or Bane

S.S. Khakase[a] ✉, **B.S. Ronald**[b], **T.M. Rathi**[c]
Symbiosis Law School, Maharashtra, India
[a] https://orcid.org/0000-0001-5646-6481; [b] https://orcid.org/0000-0002-2646-2620;
[c] https://orcid.org/0000-0002-8963-6333
✉Автор для корреспонденции

ABSTRACT

The Global Depository Receipt ("GDR" or "DR") is a structured financial instrument denominated in foreign currency and Indian companies issue equity shares/securities underlying the GDR to international investors. Many companies have used GDRs for manipulative and fraudulent practices and the Indian regulator, SEBI has penalised them. This paper **aims** to evaluate the legitimacy of the GDRs and malpractices associated with them and to find if there is any need for reform in the GDR Scheme, to see if the GDRs are beneficial to the economy or are inherently manipulative instruments and looks at the need to reform the laws governing GDR. The authors have employed the **methods,** literature review and empirical research. The authors have conducted empirical research of the participants in the Indian GDR industry in April and May of 2021 by way of an online Questionnaire and unstructured telephonic interviews. The study **results** in the author's conclusion that the GDRs are legitimate instruments but the participants abused the Scheme and led to malpractices. The authors failed to conclude about the need for reforms in the GDR laws. The paper **recommends** the suitable amendment of the DR scheme with an intention to plug its loopholes and allow it in foreign jurisdictions with the highest compliance requirements while keeping in mind the cost of such compliance.

Keywords: American Depository Receipt (ADR); Depository Receipt (DR); Global Depository Receipt (GDR); India; malpractices

For citation: **Khakase S.S., Ronald B.S., Rathi T.M. Global depository receipts in India: Boon or bane. *Finance: Theory and Practice*. 2021;25(5):117-132. DOI: 10.26794/2587-5671-2021-25-5-117-132**

INTRODUCTION

Neo-liberalisation, by way of economic liberalisation in 1991, put an end to dirigisme and implemented economic policies in favour of a market driven Indian economy coupled with private and public investment. Financial industry, including capital markets were also influenced, policies were drafted to attract investments, domestic and international, Foreign Currency Convertible Bonds and Ordinary Shares (through Depository Receipt Mechanism) Scheme, 1993 (the "1993 DR Scheme") was one of such measures.

The 1993 DR Scheme, with the aim of attracting foreign investment and facilitating international capital market access, has assisted many Indian companies to raise foreign funds through the GDRs.[1] With humble issuances in the early period, and the DR transactions surged during 2004–2011, around US$ 9 bn worth of GDRs were issued only in one financial year 2007–2008 [1, 2].

"Aquila Non Capit Muscam" means "a noble doesn't deal with insignificant issues", but the malpractices and fraudulent activities carried out in relation to the DR Scheme started affecting Indian Investors. It was no more insignificant, the regulator, the Securities and Exchange Board of India (the "SEBI") acted against such practices and restrained fraudsters from the Indian capital market. The 1993 DR Scheme, after observing irregularities and malpractices, went through several changes, stringent provisions were laid to reduce apprehension of the GDR abuse, but again, it was liberalised by the Ministry of Finance by the Depository Receipt Scheme, 2014 (the "2014 DR Scheme") [3] which further amended in 2019 and 2020 restricting GDR issuances only to listed companies,

[1] See Section 2(44) of the Companies Act, 2013. Global Depository Receipt means any instrument in the form of a depository receipt, created by a foreign depository outside India and authorised by a company making an issue of such depository receipts. Same definition is used throughout this paper. GDR includes all depository receipts including ADR issued in the USA and GDR issued in the rest of the world. The GDRs and the DRs are alternatively used; and plural forms are the GDRs and the DRs.

permissible jurisdictions, etc. The SEBI imposed penalties for dozens of the GDR transactions; even in 2021, several companies and participants have been penalised for decade-old GDR issuances.

The changes in regulatory policies and subsequent effects have zeroed down the new DR issuances in 2019–2020. These policy framework amendments raised several questions about the DR Schemes and policies, its effectiveness of accessing foreign funds and capital market, the quantum of malpractices and SEBI's action and market response to it. Further, the amendment of the 2020 in Companies Act, allowing direct overseas listing ("DOL"), has made participants believe the 'end of the DR era in India'.

Naturally, a question pops up, whether the GDR is good or bad: a boon or bane? That has been discussed on the basis of the methodology stated in the next section.

METHODS

In the last decade, the SEBI, Securities Appellate Tribunal (SAT) and the Supreme Court had penalised and restricted many companies for their manipulative practices related to the DR transactions [4]. These incidents split opinions, Sahoo Committee wanted to liberalise the GDR framework whereas SEBI restricted it, creating regulatory uncertainty about the instrument.

This paper is purported to understand the concept of GDR, indulgence into any manipulative or fraudulent practices related to GDR and evaluate if the DR scheme is a boon or a bane in India. Though this study attempts to address issues pertaining to the Indian legal system, it is of global significance as the DRs are commonly used financial instruments across the globe. This study may help to understand possible malpractices in all DR jurisdictions in the world and curative ways to curb them by framing a prudent GDR framework. Secondly, the DRs avail investors opportunities to exploit the international capital market and impart economic growth. The alterations in the Indian policy framework and its effect on the DR issuances will also be helpful to other economies in dealing with the malpractices by prudent policies.

The methodology was based on empirical analysis coupled with a logical literature review.

Traditional and semi-systematic approaches of the literature review were used wherein secondary data was reviewed from existing literature, legislations and other sources of data and information including various publications of the Government of India and others, published reports and newspapers. Based on the available literature, inductive and deductive reasoning approaches have been used to arrive at suggestive conclusions.

Primary research, exploratory and applied, was conducted with a structured questionnaire and unstructured telephonic discussions. Using purposive, convenience and stratified random sampling, primary data was collected from 40 stakeholders, excluding 1 outlier, ("Respondents" or "Participants") maintaining their anonymity.

The sample size has been stratified into five strata, namely GDR Issuer, Advisor to Issuer/Placement Agent and Legal Counsel were having 10 Respondents each. There were 5 Respondents from categories of the Lead Manager and Depository each. Hence, *Figure 1* presents the stratification of Respondents under this survey/data analysis.

This research intends to examine whether the DR or the DR scheme is a boon or a bane in India? Other research questions framed are stated hereunder:

a) Do companies indulge into manipulative or fraudulent practices related to the GDRs or the DR Schemes in India?

b) Are the prevailing laws related to the GDR mechanism sufficient to restrict or curb malpractices:

c) Is there any need for reform in the DR Schemes?

To find answers, let's briefly understand the GDR and its structure.

GLOBAL DEPOSITORY RECEIPTS: DEFINITION & MEANING

The Global Depository Receipt that is the GDR[2] is stated in Cambridge dictionary as "an abbreviation for Global Depositary Receipt which is an official document that makes it possible for investors to buy shares of foreign companies". Cambridge dictionary defines the "depository receipt"[3] as "a document that represents a certain number of shares, bonds, etc. that have been bought from a stock market in another country and paid for in the currency of the buyer's country".

The first DR of the world was issued in 1927 when

[2] CAMBRIDGE DICTIONARY (Online 2020). URL: https://dictionary.cambridge.org/dictionary/english/gdr (accessed on 28.03.2021).

[3] Id. URL: https://dictionary.cambridge.org/dictionary/english/depository-receipt (accessed on 28.03.2021).

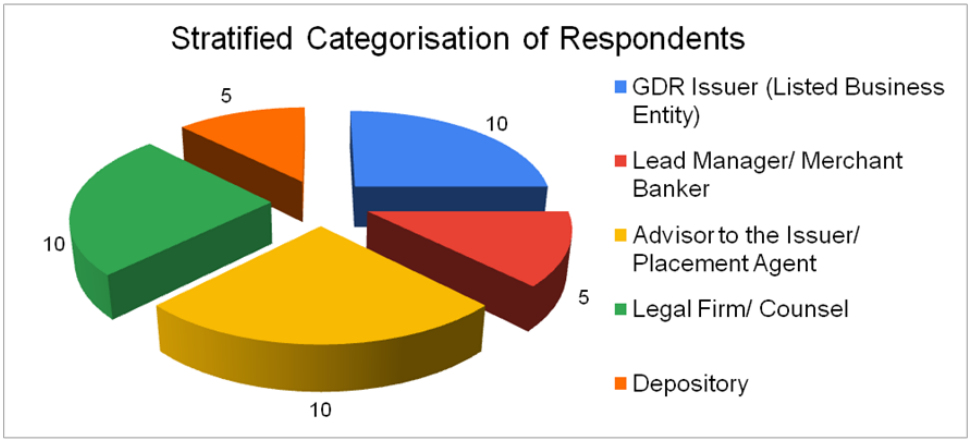

Fig. 1. **Stratified Sampling in the Empirical Study**

Source: compiled by the authors from the survey conducted by them.

British companies, under British laws, were prohibited from registering their shares out of the country whereas ADRs were permitted to be subscribed by the investors of the United States [5] and thus depository receipts underlying equity shares came into existence. United Kingdom's Selfridges Provincial Stores Limited (now known as Selfridges PLC) was the first Issuer and JPMorgan was credited to have acted as the first Depository.[4]

In the Indian context, the GDR is a synonym for the DR: the Companies Act, 2013, under section 2(44) defines the GDR as "Global Depository Receipt means any instrument in the form of a depository receipt, created by a foreign depository outside India and authorised by a company making an issue of such depository receipts."

The 2014 DR Scheme[5] has defined the 'depository receipt' as a foreign currency denominated instrument, whether listed on an international exchange or not, issued by a foreign depository in a permissible jurisdiction, on the back of permissible securities issued or transferred to that foreign depository and deposited with a domestic custodian and that includes 'global depository receipt' as defined in section 2 (44) of the Companies Act, 2013.

Further, the meaning of 'Permitted Securities' is imported from the term 'securities' as defined in Section 2(h) of the Securities Contract (Regulation) Act, 1956 wherein the term 'securities' is broadly defined covering shares, scrips, stocks, bonds, debentures, debenture stock or other marketable securities include derivatives, Government securities, etc. and rights or interest in securities. If any of these securities are issued in dematerialised form and acquired by foreign residents under FEMA,[6] then they can be used as underlying security for issuing the DRs in foreign markets [6].

Considering the above definitions, "the GDRs" or "the DRs" are synonyms in the Indian legal context and its meaning can be deduced as "any instrument created or issued by a depository in one country offered to investors in domestic currency whereas such instrument carries underlying (permitted) securities which are issued by a company in another country and in foreign currency."

Christopher J. Mailander [7] has cited several benefits of the ADRs, these are applicable to the DRs, *mutatis mutandis,* stated below:

1. The DR is an alternative instrument to equity shares when equity shares cannot be offered directly.
2. The DRs allow a company to have access to the foreign security market.
3. The DRs are offered in the local currency of investors, hence nullifying currency fluctuation risk.
4. Most countries including the USA, Europe, Singapore, etc., don't restrict purchasing of DRs underlying foreign securities.

Rishi Shroff [8] tried to point out the negative aspects of the DRs. Shroff stated that allowing foreign listing by way of the DRs is halfway of the capital market liberalisation and hence, it may not benefit Issuers completely in terms

[4] JPMorgan Chase & Co. Investor Relations: JPMorgan Chase celebrates 75th anniversary of the ADR. April 29, 2002. URL: https://jpmorganchaseco.gcs-web.com/news-releases/news-release-details/jpmorgan-chase-celebrates-75th-anniversary-adr (accessed on 28.03.2021).

[5] Ministry of Finance, Government of India. Notification. Gazette of India. Oct 24, 2014; New Delhi.

[6] Foreign Exchange Management Act, 1999.

of true overseas pricing, valuation, visibility and others. In absence of direct listing, the DRs may be listed on secondary platforms of foreign exchange.

STRUCTURE OF THE GDR

The DR, being derivative instruments, its value is derived from the value of underlying securities, generally, shares but other securities are also permitted subject to the laws of the land.

Dr. P.R. Kousalya and Ms. S. Niranjana [9] along with other independent authors, Manoj Kumar [10] and N.M. Desai [11] have elaborated the mechanism or structural flow of the DRs from India. Inspired by those, a simplified structure is depicted in *Figure 2*.

In India, the GDR issuance is like any other public offering and is equally complex in terms of documentation, procedure and compliance. For ease of understanding, the process of GDR issuance has been divided into five broader steps:

1. Issue of Shares
2. Deposition of Shares with the Custodian
3. Receipt of Shares confirmation by Custodian to the Depository
4. Issue of the DRs by the Depository
5. Offering/ Sale of the DR

Generally, the Issuer issues shares that underlie the GDRs issued by the Depository. Issuance of shares is also a cumbersome process; many parties are involved like a Lead Manager who guides the DR transactions and determines the ratio of the DRs to the Share ("DR Ratio"), inter alia, other functions of coordination and the DR placement or book building.

The Issuer, pursuant to the Deposit Agreement, deposits the shares with the custodian which holds the shares on behalf of the Depository and will follow its instruction, abiding the agreements agreed by the parties.

The Depository, against the acknowledgment of the Custodian, issues the DRs. These DRs are negotiable instruments that guarantee the delivery of underlying shares, either on-demand, or at a predetermined time. These DRs, then, are offered to foreign investors for subscription and purchase price is paid to the Issuer or holders of underlying shares, as the case may be.

Like other countries, India has allowed two-way fungibility for the DRs, which means shares (or underlying securities) can be converted into the DRs and the DRs can be cancelled to the underlying securities [12].

TYPES OF THE DRS

The DRs have been differentiated on various grounds. *Figure 3* delineates different types of the DRs on the basis of three broad distinguishing grounds namely:

1. Location of the DR issuance
2. Consent of the Issuer
3. Laws or Targeted investors

1. Location of the DR issuance

On the basis of the Location of the DR issuance, the DRs can be divided into types:

1. ADRs, mean American Depositary Receipts, are the DRs issued and/ or listed only in the US markets [10].

2. GDR are generally issued and/ or listed in the European markets, but the term is used for any DR issued or listed across the globe except in the USA, including Singapore, Hong Kong, etc.

3. IDR[7] or BhDR[8] are similar to ADRs and GDRs wherein foreign companies are allowed to issue and lists their DRs in the Indian market[9] [13].

2. Consent of the Issuer

Unsponsored DRs: Unsponsored DRs imply that the DRs are issued without formal consent or approval of the Issuer. Hence, such DRs are issued against the existing issued and subscribed shares held by any shareholder. These shareholders give custody of their shares to the Custodian and against such shares, the Depository issues the DRs. The DR buyer or the investor pays to the shareholders through the Depository.

In India, Unsponsored DRs were permitted by the 2014 DR Scheme[10] had overridden conflicting provisions under 2(44) of the Companies Act.[11] Sandeep Bhagat with co-authors [14] was unclear about the status of Unsponsored DRs. Restrictions imposed by the

[7] IDR means Indian Depository Receipt as defined under Section 2(48) of the Companies Act 2013.

[8] Bharat Depository Receipt as recommended by Sahoo Committee.

[9] Ministry of Finance (Sahoo Committee III). Report of The Committee To Review The Framework Of Access To Domestic And Overseas Capital Markets (Phase II, Part II: Indian Depository Receipts). Feb, 2015; Government of India, New Delhi. URL: https://www.finmin.nic.in/sites/default/files/SahooCommittee_ecbReport_20150225.pdf (accessed on 28.03.2021).

[10] Supra Note 4. Ministry of Finance Notification in Gazette of India Dated Oct 24, 2014.

[11] Supra Note 1. The Companies Act, 2013. Section 2(44).

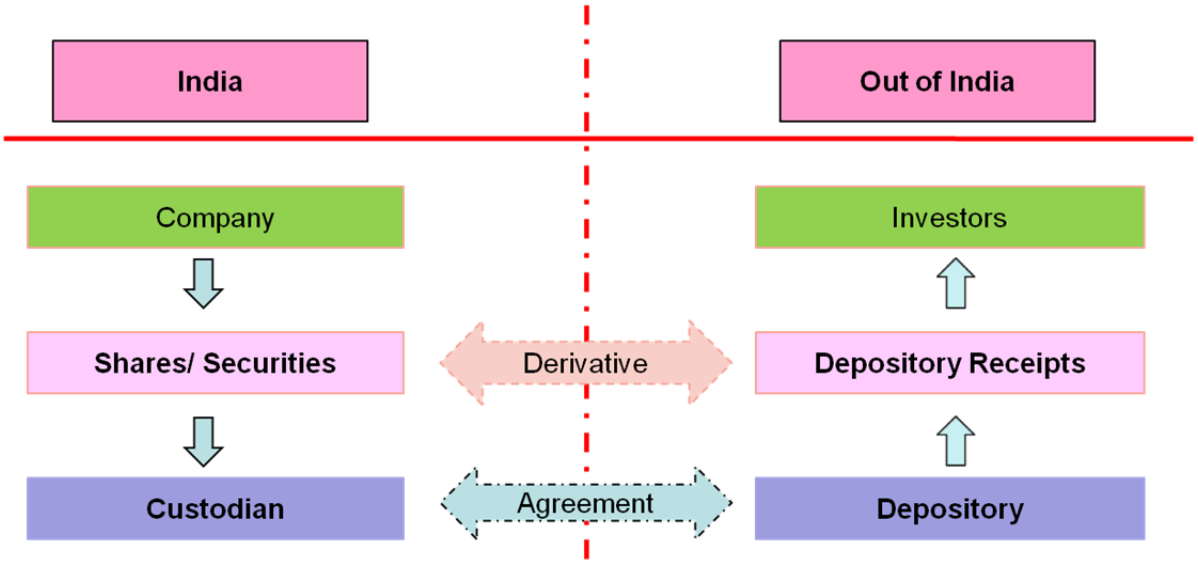

Fig. 2. **The GDR or DR issuance structure from India**

Source: compiled by the authors based on Dr. P.R. Kousalya and Ms.S. Niranjana [9] Manoj Kumar [10] and N.M. Desai [11].

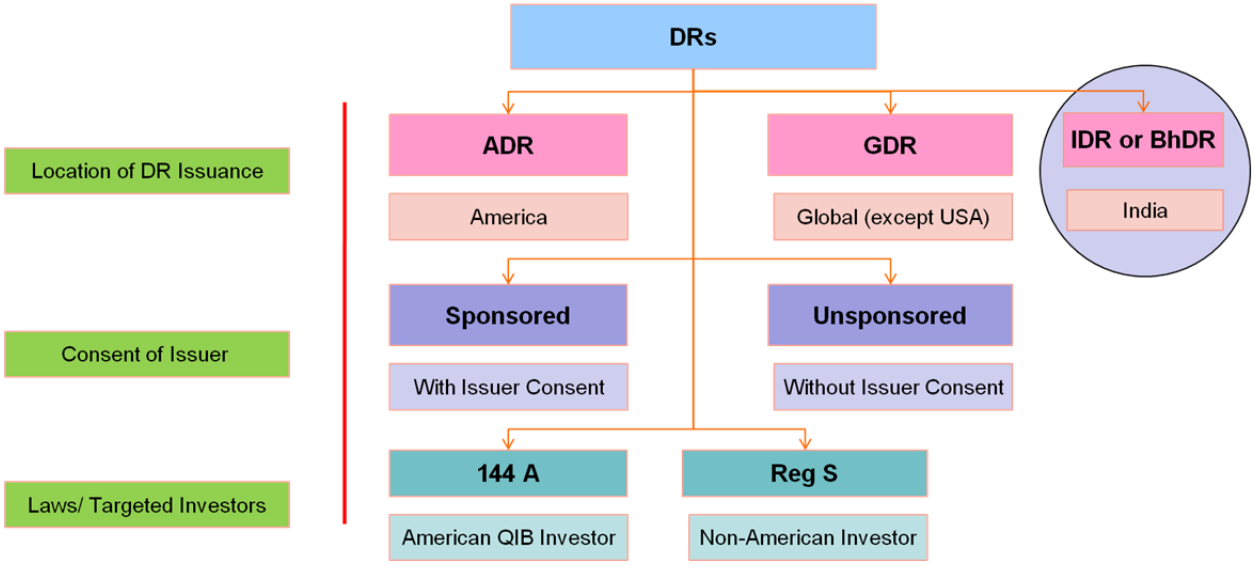

Fig. 3. **Types of the DRs**

Source: compiled by the authors based on Manoj Kumar [11], Amita Verma [13] and other literatures.

2019 Circulars dated Oct 10 and Nov 28 of 2019 have practically made it impossible.[12,13]

Sponsored DRs:

India has permitted Sponsored DR wherein the Issuer is actively involved into the issuance of the DR. In fact, the DRs are issued at the behest and initiation of the Issuer.

3. Laws/Target Investors

144A DRs: The Security Exchange Commission (the "SEC") has adopted Regulation D in 1982, and adopted Rule 144A in April 1990 which has allowed non-US to privately place their DRs/ADRs to the qualified institutional buyers ("QIBs") in the USA. Indeed, Rule 144A has availed an opportunity to foreign Issuers to offer their securities to QIBs which are defined under Rule 144A as an investor who owns and invests not less than US $ 100 million in securities on a discretionary basis. The Rule also allowed these QIBs to trade such securities among themselves privately [10].

[12] SEBI. Circular SEBI/HO/MRD 2/DCAP/CIR/P/2019/146 dated Nov 28, 2019.

[13] SEBI. Circular SEBI/HO/MRD/DOP1/CIR/P/2019/106 Dated 10 Oct, 2019.

Reg S DRs: The SEC has adopted Regulation S ("Reg S") in 1990, specifically to allow the Issuers or companies for offering their securities in the USA through a private offering to persons out of the USA. Reg S laid down the conditions or requirements to issue or to offer any security outside the USA which will be exempted from the SEC regulations or compliances.

MALPRACTICES RELATED TO THE GDR

The GDR transactions have been in vortex of malpractices for a decade. The Regulator, SEBI, has pointed out many malpractices in connection with the DR and barred many participants and Issuers from accessing Indian capital market[14,15,16] [1].

Interestingly, it to be noted that the SEBI/ SAT,[17] redefined the term 'fraud' as "if a person by his act either directly or indirectly causes the investors in the securities market in India to believe in something which is not true and thereby induces the investors in India to deal in securities, then that person is said to have committed fraud on the investors in India."

The Supreme Court also affirmed such malpractices in the GDR transactions.[18]

Also, the SEBI/SAT[19,20] tried to elaborate the way malpractices had been conducted in the GDR transaction that is pictorially outlined in *Figure 4*. These malpractices can be separated into following steps:

1. The Issuer issues the GDR.
2. The GDRs are subscribed by the Investor.
3. The Investor is funded by another financial institution or bank, by pledging the shares of Issuer or by providing other guarantee.
4. The Investor cancels the GDRs and converts them into equity shares.
5. The Investor sells the equity shares to financial institutions registered with the SEBI.
6. These financial institutions then sell the equity shares to the public and other investors.

In Re: Jindal Cotex Ltd. vs. Securities and Exchange Board of India, the SAT said that the modus operandi adopted in the above GDR issue structure has a basic element that vitiates the entire issue of the GDR. That element is "the Investor borrows from an international financial institution or Bank (Financier) to buy the GDRs issued by the Issuer wherein the Issuer itself pledges its shares to the Financier against the loan lent to the Investor". The tribunal upheld that the contention in this kind of the GDR structure is fraudulent.

POLICY CHANGES & THE EFFECT ON THE DRS

After replacing the 1993 DR Scheme, the 2014 Scheme has been liberalised, allowing unlisted, unsponsored DR issuances with underlying securities of equity, debt or other permissible/ marketable securities. On Oct 21, 2014, the Ministry of Finance (the Department of Economic Affairs) issued Notification which came into force from Dec 15, 2014, had listed out 34 permissible jurisdictions where the DRs can be issued [15].

SEBI's Circular dated Oct 10, 2019, has limited the issuance of the DRs only by listed companies in permissible jurisdictions.

On Oct 7, 2019, the Ministry of Finance (the Department of Economic Affairs) notified amendment in the 2014 DR Scheme in the Official Gazette of India allowing International Financial Services Centre in India (IFSC)[21] to be permissible jurisdiction for the DR Issuances [16]. In this regard, the SEBI, vide Circular dated Nov 28, 2019, has declared the list of permissible jurisdictions for the DR issuances wherein IFSC was included but the number of total jurisdictions were reduced to 7 (excluding IFSC) from 34.

[14] Securities Exchange Board of India (SEBI). Order WTM/SR/ISD/69/09/2014 dated Sep 19, 2014. In Re: Market Manipulation using GDR Issues. MANU/SB/0062/2014.

[15] Securities Exchange Board of India (SEBI). Order PM/AN/2020–21/10277 dated Feb 03, 2021. In the matter of GDR Issue (2008) of Beckons Industries Limited. MANU-SB-0289–2021.

[16] Jindal Cotex Ltd. vs. Securities and Exchange Board of India, Appeal No. 376 of 2019. Securities and Exchange Board of India / SEBI Appellate Tribunal Order dated Feb 05, 2020. MANU/SB/1310/2020.

[17] Securities Exchange Board of India (SEBI)/ SEBI Appellate Tribunal. Order Order/KS/VC/2020–21/7742–7743 dated May 26, 2020. In Re: GDR Issues of Asahi Infrastructure & Projects Ltd. MANU/SB/0347/2020.

[18] Securities and Exchange Board of India Vs. Pan Asia Advisors Ltd. and Another, Civil Appeal No. 10560 of 2013. Supreme Court of India judgment dated July 6, 2015. AIR 2015 SC 2782: III (2015) BC 513 (SC): [2015] 127 CLA 306 (SC): [2015] 191 CompCas 410 (SC): (2015) 3 CompLJ 241 (SC): 2015 (7) SCALE 694: (2015) 14 SCC 71: 2015 (8) SCJ 4.

[19] Supra Note 15. Jindal Cotex Ltd. vs. SEBI. MANU/SB/1310/2020.

[20] Supra Note 16. In Re: GDR Issues of Asahi Infrastructure & Projects Ltd. MANU/SB/0347/2020.

[21] Ministry of Corporate Affairs. GSR 111(E) dated Feb 13, 2020. Companies (Issue of Global Depository Receipts) Amendment Rules, 2020. MANU/DCAF/0022/2020. Government of India, New Delhi.

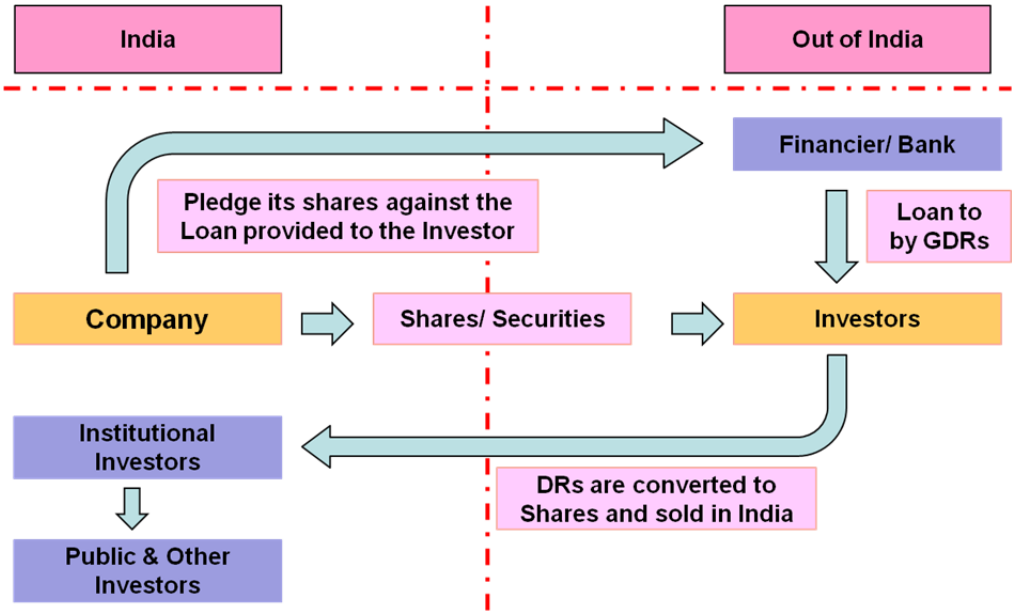

Fig. 4. **Scheme of malpractices in the DR transaction**

Source: compiled by the authors from Jindal Cotex Ltd vs. SEBI Judgment.

Because of these limited 'permissible jurisdictions' like NASDAQ, New York Stock Exchange, Tokyo Stock Exchange, London Stock Exchange, etc. with strict compliance and high cost of listing of the DRs, Indian issuers had shied away from the new DR issuances from Jan 2019 to 2021. In the year 2018, Dish TV India Ltd and Tube Investments of India Limited have issued the DRs to the tune of US$ 1.8 bn [1] and then there were no new DR issuances in 2019 and afterward[22] [17].

The DR issuances are further affected by Companies (Amendment) Act, 2020 which has allowed Indian companies to list their securities directly on overseas stock exchanges. This is expected to wipe out the DR issuances from the Indian market.

RESULT

This survey, by means of a structured questionnaire in the form of 'Google Forms' and unstructured interviews, was conducted in the month of April and May of 2021 to understand the opinions of stakeholders about the GDRs or the DRs, laws and malpractices associated with it.

The survey also attempted to understand stakeholders' opinions about the need for any reform in the GDR Scheme or framework in India.

With this survey, the following things were observed:

1. All the 40 Respondents unanimously agreed that the GDRs or DRs issued in India are legitimate means of raising funds or capital that is portrayed in *Figure 5*.

2. *Figure 6* illustrates that all Respondents believed the Issuers prefer the DRs to gain international recognition and exposure, and over 80% felt that better valuation would be another reason. The Respondents were unclear about the other reasons such as regulatory flexibility, low cost of fundraising, avoidance of Takeover Code trigger, etc.

3. All Participants found it easy to answer that the DRs are means of attracting FDI in India that is sketched in *Figure 7*.

4. As represented in *Figure 8*, 77% of the Participants were of the opinion that the existing laws and regulations related to the GDRs or DRs are sufficient to attract FDI.

5. The Respondents, replying to available alternatives of the DRs, with over 90% majority believed that Qualified Institutional Placement (QIP), Direct Overseas Listing (DOL) and Private Equity (PE) are alternatives to the DRs. 25% and below Respondents thought that Foreign Currency Convertible Bonds (FCCBs) and External Commercial Borrowing (ECB) respectively are alternatives to the DRs. *Figure 9* details the responses of Respondents (in number) answering these alternatives.

[22] Citi Bank. Global DR Directory. Depository Receipt Services. July 7, 2021. URL: https://depositaryreceipts.citi.com/adr/guides/uig.aspx?pageId=8&subpageid=34 (accessed on 28.03.2021).

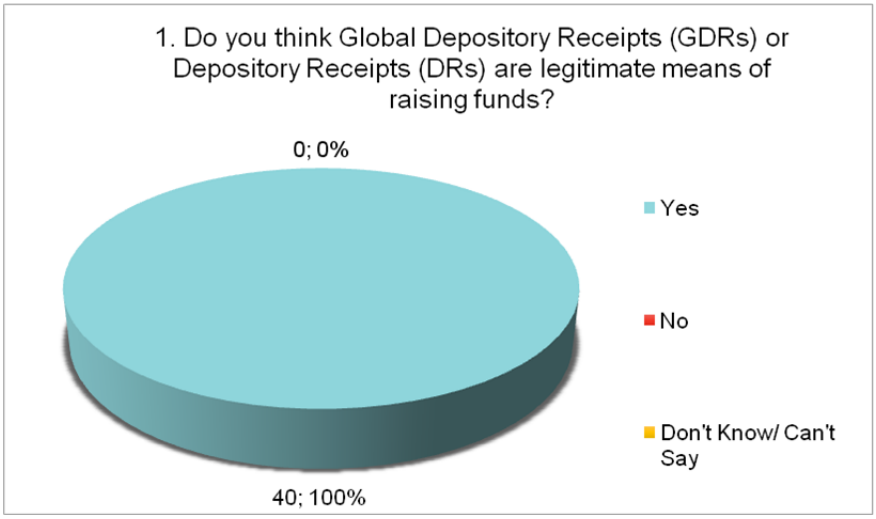

Fig. 5. **Legitimacy of the GDR issuance**

Source: compiled by the authors from the survey conducted by them.

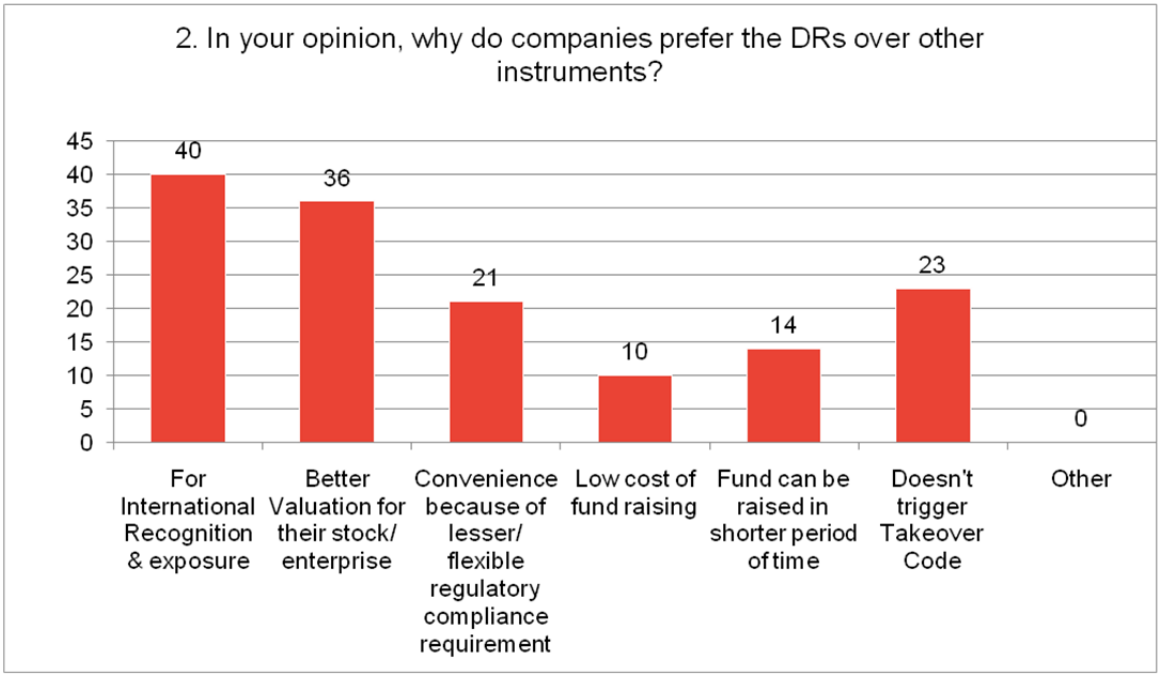

Fig. 6. **Reasons for preferring the DRs**

Source: compiled by the authors from the survey conducted by them.

6. As plotted in *Figure 10*, 75% of the Participants opined that the DRs or the DR Scheme has been used for manipulative or fraudulent practices.

Around 23% of the Respondents were not aware of malpractices and 2% believed that the DRs have not been used for manipulative or fraudulent practices.

7. *Figure 11* depicts the opinions of the Participants about the measures to be employed by the SEBI to curb malpractices. Around 80% of the Participants have opined that the Regulator/ the SEBI should employ three things to curb malpractices, namely:

a. Regulate the DR Scheme strictly and impose stringent compliance requirements,

b. Plug the loopholes which are being used for malpractices,

c. Impose Corporate Governance responsibility on both directors, executive & independent.

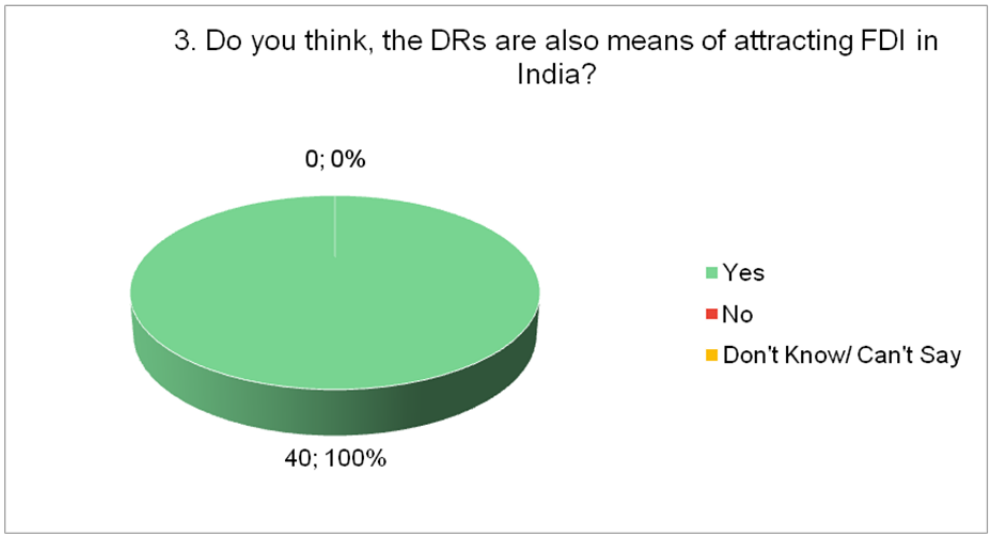

Fig. 7. **DRs as means of attracting FDI**

Source: compiled by the authors from the survey conducted by them.

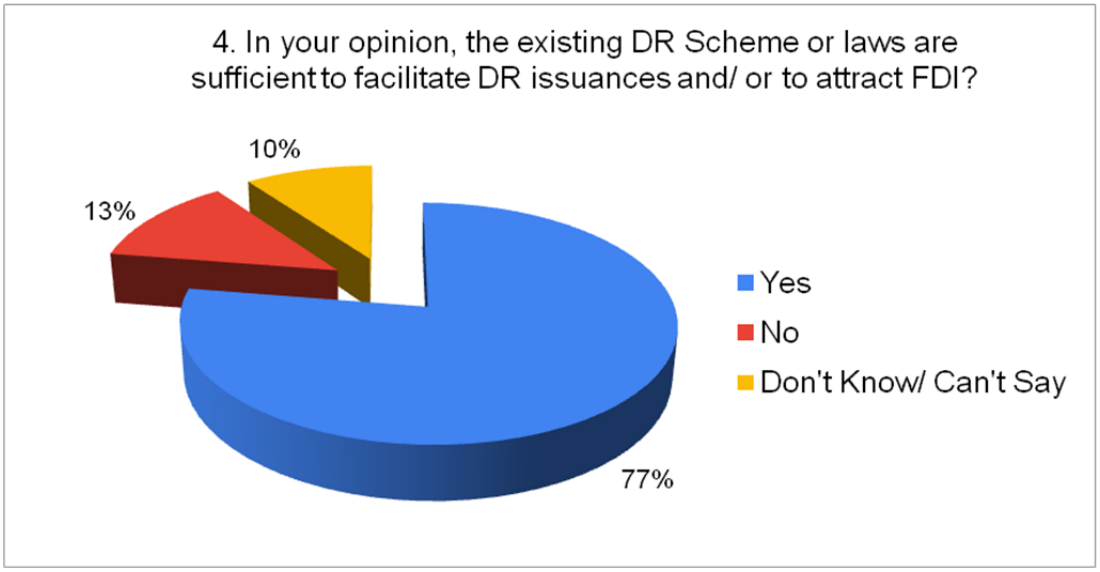

Fig. 8. **Perceived effectiveness of the laws to facilitate the DRs**

Source: compiled by the authors from the survey conducted by them.

Out of the remaining 20%, 13% opted for "Don't know/ can't Say" and 7% believed that the Regulator should plug the loopholes.

8. *Figure 12* portrays that around 80% of Respondents opined the companies might have indulged into manipulative or fraudulent practices because of the presence of loopholes or poor clarity of the DR Scheme.

Around 50% of Respondents believed that malpractices might be or have been conducted to avoid Takeover Code Trigger or to hold a majority of stake even after complying with 25% shareholding of the public in listed entities.

9. As presented in *Figure 13*, over 80% of Respondents believed that there are three reasons for the reduction in the DR issuances in the last few years which are namely:

(i) The DRs are not any more attractive investment avenues for the investors.

(ii) Unclear DR Scheme, policies and laws.

(iii) Lastly, strict compliance requirements.

Around 70% Respondents believed that the fear of being penalised by the SEBI or increment of the Takeover Code Limit to 25% may be other reasons for poor DR issuances.

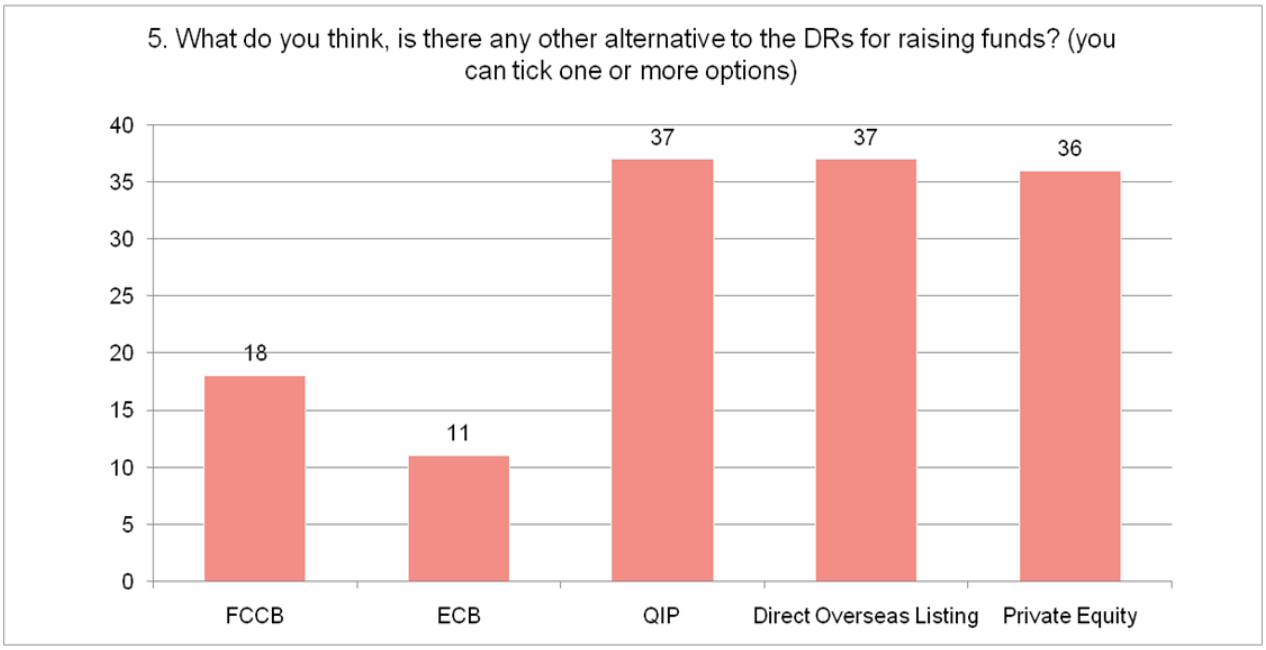

Fig. 9. **Alternatives to the DRs**

Source: compiled by the authors from the survey conducted by them.

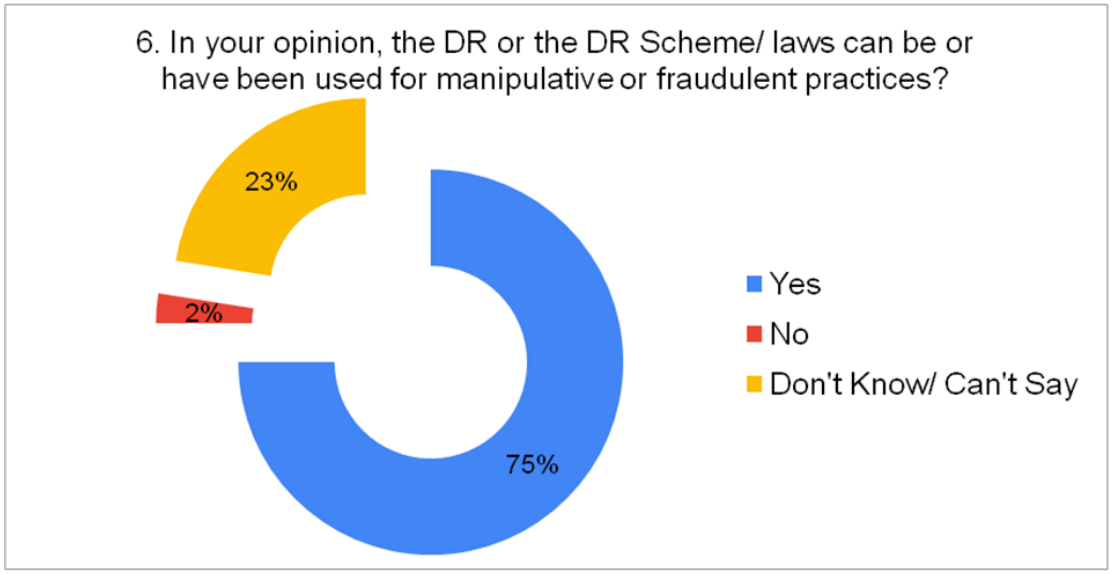

Fig. 10. **Manipulation in the DR issuances**

Source: compiled by the authors from the survey conducted by them.

10. *Figure 14* depicts interesting but non-decisive responses. 45% of the Respondents thought that the DR Scheme and existing laws related to the DR are sufficient to protect the interests of the stakeholders and curb malpractices. 15% of the Respondents thought the prevailing laws and the DR Scheme were not sufficient, whereas 40%, a substantial number chose not to say or were not aware of. Of not having a simple majority, it was observed that there was no clarity.

11. Like *Figure 14*, *Figure 15* also failed to provide majority opinion about the need for any reform in the DR laws. *Figure 15* depicts that Respondents were divided in three sects, 35% believed there is a need for reform, 40% believed there is no need and 25% were either not aware of or opted not to say on the matter.

12. Suggestions:

There were several suggestions, most were about how to make the GDR a more effective tool to attract

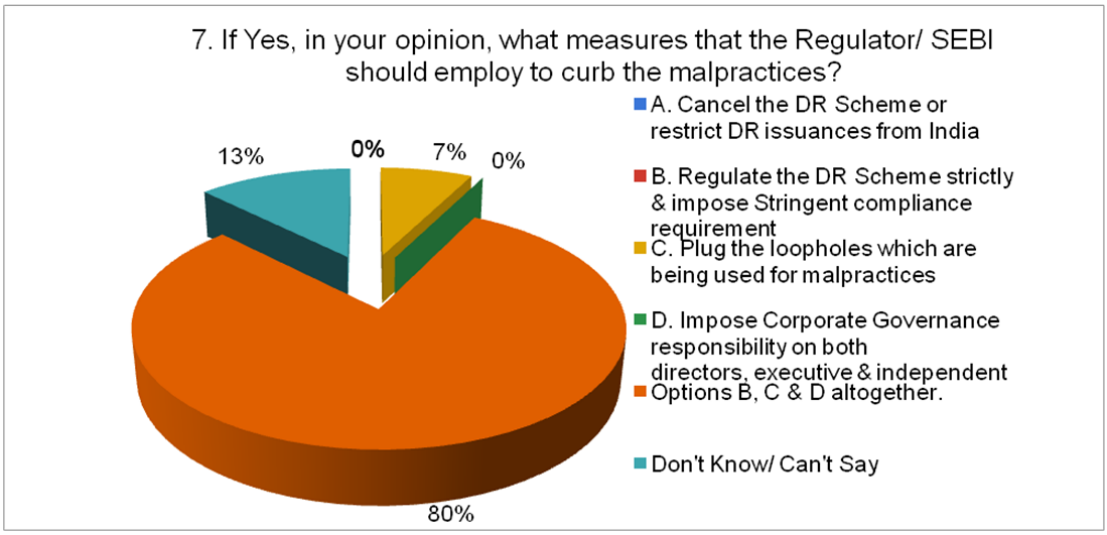

Fig. 11. **Possible measures to be taken by SEBI to curb malpractices**

Source: compiled by the authors from the survey conducted by them.

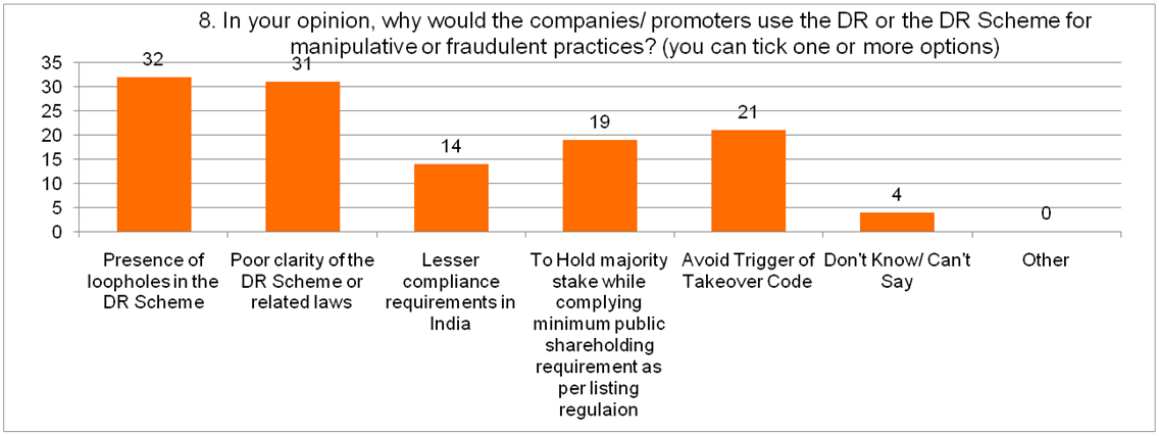

Fig. 12. **Reasons for indulging into manipulative practices**

Source: compiled by the authors from the survey conducted by them.

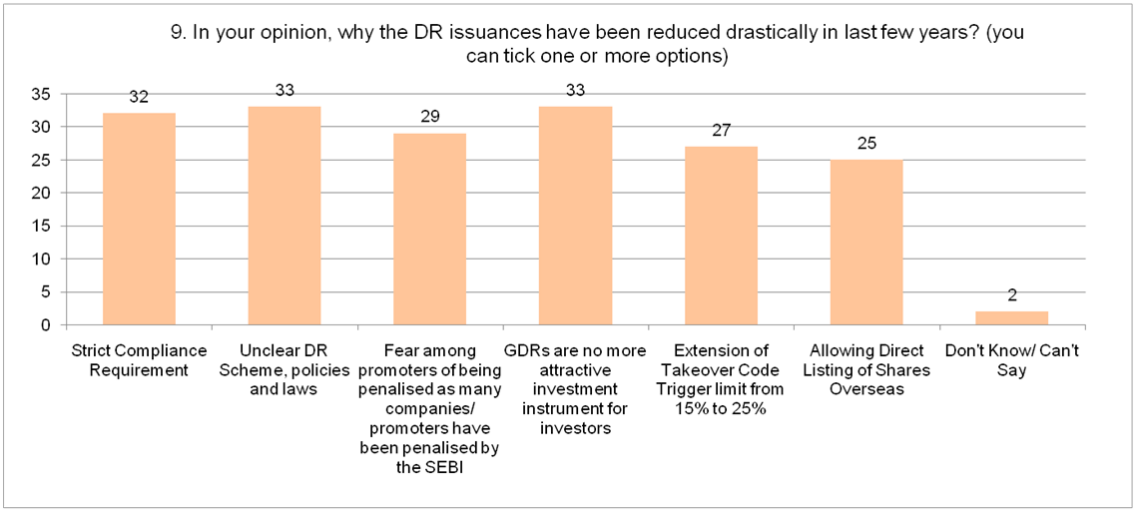

Fig. 13. **Reasons for reductions in the DR issuances**

Source: compiled by the authors from the survey conducted by them.

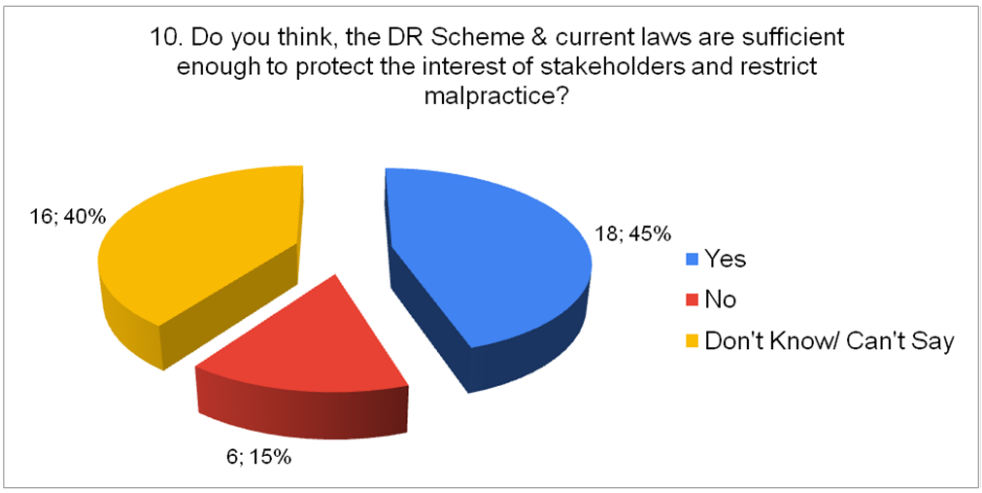

Fig. 14. **Sufficiency of prevailing laws to protect investor's interest**

Source: compiled by the authors from the survey conducted by them.

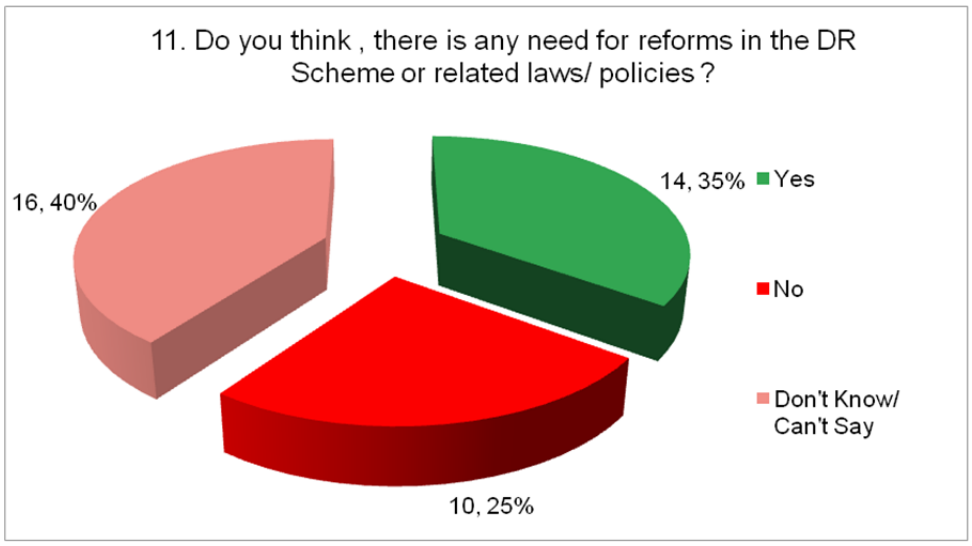

Fig. 15. **Need of Reform in the DR Scheme**

Source: compiled by the authors from the survey conducted by them.

FDI without compromising the interests of the investors. It had been suggested that the Regulator should adopt a trade-off between FDI and compliance stringency, without affecting the interests of investors. Another suggestion was to emphasise more on corporate governance practices and hold the promoters responsible for malpractices.

DISCUSSION

1. This study concluded that GDRs or DRs, being issued in India as per the DR Schemes, are legitimate means of raising funds or capital. Rajeevan [18], Datta [19] and Manoj Kumar [10] also found the same.

2. In this study, it found that Issuers generally prefer the DRs for international recognition and exposure and better valuation which was also mentioned by Pratik Datta [20]. Datta [20] further stated the three benefits of the DRS, namely:

a. The DRs, being traded in foreign markets in its own currency, help to overcome the currency and local security related home bias problem.

b. The DRs provide potential to improve the valuation of Indian companies, importantly in innovative and technology-driven sectors.

c. The DRs offer several commercial advantages to Indian companies including gaining the trust of customers and government and also building brand value.

3. Madhavan and Ray [1] wrote that the GDR activities had declined in the last few years mainly

because of SEBI's stringent action against companies involved in the GDR manipulation; and, secondly, QIP arose as an alternative way to raise capital which is cheaper and convenient. Further, the SEBI, vide 2020 amendment of the Companies Act, allowed DOL which is likely to reduce the DR transactions. This study also found that QIP along with DOL and PE are alternatives to the DRs. Bhumesh Verma [4] mentioned that DOL is a positive move in the capital market whereas the GDRs are passé and lack clarity.

4. In this survey, it has been observed that the DRs or the DR Scheme have been used for manipulative or fraudulent practices. This outcome has been demonstrated by Madhavan & Ray [1] and several orders of the SEBI like Securities and Exchange Board of India Vs. Pan Asia Advisors Ltd. and Another,[23] In Re: GDR Issues of Asahi Infrastructure & Projects Ltd.[24] and Jindal Cotex Ltd. vs. Securities and Exchange Board of India.[25]

5. Siddharth Rajeevan [18], Yash J. Ashar [21] and Minal Shah [22] studied the 2019 SEBI Circular issued on Oct 10, 2019 with the previous provisions of the 2014 DR Scheme. They found that the DR scope has been curtailed. In this study, major problems of limiting the GDR issuances, have been pointed out as:

a. The DR or GDR issuances may drop, affecting the FDI inflow to India.

b. If the DR Scheme is relaxed, there will always be a fear of malpractices, subject to compliance requirements in the DR (foreign) jurisdiction.

c. The SEBI, vide 2020 amendment of the Companies Act, allowed DOL. This overseas direct listing, like the DR listing, may attract malpractices.

BOON OR BANE?

The DR Schemes and the GDR issuances had been studied with perspectives of the Regulator, companies, investors and the Indian economy. The pros and cons which were determinants of the DR Schemes, are tabulated hereunder to find the answer for 'Whether the GDR is Boon or Bane?' (see *Table*).

This research could not find an answer with a majority whether the prevailing laws are sufficient to restrict or curb malpractices or if there is any need for the reforms. With an indecisive outcome, "Whether the GDR is Boon or Bane?" is believed to be more complex and subjective, and needs further deductive and quantitative research. At this juncture, it cannot be wrong to say that the DRs are neither a boon nor a bane; the future will depend upon the legal framework and compliance requirements and prudential conduct of the participants.

CONCLUSION

The 2014 DR Scheme, replacing the 1993 DR Scheme, has liberalised the DR mechanism and further amendments in 2019, it is made more rigid and prohibitive to Indian companies of using the DR route for accessing foreign capital markets. By the amendment of the Companies Act in Sep 2020, direct overseas listing (DOL) allowed to Indian companies, is likely to diminish new DR issuances.

De facto, the DR mechanism is a means to attract FDI and to assist in the economic development of the country. It will keep availing access to foreign capital to Indian companies and may provide a better valuation. In view of globalisation, foreign investors can invest in the Indian equity market in their local currencies using the DR scheme. These GDR benefits imply that the DR Scheme, prevailing or former, is or has been a boon.

The 2014 DR Scheme and former, were neither inherently fraudulent nor availed participants any opportunity for fraudulent activities or malpractices. Having said that, there have been many companies, directors and participants who have been penalised for indulging into fraudulent activities or malpractices in connection with the GDR programs. One of the reasons: loopholes available in the scheme can be corrected by:

1. Imposition of corporate governance rules related to the GDR issue, subscription and receipt disclosures.

2. Prohibiting, expressly, Indian companies to enter into any agreement with the GDR subscribers or investors or participants securing their investment by pledging shares or other means.

3. Inducting provisions, expressly, related to vicarious liability and lifting of corporate veil in matters of the GDR Scheme abuse.

The above suggestion can also be used in designing a framework for DOL which is again aimed to attract FDI

[23] Supra Note 17. SEBI Vs. Pan Asia Advisors Ltd. AIR 2015 SC 2782.

[24] Supra Note 16. In Re: GDR Issues of Asahi Infrastructure & Projects Ltd. MANU/SB/0347/2020.

[25] Supra Note 15. Jindal Cotex Ltd. vs. Securities and Exchange Board of India, Appeal No. 376 of 2019. Securities and Exchange Board of India / SEBI Appellate Tribunal Order dated Feb 5, 2020. MANU/SB/1310/2020.

Table

The DRs: Boon or bane

Perspectives of	Boon Factors	Bane Factors
Regulator (the SEBI)	The Regulator has, inter alia, an objective to expand capital market participation and the GDRs facilitate foreign entities to participate in the Indian capital market	The SEBI has identified malpractices and fraudulent activities in connection with the GDR issuances
	Secondly, the GDRs attract foreign investment in the Indian market and foster it	The GDR is issued in foreign markets and the SEBI could not control or regulate the GDR issuances and hence it has to rely on the prudence of the foreign GDR jurisdiction
Companies (the DR Issuers)	Foremost reason for issuing the GDRs, it provides international capital market access to Indian companies*	After detecting malpractices about the GDRs, the SEBI has imposed strict regulations and compliance related to the GDR issuances. The regulator is also distrustful about the DR Schemes & mode of fund raising, deterring the GDR issuances
	Secondly, the USA and Europe, being mature capital markets, are having high investible funds. It makes Indian companies expect higher valuations in these markets	Most of the GDRs, though listed, are not traded overseas regularly. Being illiquid, they are unlikely to attract better valuation.
Investors	The DR Scheme facilitates foreign investors to participate in the Indian capital market which, being an emerging market, is generating significant returns	In most of the GDR investments, the investors have lost their funds. 85% of investors have incurred losses in their investments made via the GDRs (excluding ADRs) in 2010 [4]
	Secondly, the GDRs are bought in their own currency, mitigating the risk of currency fluctuation	The Investor or the issuer has to pay depositories for cancelling the GDRs or dividend distribution or split or bonus of underlying shares, etc
Economy	The Indian economy is looking for economic growth, FDI is perceived as a vehicle and expects the GDR to attract FDI and contribute to the economy	Malpractices related to the GDR evidenced that there were no actual inflows in the economy through these issuances

Source: compiled by the authors.

* Ministry of Finance (Sahoo Committee II). Report of The Committee To Review The Framework Of Access To Domestic And Overseas Capital Markets (Phase II, Part I: Indian Depository Receipts). June 2014. Government of India, New Delhi.

and avail international capital market access. There are a few things that still favour the GDRs, first, the shares of the Issuer will be in India, secondly, DOL may face the same issues and malpractices and thirdly, offering a second option to access the international capital market can't be that bad.

'Omnia Mutantur, Nihil Interit', agree nothing is permanent; but changing the DR policies to address the problem of foreign jurisdiction without fruitful results, will it prove Latin maxim true, *'Coelum Non Animum Mutant Qui Trans Mare Currunt'* that means 'those who are in hurry to cross the sea, change the sky'. Expecting, the DR Scheme will be altered suitably to attract investments, generate business opportunities for participants within the laws and without affecting the interest of the Indian investors detrimentally, conclude.

SUGGESTIONS

The 2014 DR Scheme, based on the recommendation of the Sahoo Committee was liberal in two senses, first availing more liberty to Indian companies to issue the DRs, even unsponsored and unlisted were permitted, for not only equity but also debt securities. Secondly, the 2014 DR Scheme, was more focused on the protection of interests of Indian investors and hence, activities under foreign jurisdiction which were neglected if it not detrimentally affecting Indian investors. By redefining the term "fraud" by the SEBI or SAT, even misinforming Indian investors to induce them into security trading, leads to 'fraud'.

Hence, suggestive reforms deduced from this study, are mentioned hereunder:

The 2014 DR Scheme should be balanced, liberal enough to attract foreign investors, as recommended

by the Sahoo Committee and strict enough to curb malpractices and sufficient to protect Indian investor's interests.

1. The 2014 DR Scheme should protect Indian investors from malpractices and misinformation. Hence, only sponsored GDRs should be allowed and the issuer or company must be held responsible for the actual inflow of funds into the account.

2. The Company must adhere to the "Use of Proceeds" mentioned in the GDR prospectus with slight allowance, and the Company and its management should be held responsible, severally and jointly, for any deviation of funds or misinforming Indian investors.

3. Malpractices related to the GDRs like 'round tripping' can be restrained by inserting specific clause related "Parking of Proceeds" regulating the flow of funds.

4. The DR issuing companies must be expressly restricted from entering into any agreement with investors or financers of investors which provides security for their investment by way of the DR or underlying shares of the DRs.

5. Permissible Jurisdiction for issuing the DRs, must be identified on the basis of strict compliance requirements and cost feasibility for Indian Issuer to list there.

6. Corporate governance practices should be followed in the GDR transaction. The GDR issuing companies must inform Indian Investors about funds received through the GDR and utilisation of these funds, and any contractual arrangement or agreement made by the Issuers or companies with the intermediaries or investors, helping Indian investors to take "Informed Decision" in relation to investment.

REFERENCES

1. Madhavan V., Ray P. How to revive depository receipts market. The Hindu Business Line. Feb. 05, 2020. URL: https://www.thehindubusinessline.com/opinion/how-to-revive-depository-receipts-market/article30744488.ece
2. Ramarathinam A., Jethmalani H. The demise of overseas equity offerings by Indian companies. LiveMint. Apr. 05, 2017. URL: https://www.livemint.com/Money/ttPGDOVUFYonTSNL8vg6ZP/The-demise-of-overseas-equity-offerings-by-Indian-companies.html
3. Gidwani S., Ajmera S. Global depository receipts: Clarity is missing. VCCircle. Mar. 04, 2015. URL: https://www.vccircle.com/global-depository-receipts-clarity-missing/
4. Verma B., Shelke K. Direct listing: The beginning of demise of GDR and IDR routes. SCC Online. Aug. 12, 2019. URL: https://www.scconline.com/blog/post/2019/08/12/direct-listing-the-beginning-of-demise-of-gdr-and-idr-routes/
5. Feigen J. Potential exiting through ADRs (and/or GDRs) for international private equity investors. *American University International Law Review*. 1999;13(1):109–124. URL: https://digitalcommons.wcl.american.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=1345&context=auilr
6. Govindrajan M. Depository receipt scheme, 2014 — An overview. Tax Management India. Jan. 17, 2015. URL: https://www.taxmanagementindia.com/visitor/detail_article.asp? ArticleID=6015
7. Mailander C.J. Searching for liquidity: United States exit strategies for international private equity investment. *American University International Law Review*. 1999;13(1):71–108. URL: https://digitalcommons.wcl.american.edu/cgi/viewcontent.cgi?article=1344&context=auilr
8. Shroff R. India's sweeping regulatory and policy changes: Heralding a new era in investor protection in M&A transactions? *Oxford University Commonwealth Law Journal*. 2014;14(1):105–125. DOI: 10.5235/14729342.14.1.105
9. D.P., Niranjana S. Global depository receipt. *Global Journal for Research Analysis*. 2017;6(9):539–541. DOI: 10.36106/gjra
10. Kumar M. Depositary receipts: Concept, evolution and recent trends. *SSRN Electronic Journal*. 2000. DOI: 10.2139/ssrn.951425
11. Desai N.M. Legal and tax considerations confronting Indian companies issuing GDRs/ADRs. Nishith Desai Associates. Mar. 31, 1999. URL: http://www.nishithdesai.com/fileadmin/user_upload/pdfs/Legal_and_Tax_Considerations_Confronting_Indian_Companies_Issuing_GDRs_or_ADRs.pdf
12. Lu H., Huang H., Deva S. Unraveling the puzzle of differing rates of FDI and FVCI in India and China. *Asian Journal of Comparative Law*. 2009;4:1–31. DOI: 10.1017/S 2194607800000429

13. Verma A. Indian depository receipts: An outset of global trust upon Indian economy. *Law Mantra Quarterly Online Journal*. 2017;4(9). URL: http://journal.lawmantra.co.in/wp-content/uploads/2017/05/9.pdf
14. Bhagat S., Singh J., Dasgupta O. India: SEBI framework for issuance of depository receipts. Mondaq. Dec. 19, 2019. URL: https://www.mondaq.com/india/shareholders/876696/sebi-framework-for-issuance-of-depository-receipts
15. Agarwal S. Depository receipt scheme 2014. India Law. Dec. 16, 2014. URL: https://www.indialaw.in/blog/blog/policy/depository-receipts-scheme-2014/
16. Kale A. India: Framework for issue of depository receipts. Mondaq. Dec. 18, 2019. URL: https://www.mondaq.com/india/commoditiesderivativesstock-exchanges/%20872956/framework-for-issue%20-of-depository-receipts
17. J.P. Morgan's adr.com. Feb. 22, 2021. URL: https://www.adr.com/dr/drdirectory/drUniverse
18. Rajeevan S., Dubey R. DR issuances: Analysis of SEBI DR circular. Indus Law. Nov. 2019. URL: https://induslaw.com/app/webroot/publications/pdf/alerts-2019/Infolex-Alert-Depository-Receipt-Issuance-Analysis-of-SEBI-DR-Circular.pdf
19. Datta P. SEBI should operationalise framework for easing restrictions on raising money abroad. The Indian Express. Sep. 13, 2019. URL: https://indianexpress.com/article/opinion/columns/depository-receipts-scheme-sebi-nirmala-sitharaman-5990408/
20. Datta P. The depository receipts scheme, 2014: Lessons in policy implementation. *NLS Business Law Review*. 2015;1. URL: https://www.academia.edu/19122778/The_Depository_Receipts_Scheme_2014_Lessons_in_policy_implementation
21. Ashar Y.J. SEBI introduces framework for issuance of depository receipts. India Corporate Law. Oct. 15, 2019. URL: https://corporate.cyrilamarchandblogs.com/2019/10/sebi-introduces-framework-for-issuance-of-depository-receipts/
22. Shah M. Depository receipts — concepts and evolution of framework. The Securities Blawg. Oct. 13, 2019. URL: https://www.thesecuritiesblawg.in/post/depository-receipts-concepts-and-evolution-of-framework

ABOUT THE AUTHORS

Sandeep S. Khakase — Master's Degree student, Symbiosis Law School, Maharashtra, India
20010143009@symlaw.ac.in

Trupti M. Rathi — LLM, Asst. Prof., Symbiosis Law School, Maharashtra, India
trupti.rathi@symlaw.ac.in

Bindu S. Ronald — PhD, Prof., Deputy Director, Symbiosis Law School, Maharashtra, India
bronald@symlaw.ac.in

Authors' declared contribution:
Khakase S.S.— developed Theoretical/Conceptual Framework, conducted an empirical survey and analysed the data.
Ronald B.S.— helped in framing the Questionnaire and reviewed the Theoretical/Conceptual Framework. The outcome of the survey was also reviewed by Dr. Bindu Ronald and suggested the changes which were incorporated in the final paper.
Rathi T.M.— reviewed the full paper and ensured the changes were incorporated correctly.

The article was submitted on 13.06.2021; revised on 11.07.2021 and accepted for publication on 20.07.2021.
The authors read and approved the final version of the manuscript.

ORIGINAL PAPER

DOI: 10.26794/2587-5671-2021-25-5-133-149
UDC 336.74(045)
JEL E42, E52, E58, G28

Central Bank Digital Currencies: Key Aspects and Impact on the Financial System

D.M. Sakharov
Financial University, Moscow, Russia
https://orcid.org/0000-0002-0628-0133

ABSTRACT

This research discusses various issues associated with central bank digital currency that is identified as a new form of money. This paper aims to identify the key prerequisites for the issuance of central bank digital currencies, to discuss the key characteristics of central bank digital currencies and analyze the possible impact of central bank digital currencies on the financial system. The author uses the methods of synthesis, analysis, logical method, comparison, induction, deduction. The research highlights the key principles that should be considered when making decisions on the issuance of central bank digital currency. The paper emphasizes that the issuance of central bank digital currency can be successful if it has competitive advantages over existing forms of fiat money. The research identifies the main characteristics of central bank digital currencies. The paper discusses whether central banks should pay interest on fiat digital currencies. The author notes that the impact of central bank digital currencies on the financial system is expected to vary in different periods of time depending on the phase of the economic cycle and the level of interest rates in the economy. The research shows that central bank digital currency will stimulate the digitalization of the financial system while at the same time it will not create additional risks to financial stability. Introducing central bank digital currency is primarily aimed at promoting the efficient payment system. Further research is needed into mechanisms for the technical implementation of digital currency issuance, taking into account the possible risks associated with introducing fiat digital money.

Keywords: payment system; central bank digital currencies; issuing fiat digital currency; financial system; crypto-assets; monetary policy; central banks; financial stability; banking sector; digitalization

For citation: **Sakharov D.M. Central bank digital currencies: Key aspects and impact on the financial system. *Finance: Theory and Practice.* 2021;25(5):133-149. DOI: 10.26794/2587-5671-2021-25-5-133-149**

INTRODUCTION

Digitalization remains one of the most important trends in the development of the modern global financial system. This is reflected in the emergence of new forms of payments and settlements, the development of the digital asset market, the entry of high-tech companies into the financial services market, as well as the emergence of new products and services in the global financial market. The use of digital technologies by credit institutions has led to significant changes in the banking services market and created the basis for the development of such products and services as mobile banking, instant payments, remote banking services and Internet banking [1]. The digitalization processes not only led to the emergence of new financial products and a significant change in the business models of credit institutions, but also required a revision of many problems associated with the development of the monetary system, regulation of the activities of credit institutions, as well as the role of central banks in the modern economy.

The question of how central banks in developed and developing countries should respond to the digitalization of global finance and technological innovation in recent years is equally important. In particular, the rapid development of the digital asset market and the growing popularity of blockchain technology have made CBDCs increasingly relevant.

A significant number of central banks are currently considering the possibility of introducing CBDCs in the context of the digital transformation of global finance. Despite the fact that the problems of issuing CBDCs are new

for financial science, they are already attracting significant interest from both financial market participants and regulators. According to the Bank for International Settlements, all the world's leading central banks are conducting research on digital currencies and are at various stages of assessing the prospects for introducing the CBDCs into circulation. [2]. The European Central Bank, the Bank of Sweden, the Bank of Canada, the Bank of Russia, the Bank of England, the Reserve Bank of Australia, and the People's Bank of China are at different stages of deciding to issue CBDCs.

In particular, the Bank of Russia prepared a report on CBDCs and announced public consultations on the digital ruble.[1] As part of an ongoing study of digital money, the Bank of Russia also published the Concept of the Digital Ruble,[2] which defines the model of the digital ruble, the possible consequences of the digital ruble issue for the Russian economy, and the stages of further work on the project.

The Bank of Sweden has launched an e-krona pilot project that tests various approaches to issuing digital fiat money and assessing their possible impact on the financial system.[3]

The Bank of Canada is doing a lot of research on digital fiat money. At the same time, the Bank of Canada will not issue CBDCs in the near future and plans to continue researching digital currencies to develop a possible model for issuing digital currencies, as well as to define a system of criteria to assess the feasibility of issuing digital money in the context of solving the problems facing the central bank.[4]

The People's Bank of China is one of the leaders in digital money research and has already decided to issue a digital yuan in the future. Currently, the infrastructure necessary for the circulation of the digital yuan is being created in China, and the digital yuan is being actively tested with the involvement of banks and individuals.

Research on CBDCs is also carried out by the Bank for International Settlements and the International Monetary Fund [3–6].

At the same time, no unambiguous answer has been formulated to the question of the very expediency of issuing CBDCs. In many ways, questions remain about what characteristics national digital currencies should have if they are to be issued. In addition, issues related to assessing the impact of the issuance of CBDCs on the conditions of monetary policy and the possible consequences of their issue for the financial sector require separate consideration.

This paper justifies the need to issue CBDCs, identifying the key characteristics of CBDCs and the conditions for their successful issuance, as well as assessing the possible impact of CBDCs on the monetary policy pursued by the central bank.

CONCEPT AND BASIC CHARACTERISTICS OF CBDCs

Money is an essential element of the economic system. Physical cash and non-cash money have traditionally been viewed as the main forms of modern fiat money. Electronic money is a type of non-cash money that has arisen as a result of the development of financial relations at the present stage. The ongoing processes of digitalization of the global financial system are reflected in the growing popularity of blockchain technology and the emergence of a new type of asset — digital assets. The development of the digital asset market and the decline in the popularity of physical cash among economic entities in developed countries required central banks not only to formulate their attitude to this phenomenon but also to determine the directions for supporting digitalization processes. One of the areas of such support is the issuance of CBDCs.

[1] The Bank of Russia website. Digital ruble. Public Consultation Report. October 2020. URL: https://cbr.ru/StaticHtml/File/112957/Consultation_Paper_201013.pdf (accessed on 19.04.2021).

[2] Bank of Russia website. Digital ruble concept. April 2021. URL: https://cbr.ru/Content/Document/File/120075/concept_08042021.pdf (accessed on 19.04.2021).

[3] E-krona pilot Phase 1. Sveriges Riksbank. April 2021. URL: https://www.riksbank.se/globalassets/media/rapporter/e-krona/2021/e-krona-pilot-phase-1.pdf (accessed on 19.04.2021).

[4] Contingency Planning for a Central Bank Digital Currency. Bank of Canada. February 2020. URL: https://www.bankofcanada.ca/2020/02/contingency-planning-central-bank-digital-currency (accessed on 19.04.2021).

In scientific publications in recent years, the term "cryptocurrency" has become very popular. It is important to note that the use of the word "currency" in this context is inaccurate since crypto assets are not currencies and cannot be considered money (*Fig. 1*). In particular, crypto assets do not fully fulfill the function of a measure of value and a store of value. Crypto asset prices are highly volatile. In addition, none of the crypto assets can be considered as a universal means of payment. Thus, crypto assets do not fulfill all the functions of modern fiat money, which is why this article uses the term "crypto assets". CBDCs, on the other hand, is a new form of fiat money along with the existing forms of money — cash and non-cash money.

Due to the relatively small volume of the cryptoasset market compared to the traditional segments of the financial market and the low popularity among investors, digital assets do not significantly affect the stability of the financial systems of developed countries and do not change the conditions for conducting monetary policy. This conclusion was obtained by the author based on the research [7–9]. On the other hand, CBDCs, if issued, can have a significant impact on the financial system. The nature and degree of such influence will largely depend on the specific characteristics of CBDCs. In this regard, the assessment of such changes is possible only after determining the main characteristics of CBDC.

The presence of different, sometimes diametrically opposed points of view regarding the properties and desirable features of digital money makes it impossible at the moment to formulate a single definition of CBDC.

In this article, CBDC refers to the digital form of fiat money issued by a central bank and capable of performing all the functions of modern money. The CBDC is considered an accessible form of money for business entities and can be used by them to make payments or settlements at any time, including paying taxes, as well as direct P2P and P2B settlements.

Unlike modern non-cash money, which for individuals and companies is always tied to a bank account, digital money can be stored in a separate electronic wallet or in an individual account with a central bank, and settlements using CBDCs can be carried out directly between business entities without opening an account in a bank [10].

When deciding on the feasibility of issuing CBDCs, it is important to assess how attractive this form of money will be, both from the point of view of the Central Bank and from the point of view of business entities.

The most important tasks of the central bank in modern conditions include: ensuring financial stability, promoting the development of the financial system, as well as the development of the payment system. The issue of the feasibility of CBDCs should also be considered taking into account the tasks and priorities facing the central bank, which are largely determined by the level of economic development and the current situation in the economy. At the same time, it is important to keep in mind the general principles that are relevant to all central banks considering issuing CBDCs.

According to the author, such principles are:

- ensuring financial stability. The issuance of CBDCs should contribute to the fulfillment of the tasks entrusted to it by the central bank and maintain financial stability;
- coexistence with existing forms of money. CBDCs should complement the currently existing forms of money in the interests of the end-users of financial services;
- maintaining and stimulating competition in the financial services market. The CBDC issuance should contribute to the development of an innovative environment, stimulate competition and ensure high quality of services provided;
- cooperation and interaction between regulators and economic actors. Issuing fiat digital money can only be successful if this instrument is attractive to business entities. The main parameters of CBDCs must meet the needs of financial market participants, which implies the interaction of all interested parties in the process of developing and implementing a project to create the CBDCs infrastructure required;

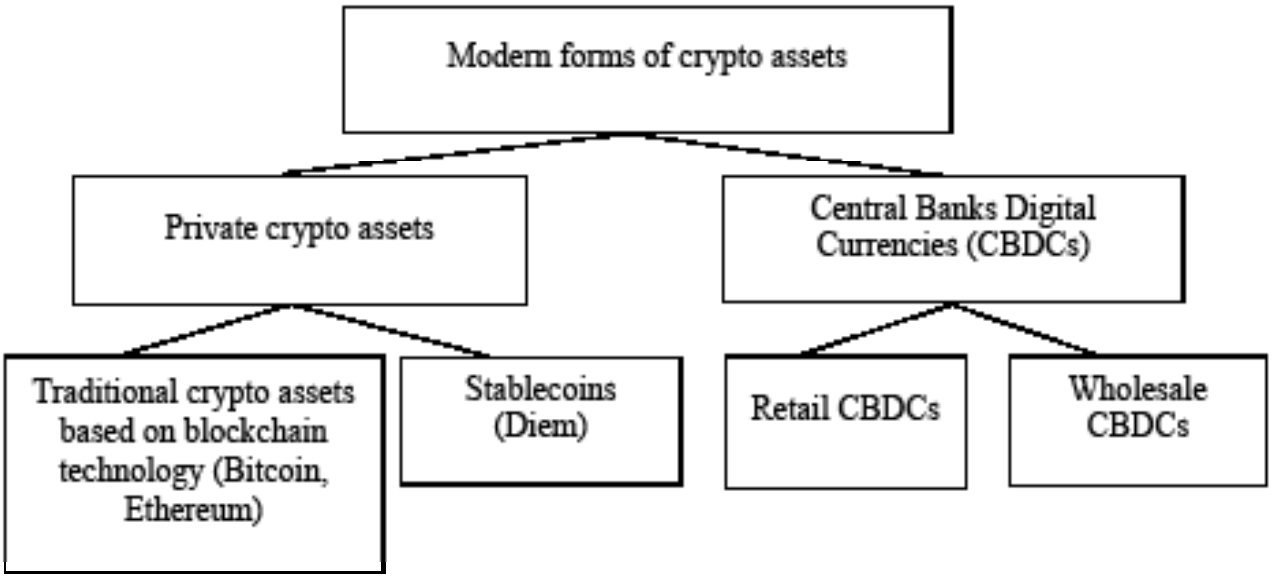

Fig. **Classification of new forms of crypto-assets**

Source: compiled by the author based on Dong He et al. Digital Money Across Borders: Macro-Financial Implications. IMF Staff Report. October 2020; Wouter Bossu et al. Legal Aspects of Central Bank Digital Currency: Central Bank and Monetary Law Considerations. IMF Working Paper. Nov. 2020.

• ensuring information security. The CBDC issuance involves the creation of an infrastructure capable of protecting potential users of digital money from cyberattacks and other information security threats.

CBDC issuance involves country specifics, in particular, the level of development of the financial system and consumer preferences. Nevertheless, a prerequisite for the demand for CBDCs among end-users is the presence of obvious competitive advantages in comparison with the currently existing forms of payments and settlements.

The presence of such competitive advantages, in particular, implies the availability of CBDCs for end consumers, wide opportunities for using CBDCs in making payments and settlements on an equal basis with other forms of money, low cost and ease of making payments, the equivalence of a new digital form of money and existing forms, the ability to seamlessly transfer money from one form to another, as well as the reliability and safety of digital money.

When defining the characteristics of CBDCs, it is also important to note that one of the reasons for the growing popularity of digital assets is the ability to conduct direct transactions between participants without the involvement of financial intermediaries.

Consideration of various projects for the issuance of CBDCs allows classifying them into wholesale and retail [11, 12]. The main difference between retail and wholesale CBDCs is that access to retail CBDCs is open to a wide range of economic entities, including companies and individuals, while wholesale CBDCs are available only to credit institutions. The differences between wholesale and retail CBDCs are discussed in [13, p. 7–8].

Despite the fact that wholesale CBDCs in most studies also refer to digital money, according to the author, wholesale CBDCs are very close to existing non-cash money, which does not allow them to be fully attributed to the new form of digital money. Wholesale CBDCs are more likely to create the potential to further develop existing settlement and payment technologies. The wholesale CBDCs issuance does not imply significant changes to the financial infrastructure. Wholesale CBDCs do not have clear competitive advantages over payment and settlement systems operating in developed countries, which casts doubt on their relevance among end consumers. This conclusion is

consistent with the results of studies [14–16]. Comparative characteristics of retail digital money in comparison with cash and non-cash forms of money are presented in *Table 1*.

If issued, retail CBDCs create the basis for the development of digitalization processes and allow full use of the potential inherent in this form of money. The retail model of issuing digital money will make it popular among business entities and provide a competitive niche in the payment system for this instrument. Thus, when considering the CBDC issuance, it seems appropriate to take the model of retail CBDCs as a basis, taking into account the country specifics.

Retail CBDCs can be implemented both on the basis of tokens and on the basis of accounts [17]. In the second case, we are talking about opening accounts of economic entities in the central bank system. This approach to issuing digital money will not only require the creation of appropriate infrastructure but also create unwanted competition between credit institutions and the central bank. While CBDCs cannot provide absolute anonymity, token-based digital money issuance provides a higher level of privacy than account-based CBDCs. In addition, the issuance of token-based CBDCs will enable the innovative potential of digital money. In particular, this conclusion is consistent with the results of studies carried out by the Bank of Canada,[5] the Bank of Russia[6] and the Bank of Sweden.[7]

The issuance of token-based CBDCs, if implemented, will become a new stage in the development of payments and settlements, therefore it seems necessary to further study and subsequently test this technology in order to minimize possible risks for the financial system.

Digital money created on the basis of tokens allows full use of smart contracts, which is especially important if necessary to ensure control over the intended use of funds. For these reasons, token-based retail digital money issuance is preferred.

PREREQUISITES FOR THE ISSUANCE OF CBDCs IN DEVELOPED COUNTRIES

Digitalization processes have led to significant changes in the financial systems of developed countries. In particular, new technologies have significantly influenced the development of payment and settlement systems. Instant payment systems have become widespread, allowing the bank's customers to make P2P and P2B transfers.

Digitalization processes in developed countries also influenced the preferences of business entities, which led to a decrease in the share of physical cash payments and an increase in the popularity of e-money. For example, in Sweden, the amount of physical cash in circulation to GDP has declined from 3% to 1% over the past ten years.[8]

The significant increase in the popularity of electronic payment systems using smartphones, such as ApplePay and GooglePay, confirms the popularity of digital technologies among businesses and indicates a continuing trend towards a decrease in the demand for cash in developed countries.

The rapid development of digitalization processes sets the central banks of developed countries the task of guaranteeing the stability and efficiency of the financial system in the new conditions, as well as creating additional competitive advantages for the national currency in the face of increasing foreign exchange competition in world financial market. The issuance of retail CBDCs in developed countries can help address these problems.

[5] Charles M. Kahn, Francisco Rivadeneyra. Security and convenience of a central bank digital currency. Staff Analytical Note. Bank of Canada. October 2020. URL: https://www.bankofcanada.ca/wp-content/uploads/2020/10/san2020–21.pdf (accessed on 19.04.2021).

[6] The Bank of Russia website. Digital ruble concept. April 2021. URL: https://cbr.ru/Content/Document/File/120075/concept_08042021.pdf (accessed on 19.04.2021).

[7] E-krona pilot Phase 1. Sveriges Riksbank. April 2021. URL: https://www.riksbank.se/globalassets/media/rapporter/e-krona/2021/e-krona-pilot-phase-1.pdf (accessed on 19.04.2021).

[8] The Bank of Sweden website. URL: https://www.riksbank.se/en-gb/payments — cash/payments-in-sweden/payments-in-sweden-2020/1.-the-payment-market-is-being-digitalised/ (accessed on 19.04.2021).

Table 1

Analysis of key characteristics of new forms of money

Characteristic	Forms of money		
	Cash	Non-cash money	CBDC
Issuer	The types of modern physical cash are coins and banknotes. The emission of banknotes and coins is carried out by the central bank. Physical cash is an unconditional obligation of the central bank to its owners	The emission of non-cash money is carried out by the central bank and credit institutions. Two types of modern non-cash money are deposit money and e-money. Deposit money exists in the form of entries on the personal accounts of their owners in banks. Deposit money is the balance of funds in bank accounts that can be used for settlements. A feature of e-money as a type of non-cash money is the use of modern electronic technologies for storing money, as well as for making settlements and payments	Wholesale and retail CBDCs can be considered as types of digital fiat money. Retail CBDCs, like physical cash, are an unconditional obligation of the central bank to their owners. The issuance of retail CBDCs is carried out by the central bank. Both central banks and credit organizations can act as issuers of wholesale CBDCs
Possibility to charge interest	Physical cash is an interest-free obligation of the central bank to its owners	Credit institutions pay interest on deposits. By setting rates on deposits, credit institutions have the ability to regulate the inflow of funds from clients	CBDCs can be either interest-bearing or non-interest-bearing. Interest-bearing retail CBDCs involve the payment of interest by the central bank in favor of the owners of CBDCs.
Anonymity	Physical cash is available to all economic entities and can provide them with complete anonymity, considering the requirements of the law	Cashless payments do not provide complete anonymity. When making non-cash payments, customer identification is required. At the same time, in developed countries, the legislation on bank secrecy guarantees the confidentiality of data on the operations	CBDCs, in contrast to cash payments, do not provide complete anonymity for economic entities. At the same time, the issuance of retail CBDCs on the basis of tokens provides a greater level of confidentiality for economic entities, in comparison with the issuance of CBDCs on the basis of accounts with the central bank
Online settlements and payments	Making settlements and payments online using cash is possible	Modern payment infrastructure allows online cashless payments using various technologies, including mobile banking and fast payment services	The issuance of digital money implies the possibility of online settlements, which will ensure the attractiveness of the infrastructure of CBDCs for economic entities
The ability to use smart contracts	Not available	Currently not available	The issuance of retail digital money based on tokens allows using the capabilities of smart contracts, which are digital codes and contain the necessary conditions for making payments and settlements

Table 1 (continued)

Characteristic	Forms of money		
	Cash	Non-cash money	CBDC
Possibility of direct payments P2P and P2B	Cash is used as a means of direct payments between economic entities	Currently, in many countries, as part of the development of financial infrastructure, projects have been implemented that allow transfers between individuals and payments in favor of companies.	Retail CBDCs offer direct P2P and P2B transfers

Source: compiled by the author.

One of the most important reasons for considering the CBDCs issuance is the diminishing role of physical cash in settlements and payments in developed countries. For developing countries, this trend is not so obvious. The popularity of cash in developing countries is largely due to the doubts of economic agents about the reliability of credit institutions and the ability of regulators to ensure financial stability in the long term.

Retail digital money can combine the versatility and ease of use of cash with the digital capabilities of telecommuting. Thus, the reduction in the use of physical cash in developed countries poses a challenge for central banks to issue a digital currency that ensures the stability and efficiency of the payment system in the context of the digitalization of the financial system and the decline in the popularity of physical cash among business entities.

Retail CBDCs, like physical cash, are a direct obligation of the central bank to the holder, which makes them a risk-free asset.

Non-cash money in bank accounts cannot be considered completely risk-free due to the fact that banks have credit risks. The deposit insurance systems created in developed countries, combined with a high degree of reliability of credit institutions, as well as the willingness of regulators to provide support to credit institutions in crisis conditions, significantly reduce the credit risks of banks. The conditions prevailing in developed countries make it possible to assert that the credit risks of banks are actually very low. However, we cannot speak of their complete absence.

National government bonds are also not a completely risk-free asset for economic entities, since they have market risk. These circumstances are fundamentally important since, in the context of the digitalization of the financial system, it is important for the central banks of developed countries to offer the market a digital, risk-free form of money. Retail CBDCs can simultaneously serve as a risk-free asset for economic agents and act as a new form of money that meets the needs of the digital economy. In this context, it is important to note that the issuance of digital fiat money will help improve the reliability of the financial system, as economic entities will have access to a new risk-free asset that meets their needs.

The issuance of the retail CBDCs increases competition in the financial services market. The further strengthening of the role of systemically important banks and existing electronic payment systems, combined with a decrease in the popularity of cash, could in the long term lead to a monopolization of the payments market and a decrease in incentives for innovation on the part of large market participants.[9] As a result of a possible monopolization of the market, there are also risks of growth in tariffs and a decrease in the quality of services provided.

Despite the fact that the payment services market in developed countries is currently competitive, nevertheless, central banks are faced with the task of eliminating the risks of market monopolization and creating additional prerequisites for increasing competition.

The emergence of retail CBDCs could be an additional factor contributing to increased

[9] Annual Economic Report. Bank for International Settlements. June 2020. P. 67–89. URL: https://www.bis.org/publ/arpdf/ar2020e.pdf (accessed on 19.04.2021).

competition and the development of an innovative payment market. The issuance of CBDCs can, in the long term, reduce the impact on the market of large banks, existing mobile payment systems, as well as reduce the dominant position of such international payment and settlement systems as Visa and MasterCard. The development of the payment system based on increased competition in the payment and settlement market can give an additional impetus to the development of the financial system. Thus, the issuance of CBDCs contributes to the fulfillment of the central bank's function of promoting the development of the national payment system.

CBDC needs serious consideration in the context of the unprecedented support measures provided by the governments of developed countries in connection with the coronavirus pandemic. During a crisis, retail CBDCs can be used as a tool to provide direct government support to citizens. In such cases, the infrastructure of CBDCs can be used to make direct payments to G2P to support those affected by the crisis. Thus, retail digital money can become an additional mechanism for providing direct support to individuals, which can be competitive with traditional mechanisms in terms of convenience, transparency, and ease of use.

Digitalization processes pose challenges for central banks to ensure access to high-quality and modern financial services for businesses that need them. As the economy develops and the well-being of the population grows, continuous and guaranteed access to high-quality financial services becomes more and more important for economic agents. The higher the level of economic development and well-being of the population and, accordingly, the higher the demand for financial services, the more priority this task becomes for the central bank. The issuance of CBDCs can contribute to its solution if this form of money is attractive and can earn the trust of consumers.

The overwhelming majority of the population of developed countries has access to modern payment and settlement technologies. For example, in the United States, 95% of the adult population has an account with a credit institution,[10] in Sweden this figure exceeds 99%.[11]

In developing countries, on the contrary, a significant part of the population does not use the services of credit institutions. In particular, a significant part of the population in developing countries still does not have a bank account and does not use modern payment technologies. According to the author, this situation in developing countries may be partly related to low levels of financial literacy, accessibility and level of development of financial services, but, first of all, this is due to insufficient demand for these services due to low incomes of the population. The demand for financial services in developing countries will grow as incomes and quality of life rise.

On the one hand, an increase in the welfare of the population contributes to an increase in demand for digital technologies, on the other hand, the development of digitalization processes contributes to economic development and creates additional competitive advantages for the economies of the developed countries.

Facilitating digitalization of the financial system includes central bank policies to remove potential barriers to digital access by fostering the innovative development of the payment system.

The CBDC issuance in retail form creates the preconditions for the existence of various payment instruments, competing with each other, which allows economic entities to choose the most suitable instrument for them. The CBDC issuance is able not only to support the digitalization of the financial system but also to provide access for economic entities to an additional settlement system based on the use of digital money.

Thus, retail CBDCs are designed to guarantee in the future access of economic entities to

[10] How America Banks: Household Use of Banking and Financial Services. 2019 FDIC Survey. URL: https://www.fdic.gov/analysis/household-survey/2019report.pdf (accessed on: 19.04.2021).

[11] URL: https://data.worldbank.org/indicator/FX.OWN.TOTL.ZS (accessed on 19.04.2021).

modern technologies for making payments using a digital form of money available to economic entities, which is a top priority for central banks of developed countries in the face of the growing prosperity of economic entities and processes of digitalization of the economy.

CBDC-based payments allow creating prerequisites for optimizing the interaction of sellers and buyers based on the use of digital technologies, which will increase sales, as well as create preconditions for the development of the financial system and economic growth. The development of retail payment systems based on the use of digital money can be considered as a factor contributing to the development of channels for the sale of goods and services, which is especially important for the economies of developed countries, where final consumption expenditures form the basis of GDP. The issuance of digital money can have a positive effect on both the state of the financial system and the real sector of the economy.

The development of the crypto asset market, with the timely adoption of government regulation measures, does not create risks for the financial stability of developed countries. Moreover, the development of the crypto asset market can enhance the competitive advantages of financial systems. Private crypto assets and CBDCs do not compete with each other but complement each other. CBDCs act as a full-fledged form of fiat money, and private digital assets as a possible investment target for a limited number of investors. It is important to note that despite the growing popularity of crypto assets, their capitalization remains insignificant compared to traditional assets, and they will not play a significant role in the global financial market for the foreseeable future.

Fostering digitalization of the financial system involves a two-pronged approach by central banks and national governments, combining measures to stimulate digitalization through the issuance of CBDCs and government regulation of digital assets.

The issuance of CBDCs and measures of state regulation of crypto assets are designed to facilitate the further development of digitalization processes, which will allow business entities to gain access to both private crypto assets and fiat digital money.

In this context, it is important to note that the development of the business of social networks and messengers objectively contributes to the digitalization of the financial systems of developed countries. In particular, the social network Facebook is considering a project to launch the stablecoin Diem,[12] formerly known as Libra. By now, the requirements of the regulators have been considered, the launch of Diem is scheduled for 2021.

Papers [18–21] indicate that private crypto assets can be viewed as a potential threat to financial stability, can create problems for central banks in their monetary policy, and contribute to the crowding out of the national currency by crypto assets. In particular, such a threat can come from bitcoin, as well as from stablecoins.

According to the author, the possible emergence of stablecoins similar to Diem does not pose risks to the financial stability of developed countries. Moreover, such stablecoins can enhance the competitive advantages of the currencies of developed countries through the development of digital services provided by private companies, which will make the corresponding fiat currencies more attractive and have a positive impact on the competitiveness of these countries.

At the same time, the issuance of retail CBDCs by central banks of developed countries with the admission of non-residents to them, as well as the launch of stablecoins based on fiat money from developed countries, can create additional risks for developing countries. If such CBDCs and stablecoins are successful, payment systems based on them can create additional competition for the currencies of developing countries. In the absence of financial stability and distrust of economic entities in the ongoing

[12] Сайт Diem. URL: https://www.diem.com/en-us/learn-faqs/ (accessed on 19.04.2021).

monetary policy, the risks of mass exodus of economic entities from the national currencies of developing countries will increase, since stablecoins and CBDCs of developed countries can become additional convenient tools for such actions. These circumstances highlight the need to ensure financial stability, create an attractive business environment and work on the development of payment systems in developing countries. If the projects of CBDCs in developed countries are successful, the central banks of developing countries are also preferable to be ready to issue them, which emphasizes the need for a comprehensive study of issues related to the issuance and circulation of digital money.

Support for digitalization processes should be aimed at strengthening the competitiveness of the national economy and increasing the attractiveness of the national currency for investors. When pursuing policies aimed at stimulating digitalization processes, it is also important to take into account the risks associated with this phenomenon [22]. Pursuing a policy aimed at strengthening competitive advantages for the economies of developed countries involves stimulating digitalization processes through the issuance of CBDCs and taking regulatory measures in relation to the digital asset market aimed at ensuring the rights of investors and ensuring financial stability. In this context, the issuance of CBDCs will contribute to the development of digitalization processes and ensure financial stability.

ASSESSING THE IMPACT OF CBDCs ON THE FINANCIAL SYSTEM

The degree of influence of CBDCs on the financial system and the conditions for conducting monetary policy will be largely determined by the characteristics of the new form of money and its demand among economic entities. One of the most difficult issues requiring consideration in the framework of the implementation of projects for the issuance of retail CBDCs is the possibility of issuing interest-bearing CBDC [23–25]. This issue is key when deciding on the feasibility of issuing CBDCs and goes far beyond the discussion about the possible characteristics of digital currencies.

Arguments in favor of issuing interest-bearing retail CBDCs are primarily related to the search for opportunities to improve transmission mechanism in the conduct of monetary policy by reducing the effective lower bound of the interest rate. The effective lower bound is understood as the key rate of the central bank, below which its further reduction is not effective due to limitations in the transmission mechanism.

The problem of an effective lower bound remains relevant and should be taken into account when conducting a stimulating monetary policy in developed countries [26, 27]. At the same time, at present, there is no consensus about the degree of importance of this problem and the ways of its solution. Nevertheless, it can be argued that an effective lower bound may, in certain situations, create difficulties in the implementation of a stimulating monetary policy by central banks of developed countries. A decrease in rates below the effective border ceases to have a stimulating effect on the economy.

The existence of an effective lower bound is explained by the fact that economic agents can convert funds into cash and thus avoid negative interest rates, which reduces the effect of the introduction of negative interest rates by central banks.

The effective lower bound of the interest rate for the economies of developed countries can be either close to zero or below zero due to two important circumstances. Firstly, keeping cash for credit institutions is associated with certain costs. Secondly, developed countries are characterized by a high degree of involvement of business entities in the financial market, therefore, the possibility of permanent transactions with financial instruments is of particular importance for them. These circumstances significantly reduce the attractiveness of cash for business entities in developed countries.

Some studies suggest that central banks of developed countries in a deep economic crisis may need to reduce rates to levels well below zero values [28, 29]. For such a reduction in rates to have the necessary stimulating effect, an increase in the efficiency of the transmission mechanism is required.

The issuance of interest-bearing retail CBDCs can be seen as an instrument that can significantly increase the sensitivity of the economy to central bank interest rates and thus improve the efficiency of the transmission mechanism. It is important to note that the interest rate of CBDCs should not be higher than the deposit rate of the central bank so that economic entities do not have arbitrage opportunities. Issuing interest-bearing digital money also implies the possibility of an economic entity "receiving" a negative interest rate if the central bank's deposit rate also becomes negative. Due to the fact that the rate charged on balances on digital money will be available to companies and individuals, lending institutions will promptly adjust rates on deposits and other products in accordance with changes in central bank rates. Changes in central bank rates will lead to rate changes in the economy much faster. Thus, interest payments on CBDCs can help strengthen monetary transmission mechanism and enhance the ability of central banks in developed countries to pursue stimulating monetary policy in the face of negative interest rates [30].

According to the author, considering CBDCs in the context of solving the problem of strengthening the transmission mechanism is difficult, since the availability of physical cash will further limit the ability to set negative interest rates below a certain level. Consequently, in practice, it is possible to achieve a significant enhancement of the transmission mechanism by issuing fiat digital money only if physical cash is canceled and replaced by CBDCs, which, of course, is not justified and contradicts the main objectives of issuing CBDCs. The abolition of physical cash will create risks for financial stability and reduce the confidence of economic agents in the financial system.

In addition, the issuance of CBDCs with the possibility of charging interest can amplify the processes of disintermediation many times over, since digital money will directly compete with bank deposits. Charging interest on digital money will mean that banks will effectively be forced to compete with the central bank in the market for banking products. The movement of funds between bank deposits and CBDCs will also increase the volatility of bank liabilities.

To preserve the resource base, credit institutions may face the need to significantly increase deposit rates and increase the share of wholesale financing in the balance sheet structure. Heightened disintermediation processes, combined with a reduction in the resource base, will lead to a deterioration in the credit quality of banks and create risks for financial stability. A decrease in liabilities and an increase in their volatility may cause a reduction in lending to business entities from the banking system. To mitigate the negative impact, central banks may need to significantly increase the volume of liquidity provision to the banking system through repo transactions. The increase in the limits on repo transactions, in turn, will require an expansion of the list of instruments that can be accepted as collateral for transactions. In connection with the increase in the limits on repo transactions, the problem of the credit quality of collateral may arise. The need to provide banks with additional liquidity from the central bank can increase credit risks for the central bank and increase the dependence of banks on financing from the central bank.

Charging interest on CBDC will not lead to a significant improvement in the transmission mechanism in the long term. It will also cause significant problems for the financial system and complicate the implementation of monetary policy.

The issuance of non-interest-bearing CBDC is preferable. One of the most important consequences of such a decision for the financial system will be the de facto zero lower bound for nominal interest rates. In the absence of restrictions on transactions with CBDCs, as well

as in compliance with the principles of equality and equivalence of CBDCs and existing forms of money, business entities will prefer to convert funds into CBDCs in order to avoid negative interest rates. For the same reason, it will be impossible to have negative returns in the government debt market. The establishment of a zero lower bound for nominal interest rates, in the author's opinion, will not lead to an increase in risks to financial stability and will not create significant risks when conducting accommodative monetary policy by central banks of developed countries.

A negative interest rate policy, as opposed to a zero interest rate policy, is a controversial approach to stimulating monetary policy, and the possible positive effects of such a policy remain unproven [31, 32]. In particular, the successful use of a wide range of stimulating monetary policy instruments by the US Federal Reserve both during the global economic crisis of 2008 and in the context of the coronavirus pandemic did not provide for a policy of negative interest rates.

When assessing the impact of the issuance of CBDCs on the financial system and the conditions for conducting monetary policy, the key issue is the payment of interest on digital money. In the event of the retail CBDCs issuance with interest paid by the central bank, this impact would be significant and mostly negative. Non-interest-bearing retail CBDC will also have some impact on the financial system and the monetary policy environment, but the impact will be significantly less.

In this paper, the author substantiates the advisability of issuing non-interest-bearing fiat digital money, so it is important, first of all, to assess the impact of this version of CBDCs on the financial system. It should also be noted that the impact of the central bank's digital currency on the financial system at different periods of time will be different depending on the phases of the economic cycle and the level of interest rates in the economy.

The issuance of non-interest bearing CBDCs will allow financially stable banks to maintain their resource base, in case they adjust their business models taking into account the growing competition in the payments market. In a situation of economic growth and positive interest rates, the demand for digital fiat money will be determined, first of all, by the extent to which the payment systems, settlements and additional services created on their basis will attract business entities, i.e. how attractive CBDC will be as a means of payment. In such an environment, digital fiat money will be perceived by consumers as an "electronic banknote" and, possibly, a more convenient alternative to cash and existing retail payment systems. Conversion of a certain part of the cash to CBDCs will not affect the bank performance indicators. In addition, the transfer of money from cash to CBDCs will not significantly affect the transfer mechanism and the terms of the monetary policy.

The issuance of non-interest-bearing CBDC will not lead to a significant reduction in the deposit base of credit institutions, since positive interest rates will be charged on deposits. In a situation characterized by sustainable economic growth, positive interest rates and financial stability, clients of financially stable credit institutions will not abandon interest-bearing bank deposits in favor of CBDCs that do not carry interest.

At the same time, increased competition in the payment and settlement market due to the issuance of CBDC and the development of the digital services market may cause some outflow of customer funds from accounts with credit institutions. This outflow may not be significant due to the interest-free nature of CBDCs and will be replaced by wholesale funding or offset in the short term by providing credit institutions with additional liquidity through repo transactions with the central bank. In the medium term, credit institutions will be able to make the necessary changes to their business models, offering business entities products and services based on the use of CBDCs, as well as adjusting approaches to asset and liability management.

In the face of an economic downturn, central banks in developed countries are pursuing

stimulating monetary policies that combine both traditional and unconventional stimulus measures. In order to stimulate economic activity and maintain financial stability, central banks of developed countries seek to reduce the level of interest rates in the economy and stabilize the situation in the financial market. Periods of economic downturns may be accompanied by a deterioration in the credit quality of financial institutions, which may also require central banks to take timely measures to support them.

In a situation of economic downturn and low interest rates due to the stimulating monetary policy of central banks, the impact of the central bank's digital currency on the financial system may slightly increase. Since the issuance of CBDCs without the possibility of calculating interest actually sets a lower zero bound for interest rates, then when the level of nominal interest rates in the economy approaches zero, the relative attractiveness of digital money compared to cash will increase. In an economic downturn and close to zero interest rates, the demand for CBDC may slightly increase, since this form of money may be perceived by some financial market participants as a risk-free asset, which is much more convenient in comparison with cash. In the event of an increase in risks to financial stability and deterioration of the credit quality of banks during a recession, economic entities can increase investments in CBDCs by withdrawing funds from banks that could potentially face financial problems. The outflow of customer funds from bank accounts will increase the need for repo transactions with the central bank and attract additional wholesale financing in the financial market. These circumstances must be considered when conducting monetary policy, as well as policies to maintain financial stability.

Thus, in a recession, digital money can have some impact on the financial system. However, according to the author, it is important not to overestimate the degree of such influence and not to consider it as a negative factor. First of all, it should be noted that CBDCs do not create new risks for the financial system due to the fact that fiat digital money can be considered as the least risky asset in comparison with other types of assets. The transfer of part of the funds of economic entities to CBDC does not lead to an increase in risks for them. In addition, the possibility of an outflow of funds from credit institutions due to the deterioration of their credit quality exists regardless of the presence of CBDCs in the monetary system. In the face of growing risks of credit institutions, economic entities currently have the opportunity to withdraw their funds from deposit accounts and use them, for example, to purchase government bonds. In addition, CBDC is not the most attractive alternative to bank deposits for economic entities, since CBDC does not bear interest and there is no growth potential for the market value. According to the author, the issuance of CBDCs without charging interest by the central bank does not create new risks for credit institutions in a recession, since the root cause of a possible outflow of customer funds is potential problems in credit institutions due to insufficient adaptability of business models to a worsening economic situation in a recession, but not due to presence of fiat digital money in the monetary system.

The issuance of non-interest-bearing CBDCs cannot lead to the loss of financial stability of credit institutions with high credit quality or cause an increase in risks to financial stability. In this context, it is important to note the importance of the central bank's policy to maintain financial stability and ensure the stability of the banking system.

The issuance of non-interest-bearing CBDCs, in general, will have a positive impact on the development of the financial system by increasing competition in the payment and settlement market, stimulating the digitalization of the financial system, and will also contribute to ensuring financial stability. The potential positive effects of the issuance of retail CBDC are summarized in *Table 2*.

An important additional argument in favor of issuing digital fiat money by central banks of

developed countries is given in research [33, p. 15]. The presence of CBDCs will make it possible to quickly reorganize problem credit institutions. The technical advantages of digital money will allow regulators to make payments faster in favor of depositors of such banks, thus avoiding the effect of "infection" of the financial system and the emergence of threats to financial stability. Thus, the use of CBDC creates prerequisites for strengthening the confidence of business entities in the financial system and reducing risks to financial stability.

The issuance of CBDCs, first of all, should be considered within the framework of solving the problem of the development of the payment system. Considering CBDC in the context of improving monetary policy instruments is not an optimal solution. Therefore, the main criterion for the effectiveness of the issuance of CBDCs is the extent to which the issuance of digital money will have a positive impact on the development of the payment system. To solve this problem, fiat digital money should act as a digital currency available to business entities without any restrictions, issued on the basis of tokens and not involving the payment of interest by the central bank in favor of the holders. The issuance of CBDCs with such parameters will not lead to an increase in risks in the financial systems of developed countries, but, of course, will require credit institutions to adjust their business models in connection with the intensification of competition in the payment and settlement market.

CONCLUSIONS

The paper considers topical issues related to digital fiat money. In connection with the processes of digitalization of the economy, growth in the well-being of the population, a decrease in the popularity of physical cash and a high level of trust of business entities in the financial system, consideration of the issuance of digital money is becoming especially relevant for central banks of developed countries. The paper substantiates the need for central banks of developed countries to issue digital currency as a new form of fiat money. CBDCs will stimulate competition in the payment and settlement markets, create additional competitive advantages for currencies in the face of increasing global foreign exchange competition, can be used as a tool to provide direct support to economic entities in crisis conditions, and will also act as a risk-free form of money that meets the needs of the digital economy.

The CBDC issuance involves considering a large number of factors related to the peculiarities of the development of national financial systems, consumer preferences, as well as the current situation in the economy.

In defining the characteristics of CBDCs, it is important to consider that the issuance of CBDCs can only be successful if digital money has clear competitive advantages over existing forms of money.

The use of a retail model for issuing CBDCs is preferable since this model will make it possible to take full advantages of digital technologies and ensure the attractiveness of this tool for business entities.

The study formulates general principles that must be considered when deciding on the issuance of CBDCs. This includes:

- ensuring financial stability;
- coexistence with other forms of money;
- maintaining and stimulating competition in the financial services market;
- cooperation and interaction between regulators and economic actors;
- ensuring information security.

The paper defines the main characteristics of digital money that correspond to these principles and ensure the development of the payment system. This includes:

- direct access for economic agents;
- issue based on tokens.

In addition, the issuance of digital currency does not imply the possibility of interest payment by the central bank in favor of the holders.

The degree of influence of the digital currency of the central bank on the financial system and the conditions for conducting monetary policy will depend on the parameters of CBDCs, the

Table 2

Assessment of the positive impact of retail CBDCs

Positive impact of retail CBDCs	Description
Increased competition in the financial services market	The issuance of CBDCs will contribute to the development of competition through the creation of new payment and settlement instruments available to a wide range of economic entities. The infrastructure created on the basis of CBDC will allow financial service providers to create additional services based on the introduction of innovations. Growing competition will help reduce the cost of services provided and improve their quality, as well as increase the reliability of the payment infrastructure. Competition among service providers in the payment and settlement market is the basis for the creation and development of products that meet the needs of economic entities
The issuance of retail CBDCs, combining the advantages of physical cash and non-cash forms of money	Retail digital money issued by a central bank can combine the advantages of non-cash money, associated with the ability to make remote payments and transfers, and physical cash, which allows settlements without access to the Internet. Retail CBDCs will function as a means of payment, a medium of exchange, a measure of value, and a store of value, serving as another and equivalent form of money
Stimulating the processes of digitalization of the financial system	The processes of digitalization of the financial system contribute to an increase in the quality and diversity of financial services, which poses the task of stimulating these processes for central banks. One of the directions of such stimulation is the issuance of CBDCs. Retail CBDCs can become the basis for the development of new types of financial services and services that meet the needs of the digital economy
Formation of prerequisites for ensuring financial stability	The issuance of retail CBDCs could have long-term positive effects on financial stability. The confidence of economic agents in the financial system is an important condition for strengthening financial stability. The ability to conveniently and quickly convert non-cash money into digital fiat money, which is an obligation of the central bank to their owners, will increase the confidence of economic entities in the financial system, and, therefore, will contribute to the achievement of financial stability
Use as a tool for direct support of economic agents from the government	The use of retail CBDCs to provide direct support to citizens from the government in a crisis creates additional opportunities to improve the efficiency of this process in terms of convenience, transparency and ease of use of digital money
Ability to use smart contracts	The issuance of token-based retail CBDCs provides the basis for the development of financial products and services created using smart contracts. Smart contracts make it possible to simplify settlements for contractual obligations and automate control over their execution. If necessary, smart contracts can also be used to control the targeted use of funds. The issuance of retail CBDCs with the ability to use smart contracts will contribute to the development of a settlement and payment system based on the use of digital technologies
Ensuring access to high-quality financial services for economic entities that have a demand for them	The infrastructure created for CBDC will ensure the development of the financial services market based on innovations, as well as create additional opportunities for economic entities to make payments and settlements. Expanding the list of settlement instruments available to consumers will contribute to the development of a competitive environment and increase the availability of financial services
Increasing the attractiveness of the national currency in the face of heightened global foreign exchange competition	The issuance of fiat digital money will contribute to the development of payment and settlement technologies, the emergence of new products and services, thus ensuring the growth of the attractiveness of national currencies in the context of international currency competition. Retail CBDCs can become one of the factors that provide countries with a competitive advantage in the provision of financial services. Thus, the issuance of digital money can be considered an important element of the development strategy of the financial sector

Source: compiled by the author.

main of which is the ability to pay interest on digital money from the central bank. The issuance of non-interest-bearing CBDCs will have a positive effect on the development of the financial system and will not lead to additional risks to financial stability. The creation of a new payment infrastructure based on CBDC will not lead to a significant outflow of funds from accounts with credit institutions and will help the central bank to fulfill its functions of developing the payment system and ensuring financial stability.

ACKNOWLEDGEMENTS

The article is based on the results of budgetary-supported research according to the state task carried out by the Financial University in 2021 on the applied research topic: "Development of monetary polycentrism and regionalization in the process of transformation of the international monetary system". Financial University, Moscow, Russia.

REFERENCES

1. Maslennikov V.V., Fedotova M.A., Sorokin A.N. New financial technologies change our world. *Finansy: teoriya i praktika = Finance: Theory and Practice*. 2017;21(2):6–11. (In Russ.). DOI: 10.26794/2587–5671–2017–21–2–6–11
2. Boar C., Holden H., Wadsworth A. Impending arrival — a sequel to the survey on central bank digital currency. Bank for International Settlements. BIS Papers. 2020;(107). URL: https://www.bis.org/publ/bppdf/bispap107.pdf
3. Bossu W. et al. Legal aspects of central bank digital currency: Central bank and monetary law considerations. IMF Working Paper. 2020;(254). DOI: 10.5089/9781513561622.001
4. Khiaonarong T., Humphrey D. Cash use across countries and the demand for central bank digital currency. IMF Working Paper. 2019;(046). DOI: 10.5089/9781484399606.001
5. Auer R., Böhme R. The technology of retail central bank digital currency. *BIS Quarterly Review*. 2020;(March):85–100. URL: https://www.bis.org/publ/qtrpdf/r_qt2003j.pdf
6. Auer R., Cornelli G, Frost J. Rise of the central bank digital currencies: Drivers, approaches and technologies. Bank for International Settlements. BIS Working Papers. 2020;(880). URL: https://www.bis.org/publ/work880.pdf
7. Manaa M. et al. Crypto-assets: Implications for financial stability, monetary policy, and payments and market infrastructures. ECB Occasional Paper. 2019;(223). DOI: 10.2866/162
8. Auer R. Beyond the doomsday economics of "proof-of-work" in cryptocurrencies. Bank for International Settlements. BIS Working Papers. 2019;(765). URL: https://www.bis.org/publ/work765.pdf
9. Chimienti M.T., Kochanska U., Pinna A. Understanding the crypto-asset phenomenon, its risks and measurement issues. *ECB Economic Bulletin*. 2019;(5). URL: https://www.ecb.europa.eu/pub/economic-bulletin/articles/2019/html/ecb.ebart201905_03~c83aeaa44c.en.html#toc1
10. Kiff J. et al. A survey of research on retail central bank digital currency. IMF Working Paper. 2020;(104). DOI: 10.5089/9781513547787.001
11. Mancini-Griffoli T. et al. Casting light on central bank digital currency. IMF Staff Discussion Note. 2018;(08). URL: https://www.imf.org/-/media/Files/Publications/SDN/2018/SDN 1808.ashx
12. Barontini C., Holden H. Proceeding with caution — a survey on central bank digital currency. Bank for International Settlements. BIS Papers. 2019;(101). URL: https://www.bis.org/publ/bppdf/bispap101.pdf
13. Cœuré B., Loh J. Central bank digital currencies. Basel: Bank for International Settlements; 2018. 34 p. URL: https://www.bis.org/cpmi/publ/d174.pdf
14. Julin E. The Riksbank's e-krona project. Report 2. Stockholm: Sveriges Riksbank; 2018. 52 p. URL: https://www.riksbank.se/globalassets/media/rapporter/e-krona/2018/the-riksbanks-e-krona-project-report-2.pdf
15. Miedema J. et al. Designing a CBDC for universal access. Bank of Canada. Staff Analytical Note. 2020;(10). DOI: 10.34989/san-2020–10
16. Lagarde C., Panetta F. Report on a digital euro. Frankfurt am Main: European Central Bank; 2020. 55 p. URL: https://www.ecb.europa.eu/pub/pdf/other/Report_on_a_digital_euro~4d7268b458.en.pdf

17. Bordo M. D., Levin A. T. Central bank digital currency and the future of monetary policy. NBER Working Paper. 2017;(23711). URL: http://www.nber.org/papers/w23711.pdf
18. Nabilou H. Testing the waters of the Rubicon: the European Central Bank and central bank digital currencies. *Journal of Banking Regulation*. 2020;21(12):299–314. DOI: 10.1057/s41261–019–00112–1
19. Náñez Alonso S.L. et al. Reasons fostering or discouraging the implementation of central bank-backed digital currency: A review. *Economies*. 2020,8(2):41. DOI: 10.3390/economies8020041
20. Cœuré B. et al. Investigating the impact of global stablecoins. Basel: Bank for International Settlements; 2019. 37 p. URL: https://www.bis.org/cpmi/publ/d187.pdf
21. Viñuela C. et al. The future of money and the central bank digital currency dilemma. *Sustainability*. 2020;12(22):9697. DOI: 10.3390/su12229697
22. Eskindarov M.A., Maslennikov V.V., Maslennikov O.V. Risks and chances of the digital economy in Russia. *Finansy: teoriya i praktika = Finance: Theory and Practice*. 2019;23(5):6–17. (In Russ.). DOI: 10.26794/2587–5671–2019–23–5–6–17
23. Bindseil U. Tiered CBDC and the financial system. ECB Working Paper Series. 2020;(2351). URL: https://www.ecb.europa.eu/pub/pdf/scpwps/ecb.wp2351~c8c18bbd60.en.pdf
24. Agur I. et al. Designing central bank digital currencies. IMF Working Paper. 2019;(252). DOI: 10.5089/9781513519883.001
25. Nessén M., Söderström U., eds. Second special issue on the e-krona. Sveriges Riksbank Economic Review. 2020;(2). URL: https://www.riksbank.se/globalassets/media/rapporter/pov/engelska/2020/economic-review-2–2020.pdf
26. Agarwal R., Kimball M. Breaking through the zero lower bound. IMF Working Paper. 2015;(224). DOI: 10.5089/9781513567327.001
27. Rogoff K. Dealing with monetary paralysis at the zero bound. *Journal of Economic Perspectives*. 2017;31(3):47–66. DOI: 10.1257/jep.31.3.47
28. Agarwal R., Kimball M. S. Enabling deep negative rates to fight recessions: A guide. IMF Working Paper. 2019;(84). URL: https://www.imf.org/-/media/Files/Publications/WP/2019/WPIEA2019084.ashx
29. Lilley A., Rogoff K. The case for implementing effective negative interest rate policy. In: Cochrane J., Taylor J., eds. Strategies for monetary policy. Stanford, CA: Hoover Institution Press; 2020:27–102. URL: https://scholar.harvard.edu/files/rogoff/files/lilley_rogoff_implenting_effective_negative_rate_policy_sept_2019.pdf
30. Bordo M.D., Levin A.T. Digital cash: Principles & practical steps. NBER Working Paper. 2019;(25455). DOI: 10.3386/w25455
31. Di Bucchianico S. Negative interest rate policy to fight secular stagnation: Unfeasible, ineffective, irrelevant, or inadequate? *Review of Political Economy*. 2021;33(4):687–710. DOI: 10.1080/09538259.2020.1837546
32. Kurowski Ł.K., Rogowicz K. Negative interest rates as systemic risk event, *Finance Research Letters*. 2017;22:153–157. DOI: 10.1016/j.frl.2017.04.001
33. Kumhof M., Noone C. Central bank digital currencies — design principles and balance sheet implications. Bank of England. Staff Working Paper. 2018;(725). URL: https://www.bankofengland.co.uk/-/media/boe/files/working-paper/2018/central-bank-digital-currencies-design-principles-and-balance-sheet-implications

ABOUT THE AUTHOR

Dmitry M. Sakharov — Cand. Sci. (Econ.), Assoc. Prof., Department of World Finance, Financial University, Moscow, Russia
dmsakharov@fa.ru

The article was submitted on 13.04.2021; revised on 27.04.2021 and accepted for publication on 17.05.2021.
The author read and approved the final version of the manuscript.

ORIGINAL PAPER

DOI: 10.26794/2587-5671-2021-25-5-150-171
UDC 336.76,519.2(045)
JEL C22, C52, C58, E44, G12

Evolution of Bitcoin as a Financial Asset

K.D. Shilov[a] ✉, **A.V. Zubarev**[b]
Institute of Applied Economic Study, RANEPA, Moscow, Russia
[a] https://orcid.org/0000-0002-2149-3946; [b] https://orcid.org/0000-0003-2945-5271
✉ Corresponding author

ABSTRACT

The cryptocurrency market debate resumed in 2020 with renewed vigour as the price of Bitcoin surpassed late 2017 highs. This study **aims** to analyse possible factors of Bitcoin's pricing at various cryptocurrency market development stages — before the 2017 price bubble, after and during the COVID-19 pandemic. The main **method** of analysis is a generalized autoregressive conditional heteroskedasticity model with conditional generalized error distribution (GARCH-GED). Two groups of indicators are used as possible factors related to the Bitcoin dynamics. The first group consists of various quantitative indicators directly related to Bitcoin (the so-called internal factors) — the volume of exchange trade, the volume of transactions in the Bitcoin blockchain, the number of new and active wallets, hash rate, the sum of fees paid in the blockchain, as well as the dynamics of Google Trends search queries. The second group is the return on various financial assets — stock and bond indexes, commodities, and currency markets. The **results** of the analysis demonstrate the absence of a stable correlation between any of the factors under consideration and Bitcoin returns in all the periods that we focus on. In the period before the 2017 price bubble, the internal factors and Bitcoin returns showed generally co-directional dynamics, but the situation changed in 2018. In early 2021, the correlation between Bitcoin and traditional financial assets returns has increased significantly. We can **conclude** that Bitcoin is becoming a popular means of diversification as a high-risk asset, which, however, follows the pattern of a speculative bubble at the beginning of 2021. The increased demand for the need to invest in Bitcoin using various exchange-traded instruments (ETFs for cryptocurrencies) may soon lead to a further increase in the price of this cryptocurrency if such instruments are registered on the exchange.

Keywords: cryptocurrency; blockchain; Bitcoin; GARCH; financial markets; financial assets; COVID-19; Google Trends

For citation: **Shilov K.D., Zubarev A.V. Evolution of Bitcoin as a financial asset. *Finance: Theory and Practice.* 2021;25(4):150-171. DOI: 10.26794/2587-5671-2021-25-4-150-171**

INTRODUCTION

Cryptocurrencies represent an interesting phenomenon in the second decade of the 21st century. Since its inception and its first price offer in 2010 at 8 US cents, the price of the first and largest cryptocurrency in terms of capitalization, bitcoin, has skyrocketed to US$ 20,000 at the end of 2017 (which even then seemed as an exception) after which it will drop in price to US$ 3.3 thousand in the second half of 2018, and in March 2021 it will overcome the mark of US$ 60,000.

Other cryptocurrencies have experienced similar ups and downs. This volatility and the ability to generate hundreds of thousands of percent of profits have naturally attracted the attention of a large number of stock market participants, retail investors and economists. Debates about the nature and possible drivers of cryptocurrency pricing still continue, both in the corridors of hedge funds and central banks, and in academic journals.

In this article, we will try to contribute to the discussion of possible pricing factors for the largest cryptocurrency — Bitcoin. Specifically, we will examine how bitcoin profitability correlates with cryptocurrency-specific factors such as exchange trading volume, distributed ledger activity, number of active and new wallets/addresses, and commissions. Using the indicator of the dynamics of the popularity of search queries in the Google search engine (using the Google Trends service) for relevant keywords, we will assess how the profitability of

cryptocurrencies depends on public attention to them.

Many researchers have tested the link between cryptocurrency profitability and traditional financial assets. For the most part, these works indicated its absence, which opened up the possibility of including a certain (usually small) share of cryptocurrencies in the investment portfolio in order to obtain a higher expected return at the same level of risk [1]. However, we assume that between the end of 2017 and the beginning of 2018, which many researchers define as a "bubble" [1], cryptocurrencies were an extremely *"marginal"* asset class with relatively low capitalization and popularity in narrow circles.

The sharp rise in cryptocurrency quotes in 2017 significantly fueled interest in this asset class, which contributed to the dissemination of information about it to a wider audience. Although the fall in 2018 was extremely painful for newcomers and there was less interest in the topic, the burst of the 2017 bubble significantly changed the cryptocurrency market. Moreover, the COVID-19 pandemic marked the beginning of a new stage in the evolution of the cryptocurrency market and led to significant changes in its characteristics. In particular, the cryptocurrency market has become more aligned with the stock market.

LITERATURE REVIEW

The technological base of any cryptocurrency is distributed ledger technology (DLT), one of the implementations of which is blockchain [2]. Each cryptocurrency has its own distributed ledger, and some of them are not even blockchains. Moreover, the cryptocurrencies themselves may differ in their functions and not all of them strive or can fulfill the role of a "new world currency" [3], and, therefore, the pricing mechanisms may differ.

A significant number of researchers model cryptocurrency (any) as a measure of payment within a certain service and platform and the growth in the price of such a cryptocurrency is provided due to various effects. Thus, M. Sockin and W. Xiong [4] model the price of a cryptocurrency as a means of payment on some decentralized platform for the exchange of goods and services, where platform users generate demand for tokens, but the growth of speculative demand for short-term transactions can unbalance the market.

J.S. Gans and H. Halaburda [5], based on a theoretical model of a digital currency serving a certain platform, concluded that the use or expansion of such a cryptocurrency outside the platform is unlikely.

B. Biais et al. [6] constructed a model of the equilibrium price of bitcoin, based on the possible advantages and costs of using it, with the help of which they demonstrated that the actions of regulators, leading to a decrease in costs or an increase in the benefits of using bitcoin as a means of payment, have a positive effect on the price cryptocurrencies.

L. W. Cong, Y. Li and N. Wang [7] have developed a dynamic pricing model for cryptocurrencies, which are means of payment within a certain platform. They demonstrated that an increase in the number of platform users, on the one hand, leads to an increase in demand for the platform's token for transactions, and on the other hand, to an increase in the expected return from price increases due to demand, which leads to endogenous risk in token returns and an explosive dynamics in prices.

The work of J. Chiu and T.V. Koeppl is devoted to the issue of bitcoin's competition with other payment systems [8], in which the authors showed that bitcoin can compete with traditional payment systems if the scalability problem is overcome and the transaction processing speed is increased.

One of the most significant works in terms of assessing the fair value of bitcoin and cryptocurrencies built on its source code is the work of A.S. Hayes [9], in which the author demonstrated that the value of the marginal cost of mining can be used as an estimate of the fundamental value.

Almost all cryptocurrencies (except for bitcoin and separate forks from other

cryptocurrencies) appeared as a result of an initial coin offering (ICO) — a mechanism that allows creators to receive initial funds for the development of their platform from the general public in the early stages.

The theoretical work of C. Catalini and J. S. Gans [10] analyzed possible strategies of ICO initiators to achieve the maximum value of their tokens, and J. Chod and E. Lyanderes [11] analyzed the advantages and disadvantages of ICOs in comparison with venture investment.

The work of A. Simonov and V. Zyamalov [12] is devoted to an empirical analysis of long-term factors of profitability and survival of tokens after ICO [12], who, however, demonstrated that the main factor in the high profitability of ICOs is the general mood in the cryptocurrency market.

A large number of works are devoted to the study of cryptocurrencies as a new class of financial assets: to what their properties are closer — to stocks, currencies or commodities; how effective is their pricing; how they relate to markets for other assets.

The conceptual features of bitcoin, consisting in its limited supply and the need for its "extraction" (mining), led some researchers to the idea that the first cryptocurrency in its properties may be similar to gold (see, for example, [13]). However, further studies of this issue have demonstrated the controversy of this thesis. For example, D. G. Baur, T. Dimpfl and K. Kuck [14] authors using conditional heteroskedasticity models (GARCH) showed that the properties of a series of returns and volatility of bitcoin differ from the corresponding series for gold and stock indices.

Differences between Bitcoin and gold were also highlighted in the work of T. Klein, H. Pham Thu, T. Walther [15], in which the authors using models of asymmetric power GARCH (APGARCH), partially integrated APGARCH, as well as multivariate GARCH (BEKK–GARCH), showed that bitcoin cannot serve as a hedging tool, unlike gold, since the addition of bitcoin (or a portfolio of the largest cryptocurrencies, expressed through the CRIX index) leads to larger falls in the value of the portfolio during downturns in the markets.

S.J.H. Shahzad et al. [16] also demonstrated that bitcoin does not have a weak safe-haven property for developed and emerging (with the exception of China) markets.

On the other hand, A. Urquhart and H. Zhang [17] using asymmetric dynamic conditional correlation (ADCC-GARCH) models showed that bitcoin can be an instrument of short-term intraday hedging during increased volatility in some currency's markets (Canadian dollar, euro, etc. British pound). The work of S.J.H. Shahzad et al. [18] analyzes the downside: can traditional currencies act as a hedge for the largest cryptocurrencies (Bitcoin, Ethereum, Ripple, Litecoin). The authors showed that in the sample from 07.08.2015 to 31.07.2019, the Japanese yen was the best hedge for cryptocurrencies.

Cryptocurrencies, especially bitcoin, are often positioned as a means of payment. In the work of F. Glaser et al. [19], an attempt is made using empirical methods to answer the question of what bitcoin really is — a speculative asset or a means of payment? Using GARCH models, the authors analyzed daily bitcoin returns, as well as daily exchange and blockchain volumes, and concluded that speculation is the main motive for cryptocurrency buyers.

D. G. Baur, K. Hong, A. D. Lee came to similar conclusions [20], who demonstrated using information from the bitcoin blockchain that only a small part of cryptocurrency holders regularly performs any transactional transactions. Also, in this paper, the authors demonstrated that the returns on the largest cryptocurrency are not correlated with the returns on traditional financial assets (stocks, bonds, commodities, currencies).

The work of G. O. Krylova, A. Yu. Lisitsyn and L. I. Polyakov [21] demonstrated that the leading cryptocurrencies are characterized by significantly higher volatility than fiat currency rates, which indicates the premature definition of cryptocurrencies as a means of payment.

Y. Liu and A. Tsyvynkiy [22] carried out a large-scale study of possible factors that can predict the profitability of leading cryptocurrencies (Bitcoin, Ethereum, Ripple). In particular, the authors demonstrated that the profitability of cryptocurrencies can be largely explained by such cryptocurrency-specific factors as changes in the number of open wallets, active addresses, all and separate payment transactions on the blockchain. The authors did not find a significant correlation between the returns of cryptocurrencies and other financial assets, as well as the Fama-French factors, macroeconomic indicators. Momentum (momentum of price movement) and investor attention, expressed in terms of the relative frequency of searches in Google and Wikipedia, were the only indicators that significantly affect the future profitability of cryptocurrencies and to some extent can predict price movement. The presence of a two-way relationship between Google searches and bitcoin returns is also indicated by the results of the work of S. Dastgir et al. [23], obtained using the copula-based Granger causality test.

In another work, the same authors [24] attempted to construct factors specific to the cryptocurrency market, similar to the Fama-French market factors of and not only. By modeling portfolios that reflect certain factors, it has been demonstrated that only three factors — cryptocurrency market capitalization, size and momentum — can explain the expected return on a given asset class.

Many researchers are also involved in the analysis of cryptocurrency volatility. J. Chu et al. [25] reviewed 12 different GARCH model specifications for the 7 largest cryptocurrencies. The most suitable specifications turned out to be integrated GARCH (IGARCH) and asymmetric GARCH (GJR-GARCH), which indicates high stability of volatility (effect of infinite memory) in cryptocurrency returns, as well as an asymmetric response of volatility to yield shocks.

The study of the asymmetric reaction of the cryptocurrency market to news is devoted to the work of M. Malkina and V. Ovchinnikov [26], in which the authors using Markov-switching GARCH models and models of heterogeneous autocorrelation realized volatility (HAR-RV) have shown, the asymmetry effect depends on the phase (rising, falling) and the level of volatility (high, low) of the cryptocurrency market. The asymmetric influence of positive and negative news on bitcoin profitability was also demonstrated in the work of E.A. Fedorova, K.Z. Bechvaya and O. Yu. Rogov [27], and the authors showed that the influence of negative news is stronger.

In the work of H.A. Aalborg, P. Molnár, J.E. de Vries [28] using HAR-RV and panel regressions, a correlation was found between volatility and the volume of cryptocurrency exchange trades. The authors did not find a correlation between the returns of cryptocurrencies and traditional financial assets, as well as some macroeconomic factors. In a study by D. Bianchi [29], using panel regressions, it was also shown that the volatility of cryptocurrencies correlates with the volume of trade, which, in turn, can be predicted by past returns. In another work by the same author [30], it was shown that the factor of the joint influence of lags in the trading volume and profitability (i.e. the multiplication of these indicators) positively and significantly correlates with the future profitability of cryptocurrencies.

DATA AND METHODOLOGY

Data

The Cryptocompare website database is used as the main data source for the series of cryptocurrency prices in US dollars. S. Alexander and M. Dakos [31] in their study showed that the prices of this service are most suitable for research or practical use. This paper examines the factors of bitcoin pricing, but for comparison, we also use the price series of other major cryptocurrencies —Ethereum (ETH), Binance Coin (BNB), Ripple (XRP), Cardano (ADA), Litecoin (LTC), Stellar (XLM). The sampling time interval is from 01.01.2013 to 31.01.2021. *Table 1* presents descriptive

statistics of the logarithmic returns of cryptocurrencies.

Bubbles have been repeatedly detected in the dynamics of the cryptocurrency rate.[1] We will exclude from consideration the periods of bubbles in the cryptocurrency market, since they correspond to special (explosive) data generation processes, the study of which is beyond the scope of this work.

Many researchers have identified two large bubbles — at the end of 2013 and at the end of 2017. The exact dates of their start and end differ from study to study and depend on the tests with which they were carried out, the chosen window width, the method for calculating the critical values of statistics, etc.

In this work, we are guided by the results of other studies, however, we choose the specific boundaries of the periods in a certain averaged way. In *Fig. 1*, two periods of the bubble are painted over, which we will exclude from consideration — from 01.01.2013 to 01.04.2014 and from 01.05.2017 to 01.05.2018 results.

Thus, the period between the two highlighted bubbles (from 01.04.2014 to 01.05.2017) will be designated as the "formation period" of the market, when cryptocurrencies were known only in a relatively narrow circle, and the period after the bubble at the end of 2017 came the "period of maturity" when cryptocurrencies became known to the general public. Naturally, the period of the COVID-19 pandemic also belongs to the period of maturity, the beginning of which in this work we relate to the beginning of the fall in stock markets against its background, that is, from 01.03.2020. We consider the maturity period both in full and separately before the pandemic — from 01.05.2018 to 01.03.2020 — and during the pandemic — from 01.03.2020 to 31.01.2020.

In addition to direct daily close prices, the study uses a number of possible internal factors presented in *Table 2*.

All factors are considered the first difference of logarithms $\ln(x_t) - \ln(x_{t-1})$. Those indicators that are expressed in cryptocurrencies— trans, vol_b, fee_m and fee_t — are converted into US dollars by multiplying by the average the maximum and minimum values of the bitcoin rate per day.

The literature notes that one of the important factors in the pricing of cryptocurrencies is the interest of the general public. In this work, as a proxy variable of such interest, we use the dynamics of searches in Google, provided through the Google Trends service,[2] for keywords such as *bitcoin, blockchain*. The specificity of the indicator of the dynamics of the popularity of a particular search query in Google is that the search engine provides not absolute, but relative values of popularity for a selected period, but a value at the point (day/week/month) when the analyzed search query was most popular. is taken as 100, and the rest of the points are normalized relative to this maximum. Moreover, the dimension (minutes, hours, day, week, month) of a number of search query dynamics depends on the selected period for building the dynamics. Thus, when choosing a 7-day period, the service provides a breakdown by hours, a quarter (90 days) — by days, year — by weeks and, finally, by several years — by months.

To obtain the daily dynamics of search queries for the period from 01.01.2013 to 31.01.2021, for each query for the entire period, monthly series were first unloaded. Further, for each month, starting from January 2013, we sequentially unloaded daily data, divided it by 100 and multiplied by the values of the popularity dynamics of this query, obtained earlier for each month. *Fig. 2* shows the resulting series, and *Table 3* presents descriptive statistics for internal factors.

In this paper, as traditional financial assets, we use the values of the S&P500, MSCI All Countries World Index (MSCI ACWI), MSCI Emerging Markets Index (MSCI EM), MSCI

[1] For example, Li Z.-Z., Tao R., Su C.-W., Lobonţ O.-R. Does Bitcoin bubble burst? Quality & Quantity. 2019;53(1):91–105.

[2] URL: https://trends.google.com/ (accessed on 10.02.2021).

Table 1

Descriptive statistics of cryptocurrency returns

Cryptocurrency	First observation	Number of observations	Mean	Standard deviation	Minimum	Maximum	Skewness	Kurtosis
BTC	01.01.2013	2954	0.0027	0.0590	−0.8488	1.4744	4.55	164.65
LTC	24.10.2013	2658	0.0013	0.0842	−0.9742	0.8941	0.39	43.47
XRP	21.01.2015	2204	0.0015	0.0865	−0.7791	1.0280	1.24	30.56
ETH	07.08.2015	2006	0.0031	0.0688	−1.2336	0.4362	−2.87	56.56
XLM	12.02.2016	1817	0.0027	0.0895	−0.9097	1.0526	1.48	24.72
BNB	24.08.2017	1258	0.0024	0.0668	−0.5664	0.4951	−0.08	11.46
ADA	01.10.2017	1220	0.0023	0.0762	−0.5389	0.8621	1.93	22.94

Source: authors' calculations based on the data from Cryptocompare.

Fig. 1. **Dynamics of logarithmic Bitcoin prices**

Source: authors' calculations based on the data from Cryptocompare.com.

Table 2

Internal factors of Bitcoin

Variable	Name in the source	Description	Source
vol_t	volumeto	The sum of all transactions for the cryptocurrency under consideration on all cryptocurrency exchanges in one day (US dollars)	Cryptocompare.com
new	new_addresses	The number of addresses (wallets) created on this day in the cryptocurrency blockchain	Cryptocompare.com
act	active_addresses	The number of addresses that made at least one transaction during the day	Cryptocompare.com
trans	average_transaction_value	Average size of transactions during the day expressed in native cryptocurrency (the main currency of the distributed ledger)	Cryptocompare.com
hash	hashrate	Average daily difficulty (hash) for the formation of a new block in the blockchain (terahashes per second, TH/s)	Cryptocompare.com
vol_b	TxTfrValAdjNtv	The number of cryptocurrency units moved between addresses per day	Coinmetrics.io
fee_m	FeeMeanNtv	Average daily transaction fees on the blockchain expressed in cryptocurrency units	Coinmetrics.io
fee_t	FeeTotNtv	The total amount of transaction fees per day expressed in cryptocurrency units	Coinmetrics.io

Source: Cryptocompare.com, Coinmetrics.io (accessed on 10.02.2021).

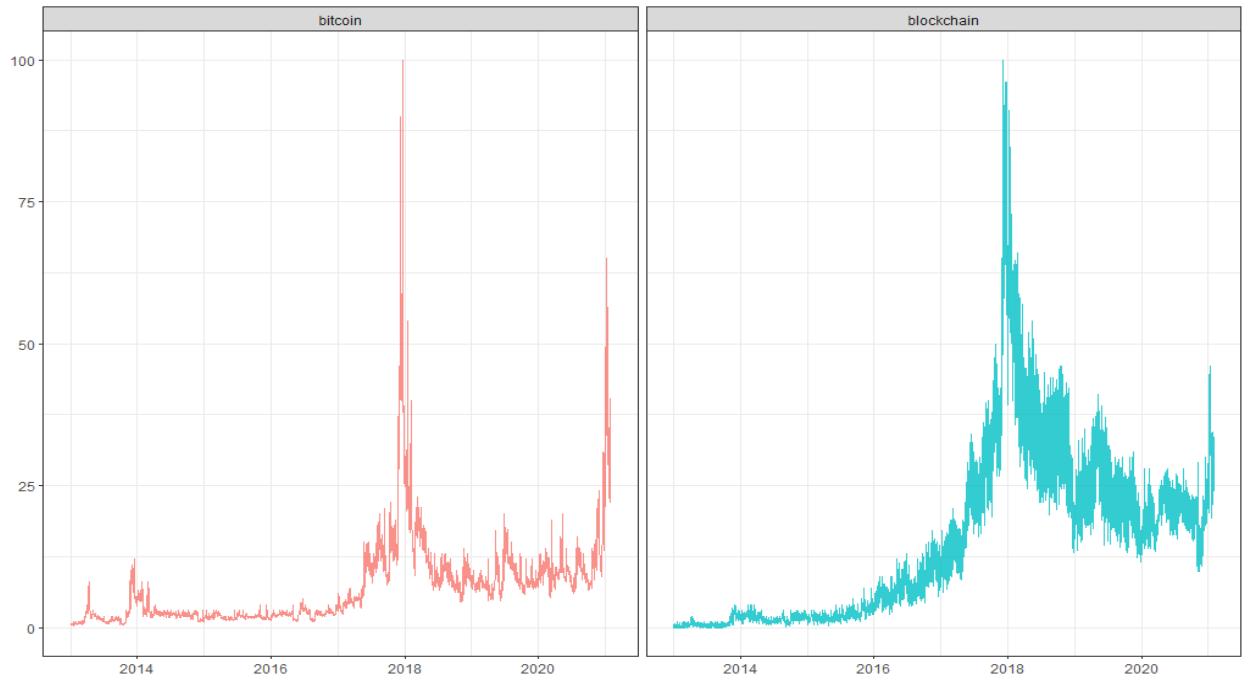

Fig. 2. **Leading search queries dynamics**

Source: authors' calculations based on the data from Google Trends. URL: https://trends.google.com/ (accessed on 10.02.2021).

Table 3

Descriptive statistics of internal factors (logarithmic differences)

Factor	Mean	Standard deviation	Minimum	Maximum	Skewness	Kurtosis
vol_t	0.0028	0.5079	–2.3428	2.7154	0.27	1.09
vol_b	0.0026	0.2981	–1.3445	1.9035	0.31	1.63
new	0.0011	0.1356	–0.7108	0.8883	0.32	1.66
act	0.0011	0.1260	–0.4604	0.6470	0.47	1.14
trans	0.0020	0.3153	–2.8745	2.4190	0.19	7.58
hash	0.0052	0.1159	–0.4828	0.6042	0.14	0.75
fee_m	0.0025	0.2301	–2.1384	1.9287	0.35	17.03
fee_t	0.0032	0.2692	–2.2495	2.0513	0.24	9.93
“bitcoin”	0.0166	0.1891	–0.7308	2.5714	2.52	18.53
“blockchain”	0.1819	1.1610	–1.0000	9.7143	6.83	52.29

Source: authors’ calculations based on the data from Cryptocompare.com, Coinmetrics.io, trends.google.com (accessed on 10.02.2021).
Note: Number of observations — 2954 from 01.01.2013 to 31.01.2021.

Emerging Markets Asia (MSCI EM-Asia), FTSE World Government Bond Index (the dynamics are taken through the dynamics of the price of shares of the exchange-traded fund IGOV), CBOE Volatility Index (VIX), as well as the US dollar index (DXY), prices for gold and Brent oil. All data is sourced from Yahoo. Finance,[3] except for MSCI indices, taken from Investing.com.[4] *Table 4* presents descriptive statistics of logarithmic returns of traditional financial assets.

METHODOLOGY

To analyze the relationship of certain variables with cryptocurrency returns, we use the conditional generalized heteroskedasticity GARCH (1,1) model. In general terms, the models look like this:

$$r_t = \mu + x_t'\theta + \varepsilon_t, \qquad (1)$$

$$\varepsilon_t = \sqrt{h_t}\,\eta_t, \quad \eta_t \sim i.i.d.GED(0,1,\kappa), \qquad (2)$$

$$h_t = \omega + \alpha_1\varepsilon_{t-1}^2 + \beta_1 h_{t-1} + x_t'c, \qquad (3)$$

where r_t — logarithmic profitability of cryptocurrencies ($\ln\frac{p_t}{p_{t-1}}$); x_t' — a vector of independent variables.

The choice of models of this class is due to the presence of heteroskedasticity in the series of returns on financial assets and cryptocurrencies [32], which must be considered to obtain correct confidence intervals and inference (statistical conclusions). The use of inappropriate conditional distribution of errors, which are assumed to be normally distributed in the standard GARCH model, can also lead to incorrect estimates of the confidence intervals. In the academic literature devoted to the analysis of the dynamics of returns, the problem of the discrepancy between the distribution of returns

[3] URL: https://finance.yahoo.com/ (accessed on 10.02.2021).
[4] URL: https://www.investing.com/ (accessed on 10.02.2021).

Table 4

Descriptive statistics of traditional financial assets

Asset	Mean	Standard deviation	Minimum	Maximum	Skewness	Kurtosis
brent	−0.00024	0.02055	−0.27976	0.27419	−0.66	39.22
dxy	0.00004	0.00346	−0.02399	0.02032	0.00	4.13
eurusd	−0.00003	0.00423	−0.02814	0.03126	0.02	6.02
gold	0.00003	0.00825	−0.09821	0.05778	−0.67	13.98
igov	0.00003	0.00386	−0.02325	0.02316	−0.15	4.33
msci_acwi	0.00022	0.00735	−0.09997	0.08059	−1.82	35.63
msci_em	−0.00013	0.01102	−0.10619	0.06015	−0.84	8.81
msci_em_asia	0.00017	0.00813	−0.05846	0.05625	−0.57	7.12
sp500	0.00032	0.00897	−0.12765	0.08968	−1.24	33.95
vix	0.00028	0.06715	−0.29983	0.76825	1.60	12.21

Source: authors' calculations based on the data from Yahoo.finance, Investing.com (accessed on 10.02.2021).

Note: Number of observations — 2954 from 01.01.2013 to 31.01.2021. Returns during weekends and holidays are stated as 0.

on assets and the normal distribution has been raised for a long time (see, for example, [33, 34]). In particular, it has been shown that the distribution of returns on financial assets has heavy tails and a higher kurtosis coefficient than the normal distribution [32]. In the tables with descriptive statistics above, you can see that redundant, i.e. more than 3, kurtosis (leptokurtosis) is present in the distributions of returns of all cryptocurrencies and financial assets. The order of the GARCH (p, q) c $p = q = 1$ was chosen on the ARCH LM test [35].

In the context of conditional heteroskedasticity models, this means that the distribution of innovations η_t will often also be far from normal. In this regard, there is a practice of using other distributions, for example, Student's t-distribution, generalized normal distribution, Pareto stable distribution, and others, as well as their "skewed" variants (see, for example, works [25, 36–38]).

In this paper, we use the Generalized Error Distribution (GED), which has an additional shape parameter κ. For $\kappa = 1$ GED corresponds to the Laplace distribution (double exponential), for $\kappa = 2$ GED — normal, and for $\kappa \to \infty$ — pointwise converges to a uniform distribution.

The models are estimated using the maximum likelihood method in the rugarch package written in R [39].[5] A number of tests are used to diagnose the quality of the evaluated models. The modernized Ljung-Box test [35] makes it possible to assess the adequacy of the mean equation (4). The null hypothesis of this test is that there is no autocorrelation in the residuals of the model. Pearson's test in the version of Vlaar and Palm [40] as a null hypothesis has the correspondence of the distribution of model errors to the selected conditional distribution

[5] R version 4.0.3, rugarch version — 1.4–4. The arguments to the ugarchfit function are used by default, except for solver = "hybrid".

Table 5

Correlation matrix of factors

BTC	r_t	vol_t	vol_b	new	act	trans	hash	fee_m	fee_t	"bitcoin"	"blockchain"
r_t		−0.05	0.10	0.03	0.01	0.09	−0.01	0.18	0.17	−0.03	0.02
vol_t	−0.05		0.49	0.34	0.29	0.24	0.01	0.17	0.29	0.41	0.07
vol_b	0.10	0.49		0.56	0.44	0.45	−0.04	0.30	0.50	0.32	0.10
new	0.03	0.34	0.56		0.77	0.17	0.18	0.13	0.48	0.27	0.09
act	0.01	0.29	0.44	0.77		0.14	0.23	0.20	0.45	0.24	0.08
trans	0.09	0.24	0.45	0.17	0.14		−0.13	0.17	0.19	0.16	0.03
hashrate	−0.01	0.01	−0.04	0.18	0.23	−0.13		−0.11	0.04	−0.01	0.02
fee_m	0.18	0.17	0.30	0.13	0.20	0.17	−0.11		0.89	0.18	0.07
fee_t	0.17	0.29	0.50	0.48	0.45	0.19	0.04	0.89		0.27	0.11
"bitcoin"	−0.03	0.41	0.32	0.27	0.24	0.16	−0.01	0.18	0.27		0.07
"blockchain"	0.02	0.07	0.10	0.09	0.08	0.03	0.02	0.07	0.11	0.07	

Source: authors' calculations based on the data from Cryptocompare.com, Coinmetrics.io, trends.google.com (accessed on 10.02.2021).

(GED). Akaike Information Criterion (AIC) and Schwarz Criterion (BIC) are used to compare models with each other.

INTERNAL FACTORS OF BITCOIN PROFITABILITY

Let us now analyze the relationship between internal factors and bitcoin yields. *Table 5* shows the correlation matrix of the difference between the logarithms of the factors under consideration (bitcoin returns are denoted as r_t).

A significant positive correlation is observed between such similar indicators as an increase in the number of active (act) and new users (new), as well as the total and average size of commissions (fee_m, fee_t). To identify higher quality variables from each pair, GARCH models of bitcoin returns were analyzed separately using each indicator separately. Akaike and Schwartz's tests showed that models with the addition of fee_t and new to the mean equation improve model quality better than fee_m and act. Thus, further in this article, we will use in our models the indicator of the total amount of commission in the blockchain per day (fee_t) and the number of new users in the network (new).[6]

We alternately use all internal factors as independent variables in the mean equation.[7] We also add an indicator of trade volumes to the variance equation. The relationship between returns on financial assets, their volatility and volume are actively studied in the scientific literature (for example, [41]). Some cryptocurrency researchers have also found the impact of trading volume on cryptocurrency volatility.[8] Adding this indicator significantly improves the quality of the model.

Table 6 shows the results of evaluating the models of the influence of internal factors on the daily profitability of the bitcoin cryptocurrency in the period from April 01, 2014, to May 01, 2017. The table shows the coefficients of interest for the GARCH (1,1) — GED model, into which each factor was substituted alternately. In all the evaluated models, the shape coefficient (ν) is in the range from 0.98 to 1.11, which is evidence in favor of the heavy-tailed distribution in the residues. Pearson's test does not reject the null

[6] These and other intermediate calculations are available upon request from the authors.

[7] Adding multiple factors at once to the mean equation does not result in significant improvements in terms of model quality over single-factor models. These results are also available upon request.

[8] See, for example, [28, 30].

Table 6

The estimation results of GARCH(1,1)-GED models in the period from 01.04.2014 to 01.05.2017

Factor	Coefficients			LogL	AIC	BIC
	θ	*c*	κ			
vol_t	0.00591***	0.00064***	1.04088***	2692.86	−4.7664	−4.7352
fee_t	0.00926***	0.00047***	1.04674***	2690.48	−4.7622	−4.7309
trans	0.00142***	0.0005***	1.06456***	2690.28	−4.7618	−4.7306
vol_b	0.00324***	0.0006***	1.02174***	2689.77	−4.7609	−4.7297
new	*0.00744*	*0.0004***	*0.99467*	*2678.68*	*−4.7412*	*−4.71*
without factors		0.0004***	1.04896***	2675.33	−4.7371	−4.7103
"bitcoin"	−0.00156	0.00038***	1.01169***	2670.95	−4.7275	−4.6963
hashrate	0.0025*	0.00035***	0.99839***	2662.89	−4.7132	−4.682
"blockchain"	−0.00005	0.00026***	0.98802***	2652.16	−4.6942	−4.6629

Source: authors' calculations based on the data from Cryptocompare.com, Coinmetrics.io, trends.google.com (accessed on 10.02.2021).
Note: Dependent variable — bitcoin logarithmic returns, θ — coefficient of factor in the mean equation, *c* — coefficient of trading exchange volume logarithmic difference in the volatility equation, κ — estimated shape parameter of GED distribution. Statistical significance is distinguished with asterisks, where *** — 1% level. μ, ω, α_1 and β_1 coefficient estimates are omitted for the reason of space economy. Models are presented in a descending order of LogL. The models with AIC and BIC lower than the model without factors are italicized. Number of observations — 1127.

hypothesis that the theoretical distribution matches the empirical distribution for the residuals of all models, therefore, the GED distribution is suitable. Also, the ARCH-LM and Ljung-Box tests do not reject their null hypotheses, which speaks in favor of the correct choice of the GARCH order and the absence of autocorrelation in the residuals, respectively.

In the period before the start of the 2017 bubble, the significant factors that had a co-directional movement with the returns of the bitcoin cryptocurrency were the trading volume (vol_t), the total amount of commissions for the movement of the cryptocurrency in the blockchain (fee_t), the average transaction volume in the blockchain (trans) and directly daily the volume of transactions on the blockchain (vol_b). Models that include these variables are also more preferable in terms of the Akaike and Schwarz criteria than the model without any factors included in the mean equation. The largest coefficient is observed with a fee_t of 0.00926. The direct calculation,[9] in this case, gives us the following interpretation: an increase in total daily commissions by 1 standard deviation relative to the average is associated with an increase in the price of bitcoin by almost 0.94%. It is noteworthy that the coefficients for search queries for the keywords "bitcoin" and "blockchain" turned out to be insignificant, as well as the complexity of mining (hash rate).

The relationship between the trading volume can be traced both with the returns of bitcoin — an increase in volumes by 1 standard deviation is associated with an increase in cryptocurrency by 0.01%,— and with volatility — the coefficient ς_1 at vol_t in the dispersion equation turned out to be significant in all models with an average value around 0.0005.

In the period after the collapse of the bubble in the cryptocurrency market and before the

[9] Hereinafter, it is calculated analytically depending on how many percent is one standard deviation of the value compared to the mean.

Table 7

The estimation results of GARCH(1,1)-GED models in the period from 01.05.2018 to 01.03.2020

Factor	Coefficients			LogL	AIC	BIC
	θ	*c*	κ			
blockchain	0.00141***	0.00107***	1.5123***	1505.5	−4.467	−4.42
vol_b	−0.00684***	0.00101***	1.42861***	1497.5	−4.443	−4.396
fee_t	0.0011**	0.00095***	1.45237***	1491.1	−4.424	−4.377
trans	−0.00514***	0.00082***	1.38016***	1486.3	−4.409	−4.362
vol_t	*−0.00213****	*0.00096****	*1.31626****	*1484.2*	*−4.403*	*−4.356*
bitcoin	*−0.00009*	*0.00095****	*1.30604****	*1483*	*−4.399*	*−4.352*
without factors		0.00073***	1.31361***	1482.2	−4.4	−4.36
new	−0.01826***	0.0008***	1.07529***	1479.4	−4.389	−4.342
hashrate	−0.01403**	0.00045***	1.2087**	1466.7	−4.351	−4.304

Source: authors' calculations based on the data from Cryptocompare.com, Coinmetrics.io, trends.google.com (accessed on 10.02.2021).
Note: Number of observations — 671. Detailed note can be found in *Table 6*.

start of the recession in the financial markets against the backdrop of the COVID-19 pandemic (from May 01, 2018, to March 01, 2020), the simulation results are slightly different (*Table 7*).

Not all of the models built for this period are sufficiently adequate in terms of quality criteria. So, for models with the volume of transactions on the blockchain (vol_b) and search queries "blockchain", the null hypothesis of the Ljung-Box test is rejected at 10 and 5% levels, respectively, which indicates the presence of autocorrelation in the mean equation. The null hypothesis of the ARCH-LM test is rejected for higher-order lags (more than 5) for models with an average transaction volume on the blockchain (trans) and again for "blockchain" queries, which may indicate the need to select more complex variants of GARCH models to describe the dynamics of the considered variables. The null hypothesis of the Pearson's test is rejected for the model with network complexity (hashrate).

The first thing that can be paid attention to in comparison with the previous models is the increase in the coefficient with the GED distribution shape index to 1.3–1.5, which indicates a slight decrease in the severity of the distribution tails. In other words, relatively large negative or positive changes in the price of Bitcoin were observed less frequently during this period.

The second is a change in the signs of almost all significant coefficients in the model (except for fee_t and blockchain) under the analyzed factors. Now all the factors that had a positive association with Bitcoin returns have changed a sign or become insignificant. The change in signs may indicate the fact that after the bubble collapsed in 2017, investors became much more cautious and closed their positions at the first signs of a correction. This is evidenced by negative coefficients in terms of trading volume and volume in the blockchain — a fall in the price of bitcoin is accompanied by larger volumes than an increase.

Among the models with higher AIC and BIC model fitting criteria than the model without factors, the highest ratio in absolute terms is observed with the volume on the Bitcoin blockchain (vol_b) — an increase in this indicator by 1 standard deviation relative to the average is associated with a fall in the price of Bitcoin by 0.27%.

Let us now extend the considered period

Table 8

The estimation results of GARCH(1,1)-GED models in the period from 01.05.2018 to 31.01.2021

Factor	Coefficients			LogL	AIC	BIC
	θ	*c*	κ			
trans	0.00016***	0.00087***	1.23774***	2189.9	−4.336	−4.301
without factors		0.00083***	1.25033***	2181	−4.315	−4.286
vol_t	0.0021***	0.00084***	1.21561***	2178.9	−4.314	−4.28
blockchain	−0.00138	0.00097***	1.19162***	2148.8	−4.2538	−4.2197
fee_t	0.0013	0.00105**	1.23667***	2174.4	−4.305	−4.271
vol_b	−0.00206***	0.00085***	1.35423***	2171.6	−4.299	−4.265
new	−0.01653***	0.00081***	1.12956***	2163.6	−4.283	−4.249
bitcoin	0.02863**	0.00078***	1.21506***	2157	−4.27	−4.236
hashrate	−0.01883***	0.0005***	1.0885***	2148.8	−4.254	−4.22

Source: authors' calculations based on the data from Cryptocompare.com, Coinmetrics.io, trends.google.com (accessed on 10.02.2021).
Note: Number of observations — 1007. Detailed note can be found in *Table 6*.

after the bubble to January 31, 2021 (*Table 8*), i.e. we will include the period of the COVID-19 pandemic and the beginning of a new rally in the cryptocurrency market.

Including a period of high volatility and extreme values as returns at the bitcoin price level degraded the quality of the models. Thus, the null hypothesis of the Ljung-Box test can be rejected at the 10% significance level for all models (except for the hashrate model) and most lags. Pearson's null hypothesis can also be rejected for almost all models, with the exception of models with the number of new users (new) and search terms "bitcoin".[10] The null hypothesis ARCH-LM is not rejected for all models; therefore, the conditional heteroskedasticity model from order (1.1) considers all heteroskedasticity in residuals.

From the point of view of the AIC and BIC criteria, only the model that considers the average transaction volume in the blockchain (trans) is slightly better than the model without factors. It is noteworthy that when adding a period from 01.03.2020, the coefficient for trans changed its sign from negative to positive. This may be due to the fact that during the new cycle of bitcoin price growth, investors who made investments at its peak in 2017 began to withdraw their funds. In 2017, it was difficult to enter fiat funds on cryptocurrency exchanges, so the purchase was mainly carried out through p2p (peer-to-peer) platforms, where purchase and sale transactions were concluded directly. Now these funds are in motion.

Also, we note that the popularity rate of the search query "bitcoin" became significant and reached the highest value among all previously evaluated models — 0.02863. That is, with an increase in the popularity of search queries by 1%, the price of bitcoin cryptocurrency grows by almost 0.03%, and with an increase in search queries by 1 standard deviation relative to the average, the price rises by 1.27%. It seems that this result is largely a direct consequence of the rise in bitcoin price: the higher the price became against the background of the recovery growth after the fall of the markets due to the pandemic, the more the media talked about it, which led to an increase in interest, which we

[10] Using the normal, normal skew, Student's t-distribution and skewed Student's distribution, and skewed GED distribution, similar results are observed.

see in popular Google Trends queries. The rise in interest leads to an inflow of investment in bitcoin, which reaches the next all-time high in prices, which leads to an increase in media mentions, etc. However, in terms of the AIC and BIC quality criteria, this model is worse than the model without factors.

Separately, we note that we were unable to find a stable short-term relationship between profitability and the dynamics of Google Trends search popularity using the chosen methodology. This result is somewhat different from the works in which a similar relationship was revealed (for example, [22, 23]), however, results similar to ours were obtained in the work of H.A. Aalborg, P. Molnár, J.E. de Vries [28]. The significance of the popularity ratio for the request "bitcoin" at a time when the largest cryptocurrency is experiencing a period of rapid growth again, may indicate a bubble in the cryptocurrency market. This is also evidenced by the fact that in recent years there have been no significant improvements or changes either in the technical part or in the regulatory part, therefore there are no fundamental reasons for such rapid growth.

The indicator characterizing the number of new wallets opened on the bitcoin blockchain (new) is also a kind of indicator of popularity, albeit somewhat noisy due to the fact that any user can open any number of wallets. In the period until 2017, the coefficient for this factor turned out to be insignificant, however, in subsequent periods, the increase in the number of wallets was associated with the fall in the price of bitcoin.

The results for such an indicator as to the difficulty of mining (hashrate) also coincide with the results of D. Fantazzini and N. Kolodin [42], who did not find a connection between the hashrate and the price of bitcoin in the period from 2016 to December 2017 and in the period from December 2017 year to February 2020 found a significant relationship, with the authors demonstrating bitcoin profitability as the hashrate Granger causes. S. Shanaev et al. [43] also found no significant relationship between bitcoin and hash rate in the sample from January 2014 to May 2019. Thus, our results, as well as the works listed above, cast doubt on the theory according to which the profitability of bitcoins is determined mainly at the cost of mining.

RELATIONSHIP WITH TRADITIONAL FINANCIAL ASSETS

We consider the relationship between the return on traditional financial assets and the return on bitcoin. It seems most obvious to demonstrate changes in this relationship using correlation matrices built for different periods.

In the period until May 2017 (*Fig. 3*), the profitability of those cryptocurrencies that already existed at that time (Bitcoin, Ethereum, Ripple, Litecoin, Stellar) had a relatively small correlation even among themselves and did not have a significant correlation with other market assets.

After the bubble burst in the cryptocurrency market (*Fig. 4*), we can observe how the returns of the largest cryptocurrencies, to which, compared to the previous period, Binance Coin (BNB) and Cardano (ADA) were added that appeared by that time, became extremely highly correlated. We can say that in the period from May 2018 to February 2020, cryptocurrencies formed as a separate class of financial assets. The dynamics of cryptocurrencies at this stage did not significantly correlate with any market assets, which made them an attractive tool for diversifying the investment portfolio.

The COVID-19 pandemic caused a significant downturn in financial markets, which also affected the cryptocurrency market. The correlation matrix, based on data covering all of 2020 and early 2021 (*Fig. 5*), shows an increase in the correlation between the returns of all major cryptocurrencies and market assets, in particular, the S&P 500 and MSCI World indices. Thus, cryptocurrencies failed to act as a short-term hedging instrument during the general recession.

Now we analyze the combined dynamics of bitcoin returns and various market factors

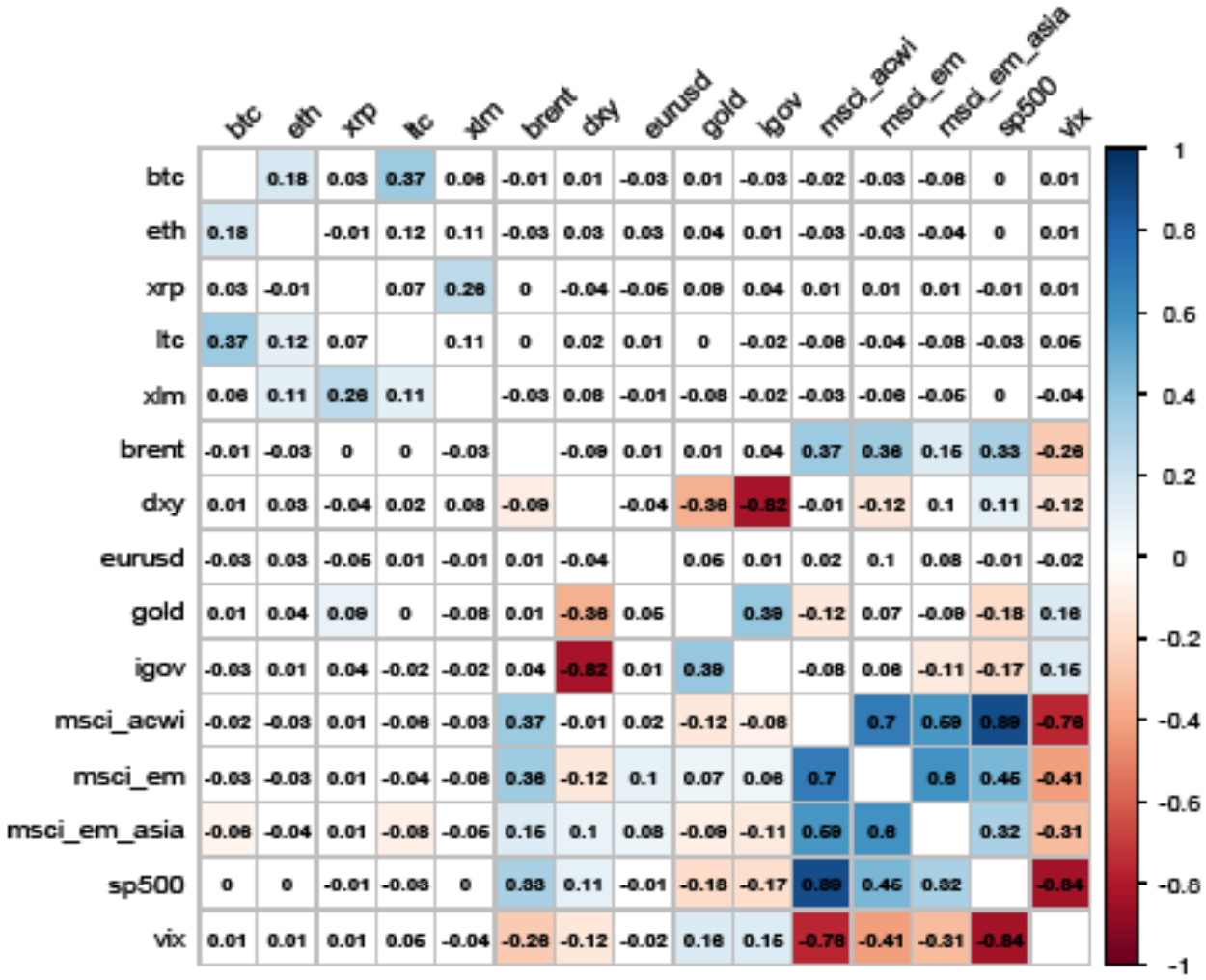

Fig. 3. **Correlation matrix of returns from 01.04.2014 to 01.05.2017**

Source: authors' calculations based on the data from Cryptocompare.com, Yahoo.finance, Investing.com (accessed on 10.02.2021).

using GARCH(1,1)-GED models. As in the previous section, we alternately replace in the equation of the average return of market assets, and in the equation of variance — the difference in the logarithms of the exchange trading volume of bitcoin on cryptocurrency exchanges, which significantly improves the model in terms of quality criteria.

Table 9 presents the results of assessing the models of the influence of market factors on the daily profitability of the bitcoin cryptocurrency in the period from April 1, 2014, to May 1, 2017.

For all evaluated models, the null hypotheses of the Ljung-Box, ARCH-LM, and Pearson's tests are rejected, indicating that there is no unaccounted-for autocorrelation in the mean equation, an appropriate order of GARCH model, and a consistency of the conditional distribution to the actual.

The inclusion of one of three market factors — the S&P 500 index yields, the euro/dollar exchange rate and Brent oil — improves the quality of the model in terms of the Akaike and Schwartz criteria compared to the model without factors. The coefficients for all three factors are significant and positive, but they are not very large — a 1% increase in the S&P 500 or Brent is associated with an increase in bitcoin by only 0.043–0.044%. However, the S&P 500 index yield model is the best in terms of the AIC and BIC criteria, even compared to the models with intrinsic factors discussed in the previous section.

It is worth noting the significant and

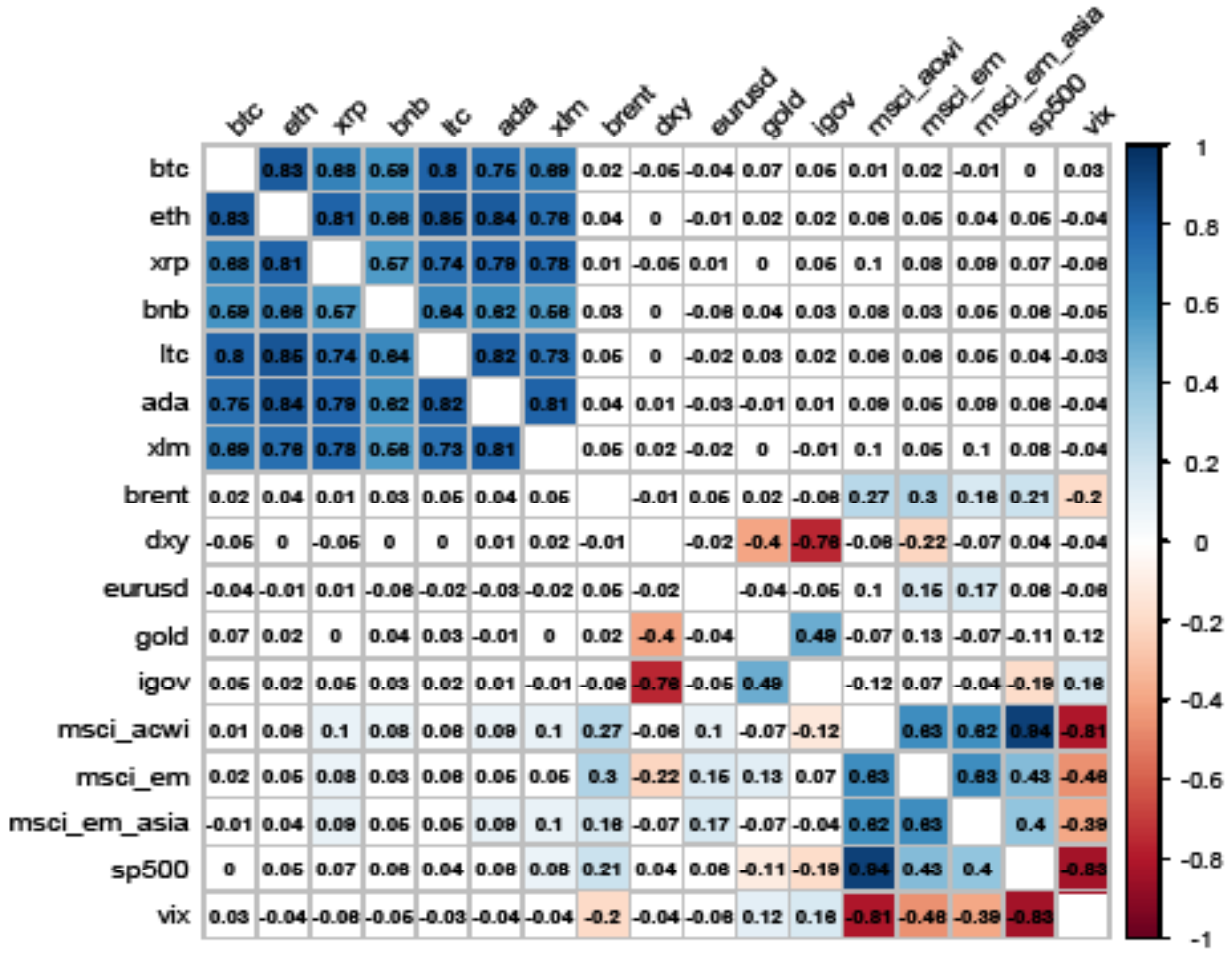

Fig. 4. **Correlation matrix of returns from 01.05.2018 to 01.03.2020**

Source: authors' calculations based on the data from Cryptocompare.com, Yahoo.finance, Investing.com (accessed on 10.02.2021).

negative sign of the index of the stock market of developing countries in Asia (MSCI EM ASIA) — a decrease in this index by 1% was associated with a rise in bitcoin by 0.38%. We note the positive ratios for gold and the volatility index. To some extent, these results can be interpreted as the presence of "protective properties" in bitcoin, which are most pronounced in relation to the market of developing countries in Asia.

In the period from May 2018 to March 2020, a different situation is observed (*Table 10*). The null hypothesis of the Ljung-Box tests rejects at the 10% significance level for the gold and developing country index (MSCI EM) models. For the S&P 500 model, the null hypothesis of this test is rejected even at the 5% level, and the null hypothesis of the ARCH-LM test is also rejected. For the model with gold, the null hypothesis of the Pearson test is also rejected.

Compared to the previous period, the yields of the S&P 500, Brent oil and the volatility index (VIX) became insignificant, while the emerging market index (MSCI EM ASIA) changed sign. Also noteworthy is the high positive and significant ratio of the non-US investment grade government bond index (IGOV), which was negligible in the previous period. The positive index for the emerging market index (MSCI EM) and the negative coefficient for the US dollar index (DXY) also became significant.

Model results for this period appear mixed, reflecting general investor uncertainty about the outlook for the largest cryptocurrency after the 2017–2018 bubble crash. Nevertheless, with a certain degree of confidence, we can say about the lack of co-directionality of bitcoin's

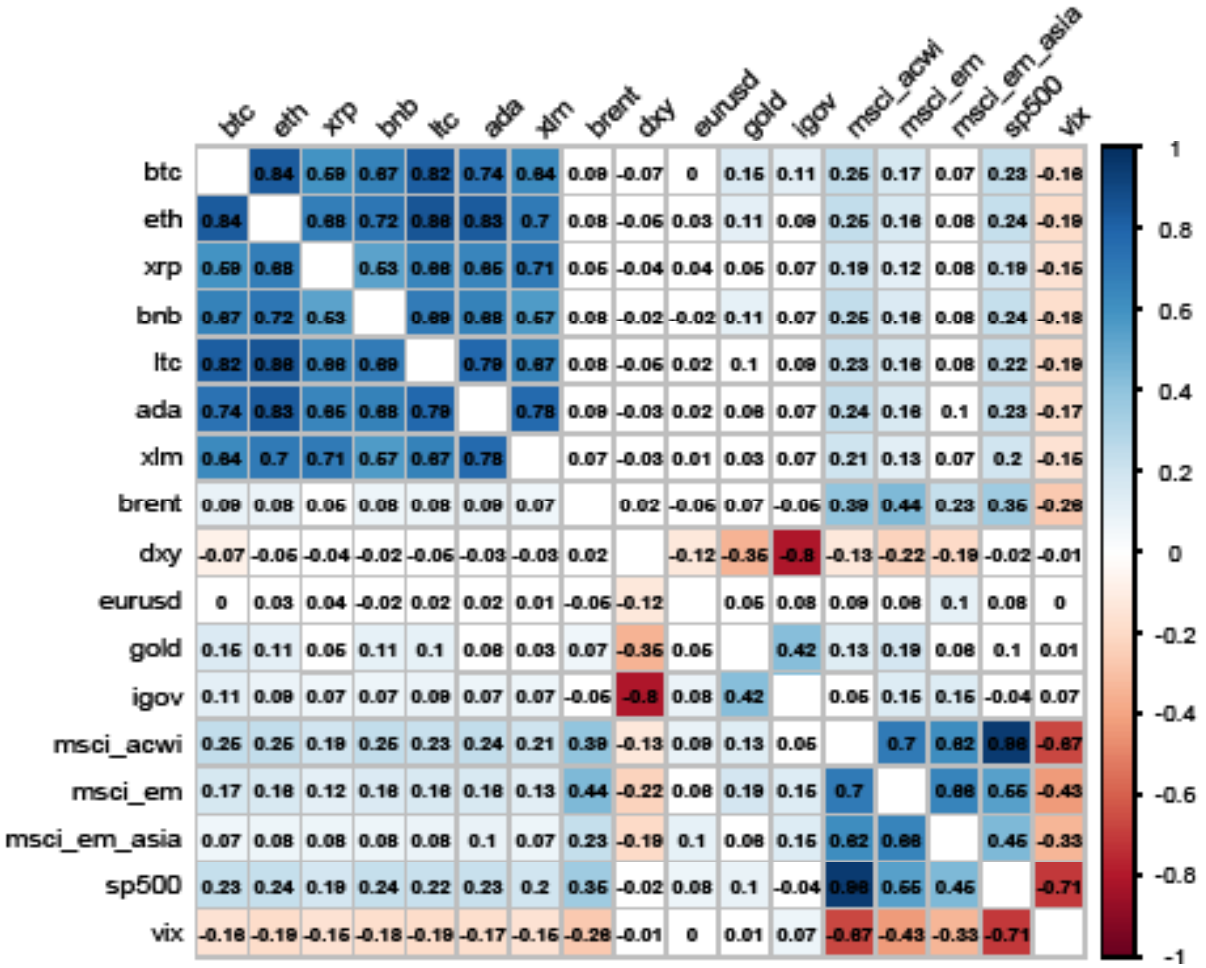

Fig. 5. **Correlation matrix of returns from 01.05.2018 to 31.01.2021**

Source: authors' calculations based on the data from Cryptocompare.com, Yahoo.finance, Investing.com (accessed on 10.02.2021).

movement with the US stock market (S&P 500) and with the VIX volatility index, which is the exact opposite of the S&P 500 in terms of the dynamics of profitability (as can be seen from the correlation matrices above). Now let's look at the results, including the period of the COVID-19 pandemic in the model (*Table 11*).

The extreme volatility of financial asset returns affected the quality of the models. Despite the rejection of the null hypothesis of the ARCH-LM test for all models, the null hypothesis of the Lyng-Box test is rejected at normal significance levels almost everywhere (the only exception is the model with the euro-dollar pair). Pearson's null hypothesis is not rejected for the US dollar index (DXY), bond index (IGOV), emerging market indices (MSCI EM), and global stock market (MSCI ACWI) models. The model with the last index is also the best among the others in *Table 11*.

When we include the COVID-19 pandemic period, we can observe how bitcoin returns show a positive and significant relationship with global stock markets (MSCI ACWI, MSCI EM, and S&P 500) and a significant negative relationship with those assets that showed the opposite dynamics — US dollar indices (DXY) and volatility (VIX). In other words, it can be argued that Bitcoin dynamics in the period after March 2020 was characterized by a unidirectional movement with the general market situation.

CONCLUSIONS

In this article, we attempted to identify various factors, the dynamics of which are associated with the profitability of the first and largest cryptocurrency in terms of capitalization —

Table 9

The estimation results of GARCH(1,1)-GED models in the period from 01.04.2014 to 01.05.2017

Market factor	Coefficients			LogL	AIC	BIC
	θ	*c*	κ			
sp500	0.04257***	0.00058***	1.13723***	2695.35	−4.7708	−4.7396
eurusd	0.17948***	0.00048***	1.04244***	2680.23	−4.744	−4.7127
brent	0.04397***	0.00043***	1.02758***	2678.92	−4.7417	−4.7104
without factors		0.0004***	1.04896***	2675.33	−4.7371	−4.7103
igov	0.00521	0.00039***	1.07534***	2672.64	−4.7305	−4.6993
msci_em_asia	−0.38475***	0.00061***	1.03255***	2670.82	−4.7273	−4.696
vix	0.00633***	0.0004***	1.01608***	2669.29	−4.7246	−4.6933
dxy	−0.01932	0.00038***	1.00402***	2666.98	−4.7205	−4.6892
gold	0.11313***	0.0004***	1.00725***	2665.44	−4.7177	−4.6865
msci_em	0.01697	0.00024***	0.92895***	2641.34	−4.675	−4.6437
msci_acwi	−0.1337***	0	0.8013***	2588.3	−4.5808	−4.5496

Source: authors' calculations based on the data from Cryptocompare.com, Yahoo.Finance, Investing.com (accessed on 10.02.2021).
Note: Number of observations — 1127. Detailed note can be found in *Table 6*.

Table 10

The estimation results of GARCH(1,1)-GED models in the period from 01.05.2018 to 01.03.2020

Market factor	Coefficients			LogL	AIC	BIC
	θ	*c*	κ			
gold	0.33708***	0.00079***	1.33132***	1489.76	−4.4196	−4.3725
sp500	0.02126	0.00074***	1.38253***	1488.3	−4.4152	−4.3682
brent	−0.00753	0.00101***	1.41934***	1487.59	−4.4131	−4.366
msci_em	*0.29278****	*0.00079****	*1.32554****	*1484.7*	*−4.4045*	*−4.3574*
vix	*−0.01825*	*0.00095*	*1.34834*	*1484.64*	*−4.4043*	*−4.3572*
igov	*0.78065****	*0.00071****	*1.29811****	*1483.67*	*−4.4014*	*−4.3544*
without factors		0.00073***	1.31361***	1482.24	−4.4001	−4.3598
dxy	−0.5581***	0.0007***	1.24822***	1481.67	−4.3955	−4.3484
msci_em_asia	0.20601***	0.00067***	1.28699***	1479.67	−4.3895	−4.3424
eurusd	0.4884***	0	0.85611***	1395.87	−4.1397	−4.0927
msci_acwi	0.34154***	0	0.82817***	1395.01	−4.1372	−4.0901

Source: authors' calculations based on the data from Cryptocompare.com, Yahoo.Finance, Investing.com (accessed on 10.02.2021).
Note: Number of observations — 671. Detailed note can be found in *Table 6*.

Table 11

The estimation results of GARCH(1,1)-GED models in the period from 01.05.2018 to 31.01.2021

Market factor	Coefficients			LogL	AIC	BIC
	θ	*c*	κ			
msci_acwi	0.48536***	0.00077	1.31236	2186.2	−4.328	−4.294
gold	0.40108***	0.00081***	1.16489***	2185.6	−4.327	−4.293
vix	−0.04124***	0.00081***	1.2485***	2183.6	−4.323	−4.289
msci_em	0.32014***	0.00087***	1.18084***	2183.4	−4.323	−4.288
msci_em_asia	*−0.03771*	*0.00086*	*1.18964*	*2181.7*	*−4.319*	*−4.285*
without factors		0.00083***	1.25033***	2181	−4.315	−4.286
sp500	0.31468***	0.00087***	1.21611***	2178.7	−4.313	−4.279
igov	1.04893***	0.00069***	1.23309***	2178.6	−4.313	−4.279
brent	0.03565	0.0007	1.21103***	2173.2	−4.302	−4.268
dxy	−0.76362***	0.00082***	1.14819***	2164.4	−4.285	−4.251
eurusd	−0.01119***	0	0.84322***	2061.1	−4.08	−4.046

Source: authors' calculations based on the data from Cryptocompare.com, Yahoo.Finance, Investing.com (accessed on 10.02.2021).

Note: Number of observations — 1007. Detailed note can be found in *Table 6*.

bitcoin. Unlike other studies that conduct econometric and statistical analysis for the entire available period, we excluded from consideration the periods of two known bubbles in the dynamics of the price of bitcoin — at the end of 2013 and in 2017–2018, and also analyzed the period separately without considering the COVID-19 pandemic and with it. Considering the presence of heavy tails and unstable variance in the yield distribution of the bitcoin, we used conditional heteroskedasticity models with generalized normal distribution (GED) errors as the main method.

Our analysis allows us to draw the following conclusions. First, the dynamics of bitcoin have no connection with the indicators of complexity (hashrate), and therefore, with mining. If there was a connection, then an increase in the complexity of mining would lead to an increase in the price, but in the period until 2017 this was not observed, and after that, it was rather the opposite.

Second, we did not find a significant relationship between the dynamics of popular search queries and the dynamics of bitcoin in the period before the 2017 bubble. A possible explanation for this is precisely the fact that we excluded the period of the bubble. The graphs clearly show that the peak of popularity was during the period of the bubble. The inclusion of the COVID-19 pandemic period in the analysis also revealed a significant correlation between the dynamics of search queries and the profitability of bitcoin. It seems that this result may be an indirect sign that currently (as of the first half of 2021) we are witnessing another bubble.

Third, an analysis of the relationship between the profitability of bitcoin and other traditional assets revealed that this cryptocurrency is gradually becoming a part of the modern space of financial instruments. During a downturn in the markets, bitcoin, like any high-risk asset, fell more than the stock market, followed by an increase that many times exceeded the growth of other financial

assets.

Thus, the results of our analysis demonstrate the absence of a stable relationship between bitcoin yields over the entire period under consideration (from 2014 to the beginning of 2021), both with internal factors related directly to the numerical indicators of the cryptocurrency blockchain and the dynamics of its popularity and with a number of traditional financial assets. However, there has been a recent trend in the perception of cryptocurrencies by investors, and bitcoin in particular, as a specific financial asset with a high degree of risk, which is a rather attractive means of diversification. The demand for cryptocurrencies from market players is growing, which is reflected, for example, in the rapid growth of assets under the management of the Grayscale Bitcoin Trust, whose shares are traded on the OTC market. Investors expect the launch of exchange-traded funds (ETFs) from major financial institutions as Fidelity and VanEck, which will allow them to add cryptocurrency to their investment portfolios in a completely legal, transparent manner and with low fees. The launch of such ETFs could contribute to further growth in cryptocurrency prices.

ACKNOWLEDGEMENT

The article was written on the basis of the RANEPA state assignment research programme. RANEPA, Moscow, Russia.

REFERENCES

1. Stolbov M.I. The 10th anniversary of the cryptocurrency market: Its current state and prospects. *Voprosy ekonomiki*. 2019;(5):136–148. (In Russ.). DOI: 10.32609/0042–8736–2019–5–136–148
2. Shilov K.D., Zubarev A.V. Blockchain and distributed ledgers as a type of database. *Innovatsii = Innovations*. 2018;12:77–87. (In Russ.).
3. Sinel'nikova-Muryleva E.V., Shilov K.D., Zubarev A.V. The essence of cryptocurrencies: Descriptive and comparative analysis. *Finansy: teoriya i praktika = Finance: Theory and Practice*. 2019;23(6):36–49. (In Russ.). DOI: 10.26794/2587–5671–2019–23–6–36–49
4. Sockin M., Xiong W. A model of cryptocurrencies. NBER Working Paper. 2020;(26816). DOI: 10.3386/w26816
5. Gans J.S., Halaburda H. Some economics of private digital currency. In: Goldfarb A., Greenstein S.M., Tucker C.E., eds. Economic analysis of the digital economy. Chicago, IL: University of Chicago Press; 2015:257–276. DOI: 10.7208/chicago/9780226206981.003.0009
6. Biais B., Bisiere C., Bouvard M., Casamatta C., Menkveld A.J. Equilibrium Bitcoin pricing. *SSRN Electronic Journal*. 2020. DOI: 10.2139/ssrn.3261063
7. Cong L.W., Li Y., Wang N. Tokenomics: Dynamic adoption and valuation. *The Review of Financial Studies*. 2021;34(3):1105–1155. DOI: 10.1093/rfs/hhaa089
8. Chiu J., Koeppl T.V. The economics of cryptocurrencies — Bitcoin and beyond. *SSRN Electronic Journal*. 2017. DOI: 10.2139/ssrn3048124
9. Hayes A.S. Cryptocurrency value formation: An empirical study leading to a cost of production model for valuing bitcoin. *Telematics and Informatics* 2017;34(7):1308–1321. DOI: 10.1016/j.tele.2016.05.005
10. Catalini C., Gans J.S. Initial coin offerings and the value of crypto tokens. NBER Working Paper. 2018;(24418). DOI: 10.3386/w24418
11. Chod J., Lyandres E. A theory of ICOs: Diversification, agency, and information asymmetry. *Management Science*. 2021. In press. DOI: 10.1287/mnsc.2020.3754
12. Simonov A., Zyamalov V. Long run return and survival factors of ICO. *Ekonomicheskii zhurnal Vysshei shkoly ekonomiki = The HSE Economic Journal*. 2019;23(4):585–604. (In Russ.). DOI: 10.17323/1813–8691–2019–23–4–585–604
13. Dyhrberg A.H. Bitcoin, gold and the dollar — A GARCH volatility analysis. *Finance Research Letters*. 2016;16:85–

92. DOI: 10.1016/j.frl.2015.10.008
14. Baur D.G., Dimpfl T., Kuck K. Bitcoin, gold and the US dollar — A replication and extension. *Finance Research Letters*. 2018;25:103–110. DOI: 10.1016/j.frl.2017.10.012
15. Klein T., Pham Thu H., Walther T. Bitcoin is not the New Gold — A comparison of volatility, correlation, and portfolio performance. *International Review of Financial Analysis*. 2018;59:105–116. DOI: 10.1016/j.irfa.2018.07.010
16. Shahzad S.J.H., Bouri E., Roubaud D., Kristoufek L., Lucey B. Is Bitcoin a better safe-haven investment than gold and commodities? *International Review of Financial Analysis*. 2019;63:322–330. DOI: 10.1016/j.irfa.2019.01.002
17. Urquhart A., Zhang H. Is Bitcoin a hedge or safe haven for currencies? An intraday analysis. *International Review of Financial Analysis*. 2019;63:49–57. DOI: 10.1016/j.irfa.2019.02.009
18. Shahzad S.J.H., Balli F., Naeem M.A., Hasan M., Arif M. Do conventional currencies hedge cryptocurrencies? *The Quarterly Review of Economics and Finance*. 2021. In press. DOI: 10.1016/j.qref.2021.01.008
19. Glaser F., Zimmermann K., Haferkorn M., Weber M.C., Siering M. Bitcoin — Asset or currency? Revealing users' hidden intentions. In: Proc. 22nd European conf. on information systems (ECIS-2014). (Tel Aviv, June 9–11, 2014). Frankfurt am Main: Goethe University; 2014. URL: https://www.researchgate.net/publication/286338705_Bitcoin_-_Asset_or_currency_Revealing_users'_hidden_intentions
20. Baur D.G., Hong K., Lee A.D. Bitcoin: Medium of exchange or speculative assets? *Journal of International Financial Markets, Institutions and Money*. 2018;54:177–189. DOI: 10.1016/j.intfin.2017.12.004
21. Krylov G.O., Lisitsyn A. Yu., Polyakov L.I. Comparative analysis of volatility of cryptocurrencies and fiat money. *Finansy: teoriya i praktika = Finance: Theory and Practice*. 2018;22(2):66–89. (In Russ.). DOI: 10.26794/2587–5671–2018–22–2–66–89
22. Liu Y., Tsyvinski A. Risks and returns of cryptocurrency. *The Review of Financial Studies*. 2021;34(6):2689–2727. DOI: 10.1093/rfs/hhaa113
23. Dastgir S., Demir E., Downing G., Gozgor G., Lau C.K.M. The causal relationship between Bitcoin attention and Bitcoin returns: Evidence from the Copula-based Granger causality test. *Finance Research Letters*. 2019;28:160–164. DOI: 10.1016/j.frl.2018.04.019
24. Liu Y., Tsyvinski A., Wu X. Common risk factors in cryptocurrency. NBER Working Paper. 2019;(25882). DOI: 10.3386/w25882
25. Chu J., Chan S., Nadarajah S., Osterrieder J. GARCH modelling of cryptocurrencies. *Journal of Risk and Financial Management*. 2017;10(4):17. DOI: 10.3390/jrfm10040017
26. Malkina M. Yu., Ovchinnikov V.N. Cryptocurrency market: Overreaction to news and herd instincts. *Ekonomicheskaya politika = Economic Policy*. 2020;15(3):74–105. (In Russ.). DOI: 10.18288/1994–5124–2020–3–74–105
27. Fedorova E.A., Bechvaya K.Z., Rogov O. Yu. The influence of the tonality of news on the exchange rate of Bitcoin. *Finansy: teoriya i praktika = Finance: Theory and Practice*. 2018;22(4):104–113. (In Russ.). DOI: 10.26794/2587–5671–2018–22–4–104–113
28. Aalborg H.A., Molnár P., de Vries J.E. What can explain the price, volatility and trading volume of Bitcoin? *Finance Research Letters*. 2019;29:255–265. DOI: 10.1016/j.frl.2018.08.010
29. Bianchi D. Cryptocurrencies as an asset class? An empirical assessment. *The Journal of Alternative Investments*. 2020;23(2):162–179. DOI: 10.3905/jai.2020.1.105
30. Bianchi D., Dickerson A. Trading volume in cryptocurrency markets. *SSRN Electronic Journal*. 2019. DOI: 10.2139/ssrn.3239670
31. Alexander C., Dakos M. A critical investigation of cryptocurrency data and analysis. *Quantitative Finance*. 2020;20(2):173–188. DOI: 10.1080/14697688.2019.1641347
32. Enders W. Modeling volatility. In: Enders W. Applied econometric time series. 4th ed. Hoboken, NJ: John Wiley & Sons, Inc.; 2015:118–180.
33. Fama E.F. The behavior of stock-market prices. *The Journal of Business*. 1965;38(1):34–105. URL: http://www.e-m-h.org/Fama65.pdf
34. Mandelbrot B.B. The variation of certain speculative prices. In: Mandelbrot B.B. Fractals and scaling in finance:

Discontinuity, concentration, risk. New York: Springer-Verlag; 1997:371–418.
35. Fisher T.J., Gallagher C.M. New weighted portmanteau statistics for time series goodness of fit testing. *Journal of the American Statistical Association*. 2012;107(498):777–787. DOI: 10.1080/01621459.2012.688465
36. Nelson D.B. Conditional heteroskedasticity in asset returns: A new approach. *Econometrica*. 1991;59(2):347–370. DOI: 10.2307/2938260
37. Curto J.D., Pinto J.C., Tavares G.N. Modeling stock markets' volatility using GARCH models with Normal, Student's *t* and stable Paretian distributions. *Statistical Papers*. 2009;50(2):311–321. DOI: 10.1007/s00362–007–0080–5
38. Alberg D., Shalit H., Yosef R. Estimating stock market volatility using asymmetric GARCH models. *Applied Financial Economics*. 2008;18(15):1201–1208. DOI: 10.1080/09603100701604225
39. Ghalanos A. Package 'rugarch': Univariate GARCH models. R package version 1.4–4. 2020. URL: https://cran.r-project.org/web/packages/rugarch/rugarch.pdf
40. Vlaar P.J.G., Palm F.C. The message in weekly exchange rates in the European monetary system: Mean reversion, conditional heteroscedasticity, and jumps. *Journal of Business & Economic Statistics*. 1993;11(3):351–360. DOI: 10.1080/07350015.1993.10509963
41. Andersen T.G. Return volatility and trading volume: An information flow interpretation of stochastic volatility. *The Journal of Finance*. 1996;51(1):169–204. DOI: 10.1111/j.1540–6261.1996.tb05206.x
42. Fantazzini D., Kolodin N. Does the hashrate affect the Bitcoin price? *Journal of Risk and Financial Management*. 2020;13(11):263. DOI: 10.3390/jrfm13110263
43. Shanaev S., Sharma S., Shuraeva A., Ghimire B. The marginal cost of mining, Metcalfe's law and cryptocurrency value formation: Causal inferences from the instrumental variable approach. *SSRN Electronic Journal*. 2019. DOI: 10.2139/ssrn.3432431

ABOUT THE AUTHORS

Kirill D. Shilov — Researcher, Institute of Applied Economic Research, Russian Presidential Academy of National Economy and Public Administration (RANEPA), Moscow, Russia
shilov-kd@ranepa.ru

Andrei V. Zubarev — Can. Sci. (Econ.), Senior Researcher, Institute of Applied Economic Research, Russian Presidential Academy of National Economy and Public Administration (RANEPA), Moscow, Russia
texxik@gmail.com

The article was submitted on 07.05.2021; revised on 21.05.2021 and accepted for publication on 27.08.2021.
The authors read and approved the final version of the manuscript.

ORIGINAL PAPER

DOI: 10.26794/2587-5671-2021-25-5-172-185
UDC 336.221(045)
JEL H26

Improving Tax Administration of VAT on Timber Export

E. Yu. Mitusova
Interregional Inspectorate of the Federal Tax Service for the largest taxpayers No. 9, Moscow, Russia
https://orcid.org/0000-0002-0782-8447

ABSTRACT

The export of timber can be used by unscrupulous taxpayers in illegal schemes to reimburse VAT from the budget to obtain an unjustified tax benefit by overstating the amount of tax deductions, which confirms the **relevance** of the research. The **subject** of the paper is the economic relations between the exporting country and the importer of goods, works or services and their impact on VAT taxation. The **aim** of the study is to identify the vulnerabilities of the current tax legislation in the field of value-added tax reimbursement and analyze the improvement and optimization of the mechanism for administering value-added tax to ensure national economic security and preserve federal budget revenues as a result of reducing the amount of budget funds reimbursed to taxpayers. The author applies such **methods** as abstract-logical, analysis and synthesis, induction and deduction. As a **result,** the study reveals the problems of illegal VAT refunds in the export of timber associated with the use of new methods by taxpayers to minimize tax liabilities and the complication of the form of contractual relations. The author makes a **conclusion** about a possible solution to the problems of tax administration when taxpayers carry out export operations with exported products, using the experience of the functioning of the Charter of the agro-industrial complex. The **novelty of the study** lies in the proposal to adopt a ban on multi-stage sales and purchases by the tax authority as the basis for regulating the export of products outside the territory of the EAEU. This will exclude artificial price increases. The results obtained can be used in the further development of the tax administration system, in the analytical work of state bodies authorized to control and supervise taxes and fees.

Keywords: federal budget; financial and economic activities; timber industry; international trade; timber export; illegal timber trade; value-added tax; VAT refund; fictitious document flow; tax control; cameral tax audit

For citation: **Mitusova E. Yu. Improving tax administration of VAT on timber export. *Finance: Theory and Practice.* 2021;25(5):172-185. DOI: 10.26794/2587-5671-2021-25-5-172-185**

INTRODUCTION

The issues of globalization and the intensification of foreign economic activity are an important component of the economic development of the world space and states. The countries are interested in global integration, since these processes allow to increase the inflow of public funds, improve the balance of payments, and also strengthen their positions in the world market. Thus, the export orientation of business operations contributes to the expansion of the sales market, an increase in the potential of economic entities and the diversification of trade.

To support entrepreneurs and organizations whose activities are related to export operations, the tax legislation of the Russian Federation provides for the application of the 0% value added tax (hereinafter — VAT) rate to tax the cost of selling exported products. This, in turn, significantly reduces the level of tax burden on an economic entity, and also stimulates the further development of financial and economic activities, increases interest in foreign trade transactions.

However, in addition to the goals of expanding the economic activities of organizations, operations for the export of products outside the state can be used by unscrupulous taxpayers in order to obtain unjustified tax benefits by overstating the amount of tax deductions generated at 0% VAT, which leads to the formation of the amount of VAT declared for reimbursement from the budget. For this reason, the tax authorities carry out control measures aimed at identifying the facts of violation of tax legislation, and also conduct a constant methodological assessment of the current procedure for applying tax deductions.

The cases of illegal tax refunds suggest that in the context of stimulating the export orientation of financial and economic activities, the tax authorities need to pay due attention to this area when carrying out control measures. Improving the effectiveness of control in the context of reducing the timing of their implementation and simplifying the procedure for confirming the right to apply the 0% value-added tax rate when exporting goods (works, services) will ensure the preservation of national and economic security.

TAX CONTROL FOR VERIFICATION OF APPLICATIONS WITH THE STATED AMOUNT OF VAT REFUND

The right to apply the 0% VAT rate on the export of goods can be called the main method of stimulating foreign economic activity of economic entities since tax payments on value-added tax to the budget are a significant item of expenditure for taxpayers.

Granting the right to apply a zero rate significantly reduces the level of the tax burden on the exporter. In addition, in most cases, the application of the 0% VAT rate leads to an excess of the amount of tax deductions for VAT over the amount of calculated tax, which is the reason for the formation of the amount of VAT to be reimbursed from the budget.[1] In accordance with the provisions of Article 176 of the Tax Code of the Russian Federation, a value added tax refund is the excess of the amount of tax deductions for VAT over the amount of tax payable to the budget.

Reimbursement of VAT amounts by conscientious taxpayers is used to expand financial and economic activities, increase production volumes, its scientific and technical component, increase the number of jobs, as well as significantly reduce the level of a tax burden on business since the amount of value-added tax payments to the budget make up a significant share costs of business entities. In addition, the possibility of reimbursing the declared amount of VAT from the budget during export operations can be called an incentive to expand and develop

[1] Corporate-other taxes. Input VAT recovery. URL: https://taxsummaries.pwc.com/russian-federation/corporate/other-taxes (accessed on 08.02.2021).

foreign economic operations, increase the competitiveness of domestic goods and strengthen the position of Russian goods in the world market.

An urgent task of tax control and VAT administration is to solve problems in the field of counteracting illegal tax refunds from the federal budget of the Russian Federation [1]. A significant amount of refunded value-added tax negatively affects tax revenues from VAT to the budget and also poses a threat to the national security of the country [2]. Therefore, a desk audit of a tax return with a declared amount of VAT refund from the budget has features and provides for in-depth control measures.

Desk and field tax audits of business entities exporting goods (works, services) outside Russia provide for a special list of tax control measures aimed at identifying violations of current legislation. In-depth inspections are carried out with the simultaneous absence of additional administrative costs for the business, without affecting the level of the tax burden of the business entity.

In the era of digitalization of the economy and the continuous development of information technologies, the Federal Tax Service of Russia develops relevant and effective system products [3, 4]. The software used by the tax authorities is technologically advanced and contributes to an increase in the effectiveness of control measures of tax authorities, which is further expressed in the accumulation of VAT charged for payment [5]. In addition, the development of an electronic document management system between tax, customs authorities and business representatives makes it possible to reduce the administrative costs of business entities while increasing the efficiency of tax control.

Along with the provision of benefits and preferences to authorized bodies, it is necessary to ensure an adequate level of control and supervision over the fulfillment of legislative obligations by taxpayers. Indeed, to obtain unjustified tax benefits, business representatives can carry out fictitious export operations, use tax evasion schemes or use chains of actions aimed at minimizing tax liabilities.

In addition, with a decrease in the tax burden on business due to the provision of a 0% VAT rate for export operations, a noticeable decrease in the amount of budgetary funds from the receipt of VAT payments is observed. Due to the use of the offsetting mechanism for calculating VAT according to the reporting of the Federal Tax Service of the Russian Federation in the form 1-HM and 2-VAT, the excess of the amount of tax received over the amount of VAT refunded is insignificant. In 2019, VAT tax revenues amounted to 4,258 billion rubles, and the amount of refunded taxes was 3,112 billion rubles and compared to the same period last year increased by 23.3%. It should also be noted that the growth rate of the amount of VAT reimbursed from the budget in 2019 exceeds the growth rate of VAT tax revenues and is 73% of the total volume of tax payments for the tax in question. In addition, there is a trend towards a reduction in the balance of VAT tax payments due to an increase in the amount of VAT refunded.

Thus, improving the system of control over legal VAT refunds from the budget and increasing its efficiency is currently a priority in the work of tax authorities.

Works by O. V. Mandroshchenko [2], V.V. Moroz, A. Grechina [6], R. Sh. Abakarova [7], E. V. Karpova [8], E. I. Komarova, M. A. Troyanskaya [9], L. L. Savina, D.I. Korableva [10] and others made a great contribution to the study of theoretical and methodological issues of tax control of VAT in the export of goods. The works of economists and practicing scientists investigate issues related to price manipulation by organizations, which are accompanied by an overestimation of the customs value of exported goods, substitution of codes of the commodity nomenclature of foreign economic activity, and the export of goods

under counterfeit documents. The results of the study prove the existence of illegal schemes to minimize taxation through the implementation of activities in the field of international trade in order to obtain illegal VAT refunds from the budget or proceeds from money laundering abroad. The authors analyze schematic mechanisms for modeling foreign economic activity using financing from credit institutions and shell companies without actually exporting goods abroad, and also consider the use of pseudo-export mechanisms by unscrupulous market participants for tax evasion. In addition, the works of economists investigate the issues of the current mechanism of tax control of export operations. Attention is drawn to the gradually developing system of electronic declaration, the reduction of the release time of goods, the reduction in the duration of desk audits of VAT tax returns, as well as the simplification of the system for confirming the validity of the application of the zero VAT rate. This, according to economists, should reduce the burden on regulators and reduce the possibility of administrative pressure on persons in respect of whom appropriate control measures are taken.

However, methodological issues of taxation of export earnings at a zero rate, the use of VAT tax deductions for the sale of goods for export, as well as problems of improving the administration and control of VAT taxation to increase the effectiveness of control measures used to check the validity of VAT refunds from the budget are not given due attention. The need for a detailed analysis of the procedure for tax administration of export operations, as well as the identification of the main problems of this process at this stage, served as the basis for choosing a research topic..

VAT MANAGEMENT PRACTICE ON THE EXAMPLE OF TIMBER EXPORT

More than 20% of the world's timber and forest reserves are located on the territory of Russia [11]. The timber industry complex in Russia is highly dynamic, which is confirmed by Rosstat data. The wood production index has a steady growth trend, the total volume of felling of industrial and fuel wood in 2019 reached 141.2 million m3, which is 5.3% more than in the same period last year.[2]

According to the Federal Customs Service of Russia, timber exports make up one fifth of the total volume of cut raw materials in the forestry complex of the Russian Federation. At the same time, the volume of timber export outside the customs territory is gradually increasing, which allows us to judge the interest of Russian exporters in the implementation of the considered business operations.[3] To assess the state of the timber export sector, it is necessary to analyze the value of export earnings. The data on the value of the exported resources of the timber industry complex are presented in *Figure*.

Based on the presented data, we can conclude about the high and stable profitability of export operations of the timber industry complex in Russia. It should be noted that the rate of decline in export revenue in 2019 is associated with restrictions on the export of round timber. Moreover, in the context of the instability of the Russian ruble due to economic turbulence, the export orientation of the activities of organizations of the timber industry complex is beneficial. The dynamics of production development and the attractiveness of the timber export sector are also explained by the stable growth of international trade.[4] The data of the international study of the growth rates of the export of forest resources are presented in *Table 1*.

---

[2] Timber industry of Russia in 2019: Production results. URL: https://proderevo.net/analytics/main-analytics/lpk-rossii-v-2019-godu-itogi-proizvodstva.html (accessed on 12.01.2021).

[3] Official website of the Federal Customs Service of Russia. URL: https://customs.gov.ru/ (accessed on 17.01.2021).

[4] Draft national export strategy of Russia for the period up to 2030 (prepared by the Ministry of Economic Development of Russia). Access from the Consultant Plus legal reference system. URL: http://www.consultant.ru/cons/cgi/online.cgi?req=doc&base=PNPA&n=3312#050846130587566 01 (accessed on 21.03.2021).

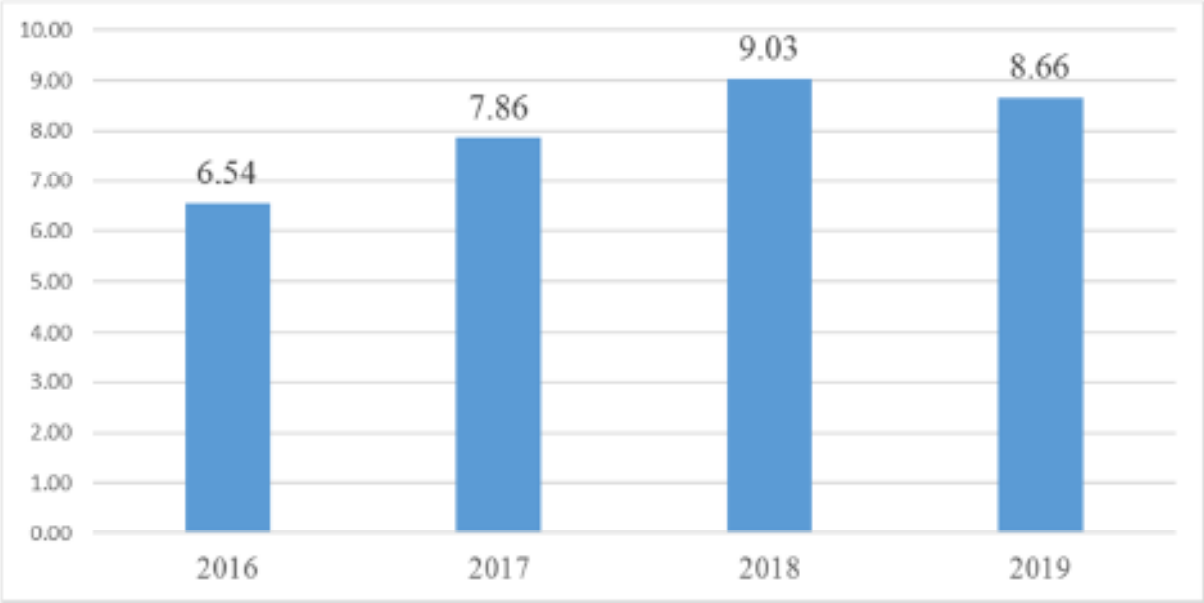

Fig. **Value indicators of export proceeds from the sale of timber products (USD million)**

Source: Russian foreign trade statistics. URL: https://statimex.ru/statistic/44/export/2016–2020/world/RU/ (accessed on 31.03.2021).

The reason for choosing the branch of the timber industry complex to study illegal VAT refunds in the implementation of export operations is the extremely low rates of VAT tax revenues, at the same time a high level of development of the industry and a constant increase in production rates (*Table 2*).

Obviously, VAT revenue from taxpayers of the Russian timber industry complex is insignificant, which is paradoxical given the high growth rates of the economic sector under consideration. The main reason for the minimum tax payments is a significant share of tax deductions, which in most cases leads to the formation of the amount of VAT to be reimbursed from the budget. This occurs as a result of applying a zero tax rate to the tax base formed in the implementation of export operations and deducting the amount of VAT associated with the acquisition or harvesting of timber that is subsequently sold. For example, according to the report of the Office of the Federal Tax Service of Russia in Moscow, the amount of VAT refunds to organizations of the timber industry complex is, on average, three times the amount of accrued and paid tax.

The results of the control activities of the tax authorities, as well as the analysis of judicial practice, indicate a high degree of involvement of unscrupulous entrepreneurs in the sphere of customs legal relations when exporting timber [11]. Carrying out in-depth tax measures with the involvement of customs specialists is caused by the need to suppress attempts to steal funds from the federal budget. In addition, the main task of the federal services is to free the timber industry complex from the activities of unscrupulous participants, the purpose of which is to fill the foreign market with illegally acquired timber on a non-competitive basis with significant price dumping.

Summary of arbitration practice in cases dated May 19, 2017, No. A56–57316/2016, No. F04–3165/2018 dated April 25, 2019, No. F07–11286/2018 dated September 6, 2018, No. F01–4221/2019 dated September 3, 2019, allows us to conclude that currently, the most common violation of tax legislation in the field of exporting timber from the customs territory of the EAEU is the purchase of timber harvested and felled illegally. Timber products are purchased from individuals and entrepreneurs who are not VAT payers for cash without the

Table 1

Average annual growth rates of exports in 2008–2028

Index		2008–2018, %	2019–2028, %
Export growth rates	In the world	1.8	5.7
	In Russia	–0.2	4.3
Timber export growth rates	In the world	1.4	4.2
	In Russia	3.3	4.7

Source: compiled by the author on the basis of the draft national export strategy of Russia for the period up to 2030.

Table 2

VAT receipts in the consolidated budget of the Russian Federation by type of economic activity in 2016–2019 (billion rubles)

Index	2016	2017	Growth rate	2018	Growth rate	2019	Growth rate
VAT received in the consolidated budget of the Russian Federation	2808.3	3233.4	+15.1%	3762.4	+16.4%	4486.6	+19.2%
— including in the field of forestry	2.31	2.77	+19.1%	4.02	+45.1%	3.6	–10.4%
Share in total tax revenues by type of activity	0.08%	0.08%	–	0.1%	–	0.08%	–

Source: compiled by the author based on the report of the Federal Tax Service of Russia in the form 1-NOM. URL: https://www.nalog.ru/rn77/related_activities/statistics_and_analytics (accessed on 01.03.2021).

exporter paying the corresponding amounts of VAT. In addition, the timber sale and purchase agreement, other primary documents, and shipping documents are drawn up on behalf of fictitious suppliers of the first, second and, in some cases, the third level, registered in regions remote from the place of timber shipment. The use of other organizations is aimed at creating the appearance of standard financial and economic activities [12–14].

To confirm the legality of the application of the 0% VAT rate, exporters are required to submit to the tax authority the documents provided for by the provisions of the Tax Code of the Russian Federation, as well as the norms of EAEU Treaty Appendix 18 to the Tax Code of the Russian Federation. In practice, many organizations use fictitious document circulation and submit documents confirming the purchase of timber exported in the customs procedure for export to the domestic market, with the corresponding payment of VAT.

In the case of illegal turnover of unprocessed wood in order to obtain VAT refunds from the budget, in most cases the following parties to the transaction interact: buyers, exporters, commission agents, and fictitious suppliers.[5] The involvement of a

[5] Timber for export — without intermediaries. URL: https://www.nalog.ru/rn29/news/smi/7101855/ (accessed on 01.02.2021).

commission agent in the chain of operations is associated with the need to obtain a license from the Ministry of Industry and Trade of Russia for the export of unprocessed timber. In practice, timber removal is carried out by several commission agents. In many cases, one commission agent carries out customs clearance of timber of several committees, which makes it as difficult as possible to identify the consignments sent for export and makes it difficult to track the joining of goods with a first-tier supplier [15].

The gradual complication of illegal VAT refunds in the field of timber exports should be noted. Exporters claiming VAT refunds on their tax returns are dealing with suppliers that are not obvious shell companies. Indeed, business entities — timber suppliers participating in the scheme of illegal increase in the value of sold products in order to inflate tax deductions by the exporter and form the amount of VAT to be refunded, submit tax reports, have formal contractual relations with transport companies, declare transactions with timber. The nominee directors of the companies in question conduct business correspondence and appear during interrogations. In other words, the tax authorities are increasingly faced with the problem of collecting a sufficient evidence base to make a reasoned decision to refuse to refund the declared VAT amounts when carrying out export operations with timber.

In the course of in-depth desk audits of VAT returns with the declared amount of compensation for the sale of timber for export, the tax authorities carry out many control measures [16]. First of all, the procedures for claiming documents (information) are initiated along the entire chain of sellers: from exporters to actual buyers. In most cases, the tax authority does not establish a list of specific suppliers participating in the transaction, which significantly complicates further control activities. In addition, in order to identify inconsistencies between the data submitted to the Federal Tax Service of Russia and the data of the customs authorities, the tax authorities conduct a detailed comparison of the information received, send motivated requests to the Federal Customs Service of Russia for assistance in carrying out control activities and providing information about the exporter.

The selection of the main objects of inspection when carrying out in-depth control measures in relation to VAT tax returns with the declared amount of VAT refund in the implementation of export operations with wood is made according to the following criteria:

- counterparties-suppliers of the exporter do not have production facilities for harvesting, processing, and transportation of timber;
- formation of the main share of tax payments due to the supply of non-core products;
- overestimation of the purchase price of timber products in comparison with the prevailing market prices;
- use of shell companies as suppliers that do not submit tax reports and are not located at the registration address, do not have employees and working capital, conduct fictitious document flow and belong to persons affiliated with the audited organization;
- the presence of interdependence of the parties to the transaction for the purchase and supply of timber products;
- improper execution or absence of documents confirming the loading and transportation of timber;
- interaction with counterparties — individuals who are not VAT payers;
- carrying out mutual settlements in physical cash [17].

It is important to note that the practice of arbitration courts when considering applications to challenge the decisions of the Federal Tax Service of Russia to refuse VAT refunds is based on the presumption of good faith of the taxpayer who documented

the purchase of goods for VAT is included in the transaction with product suppliers. In this regard, the tax authorities, to make a reasoned decision on the VAT refund, take comprehensive control measures that affect the entire cycle of the organization's financial and economic activities. In particular, when conducting a desk tax audit of a VAT return with a declared amount of reimbursement for export operations, the tax authority checks in detail the circumstances and technical conditions of the production of finished products, the conformity and use of the goods purchased for industrial purposes. The study of the specifics of the production process is aimed at identifying the facts of purchasing products without an economically justified goal (overstating the amount of tax deductions).

The tax authorities compare the volumes of purchased raw materials and materials and their actual use in the manufacture of products within the framework of the terms of reference. Moreover, the tax authority often checks the validity of the application of tax deductions in relation to the energy consumption of production by examining information on the energy intensity of each piece of equipment and the actual consumption of electricity.

Particular attention is paid to checking and comparing tax and accounting statements when checking tax returns with the declared amount of VAT refund from the budget, formed through the implementation of export operations for the sale of timber. The tax authorities are studying the process of writing off residues and surplus of timber to identify the facts of their illegal sale without documentary registration. The procedure for taxation and accounting for surplus forest raw materials is subject to consolidation in the accounting policy.

The study of the process of transportation of timber is also aimed at checking the legality and documentary evidence of the transactions being made. As part of the check, the terms of the contract with carriers and transport companies are studied, data on the place of loading, storage, and unloading of timber are compared. The tax authorities study warehouse accounting documents, namely: journals of entry and exit of vehicles, video recordings from CCTV cameras, data of weight sheets issued on the weighing platforms of checkpoints.[6] Tax officers conduct interrogations of security guards, materially responsible persons of warehouses, as well as drivers and other persons involved in the process of loading and delivering products. To determine the route of movement of vehicles, the tax authorities interact with the traffic police of Russia, sending requests for information from CCTV cameras on the road.

The list of activities under consideration is not exhaustive. The complex of necessary control procedures is determined by the tax authority individually, depending on the specifics of the transaction, as a result of which the amount of VAT refund from the budget was formed. However, it should be noted that the main purpose of the control measures being carried out is to identify the source of origin and the actual owner of the wood, as well as to exclude the possibility of illegal overstatement of tax deductions to obtain unjustified VAT refunds.

Information resources of the Federal Tax Service of Russia, such as ASK VAT 2, SUR ASK VAT 2, EAEU-Exchange, Banking Exchange, KOE AIS Tax-3, are used to identify signs of illegal timber sales in order to recover VAT from the budget and in the future control work as part of the audit of compliance with tax legislation [18]. As part of ensuring cooperation under an agreement between the Federal Tax Service and the Federal Customs Service of Russia, the tax authorities use the information resource "Customs-F" to check the availability of declarations for goods and marks of the actual shipment of goods

[6] The 0% rate. URL: https://www.vanrhijnlegal.com/vat-in-russia/ (accessed on 06.02.2021).

from the customs territory of the Russian Federation. In addition, the tax authorities use online services, for example, the software product SPARK-Interfax and Kontur-Focus. When verifying the legality of applying a zero VAT rate for the export of timber, the Unified State Automated Information System for accounting for timber and operations with it (EGAIS-Les) is applied.

Currently, the process of conducting a desk audit of a VAT return with a declared refund amount in connection with the implementation of export operations is associated with an expanded set of control measures. The measures under consideration are aimed at a detailed audit of financial and economic activities in order to identify the facts of violation of tax legislation or their absence. Increased attention to checking the validity of VAT amounts claimed for refund is associated with numerous cases of unscrupulous taxpayers using the refunded tax to obtain an unjustified tax benefit.

Based on the study of illegal VAT refunds on the example of timber exports, it is necessary to highlight the most common methods of minimizing tax liabilities to obtain VAT refunds from the budget:

- unjustified overstatement of tax deductions due to participation in a network of shell companies [19];
- a large number of intermediary counterparties who participate in the fictitious sale and purchase transactions from a manufacturer of products to an exporter without an economic purpose to artificially increase prices;
- carrying out business transactions between affiliated persons on terms different from market ones due to the control of business entities.

In addition to the methods used by unscrupulous taxpayers for illegal VAT refunds from the budget, it is necessary to pay attention to administrative problems that in some cases force the tax authority to make an unjustified decision on VAT refunds in export operations:

- the need to carry out in-depth control measures in a short time due to the reduction of the desk VAT audit to two months;
- the need to conduct a detailed audit of the entire financial and economic cycle of the taxpayer, involving interaction with law enforcement and other regulatory authorities, financial and credit organizations, statistics and certification bodies, the traffic police of the Ministry of Internal Affairs of Russia;
- the need to determine the degree of conscientiousness of the counterparties of the audited taxpayer;
- the duration of the process of researching the supply chain of goods from the manufacturer to the exporter in cases of the participation of counterparties — resellers of products.

In other words, at present, the process of verifying the validity of the claimed VAT refund from the budget established in connection with export operations is rather time-consuming. In addition, as the economy develops, taxpayers apply new methods to minimize tax liabilities and complicate the form of contractual relations. Thus, it is obvious that there is a need to improve the current procedure for administering VAT in the field of export operations.

DIRECTIONS FOR IMPROVING TAX MANAGEMENT

Improvement of the VAT administration system is one of the priority areas of the tax authorities' work to increase the level of the revenue component of the federal budget of the Russian Federation. In connection with the continuous development of the economy, the multilateral complication of contractual relations between business representatives, and the general process of digitalization, the issue of timely transformation of the current procedure for administering VAT taxation is the key to ensuring national economic security [20–24]. To form an effective system of control and supervision in the field of taxation, information resources and technical

capabilities of tax authorities should take into account current trends and timely identify facts of illegal enrichment or receiving unjustified tax benefits.

To restore fair competition when exporting goods outside the customs territory of Russia, it is necessary to make the following changes to tax legislation. In cases where a taxpayer plans to carry out export operations, one of the following conditions must be met with respect to products intended for export outside the Russian Federation:

- the products are the result of the potential exporter's own production;
- goods sold outside the customs territory of the EAEU must be purchased directly from the manufacturer of the goods;
- goods sold outside the customs territory of the EAEU must be purchased from economic entities interacting with the manufacturer of goods on the basis of a commission agreement or other intermediary agreement.

The proposed changes will allow excluding cases of multiple resales of products to artificially inflate the price and amount of tax deductions to form the amount of VAT to be reimbursed from the budget for export. Indeed, when carrying out control measures, the tax authority will not need to investigate a large-scale chain of counterparties and study the exporter's due diligence when choosing counterparties. It is obvious that organizations that have real production, the necessary technical potential, and personnel and do not use illegal methods of tax optimization meet all the criteria of a conscientious taxpayer.

The implementation of the considered proposal to improve the procedure for administering export operations is possible based on the experience of the functioning of the Charter of the agro-industrial complex created in 2017 (hereinafter — the Charter). The Agricultural Turnover Charter is a joint policy of tax authorities and market participants to counter misconduct in the agricultural turnover market. Organizations working in the field of agriculture have the opportunity to voluntarily join the association of bona fide participants in the relevant market by applying for accession to the Charter. The participation of an organization in the Charter assumes the following conditions for the implementation of financial and economic activities:

A ban on multi-stage sales and purchases of products subsequently exported outside the customs territory of Russia will eliminate artificial price increases to overstate tax deductions and receive VAT refunds from the budget.

- exclusion of the possibility of obtaining competitive advantages due to non-payment of tax payments or participation in schemes for organizing illegal VAT refunds;
- purchase of agricultural products directly from agricultural producers, processors, or commission firms, as well as from other conscientious market participants;
- when purchasing products from suppliers other than agricultural producers, the Charter participants undertake to exercise due diligence and conscientiousness when choosing a counterparty and strive to purchase products from intermediary firms under commission agreements on behalf of or on behalf of the agricultural producer;
- exercise due diligence when selecting carriers.

Due diligence in accordance with the Charter is achieved by including in the contract a "tax clause" — a condition that allows you to recover losses or property damage from counterparties who have violated guarantees and assurances. If the tax authorities file claims before making a decision on bringing to tax liability (refusing

Table 3

Tax receipt in agriculture in 2017–2019 (million rubles)

Index	2017	2018	Growth rate	2019	Growth rate
Tax collection in the field of crop and livestock production	–16 641	–21 521	+29.32%	–13 606	–36.77%
Deviation	–	+4 880	–	–7915	–

Source: compiled by the author based on the report of the Federal Tax Service of Russia in the form 1-NOM.

to bring to tax liability, refusing to refund VAT), the Charter member has the opportunity to reimburse his losses from interaction with an unscrupulous taxpayer and exclude further economic cooperation with the "problem" organization.

It should be noted that the tax authorities constantly inform the participants of the Charter about the latest changes in the operating procedure, develop standard forms of contracts for the sale and transport of goods for participants, and recommend a list of requested documents from counterparties in order to verify their conscientiousness. In addition, within the framework of the Charter in the section "Information resource with information on tax gaps" the following can be checked:

- the presence of an incomplete source in the chain of suppliers of goods (works, services) for accepting VAT deduction;
- the presence of Consent to the recognition of information constituting a tax secret, publicly available in the part of an unaware source for the acceptance of VAT deduction.[7]

In the structure of the Federal Tax Service of Russia, a special working group has been created, whose activities are related to the development of the Charter, control over the conduct of desk audits of the participants of the Charter, and their fulfillment of the obligations of the association of conscientious participants in the agro-industrial complex [25]. The organization's participation in the Charter allows us to conclude that market participants are law-abiding and socially responsible, which significantly increases the organization's rating and contributes to the expansion of economic activity.

The considered procedure for the operation of the Charter should be extended to all participants in foreign economic activity related to the export of products in the export customs procedure, through the creation of an "Association of Exporters". A prerequisite for the export of products is the acceptance of the exclusion of the possibility of using a multi-stage process of resale of subsequently exported products to form an unreasonable amount of VAT refund from the budget.

For a full analysis of the proposed direction for improving the process of administering export operations, it is necessary to assess its effectiveness. Since it is proposed to adopt the current procedure for the functioning of the Charter of the agro-industrial complex as a basis for regulating the export of products outside the territory of Russia, it is necessary to study the results of the Charter in 2018–2019.

According to the Federal Tax Service of Russia, the budgetary benefit from the transition to direct supplies and the refusal of contracts with intermediaries with signs of problems and transit in 2018 was estimated at 57.4 billion rubles. As of 01.01.2020, 5449

[7] "Information resource with information on tax gaps" will help to check contractors in the field of the agro-industrial complex. URL: https://www.nalog.ru/rn73/news/activities_fts/8878785/ (accessed on 08.01.2021).

organizations of the agro-industrial complex from 76 regions of Russia are members of the Charter, as of 01.01.2021–6502 organizations from 79 regions. The study of statistical reporting allows us to conclude about the effectiveness of the functioning of the Charter in the field of agricultural products turnover (*Table 3*).

Despite the increase in the amount of VAT declared for reimbursement from the budget in 2018, the effect of the introduction of the rules for carrying out financial and economic activities is observed in 2019 when the amount of VAT declared for reimbursement decreased by 37% and by 18% compared to the data of 2017. Thus, despite the voluntary participation in the Charter, the effectiveness of the application of the rules of association in the field of agricultural products turnover is expressed in a decrease in the amount of VAT refund from the budget. This fact allows us to judge the decrease in cases of unjustified overstatement of tax deductions for the VAT due to the multi-stage process of resale of agricultural products and artificial overstatement of prices.

CONCLUSIONS

At the moment, the process of conducting desk tax audits with the declared amount of VAT refund in connection with the implementation of export operations is in-depth and time-consuming. The tax authorities are forced to investigate the full cycle of financial and economic activities of the audited taxpayer to study in detail the peculiarities of the organization's functioning to exclude cases of violation of tax legislation and illegal VAT refunds. The process under consideration is complicated by the use of tax optimization methods by taxpayers aimed at minimizing tax liabilities. An effective way to reduce the scale of illegal exports and get an unjustified tax benefit in the form of VAT refunds is to apply special conditions for conducting export activities. A ban on multi-stage sales and purchases of products subsequently exported outside the customs territory of Russia will eliminate artificial price increases to overstate tax deductions and receive VAT refunds from the budget. The effectiveness of the proposed measures is confirmed by the results of the functioning of the Charter of the agro-industrial complex, the participants of which adhere to the principles of conducting activities in the field of agriculture established by the Charter.[8]

By analogy with the Charter of the agro-industrial complex, participants are recommended to purchase products directly from manufacturers, processors, or commission agents, but without artificially including additional persons in the sales chain in order to restore fair competition. When carrying out control measures, the tax authority will not need to look for a real manufacturer along the entire chain of counterparties and study the exporter's due diligence when choosing counterparties.

It is important to note that the adoption of the procedure for the functioning of the Charter should not affect the VAT refund on timber exports, since the refund on export in any industry is a common practice, the impact will be on illegal tax refunds and especially on the overstatement of tax deductions.

Currently, the procedure for administering VAT amounts declared for reimbursement from the budget in connection with the implementation of export operations has been simplified, the terms of tax audits are being reduced, and the right to apply a declarative procedure for VAT reimbursement is provided. However, the presence of cases of illegal tax refunds indicates the need to amend tax legislation in terms of the procedure for conducting export operations to restore fair competition when exporting goods outside Russia.

[8] Charter in the field of circulation of agricultural products — a joint policy of countering illegal activities in the agricultural market. URL: https://хартия-апк.радо.рус (accessed on 11.01.2021).

REFERENCES

1. Ilyin V.A., Povarova A.I. Failures of big business tax administration and their impact on regional budgets. *Ekonomika regiona = Economy of Region*. 2017;13(1):25–37. (In Russ.). DOI: 10.17059/2017–1–3
2. Mandroshchenko O.V. Problems of VAT refunds by taxpayers. *Evraziiskii soyuz uchenykh = Eurasian Union of Scientists*. 2015;(1–3):65–66. (In Russ.).
3. Leonov E.A., Sokolov I.A. Collection efficiency of the value added tax: Identifying new determinants. *Ekonomicheskaya politika = Economic Policy*. 2020;15(6):42–65. (In Russ.). DOI: 10/18288/1994–5124–2020–6–42–65
4. Nevskaya A.A. The digitalization of Russia-EU trade. *Sovremennaya Evropa = Contemporary Europe*. 2020;(4):91–101. (In Russ.). DOI: 10.15211/soveurope4202091101
5. Lazhentsev V.N., Chuzhmarova S.I., Chuzhmarov A.I. Tax administration in the forest management system and its influence on the budgets of Northern Territories. *Economic and Social Changes: Facts, Trends, Forecast*. 2020;13(1):125–143. DOI: 10.15838/esc.2020.1.67.7
6. Moroz V.V., Grechina A.I. The work of the tax authorities to control the calculation and payment of VAT by taxpayers. *Problemy ekonomiki i yuridicheskoi praktiki = Economic Problems and Legal Practice*. 2018;(2):53–57. (In Russ.).
7. Abakarova R. Sh. VAT refund mechanism improvement problems. *Vestnik Irkutskogo gosudarstvennogo tekhnicheskogo universiteta = Proceedings of Irkutsk State Technical University*. 2015;(5):168–172. (In Russ.).
8. Karpova E.V. "Export" VAT. *NDS: problemy i resheniya*. 2017;(12):6–12. (In Russ.).
9. Komarova E.I., Troyanskaya M.A. Directions of reforming of an order of collecting and refunding VAT. *Azimut nauchnykh issledovanii: ekonomika i upravlenie = ASR: Economics and Management (Azimuth of Scientific Research)*. 2019;8(3):188–192. (In Russ.). DOI: 10.26140/anie-2019–0803–0045
10. Savina L.L., Korableva D.I. Problems of illegal compensation of tax on value added in Russia. *Problemy sovremennoi nauki i obrazovaniya = Problems of Modern Science and Education*. 2017;(13):71–75. (In Russ.).
11. Nazmeeva L.R. Illegal value added tax refund: The mechanism of crime and its detection. *Uchenye zapiski Kazanskogo yuridicheskogo instituta MVD Rossii = Scientific Notes of the Kazan Law Institute of MIA of Russia*. 2019;4(2):83–87. (In Russ.).
12. Bulgakova L.S. Prosecutor's supervision of the implementation of customs legislation in the export of timber. *Obrazovanie i pravo*. 2019;(9):71–74. (In Russ.).
13. Ditsevich Ya.B., Belykh O.A., Rusetskaya G.D. Counteracting crimes in the sphere of forest resources' use: Problems and perspectives. *Vserossiiskii kriminologicheskii zhurnal = Russian Journal of Criminology*. 2017;11(2):308–317. (In Russ.). DOI: 10.17150/2500–4255.2017.11(2).308–317
14. Denisova N.A. Analysis of problem aspects of the export of timber materials 44 group according to the commodity nomenclature of foreign trade activities of the EAEU through the prism of judicial practice. *Byulleten' innovatsionnykh tekhnologii = Bulletin of Innovative Technologies*. 2020;4(3):61–67. (In Russ.).
15. Ivanov P.I., Kuznetsov P.G. Some problems of combating crime in the sphere of illegal traffic of timber and timber products. *Vestnik Kazanskogo yuridicheskogo instituta MVD Rossii = Bulletin of the Kazan Law Institute of MIA Russia*. 2016;(2):50–55. (In Russ.).
16. Labunets Yu.E., Mayburov I.A. Tax control of VAT refund in Russia and in the Scandinavian countries on the example of timber industry. *Vestnik Tyumenskogo gosudarstvennogo universiteta. Sotsial'no-ekonomicheskie i pravovye issledovaniya = Tyumen State University Herald. Social, Economic, and Law Research*. 2020;6(2):168–192. (In Russ.). DOI: 10.21684/2411–7897–2020–6–2–168–192
17. Belokhrebtov V.S. Problems of detecting and disclosing fraud in the reimbursement of value added tax in the field of the timber industry. *Vestnik Kazanskogo yuridicheskogo instituta MVD Rossii = Bulletin of the Kazan Law Institute of MIA Russia*. 2015;(3):119–123. (In Russ.).
18. Tsindeliani I., Kot S., Vasilyeva E., Narinyan L. Tax system of the Russian Federation: Current state and steps towards financial sustainability. *Sustainability*. 2019;11(24):6994. DOI: 10.3390/su11246994

19. Drozdova E.A., Volkova O.V. Value added tax: The problem of prevention of illegal compensation. *Problemy ekonomiki i yuridicheskoi praktiki = Economic Problems and Legal Practice.* 2018;(5):225–226. (In Russ.).
20. Evnevich M.A., Ivanova D.V. Research on tax administration reforms in the Russian practice. *Daidzhest-Finansy = Digest Finance*. 2020;25(2):157–169. DOI: 10.24891/df.25.2.157
21. Magradze T. Tax administration in the Russian Federation: Current problems and development prospects. *Colloquium-Journal*. 2020;(5):129–132. DOI: 10.24411/2520–6990–2020–11439
22. Sizova M.O. Legal framework for tax control in transactions between related parties in the Russian Federation. *Skif. Voprosy studencheskoi nauki = Sciff. Issues of Students' Science.* 2019;(4):431–434.
23. Timchenko T.N. Conditions for collecting VAT on goods imported into free economic zones. *Trud i sotsial'nye otnosheniya = Labour and Social Relations Journal*. 2020;(3):158–170. DOI: 10.20410/2073–7815–2020–30–3–158–170
24. Arestova Yu.A., Tonkonog V.V. Directions for the development of the Federal customs service and the Federal tax service on interagency cooperation. *Trud i sotsial'nye otnosheniya = Labour and Social Relations Journal*. 2020;(3):171–184. DOI: 10.20410/2073–7815–2019–30–3–171–184
25. Pakhomov S.V. Organizational and legal issues of interaction between law enforcement and tax authorities in detecting signs of tax crimes (on the example of agroindustrial complex functioning). *Vestnik Krasnodarskogo universiteta MVD Rossii = Bulletin of Krasnodar University of Russian MIA*. 2019;(1):41–44. (In Russ.).

ABOUT THE AUTHOR

Elena Yu. Mitusova — senior state tax inspector OKP No. 2, Interregional Inspectorate of the Federal Tax Service of Russia for the largest taxpayers No. 9, Moscow, Russia
Mitusova1996@mail.ru

The article was submitted on 22.04.2021; revised on 06.05.2021 and accepted for publication on 17.05.2021.
The author read and approved the final version of the manuscript.

ORIGINAL PAPER

DOI: 10.26794/2587-5671-2020-25-5-186-199
UDC 336.7(045)
JEL E58, G21, C53

Comparative Analysis of Machine Learning Methods to Identify Signs of Suspicious Transactions of Credit Institutions and Their Clients

Yu.M. Beketnova
Financial University, Moscow, Russia
https://orcid.org/0000-0002-1005-6265

ABSTRACT

In the field of financial monitoring, it is necessary to promptly obtain objective assessments of economic entities (in particular, credit institutions) for effective decision-making. Automation of the process of identifying unscrupulous credit institutions based on machine learning methods will allow regulatory authorities to quickly identify and suppress illegal activities. The **aim** of the research is to substantiate the possibilities of using machine learning methods and algorithms for the automatic identification of unscrupulous credit institutions. It is required to select a mathematical toolkit for analyzing data on credit institutions, which allows tracking the involvement of a bank in money laundering processes. The paper provides a comparative analysis of the results of processing data on the activities of credit institutions using classification **methods** — logistic regression, decision trees. The author applies support vector machine and neural network methods, Bayesian networks (Two-Class Bayes Point Machine), and anomaly search — an algorithm of a One-Class Support Vector Machine and a PCA-Based Anomaly Detection algorithm. The study presents the results of solving the problem of classifying credit institutions in terms of possible involvement in money laundering processes, the results of analyzing data on the activities of credit institutions by methods of detecting anomalies. A comparative analysis of the results obtained using various modern algorithms for the classification and search for anomalies is carried out. The author **concluded** that the PCA-Based Anomaly Detection algorithm showed more accurate results compared to the One-Class Support Vector Machine algorithm. Of the considered classification algorithms, the most accurate results were shown by the Two-Class Boosted Decision Tree (AdaBoost) algorithm. The research results can be used by the Bank of Russia and Rosfinmonitoring to automate the identification of unscrupulous credit institutions.

Keywords: suspicious transactions; money laundering; bank; credit institution; anomaly detection methods; machine learning

For citation: **Beketnova Yu.M. Comparative analysis of machine learning methods to identify signs of suspicious transactions of credit institutions and their clients. *Finance: Theory and Practice*. 2021;25(5):186-199. DOI: 10.26794/2587-5671-2021-25-5-186-199**

INTRODUCTION

Credit organizations [and other subjects of Federal Law No. 115-FZ dated 07.08.2001 "On Counteracting Legalization (Laundering) of Criminally Obtained Incomes and Financing of Terrorism"[1]] are on the first line in the fight against illegal financial activities. They are designed to collect and analyze information about their clients and their financial transactions and report in case of suspicious activity in Rosfinmonitoring. However, credit institutions can also be involved in illegal activities, deliberately covering up shadow schemes, or because of a weak internal control system.

Money laundering processes affect various sectors of the economy and are reflected, for example, in the amount of taxes and fees paid, money withdrawn abroad, the dynamics of the creation and liquidation of Russian legal entities, foreign trade, and the general state of crime, migration trends, etc.

Rosfinmonitoring is the central link in the Russian anti-money laundering system, interacting on this issue with other financial intelligence units, international organizations, federal executive authorities, law enforcement agencies, and credit institutions.

In the process of financial monitoring, the following negative manifestations can be identified on the part and/or in relation to credit institutions:

- using the banking infrastructure to organize schemes for the provision of shadow financial services and money laundering;
- withdrawal of funds from the bank — for example, the issuance of deliberately bad loans before bankruptcy or deliberate bankruptcy;
- bankruptcy of a credit institution.

In practice, one has to deal with a combination of these components at different degrees of their manifestation. Therefore, in the future, we will use the term "deviant component of a credit institution's activities", meaning one or more of the negative manifestations described above.

The features of the analysis of financial monitoring data and the identification of persons and organizations involved in money laundering are as follows:

1. Deviant subjects seek to hide their involvement in illegal activities and actively disguise themselves as law-abiding participants, using modern information technologies and expert knowledge of professionals in the field of finance, law, etc.

2. In connection with Clause 1, Rosfinmonitoring analysts need to analyze large volumes of heterogeneous data to identify hidden violations.

3. Carrying out this kind of analysis for each object requires from the analyst deep professional knowledge and practical experience in the subject area, on the one hand, and significant time resources, on the other.

When analyzing credit institutions, Rosfinmonitoring analysts have to operate with large amounts of information. We provide some statistics to illustrate this claim.

According to the official information of the Bank of Russia, as of 01.01.2020, there are 442 credit institutions and 618 branches[2] operating in the Russian Federation. Bank reporting contains hundreds of parameters. In addition, the federal database of Rosfinmonitoring maintains its own records of information on each credit institution — up to 50 data fields.

In addition to the initial data in the federal database of Rosfinmonitoring, statistics and additional identification information is generated for each type of object — addresses, data of identity documents, etc. Rosfinmonitoring's departmental data is

[1] Federal Law No. 115-FZ of 07.08.2001 "On Counteracting the Legalization (Laundering) of Criminally Obtained Incomes and Financing of Terrorism". Reference and legal system "Consultant Plus". URL: http://www.consultant.ru/document/cons_doc_LAW_32834/ (accessed on 04.10.2020).

[2] Reference book on credit institutions. URL: https://www.cbr.ru/banking_sector/credit (accessed on 14.11.2020).

enriched with information from various state registers, information on the foreign economic activity of entities, tax information.

The effectiveness of the anti-money laundering system largely depends on its ability to timely identify trends and patterns in the activities of entities, which necessitates the prompt receipt of objective assessments of the work of objects of financial monitoring.

Traditionally, state bodies use an approach to inspections of objects of supervision, which consists of the sequential assessment by an expert of one object of inspection after another. Such assessments may have expert subjectivity [1, 2]. In addition, this approach is resource- and time-consuming.

The growing volume of incoming information (approximately 20% annually) leads to a decrease in the efficiency of its processing. Those responsible for making decisions are forced to work with subjective analysis results for long periods of time for their receipt [3].

The analysis of the tasks of Rosfinmonitoring in combating money laundering showed that the real need for the number of analyzed objects is many times greater than the capabilities of analysts. This problematic situation requires prioritizing checks.

The diversity of information resources and a significant volume exclude the possibility of manual processing.

A transition is required from sequential expert inspections of individual objects to parallel massive automated inspections, considering modern methodological and instrumental capabilities in the context of the digital transformation of public administration.

Modern methods of data analysis and machine learning can serve as a necessary tool for this. And the automation of the process of identifying unscrupulous credit institutions based on machine learning methods will allow regulatory authorities to quickly identify and suppress illegal activities.

The problem of money laundering through the banking sector is now well understood. There are many publications devoted to risk-based banking supervision in order to combat money laundering and terrorist financing, for example [4–8]. Much of the research in this area is aimed at improving internal control rules in banks and introducing know-your-customer principles. At the same time, the deviant component of a credit institution's activities may be associated not only with the illegal activities of its clients but also with the actions of the bank's management. And studies devoted to automating the identification of unscrupulous banks to combat money laundering and terrorist financing are quite rare. This article is intended to fill this gap, since, unlike existing studies, it analyzes the issues of automating the identification of banks' involvement in money laundering.

Research hypothesis: the diagnosis of a bank's involvement in money laundering processes can be carried out using machine learning methods.

The aim of the study is to substantiate the possibility of using machine learning methods and algorithms for the automatic identification of unscrupulous credit institutions. To do this, it is necessary to select a mathematical toolkit for analyzing data on credit institutions, which makes it possible to diagnose the involvement of a bank in money laundering processes.

ANALYSIS OF WORKS OF DOMESTIC AND FOREIGN SCIENTISTS ON THE APPLICATION OF MACHINE LEARNING METHODS

The problem of identifying deviant objects of financial monitoring — shell companies, banks acting as platforms for money laundering, credit organizations on the verge of bankruptcy and withdrawal of financial assets, unscrupulous participants in the securities market — can be approached as a classification problem.

Let us turn to the methods and algorithms that allow us to solve similar problems in the field of financial monitoring.

Logistic regression

Logistic regression is a well-studied and widely used technique in statistics. In modern studies, highlighted in publications [9–11], logistic regression is used in combination with other methods or for comparison with them [12, 13].

Decision trees

Decision trees have a number of advantages when solving classification problems:

- efficient in computing and using computer memory, which makes them suitable for working with large amounts of data;
- the choice of functions is integrated into the learning and classification processes;
- non-parametric models, which allows processing data with different distributions.

One of the significant tasks in solving classification problems is the imbalance of classes. This research is devoted to its solution [14–18].

A Two-Class Decision Forest is a concrete implementation of a decision forest that works by building multiple decision trees and then voting for the most popular output class. Voting is one of the most well-known methods of obtaining results in the ensemble model. Trees with high prediction confidence will have more weight in the final ensemble solution. Decision forest has been successfully used in socio-economic research. The study [19], which deals with the issues of energy supply to the population is an example of it.

The AdaBoost algorithm creates an ensemble of weak classifiers that are called in a cascade, each subsequent tree corrects the errors of the previous one, and the predictions are based on a set of trees. The *AdaBoost* algorithm has been successfully used in research data in the field of healthcare [20], the lending [21], and detecting fraud with bank cards [22, 23].

Support vector machine

A *Two-Class Support Vector Machine* creates a binary classification model using a support vector machine algorithm. The Two-Class Support Vector Machine is a supervised learning algorithm for tagged data.

Neural networks

Classification using neural networks is a supervised learning method and therefore requires a tagged dataset that includes a tag column. A *Two-Class Neural Network* algorithm is used to predict binary outcomes, such as whether a patient has a specific disease, whether a machine might fail within a certain period of time, or whether there are deviations from a specific financial monitoring entity.

Bayesian networks

Bayesian networks are mainly used for solving diagnostic problems. For example, they are often used in medicine, credit scoring [24, 25], and in other tasks requiring risk assessment.

The *Two-Class Bayes Point Machine* algorithm uses a Bayesian approach to linear classification, it effectively approximates the theoretically optimal Bayesian mean for linear classifiers (in terms of generalization efficiency) by choosing one “mean” classifier, the Bayesian point.

Combined methods

Combining classification algorithms in solving practical problems can also show good results, with examples presented in studies [26–28].

The paper [29] proposes the concept of combining boost algorithms and support vector machines, which has shown high performance. In [30], the use of ensemble learning based on *XGBoost* for processing data from wearable sensors about the actions of the elderly was investigated.

The article [31] proposes a combined classifier using a support vector machine, PCA-based, and *k*-nearest neighbors algorithm

methods for data processing in a gas analyzer. The work [32] studied the efficiency of ensembles of classifiers in the problems of predicting customer churn.

Anomalies detection

Another promising direction for solving financial monitoring problems is detecting anomalies. This group of methods has become widespread in modern conditions.

The problems of anomalies detection require knowing the set of values of the features $x^{(1)}, x^{(2)},..., x^{(m)}$, in order to find objects that are very different from others. The most popular anomaly detection tasks are identifying fraudulent transactions [22, 33–35], technical problems [36], detecting network intrusions, checking the values entered into the system, finding tax violators, etc.

A *One-class Support Vector Machine* creates a model that trains on data that has only one class, which is "non-anomalous". It displays the properties of "non-anomalous" cases and from these properties can predict which cases differ from the usual ones.

A *PCA-Based Anomaly Detection* algorithm analyzes the available data to determine what constitutes a "normal" class and applies distance metrics to detect anomalies [37, 38]. To detect anomalies, the projection of the values onto the eigenvectors is computed together with the normalized recovery error. Normalized error is used as an indicator of anomaly. The higher the error, the more anomalous the case is.

Classification algorithms are widely used for data analysis in medicine and healthcare [39–41].

Thus, we can conclude that any subject area has specific features, and the solution of practical problems requires the choice of a mathematical apparatus, and therefore this study is relevant.

RESEARCH METHODOLOGY

The sample of data for analysis included 334 credit institutions, 51 of them had their licenses revoked. The indicators of the bank reporting form No. 101 are investigated, in particular, the following groups of indicators are considered:

- investments in securities;
- investments in the capital of other organizations;
- loans to individuals;
- loans to enterprises and organizations;
- overdue debt;
- fixed assets and intangible assets;
- other assets;
- deposits of individuals;
- funds of enterprises and organizations.

The data slice is analyzed three months before the license revocation — based on the long-term practice of combating money laundering, this period was considered optimal, since, on the one hand, the deviant component of the bank's activities has time to manifest itself. clearly (it has been experimentally established that it *begins* to manifest itself about 6 months before the license is revoked), and on the other hand, there is still a sufficient margin of time for taking measures.

A number of experiments were carried out on data processing using binary classification algorithms:

- Two-Class Boosted Decision Tree;
- Two-Class Support Vector Machine;
- Two-Class Logistic Regression;
- Two-Class Decision Tree;
- Two-Class Neural Network;
- Two-Class Bayes Point Machine.

And for anomaly detection the One-Class Support Vector Machine and PCA-Based Anomaly Detection algorithms were used.

To determine the quality of the resulting models, we will use the *ROC* curve (Receiver operating feature) — this is a graph that allows us to assess the quality of a binary classification. The *ROC* curve displays the ratio between the proportion of objects from the total number of feature carriers, correctly classified as bearing a feature, and the share of objects from their total number, which do

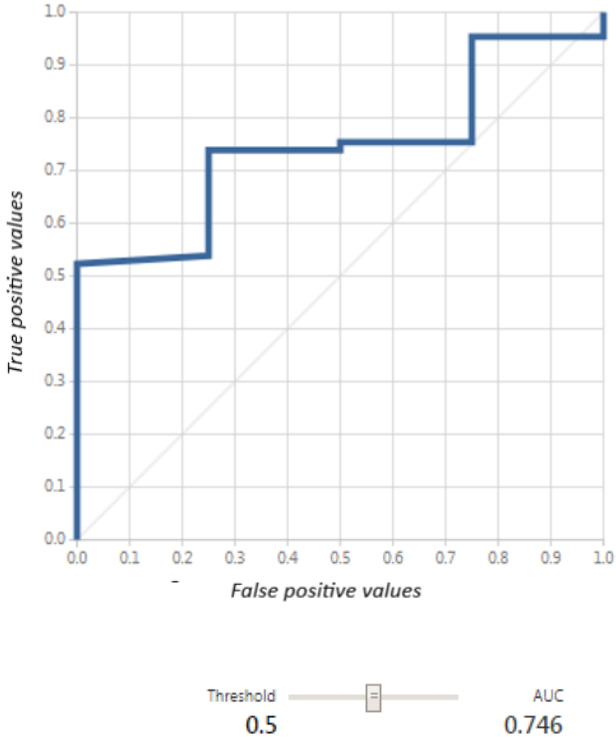

Fig. 1. **ROC curve and accuracy metrics for a Two-Class Boosted Decision Tree model**

Source: compiled by the author.

not carry a feature, erroneously classified as carrying a feature.

A quantitative interpretation of the *ROC* curve is provided by the *AUC* (area under the *ROC* curve) indicator — the area bounded by the *ROC* curve and the axis of the proportion of false-positive classifications [42–44]. The higher the *AUC*, the better the algorithm, the equality of the indicator 0.5 is equivalent to random fortune-telling.

The experiments were carried out on the *Microsoft Azure Machine Learning Studio* platform. *MS Azure ML* implements the capabilities of data analysis by various methods, including methods of classification, regression, cluster analysis, and anomaly search.

RESEARCH RESULTS

Let us demonstrate the classification of banks by prepared data using the two-class strengthened decision tree algorithm.

Fig. 1 shows the *ROC* curve of the constructed model; the value of the accuracy index AUC is 0.746.

Let's construct a Two-Class Support Vector Machine model for comparison (*Fig. 2*).

The *AUC* indicator for the constructed model is 0.619.

We will now build a Two-Class Logistic Regression and Two-Class Decision Tree models. The *ROC* curves are shown in *Fig. 3*.

The accuracy index of the *AUC* models is 0.588 for the Two-Class Logistic Regression model and 0.538 for the Two-Class Decision Tree, respectively.

Let's build a model of a Two-Class Neural Network. The *ROC* curve and accuracy index are shown in *Fig. 4*. The accuracy index of the *AUC* models is 0.654. We note that the neural network is built for three hidden layers. An increase in the number of hidden layers led to a deterioration in the quality indicators of the model's accuracy.

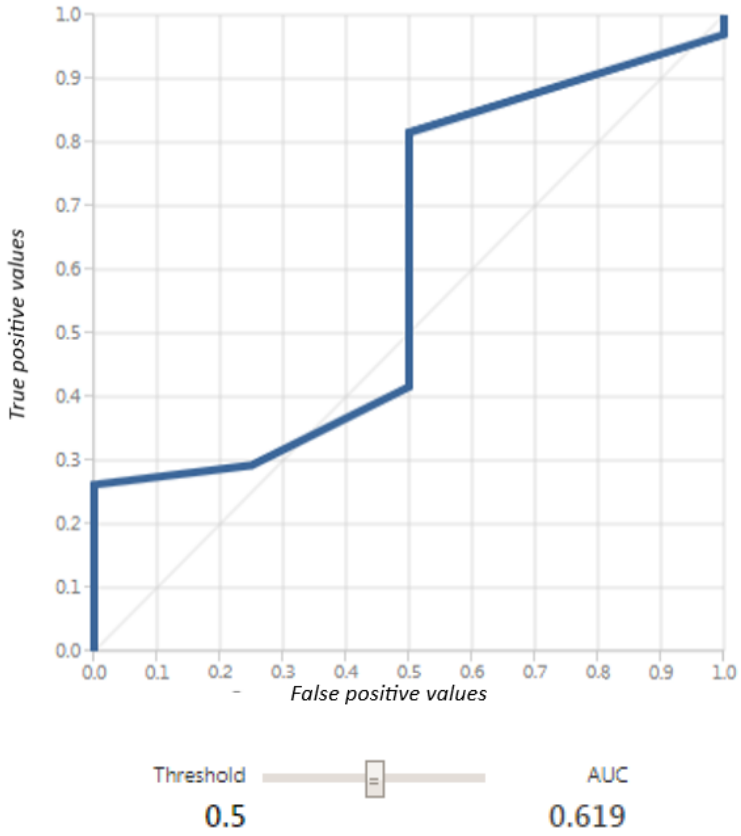

Fig. 2. **ROC curve and accuracy metrics for a Two-Class Support Vector Machine model**

Source: compiled by the author.

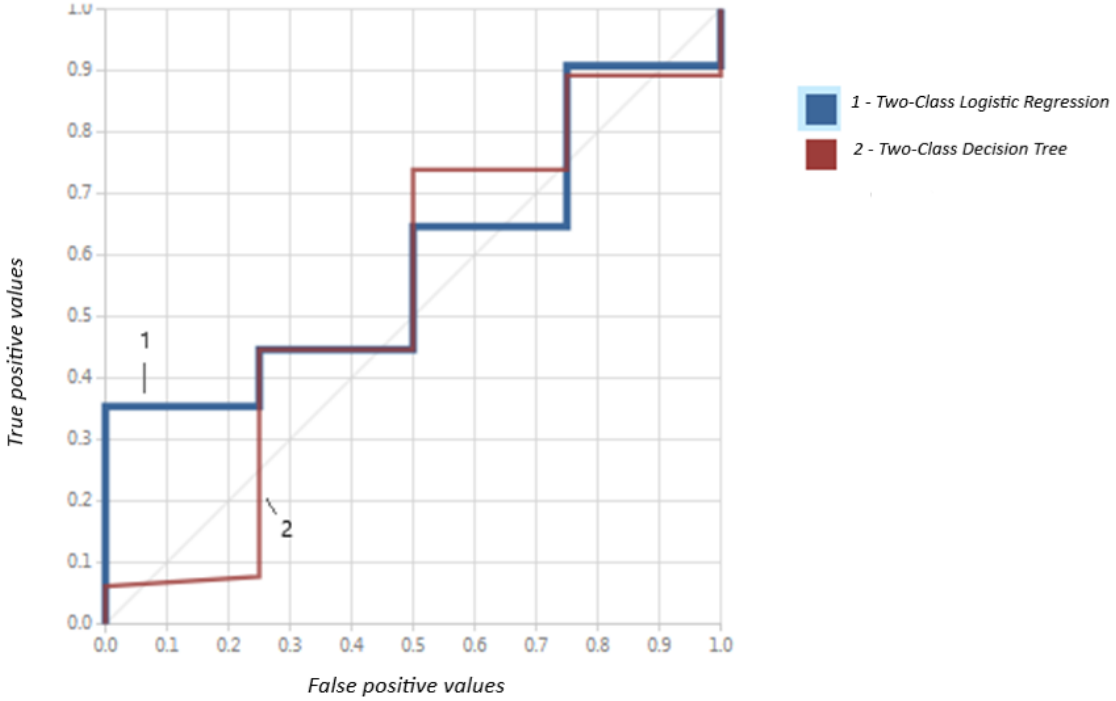

Fig. **ROC curves for Two-class Logistic Regression and Two-Class Decision Tree models**

Source: compiled by the author.

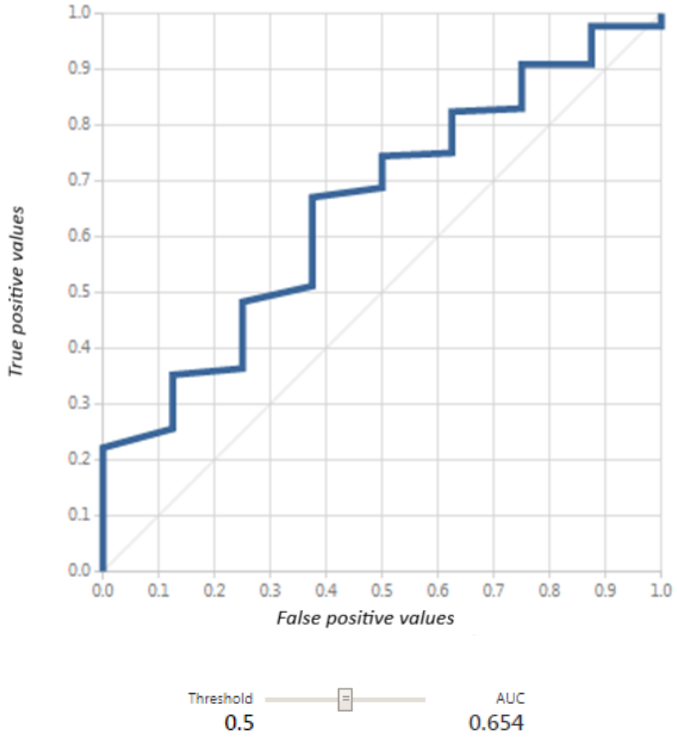

Fig. 4. **ROC curve and accuracy metrics for a Two-Class Neural Network**

Source: compiled by the author.

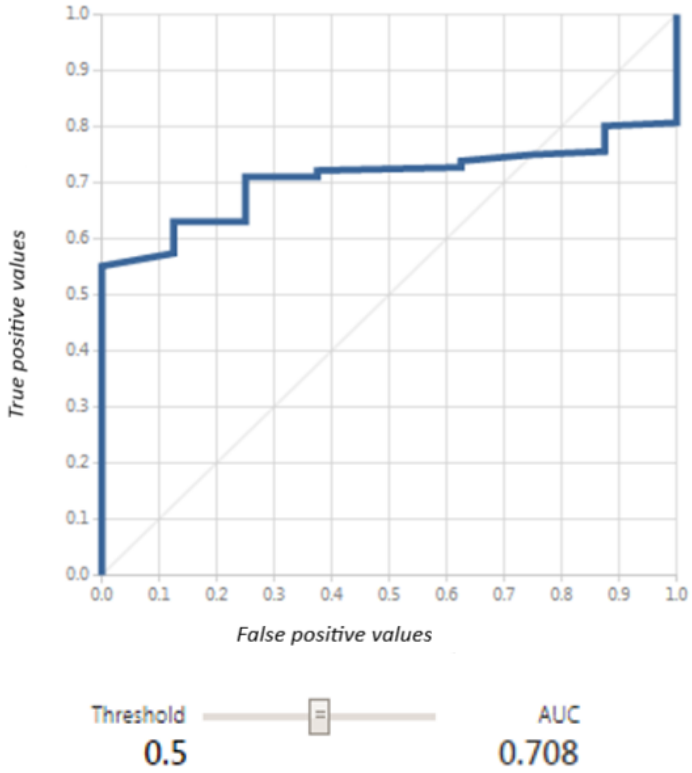

Fig. 5. **ROC curve and accuracy metrics for a Two-Class Bayes Point Machine**

Source: compiled by the author.

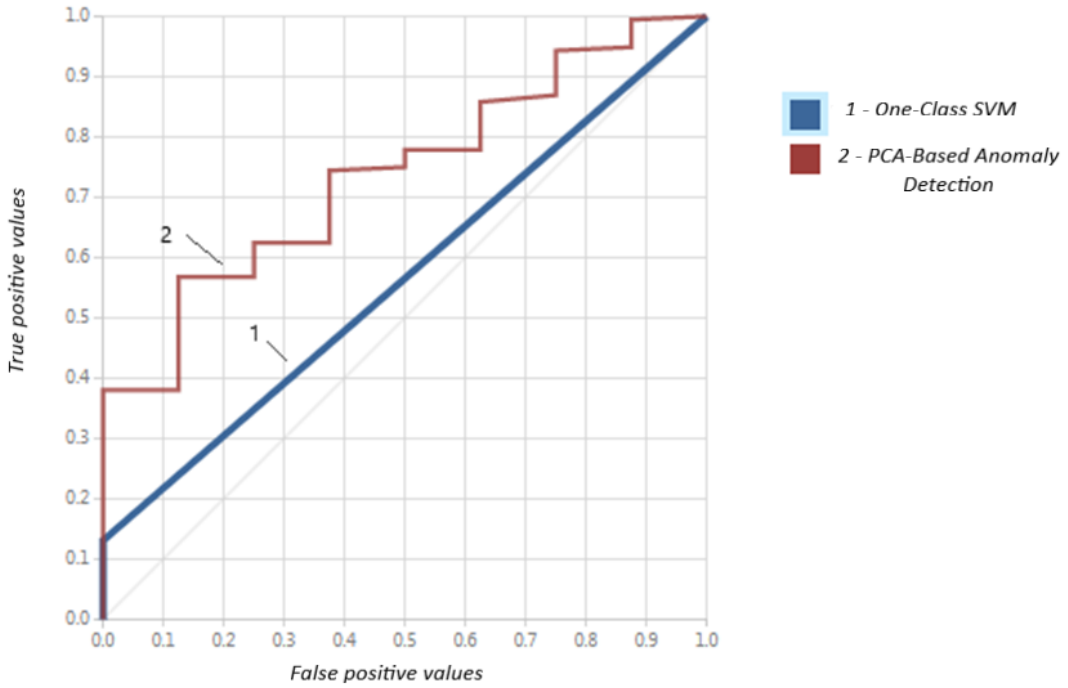

Fig. 6. **ROC curves for One-Class Support Vector Machine models and PCA-Based Anomaly Detection method**

Source: compiled by the author.

Let's build a model of a Two-Class Bayes Point Machine. The *ROC* curve and accuracy index are shown in *Fig. 5*. The accuracy index of the *AUC* models is 0.708.

Now let's look at anomaly detection algorithms — a One-Class Support Vector Machine and a PCA-Based Anomaly Detection algorithm. *ROC* curves for the One-Class Support Vector Machine and the PCA-Based Anomaly Detection models are presented in *Fig. 6*. The accuracy index of the *AUC* models is 0.683 for the One-Class Support Vector Machine model and 0.739 for the PCA-Based Anomaly Detection algorithm, respectively.

Table 1 shows the quality indicators of all models.

It can be concluded that the most accurate results were given by the Two-Class Boosted Decision Tree algorithm, and the PCA-Based Anomaly Detection algorithm method gives more accurate results compared to the One-Class Support Vector Machine algorithm.

Below are the predicted probabilities of license revocation obtained using the *Adaboost* algorithm. *Table 2* presents comparison results.

To assess the quality of the results, 50 credit institutions without deviations with a good reputation and 100 credit institutions knowingly involved in suspicious transactions were expertly selected. The greater number of objects with the lowest rating values is justified by the fact that in the tasks of financial monitoring, as a rule, it is required to find exactly deviant objects.

Of the 100 credit institutions identified as "deviant" (51 credit institutions had their licenses revoked within three months, another 46 banks had their licenses revoked within 4–10 months), *Adaboost* also classified 82 credit institutions as deviant.

Of the 50 lending institutions identified as "non-deviant", *Adaboost* classified 50 banks as "non-deviant".

Thus, the false positive rate for *Adaboost* will be:

$$False\ Positive\ Rate = FP/(TN + FP) = 0/(50 + 0) = 0.$$

The false negative rate will be:

$$False\ Negative\ Rate = FN/(TP + FN) = 18/(82 + 18) = 0.18.$$

Table 1

AUC metrics for algorithms for detecting deviations in the activities of credit institutions

	Anomaly detection algorithms		Classification algorithms					
	One-Class Support Vector Machine	PCA-Based Anomaly Detection	Two-Class Logistic Regression	Two-Class Decision Tree	Two-Class Boosted Decision Tree	Two-Class Neural Network	Two-Class Support Vector Machine	Two-Class Bayes Point Machine
AUC value	0.683	0.739	0.588	0.538	0.746	0.654	0.619	0.708

Source: compiled by the author.

Table 2

The results of the assessment of credit institutions (fragment of the table)

Bank	Has the license been revoked by the Bank of Russia	Is the bank deviant according to the AdaBoost algorithm
Sberbank	Not revoked	Non-deviant
VTB Bank	Not revoked	Non-deviant
Raiffeisenbank	Not revoked	Non-deviant
Bank GPB	Not revoked	Non-deviant
Alfa-Bank	Not revoked	Non-deviant
ROSBANK	Not revoked	Non-deviant
Rosselkhozbank	Not revoked	Non-deviant
…		
AO KB BRT	Revoked	Non-deviant
Bank RKB	Revoked	Deviant
AKB GAZSTROYBANK	Revoked	Deviant
KB TETRAPOLIS	Revoked	Deviant
KB MVKB	Revoked	Deviant
KB MEZHTRASTBANK	Revoked	Deviant
KB Prisko Capital Bank	Revoked	Deviant

Source: compiled by the author.

CONCLUSIONS

The article defines the specificity of the analysis of objects of financial monitoring, in particular, credit institutions, which is due to the high latency of deviant entities and their activities, the large volume and heterogeneous nature of information requiring analysis and interpretation, high requirements for professional knowledge and practical experience of expert analysts, and also significant time expenditures for the analysis of each individual subject.

Automation of the process of identifying unscrupulous credit institutions based on machine learning methods will allow regulatory authorities to promptly identify and suppress illegal activities.

In the field of financial monitoring, in order to make effective management decisions, it is necessary to promptly obtain objective assessments of economic entities (in particular, credit institutions), which, taking into account the specifics of the subject area, excludes a sequential manual check of the activities of entities. Automation of the process of identifying unscrupulous credit institutions based on machine learning methods will allow regulatory authorities to promptly identify and suppress illegal activities.

In order to automate the analysis of data on credit institutions, a mathematical toolkit has been selected that makes it possible to diagnose the involvement of a bank in the processes of money laundering. For this, a comparative analysis of the results of processing data on the activities of credit institutions was carried out using classification methods — logistic regression, decision trees (Two-Class Decision Forest algorithms, *Adaboost*), support vector machine (Two-Class Support Vector Machine algorithm), neural network methods (Two-Class Neural Network algorithm), Bayesian networks (Two-Class Bayes Point Machine algorithm) and anomaly detection — One-Class Support Vector Machine algorithm and PCA-Based Anomaly Detection algorithm.

The PCA-Based Anomaly Detection algorithm showed more accurate results compared to the One-Class Support Vector Machine algorithm. Of the considered classification algorithms, the most accurate results were shown by the Two-Class Boosted Decision Tree algorithm (*Adaboost*).

This confirms the hypothesis of the study on the possibility of diagnosing the involvement of a bank in the processes of money laundering using machine learning methods.

The above research results can be used by the Bank of Russia and Rosfinmonitoring to automate the identification of unscrupulous credit institutions.

REFERENCES

1. Kurkina E.P., Shuvalova D.G. Risk assessment: Expert method. *Problemy nauki.* 2017;(1):63–69. (In Russ.).
2. Zakharyan A.G. Expert assessment of the complex sustainability of a commercial bank. *Finansovye issledovaniya*. 2004;(9):14–19. (In Russ.).
3. Beketnova Yu.M., Krylov G.O., Denisenko A.S. The Problems of management and decision support in the government authorities on the example of the Rosfinmonitoring. *Informatizatsiya i svyaz' = Informatization and Communication*. 2018;(2):82–88. (In Russ.).
4. Klochko A.N., Logvinenko N.I., Kobzeva T.A., Kiselyova E.I. Legalizing proceeds from crime through the banking system. *Kriminologicheskii zhurnal Baikal'skogo gosudarstvennogo universiteta ekonomiki i prava = Criminology Journal of Baikal National University of Economics and Law*. 2016;10(1):194–204. (In Russ.). DOI: 10.17150/1996–7756.2016.10(1).194–204

5. Kononova N.P., Patlasov O. Yu., Kononov E.D. The risk-focused approach in the sphere of counteraction to laundering of the income and to financing terrorism. *Nauka o cheloveke: gumanitarnye issledovaniya = The Science of Person: Humanitarian Researches*. 2016;(2):183–189. (In Russ.). DOI: 10.17238/issn1998–5320.2016.24.183
6. Kuznetsova E.I., Burykin D.V., Masterova S.A. Risk-oriented internal control of credit institutions in the field of combating the legalization of proceeds from crime. *Vestnik ekonomicheskoi bezopasnosti = Vestnik of Economic Security*. 2017;(2):299–302. (In Russ.).
7. Pryakhin G.N., Ameleshin K.A. Improvement of methods of countering the legalization of criminal income and financing terrorism in the banking system. *Vestnik Chelyabinskogo gosudarstvennogo universiteta = CSU Bulletin*. 2019;(3):28–34. (In Russ.). DOI: 10.24411/1994–2796–2019–10304
8. Filatova I.V. Application of a risk-based approach to counteract the legalization (laundering) of proceeds from crime. *Vestnik Moskovskogo universiteta MVD Rossii = Vestnik of Moscow University of the Ministry of Internal Affairs of Russia*. 2019;(1):233–236. (In Russ.). DOI: 10.24411/2073–0454–2019–10055
9. Pavlidis N.G., Tasoulis D.K., Adams N.M., Hand D.J. Adaptive consumer credit classification. *Journal of the Operational Research Society*. 2012;63(12):1645–1654. DOI: 10.1057/jors.2012.15
10. Yap B.W., Ong S.H., Husain N.H.M. Using data mining to improve assessment of credit worthiness via credit scoring models. *Expert Systems with Applications*. 2011;38(10):13274–13283. DOI: 10.1016/j.eswa.2011.04.147
11. Khemais Z., Nesrine D., Mohamed M. Credit scoring and default risk prediction: A comparative study between discriminant analysis & logistic regression. *International Journal of Economics and Finance*. 2016;8(4):39. DOI: 10.5539/ijef.v8n4p39
12. Li Z., Tian Y., Li K., Zhou F., Yang W. Reject inference in credit scoring using semi-supervised support vector machines. *Expert Systems with Applications*. 2017;74:105–114. DOI: 10.1016/j.eswa.2017.01.011
13. Louzada F., Anacleto-Junior O., Candolo C., Mazucheli J. Poly-bagging predictors for classification modelling for credit scoring. *Expert Systems with Applications*. 2011;38(10):12717–12720. DOI: 10.1016/j.eswa.2011.04.059
14. Siers M.J., Islam M.Z. Class imbalance and cost-sensitive decision trees: A unified survey based on a core similarity. *ACM Transactions on Knowledge Discovery from Data*. 2021;15(1):4. DOI: 10.1145/3415156
15. Bunkhumpornpat C., Sinapiromsaran K. Density-based majority under-sampling technique. *Knowledge and Information Systems*. 2017;50(3):827–850. DOI: 10.1007/s10115–016–0957–5
16. Devi D., Biswas S., Purkayastha B. A cost-sensitive weighted random forest technique for credit card fraud detection. In: The 10th Int. conf. on computing, communication and networking technologies (ICCCNT). (Kanpur, July 6–8, 2019). New York: IEEE; 2019. DOI: 10.1109/ICCCNT45670.2019.8944885
17. Zhang S. Multiple-scale cost sensitive decision tree learning. *World Wide Web*. 2018;21(6):1787–1800. DOI: 10.1007/s11280–018–0619–5
18. Zhu B., Baesens B., vanden Broucke S.K.L.M. An empirical comparison of techniques for the class imbalance problem in churn prediction. *Information Sciences*. 2017;408:84–99. DOI: 10.1016/j.ins.2017.04.015
19. Hurst W., Montanez C.A.C., Shone N. Towards an approach for fuel poverty detection from gas smart meter data using decision tree learning. In: Proc. 2020 3rd Int. conf. on information management and management science (IMMS). (London, Aug. 7–9, 2020). New York: Association for Computing Machinery; 2020:23–28. DOI: 10.1145/3416028.3416034
20. Al-Yarimi F.A.M., Munassar N.M.A., Al-Wesabi F.N. Electrocardiogram stream level correlated patterns as features to classify heartbeats for arrhythmia prediction. *Data Technologies and Applications*. 2020;54(5):685–701. DOI: 10.1108/DTA-03–2020–0076
21. Malhotra D.K., Malhotra K., Malhotra R. Evaluating consumer loans using machine learning techniques. In: Lawrence, K.D., Pai D.R., eds. Applications of Management Science. Bingley: Emerald Publishing Ltd; 2020;20:59–69. DOI: 10.1108/S0276–897620200000020004

22. Yang Y., Liu C., Liu N. Credit card fraud detection based on CSat-related AdaBoost. In: Proc. 2019 8th Int. conf. on computing and pattern recognition (ICCPR'19). (Beijing, Oct. 23–25, 2019). New York: Association for Computing Machinery; 2019:420–425. DOI: 10.1145/3373509.3373548
23. Tran P.H., Tran K.P., Huong T.T., Heuchenne C., Tran P.H., Le T.M.H. Real time data-driven approaches for credit card fraud detection. In: Proc. 2018 Int. conf. on e-business and applications (ICEBA 2018). (Da Nang, Feb. 23–25, 2018). New York: Association for Computing Machinery; 2018:6–9. DOI: 10.1145/3194188.3194196
24. Wu W.-W. Improving classification accuracy and causal knowledge for better credit decisions. *International Journal of Neural Systems*. 2011;21(4):297–309. DOI: 10.1142/S0129065711002845
25. Zhu H., Beling P.A., Overstreet G.A. A Bayesian framework for the combination of classifier outputs. *Journal of the Operational Research Society*. 2002;53(7):719–727. DOI: 10.1057/palgrave.jors.2601262
26. Marqués A.I., García V., Sánchez J.S. Two-level classifier ensembles for credit risk assessment. *Expert Systems with Applications*. 2012;39(12):10916–10922. DOI: 10.1016/j.eswa.2012.03.033
27. Vukovic S., Delibasic B., Uzelac A., Suknovic M. A case-based reasoning model that uses preference theory functions for credit scoring. *Expert Systems with Applications*. 2012;39(9):8389–8395. DOI: 10.1016/j.eswa.2012.01.181
28. Akkoç S. An empirical comparison of conventional techniques, neural networks and the three-stage hybrid Adaptive Neuro Fuzzy Inference System (ANFIS) model for credit scoring analysis: The case of Turkish credit card data. *European Journal of Operational Research*. 2012;222(1):168–178. DOI: 10.1016/j.ejor.2012.04.009
29. Turchetti Maia T., Pádua Braga A., de Carvalho A.F. Hybrid classification algorithms based on boosting and support vector machines. *Kybernetes*. 2008;37(9/10):1469–1491. DOI: 10.1108/03684920810907814
30. Wu Y., Qi S., Hu F., Ma S., Mao W., Li W. Recognizing activities of the elderly using wearable sensors: A comparison of ensemble algorithms based on boosting. *Sensor Review*. 2019;39(6):743–751. DOI: 10.1108/SR-11–2018–0309
31. Faleh R., Gomri S., Othman M., Aguir K., Kachouri A. Enhancing WO_3 gas sensor selectivity using a set of pollutant detection classifiers. *Sensor Review*. 2018;38(1):65–73. DOI:10.1108/SR-12–2016–0273
32. Lee S.-C., Faloutsos C., Chae D.-K., Kim S.-W. On detecting frauds in comparison-shopping services. In: Proc. 26th Int. conf. on world wide web companion (WWW'17 Companion). (Perth, Apr. 3–7, 2017). Geneva: IWWWC Steering Committee; 2017:811–812. DOI: 10.1145/3041021.3054219
33. Sohony I., Pratap R., Nambiar U. Ensemble learning for credit card fraud detection. In: Proc. ACM India joint int. conf. on data science and management of data (CoDS-COMAD'18). (Goa, Jan. 11–13, 2018). New York: Association for Computing Machinery; 2018:289–294. DOI: 10.1145/3152494.3156815
34. Lucas Y., Portier P.-E., Laporte L., Calabretto S., Caelen O., He-Guelton L., Granitzer M. Multiple perspectives HMM-based feature engineering for credit card fraud detection. In: Proc. 34th ACM/SIGAPP Symp. on applied computing (SAC'19). (Limassol, Apr. 8–12, 2019). New York: Association for Computing Machinery; 2019:1359–1361. DOI: 10.1145/3297280.3297586
35. Li Q., Xie Y. A behavior-cluster based imbalanced classification method for credit card fraud detection. In: Proc. 2019 2nd Int. conf. on data science and information technology (DSIT 2019). (Seoul, July 19–21, 2019). New York: Association for Computing Machinery; 2019:134–139. DOI: 10.1145/3352411.3352433
36. Ray S., Wright A. Detecting anomalies in alert firing within clinical decision support systems using Anomaly/Outlier Detection Techniques. In: Proc. 7th ACM Int. conf. on bioinformatics, computational biology, and health informatics (BCB'16). (Seattle, Oct. 2–5, 2016). New York: Association for Computing Machinery; 2016:185–190. DOI: 10.1145/2975167.2975186
37. Geiger B.C., Kubin G. Relative information loss in the PCA. In: Proc. IEEE information theory workshop (ITW). (Lausanne, Sept. 3–7, 2012). New York: IEEE; 2012:562–566. DOI: 10.1109/ITW.2012.6404738
38. Howard M.C. A review of exploratory factor analysis decisions and overview of current practices: What we are doing and how can we improve? *International Journal of Human-Computer Interaction*. 2016;32(1):51–62. DOI: 10.1080/10447318.2015.1087664

39. Khan H., Srivastav A., Mishra A.K. Use of classification algorithms in health care. In: Tanwar P., Jain V., Liu C.-M., Goyal V., eds. Big data analytics and intelligence: A perspective for health care. Bingley: Emerald Publishing Ltd; 2020:31–54. DOI: 10.1108/978–1–83909–099–820201007
40. Deepa B.G., Senthil S. Constructive effect of ranking optimal features using Random Forest, SupportVector Machine and Naïve Bayes for breast cancer diagnosis. In: Tanwar P., Jain V., Liu C.-M., Goyal V., eds. Big data analytics and intelligence: A perspective for health care. Bingley: Emerald Publishing Ltd; 2020:189–202. DOI: 10.1108/978–1–83909–099–820201014
41. Ramaswami G., Susnjak T., Mathrani A., Lim J., Garcia P. Using educational data mining techniques to increase the prediction accuracy of student academic performance. *Information and Learning Sciences*. 2019;120(7/8):451–467. DOI: 10.1108/ILS-03–2019–0017
42. Eskindarov M.A., Soloviev V.I., eds. Paradigms of the digital economy: Artificial intelligence technologies in finance and FinTech. Moscow: Cogito-Center; 2019. 325 p. (In Russ.).
43. Lee J.-S. AUC4.5: AUC-based c4.5 decision tree algorithm for imbalanced data classification. *IEEE Access*. 2019;7:106034–106042. DOI: 10.1109/ACCESS.2019.2931865
44. Zhang Q., Wang J., Lu A., Wang S., Ma J. An improved SMO algorithm for financial credit risk assessment — Evidence from China's banking. *Neurocomputing*. 2018;272:314–325. DOI: 10.1016/j.neucom.2017.07.002

ABOUT THE AUTHOR

Yuliya M. Beketnova — Cand. Sci. (Eng.), Assoc. Prof., Information Security Department, Financial University, Moscow, Russia
beketnova@mail.ru

The article was submitted on 25.12.2020; revised on 03.03.2021 and accepted for publication on 17.08.2021. The author read and approved the final version of the manuscript.

ORIGINAL PAPER

DOI: 10.26794/2587-5671-2021-25-5-200-214
UDC 336.6(045)
JEL G32 M21

Accounts Receivable in the Russian Economy: Regional Trends

O.O. Drobotova
Volgograd State Technical University, Volgograd, Russia
https://orcid.org/0000-0002-0898-2390

ABSTRACT

Accounts receivable, being both a sales and financial category, is a key aspect of the development of modern market relations. At the same time, accounts receivable has become a complex object of only microeconomic research. Insufficient knowledge of accounts receivable at the macro level determined the **relevance** of the research. The **subject area** of the research is the total accounts receivable of Russian organizations. The **aim** of the study is to group Russian regions and types of economic activities depending on the conditions of conducting sales and payment activities. The **methodology** consists of a systematic approach, which allowed a comprehensive review of the object of research and macroeconomic analysis, which ensured the reliability and validity of the conclusions of the work. As a result, the author defines the total accounts receivable of organizations in the economy as an independent object of macroeconomic research. Based on the results of the analysis for 2000–2019, the author **concludes** that there is a high degree of correlation between sales revenue and accounts receivable of Russian organizations, as well as the presence of trends in the increasing importance of accounts receivable in sales and the reduction of its overdue part in the finances of organizations. The share of accounts receivable in the total sales revenue of organizations is taken as a generalized characteristic of the conditions for doing business in the sales activities of organizations, and in payment activities — the share of overdue total accounts receivable of organizations. The author's matrix for express assessment of the conditions for conducting sales and payment activities of organizations in the economy constitutes the **scientific novelty** of the study. It made it possible to group the types of activities, regions and districts of the Russian Federation, depending on the specified conditions. The **prospect** for future research of the total accounts receivable of organizations in the economy is the search for tools to determine its optimal volume and structure to timely identify the factors of the upcoming crises of non-payment and overproduction, both in the economy as a whole and in individual commodity markets.

Keywords: accounts receivable; current assets; trade credit; deferred payment; Russian regions; sales activities; payment activity; express assessment matrix; the bankruptcy factor

For citation: **Drobotova O.O. Accounts receivable in the Russian economy: Regional trends. *Finance: Theory and Practice*. 2021;25(5):200-214. DOI: 10.26794/2587-5671-2021-25-5-200-214**

INTRODUCTION

Currently, accounts receivables are an integral attribute of sales and payments in the economy. Saturation of commodity markets, growth and toughening of competition for the client lead to the active use of trade credit as one of the effective instruments of the sales policy of any modern enterprise. The formation of accounts receivable testifies, on the one hand, to the expansion of sales and, on the other hand, to a slowdown in the payment turnover both at an individual enterprise and in the economy of a country or region as a whole.

It should be noted that the illiterate management of accounts receivable at the enterprise, expressed in its unreasonable and uncontrolled increase, is fraught with the formation of significant volumes of overdue and an unrecoverable part of it. This leads to a deterioration in the financial condition of the enterprise and its "rapid progress" to bankruptcy. On a macroeconomic scale, it can lead to a crisis of non-payments and the threat of bankruptcy of most enterprises with all the ensuing negative consequences for the economy.

The opposite extreme — unreasonable avoidance or, in general, a complete refusal to provide a trade loan — will inevitably entail a loss of the customer base (market share), revenue and profit, and, consequently, loss of

competition and exit from the market. These circumstances indicate the importance of accounts receivables as a tool for sales and payment activities in the economy.

In the study of accounts receivables, the macro- and microeconomic levels of study are most clearly manifested. The main emphasis of scientists in considering this issue is made at the micro level, the level of an individual economic entity. Accounts receivable as an object of management at the enterprise is considered from the standpoint of accounting, monitoring, analysis, control, collection and other management stages.

To understand accounts receivables, the key aspects are the identification of value, the basis of origin and the moment of recognition in accounting. Accounts receivable as an accounting object in a separate enterprise arises due to the time gap between the fact of shipment of goods (provision of services, performance of work) and the fact of payment for it. Accounts receivable is considered as an element of the working capital of the organization. According to International Financial Reporting Standards, receivables are treated as a financial instrument or financial asset [IAS 39][1] and [IFRS 9][2] and are measured at fair value [IFRS 13].[3] From the point of view of an accounting approach, accounts receivable is a complex accounting object, covering calculations:

- with buyers and buyers of goods, works and services;
- on advances paid;
- with other debtors;
- with employees on corporate loans granted;
- with accountable persons, etc.

In the accounting practice of organizations, the emphasis of researchers is aimed at organizing an effective system of internal control of accounts receivable, in particular, in compliance with the principles of COSO [1]. At the same time, the problems of structuring and unifying the risks of granting a commercial loan [2], as well as tools for analyzing accounts receivable, emerge [3].

From the point of view of enterprise management, accounts receivables are the object of research attention of scientists in such areas as corporate finance, financial management, economic and financial analysis. At the same time, the key generalizing issue of the study is the relationship and mutual influence, on the one hand, of accounts receivable as an element of working capital, and on the other hand, the financial efficiency and liquidity of the organization in general. U. Rohini, K. Malarkodi, P. Vanitha [4], D. Prša [5] confirmed the positive impact of improving the efficiency of working capital management on the growth of the organization's profit. A more specific positive effect of accelerating accounts receivables turnover on profit growth was revealed by N.H.S. Farhan, M.I. Tabash, M. Yameen [6]. S.Y. Paul, C. Guermat, S. Devi identified the U-shaped effect of upfront capital in receivables on profit and sales growth [7].

Further detailing and deepening of research on debt management of debtors occurs in the following areas:

a) the credit policy of the company, in particular the provision of trade credit, payment for supplies and other conditions;

b) building effective supply chains;

c) development of factoring;

d) relationship with bankruptcy.

Accounts receivable, as an element of the organization's credit policy, is a powerful tool to stimulate sales. In this regard, the formed credit policy acts as a methodological basis

---

[1] International Financial Reporting Standard (IAS) 39 "Financial Instruments: Recognition and Measurement" (introduced in the Russian Federation by order of the Ministry of Finance of Russia No. 217n dated December 28, 2015) (as amended on February 17, 2021). URL: http://www.consultant.ru/document/cons_doc_LAW_193673/635380a79daaf1985963e2aad52fb 23a0549840a/.

[2] International Financial Reporting Standard (IFRS) 9 "Financial Instruments" (introduced in the Russian Federation as amended in 2010 by order of the Ministry of Finance of Russia dated June 27, 2016, No. 98n) (as amended and supplemented, entered into force on January 1, 2018). URL: http://www.consultant.ru/document/cons_doc_LAW_201982/.

[3] International Financial Reporting Standard (IFRS) 13 "Fair Value Measurement" (introduced in the Russian Federation by order of the Ministry of Finance of Russia dated December 28, 2015, No. 217n) (as amended on July 11, 2016). URL: http://www.consultant.ru/document/cons_doc_LAW_193740/.

for the financial management of accounts receivables at the enterprise. Conversely, the development of the companyэs credit policy uses proven effective instruments for managing accounts receivables. According to G.S. Klychova, A.R. Zakirova, Z.Z. Khamidullin, the main elements of the company's credit policy are: control over the formation and status of accounts receivable, analysis and ranking of customers, forecasting the needs of the distributor, determination of the credit limit [8].

When developing a credit policy for an enterprise, it is undoubtedly necessary to consider the findings of the following trade credit studies:

- M.C. Arcuri, R. Pisani determined the substitution effect between trade and bank loans and determined the predominance of trade credit over bank loans in the sustainable development of the debtor, especially for younger, less profitable and less liquid small and medium enterprises [9];
- D. Milosević, J. Popović, J. Avakumović, G. Kvrgić determined that trade credit, along with equity capital, increases the stability of the debtor firm in agribusiness [10];
- N. Bărbuţă-Mişu argues that the proposed trade credit is directly correlated with current liquidity and long-term bank loans, as well as with the return on equity and the size of the firm, and inversely correlated with the return on assets [11];
- J.-J. Liao, W.-C. Lee, K.-N. Huang, Y.-F. Huang point out the existence of an optimal and individual period for repayment of accounts receivable by a debtor — a retailer [12];
- R. Li, H.-L. Yang, Y. Shi, et al. built a pricing model for a retail enterprise, considering the receipt of a trade credit [13];
- P. Joe, N. Malhotra studied the provision of trade credits in e-commerce [14];
- A. Asgaonkar, B. Krishnamachari examined the direct relationship between buyers and sellers of digital goods [15].

In modern conditions, building effective supply chains in almost any market is impossible without the use of trade credit. Accounts receivables are investigated as part of the development of capital-constrained supply chain solutions. Researchers take a close look at various aspects of supply chain formation. The study of the specifics of the use of trade credit in the supply of products to retail was carried out by the following scientists. L. Zhao, L. Li, Y. Song, C. Li, Y. Wu noted that in the green supply chain, deferred payment can act as an additional incentive for a retailer to order large quantities of products. This bilateral revenue sharing agreement would allow the manufacturer to generate additional revenue through increased sales and the retailer through free financing [16].

N. Yan, X. He confirmed that trade credit can stimulate a retailer to increase the order size and therefore increase the overall profitability of the supply chain [17].

L. Liang, L. Futou found that the degree of risk aversion by the supplier and the retailer determines the optimal wholesale price in the supply chain with the supplier, not inclined to risk, and the use of trade credit [18].

Some papers are devoted to the development of a mechanism for mutual assistance between a supplier and a distributor. H. Peng, T. Pang investigated supply chains in which capital constraints are experienced by both the supplier during the production cycle and the distributor during the sales period. Scientists have proposed using a mechanism of mutual assistance, according to which the distributor provides the supplier with an advance payment during the production period, and the supplier offers the distributor a trade credit with a deferred payment during the sales period [19].

Q. Lin, B. Qiao found that when building a supply chain, market fluctuations, profit margins, status, and counterparty ownership had less impact on the "bank credit-accounts receivables" ratio than on the "bank credit-debt" ratio [20].

To benefit from the use of trade credit, Y. Zhong, J. Shu, W. Xie, Y.-W. Zhou emphasized the importance of strategically designing supply chains and optimizing warehouse locations [21].

When building supply chains in the electric power industry, G. Zhiyuan, Z. Meihua, P. Hongjun suggested using prepayment for coal supplies with compensation payments of interest, which is more efficient than bank financing of accounts receivables [22].

The conditions for the application of factoring in supply chains are investigated in the following research. B. Marchi, S. Zanoni, M.Y. Jaber proposed reverse factoring as an innovative method of supply chain finance. A creditworthy buyer confirms his payment obligations to the supplier at the bank. This, in turn, allows the supplier to attract financial resources (bank loans) at low interest rates due to receivables confirmed by the buyer [23].

The study of the role of factoring in bilateral supply chains led W. Jin, C. Wang to develop a hybrid supply finance strategy using trade credit and factoring; the key criteria here are the acceptable factoring price and the costs of the supplier's bankruptcy [24].

Also, the theory and practice of factoring is an independent topic of scientific research. The development of factoring is determined by the complexity of collecting large, overdue or doubtful accounts receivable from enterprises. Moreover, each organization forms its prerequisites for using the services of a factoring firm. The following templates are:

- J.M. Park, H.Y. Lee, S.H. Park, I. Han revealed a higher significance of accounts receivable factoring for firms with a high level than for firms with a low level of debt capital [25];
- Y. Li, C. Gu studied the factoring policy of firms with constant mass demand and limited capital [26];
- E.V. Konvisarova, A.A. Pustovarov, T.V. Bubnovskaya, T.V. Pashinina, N.S. Marchenko summarized the problems and outlined the prospects for the development of factoring in Russia [27].

Accounts receivable as an integral element of the company's current assets are property claims that are imposed on collection from the debtor. The collection procedure is a rather complex and responsible stage in the management of accounts receivable at the enterprise. In a competitive market, fear of loss of reputation and the sales market "prevents" companies from promptly applying the procedure for collecting accounts receivable from their customers. According to E. Kozarević, A. Mustafagić, A. Softić, the problem of collecting receivables is especially acute for suppliers — small and medium-sized businesses [28]. R. Dankiewicz notes that in terms of maintaining the economic security of the enterprise, it is advisable to apply insurance of the provided trade credit [29].

Untimely collection of receivables will inevitably lead to an excessive accumulation of overdue and doubtful receivables on the balance sheet of the enterprise. As a result, in the absence of additional funding sources, the supplier's bankruptcy is inevitable. According to the author, depending on its condition, receivables act as a marketing and sales component of both the economic viability and insolvency of the organization, becoming the root cause of its bankruptcy [30]. Confirming this thesis, Y. Zizi, M. Oudgou, A. El Moudden argue that the turnover of accounts receivable, along with the turnover of all assets and accounts payable, is a factor that increases the likelihood of financial collapse [31].

The legal approach to the interpretation of this concept is based on the current legislation. In particular, a receivable is recognized as an obligation[4] and acts as an object of property rights.[5] In the case of overdue receivables, it is assumed that it is collected from the debtor, which is already based on mandatory legal procedures and is the subject of legal research. At the same time, the procedure for writing off doubtful and bad accounts receivable is

[4] Civil Code of the Russian Federation (part one) dated 30.11.1994 No. 51-FZ (as amended on 09.03.2021). Art. 307. URL: http://www.consultant.ru/document/cons_doc_LAW_5142/f8f542de1a8540a32701afd8495edb3873597ece/.

[5] Ibid. Art. 128. URL: http://www.consultant.ru/document/cons_doc_LAW_5142/f7871578ce9b026c450 f64790704bd48c7d94bcb/.

regulated by the norms of the accounting[6] and tax[7] legislation of the country.

With a sufficiently high level of microeconomic elaboration of the issue at the macroeconomic level, accounts receivable "fall" into the field of vision of theoretical scientists in terms of the post-crisis description of the macroeconomic situation in the country. However, the accumulated volumes, the share in the proceeds, and most importantly, the quality of the total accounts receivable of economic entities in the national economy are not only the result of non-payment crises (a serious deterioration in the repayment of accounts receivable) and overproduction (the impossibility of selling products without deferring payment) but also one of the main internal factors of the latent stage of the crisis (deterioration of the financial condition and strengthening of the dynamics of bankruptcies of organizations) in the economy. In this regard, it becomes necessary to study the dynamics and identify macroeconomic patterns in the formation of the total accounts receivables of organizations and its overdue part in the economy, its individual industries and regions. These circumstances predetermined the choice of the author.

In this regard, the aim of the study is to group Russian regions and types of economic activities depending on the conditions for conducting sales and payment activities. The solution of the following research tasks serves to achieve this goal:1) consider the existing approaches to the study of receivables;2) on the basis of an empirical analysis of indicators of accounts receivable of organizations in the Russian economy in the context of certain types of activities and regions for 2000–2019 to identify the main trends in their dynamics;3) to group the Russian regions and types of economic activities depending on the conditions for conducting sales and payment activities.

The research hypothesis assumes a direct relationship between the volume, dynamics, quality of the total accounts receivable of organizations in the region (type of economic activity) and the assessment of the conditions for conducting sales and payment activities in the region (within the framework of a separate type of economic activity). Differences in the assessments of the conditions for conducting sales and payment activities determine the possibility of grouping Russian regions and types of economic activities according to the specified parameters.

MATERIALS AND METHODS

The theoretical basis of the study was the works of domestic and foreign scientists on the problems of managing accounts receivable of business entities, as well as the regulatory provisions of the current legislation in this area.

The methodological basis of the work was a systematic approach that allows for a comprehensive assessment of the current state of receivables in the Russian economy. When studying the theoretical and methodological foundations of the formation and management of accounts receivable of organizations, we apply such general scientific methods as hypothetical-deductive, analysis, synthesis, abstraction, comparison, generalization, analogy, etc. which allowed us to comprehensively consider the object of research.

The analysis in the work required the use of such methods as observation, description, statistical and comparative analysis, classification, trend building, grouping, tabular and graphical methods of presenting information, etc., which ensured the reliability of analytical data results and validity of conclusions.

The information base for the analysis of empirical data carried out in the work was the publications and operational-statistical

[6] Order of the Ministry of Finance of Russia dated July 29, 1998 No. 34n (as amended on April 11, 2018) "On approval of the Regulations on Accounting and Financial Reporting in the Russian Federation" (registered with the Ministry of Justice of Russia on August 27, 1998 No. 1598). URL: http://www.consultant.ru/document/cons_doc_LAW_20081/7890988 fa6ce c3201efba7e76593110a6cfe9973/.

[7] Tax Code of the Russian Federation (part two) of 05.08.2000 No. 117-FZ (as revised on 17.02.2021). Art. 265, p. 2, p. 2, Art. 266. URL: http://www.consultant.ru/document/cons_doc_LAW_28165/.

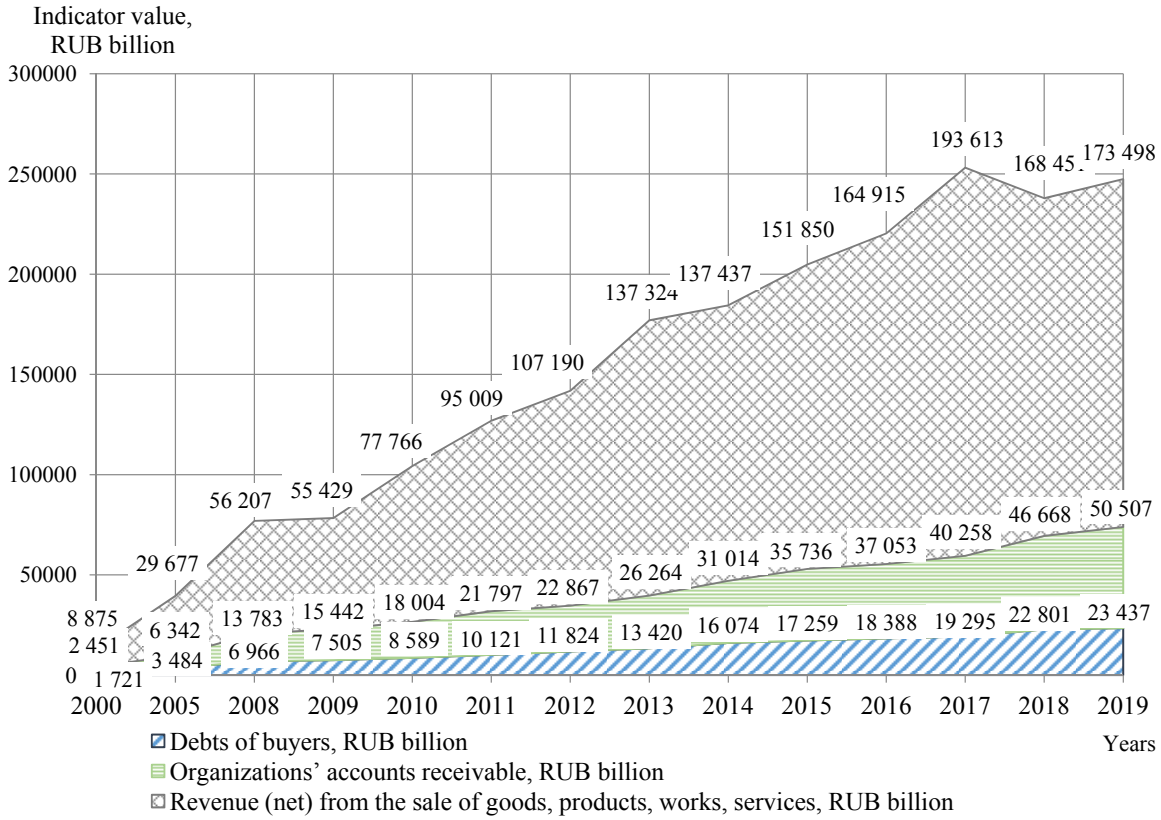

Fig. 1. **Dynamics of revenue and accounts receivable of Russian organizations, billion rubles**

Source: compiled by the author based on the data from Rosstat of the Russian Federation. URL: https://rosstat.gov.ru/ (accessed on 25.02.2020).

information of the Federal State Statistics Service of the Russian Federation (Rosstat) for 2000–2019.

RESULTS AND DISCUSSIONS

The total accounts receivable of economic organizations is one of the main characteristics of macroeconomic dynamics. This indicator, firstly, gives generalized ideas, firstly, about the conditions for the sale of products (provision of services, performance of work) of organizations in the economy and the degree of market competition in product markets, and secondly, about the conditions for the sale of products (provision of services, performance of work) in the economy. the state and level of payment discipline of counterparties in the economy. In other words, the state and dynamics of total accounts receivable and its constituent elements give a generalized description of the conditions for doing business in terms of the implementation of marketing and financial settlement activities of organizations in the economy of the industry, region of the country as a whole. By the level (to sales proceeds) and dynamics of the total accounts receivable of organizations and its elements (customer debt, overdue accounts receivable), one can judge the emerging factors of overproduction crises and non-payments in the economy (*Fig. 1*).

Fig. 1 data allow us to highlight the following trends in the dynamics of receivables in the Russian economy. First, the growth in accounts receivable prevails over the growth in revenue from sales of organizations. In 2010–2019 the growth of accounts receivable amounted to 280.5% with an increase in sales proceeds by 223.1%; the values of these indicators in 2000–2019 were 20.61 times and 19.55 times, respectively. Moreover, the growth of accounts receivable increased significantly over the years of declining sales growth: in 2018, the growth rate of accounts receivable amounted to 115.9% with a relative growth rate of revenue of 87%;

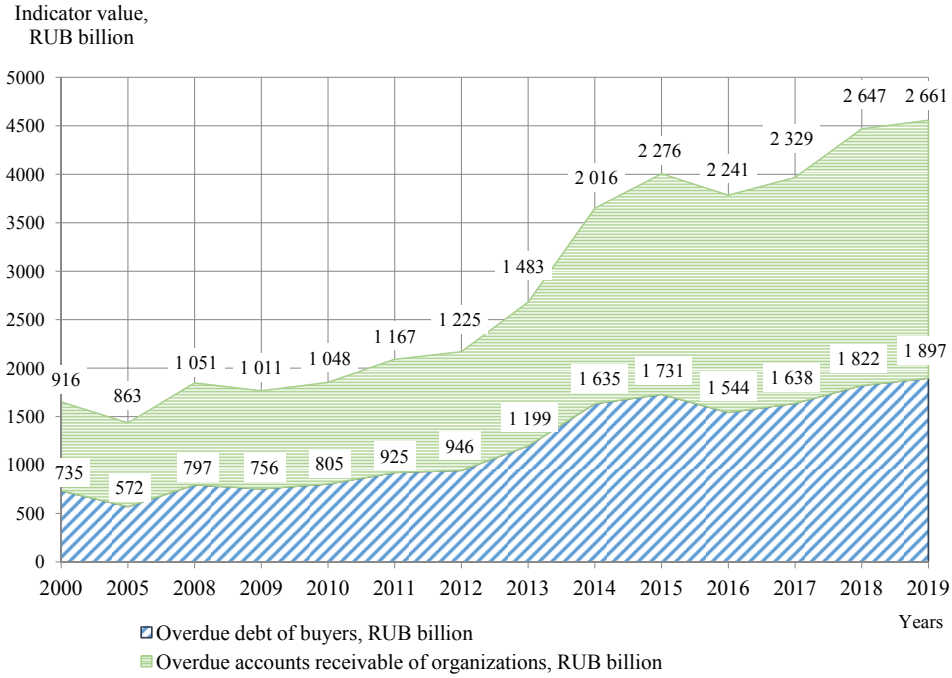

Fig. 2. **Dynamics of overdue accounts receivable of Russian organizations, billion rubles**

Source: compiled by the author based on the data from Rosstat of the Russian Federation. URL: https://rosstat.gov.ru/ (accessed on 25.02.2020).

in 2009 the growth of accounts receivable amounted to 112% with a decrease in revenue by 98.6%. In 2019, the share of receivables in sales revenue increased to 29.1% (+ 6% by 2010 and + 1.5% by 2000).

Secondly, the importance of purchase debt as a key element of organizations' accounts receivable has slightly decreased. The basic growth rate of customer debt in 2010–2019 was 272.9%, in 2000–2019–13.6 times. In the period under review, the growth rates of buyers' debt lagged behind the growth of accounts receivable (except for 2012, 2014, 2016, and 2018). As a result, the share of consumer debt in the structure of accounts receivable decreased to 46.4% (insignificantly — 1.3% by 2010 and significantly — 23.8% by 2000).

Moreover, in 2000–2019, a very high power of influence (Pearson's correlation coefficient) was indicated for both accounts receivable on sales revenue (0.9749) and customer debt on accounts receivable (0.9984).

These circumstances indicate an increase in the importance of receivables as a tool to increase sales. At the same time, the volume, level and dynamics of total accounts receivable fully allow forming an assessment of the conditions for conducting sales activities of organizations in the region and within the framework of economic activities.

The conditions for conducting settlement and financial activities in the economy are directly determined by the state of the settlement and payment discipline of counterparties, the characteristics of which are fully determined by the volume, level and dynamics of overdue receivables and overdue debts of buyers (*Fig. 2*).

Fig. 2 allows us to assert that the growth of buyers' overdue debt was inferior to the growth rate of overdue receivables: in 2000–2019–258% and 290.4%, and in 2010–2019–235.6% and 253.9%, respectively. At the same time, the annual growth rates of overdue and receivables of buyers were inferior to the growth rates of the indicators under consideration as a whole. This led to a decrease in the share of delinquencies in the structure of both receivables to 5.3% (–0.6% by 2010 and –32.1% by 2000) and buyers' debt to 8.1% (–1.3% by 2010 and –34.6% by 2000). Consequently, the settlement and payment

Table 1

Matrix for express assessment of the conditions for conducting sales and payment activities

Share of overdue accounts receivable, %		Share of accounts receivable in revenue, %			
		A acceptable	B moderate	C high	D very high
		<	20.01–30	30.01–50	>
I moderate	<	A I	B I	C I	D I
II essential	5.01–10	A II	B II	C II	D II
III significant	10.01–20	A III	B III	C III	D III
IV critical	20.01–30	A IV	B IV	C IV	D IV
V catastrophic	30.01–40	A V	B V	C V	D V
VI absolutely disastrous	>	A VI	B VI	C VI	D VI

Note: AI – the best business conditions: BI – better business conditions; AII, BII, CI – good business conditions; AIII, AIV, AV, BIII, BIV, CII, CIII, DI, DII – acceptable conditions; AVI, BV, CIV, CV, DIII, DIV – unacceptable conditions; BVI, CVI, DV, DVI – disastrous business conditions.

Source: compiled by the author.

discipline of counterparties has improved significantly.

When studying doing business in the Russian economy, with other things being equal, it is necessary to take the share of accounts receivable in the total proceeds from sales of organizations as the main characteristics of the conditions for the implementation of sales activities of organizations; settlement and financial activities — the share of overdue total accounts receivable of organizations.

To obtain a qualitative assessment, the author has developed an interval matrix for express assessment of the conditions for conducting sales and payment activities of organizations in the Russian economy (*Table 1*).

Analysis of the dynamics of total accounts receivable allowed us to identify intervals of quantitative values of the indicators used, depending on the degree of influence on the resulting financial indicators of the organization's activities. Quadrants of the Express assessment matrix are formed on the basis of a set of quantitative values of the accepted assessment indicators.

Formation of the Matrix for express assessment of the conditions for conducting sales and payment activities is possible in the context of both the economies of regions and federal districts and types of economic activity. Information about the place of the region (district), the type of economic activity in the Matrix acts as a macroeconomic characteristic of the economy of the region, district, type of economic activity. The specified information can be used by various subjects.

According to the data on the places occupied in the Matrix, business entities can monitor the situation in terms of the level of competition development and the state of payment discipline in the region (district), and the industry of presence. The data obtained will make it possible to adjust the assessments and indicators of the developed strategies (diversification of

production, selection of new sales markets, etc.) and tactics (criteria for assessing potential counterparties, the formation of conditions for trade credit, etc.) of business decisions in terms of improving their compliance with the external economic environment.

Potential investors can use the information specified in the Matrix as one of the key characteristics of the macroeconomic situation in the region and industry, both the proposed investment and product sales. In investment design, the characteristics of the conditions for conducting sales and payment activities will increase or decrease the optimism of the forecast estimate of revenue, the synchronicity of its receipt (with the shipment of products, the cost of production) and other indicators of profitability of investment projects.

Also, indirectly, the indicator of the place of the region in the Matrix indicates the efforts being made by the regional authorities to create a favorable investment climate in such areas as the commercial and financial conditions for doing business in the region. This indicator of a region's place in the Matrix can be used both by regional authorities and administrations when developing measures to support and stimulate business, and by organizations that form regional investment ratings.

In the context of types of economic activity, the following grouping is possible, depending on the results of assessing the conditions for conducting sales and payment activities of organizations (*Table 2*).

Table 2 indicates that the conditions for conducting sales and payment activities differ significantly by type of economic activity. The types of activities that produce products have good (C I) and acceptable (B III, B IV, C II, D I) conditions for conducting sales and payment activities. These industries have a higher level of receivables (excluding category A) with a wide range of arrears. Activities that provide non-financial services are in a much better position and have the best (A I), better (B I), good (B II, C I), and acceptable (D I) conditions for conducting sales and payment activities. With a wide range of the specific weight of accounts receivable, the lowest level of overdue part of it is observed. The financial sector of the economy has acceptable conditions (D I), which fully meets the specifics of the activity.

When examining the business situation in the Russian federal districts, it is necessary, to note its heterogeneity (*Fig. 3*).

The indicators shown in *Fig. 3*, allow us to state the following. The scale of sales activity in the federal districts of the Russian Federation differs significantly but is already established during 2010–2019. This made it possible to single out 3 groups of federal districts in terms of revenue from sales of organizations:

- Group I includes districts with the volume of revenue of organizations from 20,000 billion rubles and more;
- Group II — districts with revenues from10,000 to 19,999 billion rubles;
- Group III — district revenue up to 10,000 billion rubles.

In the districts, the leaders in sales (Group I), there is a fairly high level of accounts receivable (about 28–33%), but the lowest indicators of its overdue part (4–5%). This testifies to significant sales volumes with a fairly high level of competition for the client against the background of a high degree of compliance with payment discipline by counterparties in the commodity markets of these federal districts. That is, a high level of economic development in the leading regions is observed.

The federal districts included in Group II are characterized by a significant level of trade credit (21–30%) and an increased level of non-compliance with payment discipline by counterparties (5.5–9%). At the same time, in the Southern Federal District, the best conditions were formed for the specified group of districts — the lowest levels of accounts receivables and their delinquencies. In this group, we can talk about the presence and development of crisis factors of non-payments.

Group III includes areas with the worst conditions for conducting sales and payment activities. At the same time, the North Caucasian

Table 2

Assessment of the conditions for conducting sales and payment activities by type of economic activity

Group	Types of economic activity*
A I	Wholesale and retail trade; repair of motor vehicles and motorcycles [19.41; 3.53]; transportation and storage [19.09; 2.95]; activities in the field of health and social services [13.21; 4.50]; activities in the field of culture, sports, organization of leisure and entertainment [10.89; 2.05]
B I	Provision of other types of services [29.81; 2.05]; education [29.0; 2.63]; activities in the field of information and communication [21.82; 2.63]; activities of hotels and catering [20.72; 1.75]
B II	Administrative activities and related additional services [21.63; 6.35]
C I	Real estate transactions [45.47; 4.24]; processing industries [33.08; 4.31]; agriculture, forestry, hunting, fishing and fish farming [32.54; 1.64]
B III	Supply of electricity, gas and steam; air conditioning [24.66; 17.46]
B IV	Water supply; water disposal, organization of waste collection and disposal, activities to eliminate pollution [22.49; 24.55]
C II	Extraction of minerals [35.25; 8.52]
D I	Public administration and military security; social security [70.4; 3.14]; professional, scientific and technical activities [58.65; 3.85]; construction [57.53; 6.08]; financial and insurance activities [51.1; 2.79]

Note: * the values in 2019 are indicated: the share of receivables in the revenue of organizations,%; share of overdue accounts receivable, %.

Source: compiled by the author on the basis of Finance of Russia 2020. Stat. dig. Rosstat. Moscow; 2020. URL: https://rosstat.gov.ru/folder/210/document/13237/ (accessed on 25.02.2020).

Federal District is the anti-leader in all districts of the Russian Federation — with the lowest revenue (1130.5 billion rubles), the largest share of accounts receivable in revenue (38.29%) and its overdue part (15.09%). The regional economy is in a state of crisis processes of overproduction and non-payment.

Assessment of the regions of Russia using the Matrix for express assessment of the conditions for conducting sales and payment activities (see: *Table 1*) allowed us to group the regions (*Table 3*).

Table 3 data allow us to draw the following conclusions. The best business conditions (A I) are observed only in three regions, better conditions (B I) — in 15 regions. The most significant group of Russian regions (38) has the whole range of good (A II, B II, C I) conditions for conducting sales and payment activities. Also, in a significant group of regions (23), there is a wide range of categories of acceptable (A III, B III, B IV, C II, C III, D I) conditions. In the best possible categories, unacceptable conditions (A VI, C IV, D III) are presented in 4 regions; in 3 regions of the North Caucasian Federal District — disastrous (C VI, D V) conditions for conducting sales and payment activities are observed.

Consequently, the overwhelming majority of regions (78) have acceptable and better conditions for conducting sales and payment activities, which can only be assessed positively.

At the same time, according to the set of conditions for conducting sales and payment activities and the breadth of regional representation, the federal districts differ significantly from each other (*Table 4*).

Table 4 data fully confirm the conclusions of *Fig. 3*. The best conditions (A I) for conducting sales and payment activities (in conjunction with other acceptable conditions) are presented only in the Central and Siberian federal districts. Unacceptable conditions are observed in the Northwestern and Ural federal

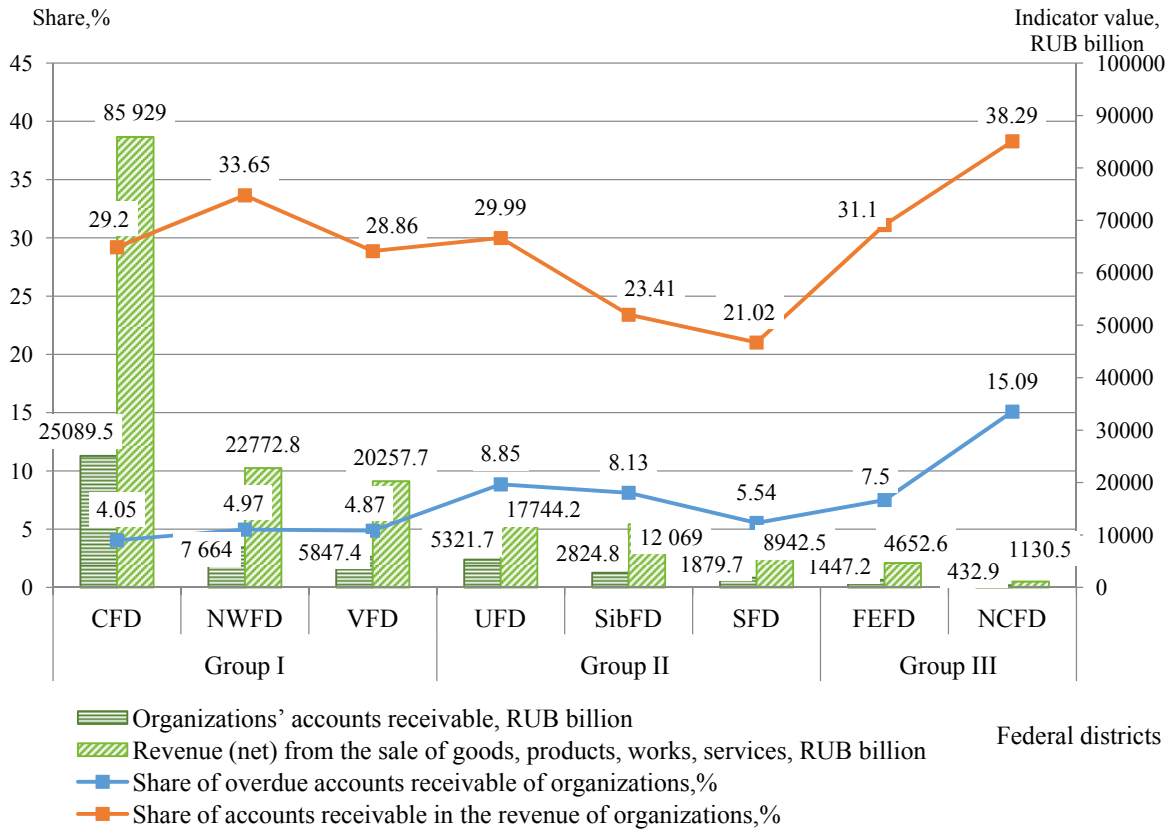

Fig. 3. **Dynamics of sales indicators by federal districts of the Russian Federation in 2019**

Note: CFD – Central Federal District; NWFD – Northwestern Federal District; VFD – Volga Federal District; UFD – Ural Federal District; SibFD – Siberian Federal District; SFD – Southern Federal District; FEFD – Far Eastern Federal District; NCFD – North Caucasian Federal District.

Source: compiled by the author based on the data from Rosstat of the Russian Federation. URL: https://rosstat.gov.ru/ (accessed on 25.02.2020).

districts. And in the North Caucasian District, in the overwhelming majority of regions, only unacceptable and disastrous conditions for conducting sales and payment activities are presented. At the same time, the best and better conditions are completely absent in the Urals, Far Eastern, and North Caucasian districts.

CONCLUSIONS

Summing up, it should be emphasized that the total accounts receivables of organizations in the economy are designated as an independent object of macroeconomic and regional research.

The analysis carried out in the work revealed a high degree of correlation between sales proceeds and accounts receivable of organizations, as well as a tendency to increase the significance of accounts receivable against the background of a slight decrease in the share of trade credit in sales of organizations. In this regard, it becomes necessary to deepen the analysis of accounts receivable for all its constituent elements, however, only accounts receivable of buyers are subject to statistical observation. In the settlement and financial activities of Russian enterprises, there is a tendency towards a decrease in the share of overdue debts of both buyers and in general.

The levels of the aggregate receivables of organizations and their overdue part are determined as generalizing characteristics of the conditions for conducting sales and payment activities in the economy and are used to construct the Matrix for express assessment

Table 3

Assessment of the conditions for conducting sales and payment activities in Russian regions

Group	Region*, **
A I	*CFD: Kaluga Reg.* [(19.8; 4.58), 0.97]; SibFD: Novosibirsk Reg. [(18.98; 1.94), 0.95]; Altai Territory [(12.29; 2.98), 0.73]
B I	*CFD*: Lipetsk reg. [(24.90; 1.36), 0.90]; Oryol reg. [(22.53; 3.06), 0.96]; Moscow reg. [(20.35; 4.32), 0.99]; Belgorod reg. [(28.61; 1.82), 0.97]; Tambov reg. [(26.97; 2.09), 0.97]; *NWFD*: Pskov reg. [(27.99; 4.85), 0.86]; Kaliningrad reg. [(21.04; 2.27), 0.79]; *VFD*: Rep. Tatarstan [(27.38; 3.3), 0.99]; Penza reg. [(23.87; 4.1), 0.97]; *SibFD*: Krasnoyarsk Territory [(28.32; 4.7), 0.98]; Tomsk reg. [(23.56; 2.74), 0.94]; Omsk reg. [(21.97; 2.67), 0.81]; Irkutsk reg. [(20.17; 4.67), 0.64]; *SFD*: Rep. Adygea [(21.65; 3.39), 0.89]; Krasnodar Territory [(20.99; 4.58), 0.94]
A II	*CFD*: Smolensk reg. [(18.81; 6.04), 0.87]; *NWFD*: Vologda reg. [(14.07; 8.91), 0.93]; Rep. Karelia [(17.87; 8.69), 0.81]; *VFD*: Perm Territory [(19.39; 7.4), 0.53]; *SibFD*: Rep. Khakassia [(18.25; 8.54), 0.60]; Rep. Altai [(14.77; 5.15), 0.35]; *SFD*: Volgograd reg. [(17.82; 7.83), 0.80]
B II	*CFD*: Kostroma reg. [(24.89; 8.54), 0.91]; Yaroslavl reg. [(27.21; 8.21), 0.96]; Kursk reg. [(24.08; 7.82), 0.94]; Bryansk reg. [(27.47; 6.71), 0.91]; Vladimir reg. [(20.55; 9.22), 0.97]; *NWFD*: Rep. Komi [(22.77; 5.5), 0.86]; Novgorod reg. [(20.57; 8.76), 0.90]; *VFD*: Ulyanovsk region. [(29.56; 8.21), 0.84]; Rep. Bashkortostan [(23.07; 5.63), 0.94]; Rep. Mari El [(22.24; 7.0), 0.84]; Saratov reg. [(25.38; 5.38), 0.93]; Chuvash Rep. [(21.32; 9.6), −0.35]; Samara region [(20.85; 5.53), 0.93]; *UFD*: Sverdlovsk reg. [(24.77; 8.23), 0.96]; Khanty-Mansi AD − Ugra [(28.00; 6.58), 0.18]; Chelyabinsk reg. [(21.60; 8.41), 0.97]; *SFD*: Rostov reg. [(22.14; 5.43), 0.94]; Astrakhan reg. [(21.50; 6.03), 0.56]; *FEFD*: Chukotka AD [(28.34; 7.23), 0.80]; Khabarovsk Territory [(27.77; 8.57), 0.11]; Rep. Sakha (Yakutia) [(21.91; 8.71), 0.86]
C I	*CFD*: Moscow [(31.34; 3.67), 0.64]; Voronezh reg. [(31.17; 2.06), 0.97]; Ryazan reg. [(30.12; 2.45), 0.95]; *NWFD*: St. Petersburg [(36.71; 4.52), 0.95]; Leningrad reg. [(31.75; 2.31), 0.95]; *VFD*: Udmurt Rep. [(33.39; 2.64), 0.90]; Rep. Mordovia [(30.11; 3.25), 0.98]; *UFD*: Yamalo-Nenets AD [(39.77; 1.95), 0.97]; *FEFD*: Sakhalin reg. [(45.02; 2.46), 0.92]; *NCFD*: Stavropol Territory [(34.71; 4.89), 0.76]
A III	*VFD:* Kirov reg. [(18.86; 10.53), 0.67];
B III	*CFD*: Ivanovo reg. [(25.74; 13.94), 0.51]; Tver reg. [(24.04; 12.86), 0.87]; *NWFD*: Nenets AD [(20.65; 16.62), −0.16]; *UFD*: Kurgan reg. [(29.65; 14.83), 0.89]; *SFD*: Rep. Crimea [(23.21; 10.21), 0.68]; *FEFD*: Jewish AD [(29.44; 14.97), 0.31]
B IV	*SibFD*: Kemerovo reg. [(25.75; 22.31), 0.94]; *FEFD*: Rep. Buryatia [(25.08; 20.04), 0.48]
C II	*NWFD*: Murmansk reg. [(36.51; 9.45), 0.80]; *VFD*: Nizhny Novgorod reg. [(36.78; 6.43), 0.96]; *UFD*: Tyumen reg. [(33.46; 8.98), 0.39]; *SibFD* Rep. Tyva [(30.36; 6.22), 0.86]; *SFD*: Rep. Kalmykia [(46.30; 7.54), 0.79]; Sevastopol c. [(33.69; 9.42), 0.68]; *FEFD*: Trans-Baikal Territory [(37.31; 8.81), 0.96]; Magadan reg. [(34.1; 6.3), 0.98]; Primorsky Territory [(30.75; 7.1), 0.94]; *NCFD*: Rep. North Ossetia-Alania [(35.93; 8.95), −0.04]
C III	*CFD:* Tula reg. [(37.38; 18.06), 0.97]; *FEFD*: Kamchatka Territory [(31.59; 11.23), 0.99]
D I	*VFD*: Orenburg reg. [(70.92; 1.82), 0.86]; *FEFD:* Amur reg. [(50.79; 4.32), 0.78]
A VI	*NCFD:* Rep. Ingushetia [(14.26; 81.75), −0.51];
C IV	*UFD:* Tyumen reg. without AD [(37.63; 26.82), 0.58]
D III	*NWFD:* Arkhangelsk reg. [(58.82; 14.13), 0.93]; *NCFD:* Karachay-Cherkess Rep. [(55.21; 12.84), 0.87]
C VI	*NCFD:* Chechen Rep. [(47.32; 45.91), 0.56]; Kabardino-Balkarian Rep. [(41.55; 48.84), 0.52]
D V	*NCFD:* Rep. Dagestan [(51.71; 38.82), 0.77]

Note: * the values in 2019 are indicated: the share of receivables in the revenue of organizations,%; share of overdue receivables,%; Pearson's correlation coefficient of revenue from sales of organizations and accounts receivable for 2010–2019.

** abbreviated: reg. – region, AD – autonomous district, Rep. – Republic, c. – city.

Source: compiled by the author.

Table 4

Assessment of the conditions for conducting sales and payment activities in the federal districts

Federal districts*							
CFD	NWFD	VFD	UFD	SibFD	SFD	FEFD	NCFD
A I (1)				A I (2)			
B I (5)	B I (2)	B I (2)		B I (4)	B I (2)		
A II (1)	A II (2)	A II (1)		A II (2)	A II (1)		
B II (5)	B II (2)	B II (6)	B II (3)		B II (2)	B II (3)	
C I (3)	C I (2)	C I (2)	C I (1)			C I (1)	C I (1)
		A III (1)					
B III (2)	B III (1)		B III (1)		B III (1)	B III (1)	
				B IV (1)		B IV (1)	
	C II (1)	C II (1)	C II (1)	C II (1)	C II (2)	C II (3)	C II (1)
C III (1)						C III (1)	
		D I (1)				D I (1)	
							A VI (1)
			C IV (1)				
	D III (1)						D III (1)
							C VI (2)
							D V (1)

Note: * regions in the district that have the appropriate conditions.

of these conditions. The use of the Express assessment matrix allowed us to group the types of activities, regions, and districts of the Russian Federation, depending on the conditions for conducting sales and payment activities.

Thus, the presented research has a complex character. The results contribute to the systematization and expansion of the theoretical foundations of the study of the total accounts receivable of organizations in the regional and sectoral context of the country's economy. In practical terms, the author has developed the Matrix of express assessment of the conditions for conducting sales and payment activities, which is applicable both in the management of a separate organization when making decisions of a strategic nature (diversification of production, choice of sales markets, formation of trade credit conditions, etc.), and to the authorities and administrations

in the development of measures to support and stimulate business, as well as rating agencies.

Further deepening of research on the total accounts receivable of organizations in the economy is seen in the search for tools to determine its optimal volume and structure for the timely identifications of the factors of upcoming crises of non-payments and overproduction both in the economy as a whole and in individual commodity markets.

REFERENCES

1. Renaldo N., Sudarno S., Hutahuruk M.B. Internal control system analysis on accounts receivable in SP corporation. *The Accounting Journal of Binaniaga*. 2020;5(2):73-84. DOI: 10.33062/ajb.v5i2.382
2. Zotov V.P., Chernichenko S.G., Chernysheva N.M. Organizing, structuring and unification of credit risk estimate problems within the commercial lending of agricultural enterprises. *Tekhnika i tekhnologiya pishchevykh proizvodstv = Food Processing: Techniques and Technology*. 2016;(4):155-163. (In Russ.).
3. Dmitrieva I.N. Methods for analysing accounts receivable and accounts payable on lease payments. *Upravlenets = The Manager*. 2018;9(2):47-53 (In Russ.). DOI: 10.29141/2218-5003-2018-9-2-8
4. Rohini U., Malarkodi K., Vanitha P. Working capital management and its impact on firm's financial performance. *International Journal for Modern Trends in Science and Technology*. 2020;6(8):10-17. DOI: 10.46501/IJMTST060803
5. Prša D. The impact of working capital management on the profitability of Croatian manufacturing SMEs. *Ekonomski Vjesnik/Econviews*. 2020;33(2):371-382.
6. Farhan N.H.S., Tabash M.I., Yameen M. The relationship between credit policy and firms' profitability: Empirical evidence from Indian pharmaceutical sector. *Investment Management and Financial Innovations*. 2020;17(2):146-156. DOI: 10.21511/imfi.17(2).2020.12
7. Paul S.Y., Guermat C., Devi S. Why do firms invest in accounts receivable? An empirical investigation of the Malaysian manufacturing sector. *Journal of Accounting in Emerging Economies*. 2018;8(2):166-184. DOI: 10.1108/JAEE-01-2017-0005
8. Klychova G.S., Zakirova A.R., Khamidullin Z.Z. Methodological approaches to the formation of the financial management policy of receivable arrears. *Vestnik Kazanskogo gosudarstvennogo agrarnogo universiteta = Vestnik of Kazan State Agrarian University*. 2019;14(1):126-131. (In Russ.). DOI: 10.12737/article_5ccedf74305b80.69036555
9. Arcuri M.C., Pisani R. Is trade credit a sustainable resource for medium-sized Italian green companies? *Sustainability*. 2021;13(5):2872. DOI: 10.3390/su13052872
10. Milosević D., Popović J., Avakumović J., Kvrgić G. The impact of the equity capital and trade credit financial sources on the company's performances sustainability. *Ekonomika Poljoprivrede = Economics of Agriculture*. 2020;67(3):735-746. DOI: 10.5937/ekoPolj2003735M
11. Bărbuță-Mișu N. Analysis of factors influencing managerial decision to use trade credit in construction sector. *Economic Research-Ekonomska Istraživanja*. 2018;31(1):1903-1922. DOI: 10.1080/1331677X.2018.1504690
12. Liao J.-J., Lee W.-C., Huang K.-N., Huang Y.-F. Optimal ordering policy for a two-warehouse inventory model use of two-level trade credit. *Journal of Industrial and Management Optimization*. 2017;13(4):1661-1683. DOI: 10.3934/jimo.2017012
13. Li R., Yang H.-L., Shi Y., Teng J.-T., Lai K.-K. EOQ-based pricing and customer credit decisions under general supplier payments. *European Journal of Operational Research*. 2021;289(2):652-665. DOI: 10.1016/j.ejor.2020.07.035
14. Joe P., Malhotra N. An exploratory study on increase of transactions with the use of deferred payment facilities. *SMART Journal of Business Management Studies*. 2021;17(1):11-19. DOI: 10.5958/2321-2012.2021.00002.6
15. Asgaonkar A., Krishnamachari B. Solving the buyer and seller's dilemma: A dual-deposit escrow smart contract for provably cheat-proof delivery and payment for a digital good without a trusted mediator. In: 2019 IEEE Int. conf. on blockchain and cryptocurrency (ICBC). (Seoul, 14–17 May, 2019). New York: IEEE; 2019. DOI: 10.1109/BLOC.2019.8751482
16. Zhao L., Li L., Song Y., Li C., Wu Y. Research on pricing and coordination strategy of a sustainable green supply chain with a capital-constrained retailer. *Complexity*. 2018:6845970. DOI: 10.1155/2018/6845970

17. Yan N., He X. Optimal trade credit with deferred payment and multiple decision attributes in supply chain finance. *Computers & Industrial Engineering*. 2020;147:106627. DOI: 10.1016/j.cie.2020.106627
18. Liang L., Futou L. Optimal decision of deferred payment supply chain considering bilateral risk-aversion degree. *Mathematical Problems in Engineering*. 2018:2721508. DOI: 10.1155/2018/2721508
19. Peng H., Pang T. A mutual-aid mechanism for supply chains with capital constraints. *International Journal of Management Science and Engineering Management*. 2019;14(4):304-312. DOI: 10.1080/17509653.2019.1578275
20. Lin Q., Qiao B. The relationship between trade credit and bank loans under economic fluctuations-based on the perspective of the supply chain. *Applied Economics*. 2021;53(6):688-702. DOI: 10.1080/00036846.2020.1809632
21. Zhong Y., Shu J., Xie W., Zhou Y.-W. Optimal trade credit and replenishment policies for supply chain network design. Omega. 2018;81:26-37. DOI: 10.1016/j.omega.2017.09.006
22. Zhiyuan G., Meihua Z., Hongjun P. Financing strategies for coal-electricity supply chain under yield uncertainty. *International Journal of Mining Science and Technology*. 2018;28(2):353-358. DOI: 10.1016/j.ijmst.2017.11.017
23. Marchi B., Zanoni S., Jaber M.Y. Improving supply chain profit through reverse factoring: A new multi-suppliers single-vendor joint economic lot size model. *International Journal of Financial Studies*. 2020;8(2):23. DOI: 10.3390/ijfs8020023
24. Jin W., Wang C. Modeling and simulation for supply chain finance under uncertain environment. *Technological and Economic Development of Economy*. 2020;26(4):725-750. DOI: 10.3846/tede.2020.12054
25. Park J.M., Lee H.Y., Park S.H., Han I. Value relevance of accounts receivable factoring and its impact on financing strategy under the K-IFRS after COVID-19 from the perspective of accounting big data. *Sustainability*. 2020;12(24):10287. DOI: 10.3390/su122410287
26. Li Y., Gu C. Factoring policy with constant demand and limited capital. *International Transactions in Operational Research*. 2020;27(6):3104-3122. DOI: 10.1111/itor.12514
27. Konvisarova E.V., Pustovarov A.A., Bubnovskaya T.V., Pashinina T.V., Marchenko N.S. Problems and prospects of factoring market development in Russia. *Revista Electrónica de Investigación en Ciencias Económicas*. 2020;8(16):502-516. DOI: 10.5377/reice.v8i16.10719
28. Kozarević E., Mustafagić A., Softić A. Liquidity of Bosnia and Herzegovina institutions and its influence on the scope of commercial transactions with small and medium sized enterprises. *TEM Journal*. 2017;6(3):629-636. DOI: 10.18421/TEM63-27
29. Dankiewicz R. Single cover as a supplement to the product offer of trade credit insurers used in risk management processes in enterprises. *International Journal of Business Performance Management*. 2020;21(4):400-416. DOI: 10.1504/IJBPM.2020.110807
30. Drobotova O.O. On the issue of insolvency and bankruptcy of organizations. *Fundamental'nye issledovaniya = Fundamental Research*. 2021;(3):49-55 (In Russ.). DOI: 10.17513/fr.42979
31. Zizi Y., Oudgou M., El Moudden A. Determinants and predictors of SMEs' financial failure: A logistic regression approach. *Risks*. 2020;8(4):107. DOI: 10.3390/risks8040107

ABOUT THE AUTHOR

Ol'ga O. Drobotova — Cand. Sci. (Econ.), Assoc. Prof., Department of Economics and Entrepreneurship, Volgograd State Technical University, Volgograd, Russia
olgfins@mail.ru

The article was submitted on 15.04.2021; revised on 29.04.2021 and accepted for publication on 27.08.2021.
The author read and approved the final version of the manuscript.

ORIGINAL PAPER

DOI: 10.26794/2587-5671-2021-25-5-215-234
UDC 330.59(045)
JEL I10, I12, C53, C55

Prospects for the Integration of Google Trends Data and Official Statistics to Assess Social Comfort and Predict the Financial Situation of the Population

M.V. Shakleina[a] ✉, M.I. Volkova[b], K.I. Shaklein[c], S.R. Yakiro[d]
[a] Lomonosov Moscow State University, Moscow, Russia; [b] Plekhanov Russian University of Economics, Moscow, Russia; [c] OJSC "Russian Railways", Moscow, Russia; [d] JSC "SOGAZ", Moscow, Russia
[a] https://orcid.org/0000-0002-1947-8640; [b] https://orcid.org/0000-0001-8941-0548; [c] https://orcid.org/0000-0003-3508-7372; [d] https://orcid.org/0000-0003-2365-8043
✉ Corresponding author

ABSTRACT

This paper aims to develop a theory of statistical observation in terms of scientific and methodological approaches to processing big data and to determine the possibilities of integrating information resources of various types to measure complex latent categories (using the example of social comfort) and to apply this experience in practice through the use of the financial situation indicators in forecasting. The authors have built a social comfort model in which the choice of weights for its components is based on a modified **principal component analysis**. The assessment is based on Google Trends data and official statistics. Google Trends data analysis methods are based on the development of an integrated approach to the semantic search for information about the components of social comfort, which reduces the share of author's subjectivity; methodology of primary processing, considering the principles of comparability, homogeneity, consistency, relevance, description of functions and models necessary for the selection and adjustment of search queries. The proposed algorithm for working with big data allowed to determine the components of social comfort ("Education and Training", "Safety", "Leisure and free time"), for which it is necessary to directly integrate big data in the system of primary statistical accounting with further data processing and obtaining composite indicators. The authors **conclude** that a stable significant correlation has been found for the "Financial Situation" component, which makes it possible to use it for further calculations and extrapolation of financial indicators. The **scientific novelty** lies in the development of principles and directions for the integration of two alternative data sources when assessing complex latent categories. The findings and the results of the integral assessment of social comfort can be used by state statistics authorities to form a new type of continuous statistical observation based on the use of big data, as well as by executive authorities at the federal, regional and municipal levels in terms of determining the priorities of socio-economic policy development.

Keywords: social comfort; well-being; harmonization of information resources; official statistics; Google Trends; integral indicator

For citation: **Shakleina M.V., Volkova M.I., Shaklein K.I., Yakiro S.R. Prospects for the integration of Google Trends data and official statistics to assess social comfort and predict the financial situation of the population.** ***Finance: Theory and Practice.*** **2021;25(5):215-234. DOI: 10.26794/2587-5671-2021-25-5-215-234**

INTRODUCTION

Over the past two decades, the popularization of Internet use has increased significantly, which has contributed to an increase in the amount of stored information about user activities. Examples of big data are social media data, telephone records, websites, search engine data [1]. New trends have attracted academic interest in the use of big data in research.

Big data is gaining popularity for measuring human well-being as well as predicting financial performance. Based on the analysis of foreign and domestic periodical publication, the following main sources of big data can be identified:

1. Google Trends (GT). Y. Algan et al. [2] use search queries to construct an index of the well-being of Google in the United States, then the methodology for constructing an index of the social well-being of Russians is tested [3]. An article by Y. Algan et al. [2] identifies several aspects of well-being: material conditions (financial well-being), social aspects and health.

3. Articles in newspapers. E. Carlquist et al. [4] investigated occurrence for 1992–2014 of 39 words in the Norwegian press media describing well-being facets of the population. Four newspapers were selected to highlight socio-cultural and regional differences. The authors primarily sought to research words and phrases related to the financial situations in everyday Norwegian vocabulary.

2. Twitter. The data can also be used to study emotional well-being [5–9]. Twitter data, based on the analysis of published tweets, allows us to build either the sentiment index or the degree of satisfaction/dissatisfaction with life.

4. Facebook status. The authors [10–12] propose a method for predicting well-being using social networks. Based on the analysis of statuses, open messages, the semantic correlation of keywords in messages is determined, then an aggregated index of well-being is built.

Big data provides vast opportunities for understanding human interactions in societies with rich spatial and temporal dynamics, as well as for identifying complex interactions and nonlinearities between variables. One of the most popular big data resources is Google Trends.

According to a study [13], the following advantages of Google Trends data are noted:

1. High frequency/periodicity. User moods and preferences change can be observed every day.

2. Search queries are better at revealing the attitudes of the individual compared to traditional polls. Many respondents answer the questionnaire for altruistic reasons since there is no motive to answer the questions frankly and deeply [14]. Search queries can reveal more personal information. For example, the topic of losing a job can be very sensitive for respondents, and they may not want to discuss it.

On the other hand, the search volume for the words "find a job", "search for a job" shows the concern for this problem for a person. Hence, it is concluded that the data obtained from search queries are more objective.

Many researchers, heads of international organizations see in the future an objective replacement of the data of expensive official statistics, which reach users with a great delay, with big data in order to conduct various real-time monitoring of the living conditions of the population, achieve the UN Sustainable Development Goals, etc. One of the successful examples of using large data for monitoring purposes is a study by J. Ginsberg et al. [15], which shows that, based on Google Trends, it is possible to track and predict the spread of influenza before the Centers for Disease Control and Prevention.

However, there are a number of methodological difficulties in using big data. The author of the study [16] notes the incomparability of big data with official statistics due to the use of different methodologies and classifications.

However, bringing big data in line with the requirements of national and international recommendations will reduce its advantages in terms of efficiency of use, timeliness and relevance, which currently provides them with high economic efficiency.

A prerequisite for the use of big data is wide access of the population to the Internet. Despite the rapid development of the Internet in the last decade, the possibilities of big data in developed countries are higher than in developing ones [16]. So, according to official statistics, in 2019 in Russia the share of the population using the Internet on a daily basis was 73%, in Moscow — 82%. This fact can lead to biased estimates of the studied variables since the reliability of the results is guaranteed not only by a large number of observations but primarily by the representativeness of the sample population.

Serious methodological work and high risks of using big data form obstacles to their successful integration into official statistics. In Russia, there are some pilot projects on the use of Internet resources to improve consumer price statistics, data from mobile operators for tourism statistics, satellite communications monitoring for the development of environmental statistics [17]. However, we note the relatively narrow scope of their application and the lack of practical experience (no official publications are presented).

At the same time, there are examples of successful implementation of big data in official statistics in some developed countries. In 2015, Statistics Netherlands expanded transport statistics with the publication of indicators that were calculated on the basis of information received from sensors on the country's highways.[1] Real-time data made it possible to make timely decisions when ice formed in the northern part of the country. An example of such integration is the experience of Canada: forecasting the yield of agricultural crops is made not only on the basis of the results of surveys of farmers but also information on the state of land and climate obtained via satellite communications [18]. Also, active work is underway to attract big data as an alternative source of information on consumer prices in Denmark, the Netherlands, Italy, Norway, Australia, Switzerland, Belgium, New Zealand, Sweden.

Since the experience of introducing big data into the practice of state statistics bodies already exists, it is necessary to continue research in the field of the principles of integrating two information sources, and not be limited only to general projects to study the potential of big data.

In this regard, the aim of the study is to develop the theory of statistical observation in terms of scientific and methodological approaches to processing big data and to determine the possibilities of integrating information resources of various types in relation to measuring complex latent categories (using the example of social comfort).

The introduction of a new economic category "social comfort" is necessary to *"determine the dynamics of the real level of well-being of the population, assess the true quality of life of people"* [19]. Despite the novelty of the study of this process in Russian practice, foreign studies provide an analysis of comfortable conditions for an individual in the following areas: geography, sociology, medicine, psychology, economics, and finance. In [19], the axiomatics and composition of the introduced category are considered in detail. Incoming categories of social comfort: health and medical services, education and learning, social support and pensions, financial situation, employment, housing and living conditions, ethical norms and values, safety, political stability, rest and leisure, ecology and the environment, infrastructure.

[1] A13 busiest national motorway in the Netherlands. URL: https://www.cbs.nl/-/media/imported/documents/2015/31/a13-busiest-national-motorway-in-the-netherlands.pdf?la=en-gb (accessed on 02.09.2021).

In this work, based on the use of the resources of the Federal State Statistics Service (Rosstat) and big data, it is proposed to assess social comfort, to determine the degree of consistency of its components built on two data sources, and to identify possible directions of integration.

EMPIRICAL APPROACHES TO SEMANTIC SEARCH OF INFORMATION ON FINANCIAL AND ECONOMIC INDICATORS BASED ON WEB REQUESTS

Most of the studies conducted have demonstrated the promise of using big data. However, the problem of choosing keywords to determine user queries is still relevant. In many works, the formation of keywords is based on a small number of user queries based on the intuitive assumptions of the authors of the study about the importance of a particular query for a person. As noted earlier, the first work on introducing big data into statistical practice and calculations focused on financial aspects.

Thus, in [20], inflation forecasting is carried out on the basis of web requests. The author examines 75 search queries that are related to financial markets, as well as the interests of the population, economic and financial phenomena, and processes. These queries were selected among the most popular ones based on the analysis of correlation dependences with inflation.

The author of the study [21] analyzes inflation expectations using the keyword "inflation", on the basis of which all kinds of search queries are built. Further, the author makes a comparative assessment with the results of inflationary expectations of the population based on the data of sociological surveys.

In [2], for each index of subjective well-being, which is represented by an index of positive and negative emotions, a set of indirect variables from Google search queries (such as happiness, respect, stress, anxiety, etc.) is used reasonably. The choice is primarily determined by the direction of the evoked emotions: positive or negative.

The author of the study [22] uses the Google Trends service as a proxy to predict the volatility of energy prices. The authors begin their research with a set of 90 terms used in the energy sector. The most popular words on this topic from Google are added to terms gleaned from professional literature. Filtration of such a set of words occurs by building various models that best predict the volatility of prices for crude oil, fuel oil, gasoline, natural gas.

The author of the study [13] compiles a list of search queries that reveal links to economic conditions. To determine the search words as objectively as possible, the author starts working with a vocabulary of finance and text analytics [23] and selects words related to "economic" words that positively or negatively affect a person's mood. Studies [13, 23, 24] use Harvard IV-4 Dictionaries, which have several editions, as the rationale for the choice of words to create an aggregated index of investor sentiment. This dictionary was developed by Dexter Dunphy and colleagues [25–27].

The result is a list of 149 words such as inflation, recession, security, etc. Then each of the 149 words is entered into Google Trends, which selects the top ten (most popular) search queries for each word. For example, the word "deficit" taken from the dictionary leads to the following search queries: "budget deficit", "attention deficit", "trade deficit", etc. As a result, 149 words increased to 1490. The last stage excludes those words/phrases provided by Google that are not related to economic conditions or finance and have zero search volume.

After the procedure of statistical processing of the received time series of search queries, the financial and economic index is constructed as a new indicator for determining and predicting investor sentiment. The high predictive power of the index is noted and

possible prospects for practical application are indicated.

It is worth noting several works that, at the initial stage, take an arbitrary set of search terms, and then select the most informative ones using the Bayesian model averaging [3, 28].

In the study [29], the authors use three different types of information to identify the determinants of the saving behavior of the population in the EU countries: macroeconomic statistics (nominal effective exchange rate, nominal GDP, inflation indicators, etc.), Google search words (42 words), which reflect the mood of economic agents, behavioral, psychological factors influencing preferences, as well as the data of opinion polls reflecting expectations regarding the current and future financial and economic situation. The selection of all variables for analysis is based on the economic intuition of the authors. The Bayesian model averaging is used as a model tool. The authors attribute its use to the lack of Google's keyword selection strategy.

APPROACHES TO LARGE DATA PROCESSING

Big data is generated by the users themselves. Unlike official statistics, they are not collected according to a specially developed and approved methodology. In this regard, for their adequate use and integration into official statistics, it is necessary to develop a special methodology for collection and processing. We will analyze the existing experience in processing big data in foreign studies.

In a study [30], the authors analyze the frequency of search queries related to tourism in Germany based on Google Trends and suggest ways to cleanse the data to eliminate false predictions.

According to the source [31], Google Trends is formed as follows: the ratio of the number of Internet requests for a specific keyword at time *t* in region *r to the total number of requests* at time *t* in region *r* is determined, and the found ratio is multiplied by 100 to standardize.

The authors propose the following modification of the initial data: find the ratio of the number of web requests for a specific keyword at time *t* in region *r to the average value* of the volume of web requests for keywords at time *t* in region *r*. The resulting modified data are called averages divided by the analyzed categories. However, this transformation raises a number of problems:

- the time series has a stronger seasonality as a result of the peculiar seasonal variations of each time series separately;
- the time series has a larger number of outliers due to the increasing role of individual time series in the denominator.

To overcome the problems mentioned above, the authors propose to find the ratio of the number of web requests for a specific keyword at time *t* in region *r* to the average trend of web requests for keywords at time *t* in region *r*. The trend is determined according to the decomposition of the time series [32]. The modified time series is called division by the average trend.

Research [24] strives to confirm the potential for public sentiment-based searches to influence the Portuguese stock market. As a way of processing queries, the author proposes to logarithm the search query for a specific word for a week, and then find the first differences between the volumes of queries for a specific word over two periods of time. To ensure comparability and consistency of the data, the author proposes to amend for seasonality and heteroscedasticity. To remove outliers, the search sample is censored, that is, 5% of the sample with the smallest and largest search volume is cut off. To test the seasonality, the analysis of variance method is used, in which the hypothesis of equality of 12-month averages is tested. Queries with a pronounced seasonality were cleared by building regression models with 12 dummy variables (for each month), in which the residuals were found and used in subsequent iterations of the analysis. To

eliminate heteroscedasticity, a standardization procedure is used using the standard deviation.

In [33], it is proposed to combine the search queries for the standard deviation and the deseasonalization procedure for clearing seasonal fluctuations, performed through the seasonal package in the R language.

The author of the study [34] proposes to use the logarithm with the further taking of the first differences to bring the time series of search queries to a stationary form.

These procedures are followed to clear Google Trends search results [2]:

1. Standardization using Z-score, as a result of which the distribution of data for different search queries is reduced to one scale, which allows comparisons.
2. Elimination of sharp jumps in popularity with the help of a moving average.
3. Removal of search queries with a continuous zero search volume.
4. Clearing the time series from the trend by building regressions with a time trend and removing search queries with a coefficient of determination higher than 0.6.
5. Clearing the time series from seasonality by constructing regressions with monthly dummy variables and using further residuals of regression models.

This methodological approach to big data processing seems to be the most complex and consistent. The main stages of the described approach will be used in the framework of the study.

SELECTING KEYWORDS AND PROCESSING GOOGLE TRENDS SEARCH REQUIREMENTS

The main problem of most research on Google Trends is that the selection of keywords for the semantic disclosure of a particular socio-economic process or phenomenon is selected intuitively, based on the author's experience. Further, a number of econometric methods are used (Bayesian model averaging, factor analysis, correlation analysis, etc.) to select the most informative search queries that reflect the analyzed index or another indicator. A significant difference of the study is a well-grounded approach to semantic information retrieval (based on Google Trends search queries) about the components of social comfort, which consists in the use of the Harvard IV-4 Dictionaries. The peculiarity of this dictionary is that it helps to solve the problem of ambiguity in assigning words to certain categories. For example, the dictionary contains groupings of words according to the following categories: words of positive worldview, negative worldview, words of joy, pain, virtue, vice; words characterizing social categories (education, finance, labor, etc.); motivational words, etc.[2] In this regard, in this study, each of the twelve components of social comfort is filled with keywords from the Harvard dictionary, then an analysis of the degree of compliance with the realities of Russian reality is carried out (such words as canoe, cowboy, Thanksgiving Day, Independence Day, Constitutional Convention, Bill of Rights, Jury — have been removed).

In order to bring the set of keywords-queries of users closer to the real conditions of everyday Russian life, the following words were added: homeowners association, minimum wage, unified national exam, amendments to the Constitution, single voting day, housing and public utilities, compulsory medical insurance, voluntary medical insurance. Of course, the share of the author's subjectivity is not excluded, but it is less than 26.5% of the total number of words. In addition, it should be noted that the set of keywords did not include verb queries: get sick, seek, play, pray, etc., as well as those that have several lexical meanings: [vena] (Vienna) and [vena] (vein); [vera] (faith) and [Vera] (Vera — name); [zhelezo] (ferrum) and [zhelezo] (iron), etc.

An example of filling each block of social comfort with search queries can be seen in

[2] URL: http://www.wjh.harvard.edu/~inquirer/homecat.htm (accessed on 02.09.2021).

Table 1, which presents only some part of the generated set of keywords.

Big data processing starts with comparability.

At the first stage of big data analysis, as the experience of the conducted research shows, scaling is necessary to ensure the comparability and consistency of the initial data. One of the most common standardization methods is standard deviation correction [2, 33], while other researchers [24, 34] use logarithms. In this article, we will rely on the variant of normalization proposed by S.A. Ayvazyan [35] when constructing complex synthetic latent categories of the population's quality of life:

$$\tilde{x}_{j,t} = \frac{x_{j,t} - x_{j,min}}{x_{j,max} - x_{j,min}} N, \quad (1)$$

where $\tilde{x}_{j,t}$ — unified search query value ($j = 1,2,\ldots,p; t = 2010,2011,\ldots,2021$);

$x_{j,min}, x_{j,max}$ — maximum and minimum values of private indicators; $N = 10$.

$$\tilde{x}_{j,t} = \frac{x_{j,max} - x_{j,t}}{x_{j,max} - x_{j,min}} N. \quad (2)$$

The first option (1) of normalization is used in the case of a positive perception of the search query by an individual, the second option (2) of normalization is used in the case of a negative perception. Information on whether a word belongs to a positive or negative worldview is available in the Harvard IV-4 Dictionaries. Words that are not represented in the Harvard IV-4 Dictionaries were categorized by the authors themselves.

It is worth noting the following regularities between the growth of interest in a particular request and its positive/negative assessment (*Table 2*).

At the second stage, the risk of overfitting the model due to sharp jumps is reduced by using a moving average. For example: "Constitution" (sharp jumps caused by voting for amendments to the Constitution in 2020) or "football" (jumps caused by the 2018 World Cup), etc.

The moving average (MA) of order q is defined as follows:

$$x_t = \mu + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + \ldots + \theta_q \varepsilon_{t-q}. \quad (3)$$

In this case, the order q is calculated considering the number of previous values of random deviations $\varepsilon_{t-1},\ldots,\varepsilon_{t-q}$. In this study, the smoothing window will be equal to three months, respectively, the order q of the moving average is equal to three [MA (3)].

At the third stage, the time series is cleared from the trend. The need for this operation is due to the fact that a strong time trend can lead to an inadequate forecast of social comfort, and also when finding correlations in the process of grouping words in a block, the problem of compiling unreliable block indicators of social comfort may arise, since the words will have the same time trend in common and not a semantic load. In this regard, a regression equation is constructed for the dependence of the search query on the trend of the form:

$$y_t = \theta_1 t + \varepsilon_t, \quad (4)$$

where $\theta_1 t$ — trend; ε_t — a random variable characterizing the deviation of the level from the trend.

Based on the constructed equation, the corrected coefficient of determination is calculated. Search query models with a value of this coefficient above 0.6 will be removed [2].

The fourth stage is the deseasonalization of search queries. The presence of extreme seasonality in queries can lead to strong correlation between themselves, caused by the correspondence of the same seasonal pattern. For deseasonalization, the statsmodels Python module is used. This module includes many classes and functions for evaluating various statistical models, as well as for performing statistical tests and examining statistical data. In particular, this module includes

Table 1

Google Trends searches describing social comfort components

	Block	Examples of search queries	Number of words in a block
1	Health and medical services	Myopia, depression, healthy lifestyle, nerves, proper nutrition, ambulance, diet, etc.	38
2	Education and learning	Graduate, Unified National Exam, Bachelor's programme, mathematics, science, postgraduate study, time management, remote learning, tutors, etc.	42
3	Social support and pensions	Pension, social protection, seniority, allowance, social rehabilitation, nursing home, social support, etc.	23
4	Financial situation	Credit, wages, bankruptcy, deposit, inflation, property, crisis, obligation, poverty, currency, etc.	37
5	Employment and working conditions	HEADHUNTER, unemployed, high-paying job, career, professional development, labor market, labor relations, job fair, dismissal, etc.	53
6	Housing and living conditions	Receipt, homeowner's association, apartment rent, real estate market, apartment prices, neighbors, management company, etc.	13
7	Ethical norms and values	Atheism, the Bible, patriotism, morality, reputation, racism, freedom of speech, the meaning of life, Christianity, feminism, honor, etc.	52
8	Safety	Attack, security, discrimination, thieves, bullying, theft, fraud, punishment, accident, suicide, theft, etc.	60
9	Political stability	Bureaucracy, democracy, citizenship, hunger strike, constitution, parliament, officials, voice, legitimacy, bribes, extremism, etc.	53
10	Rest and leisure	Fishing, volleyball, vacation, seaside vacations, fiction, picnic, boarding house, zoo, museums, hotel, etc.	54
11	Ecology and the environment	Atmosphere, environment, waste recycling, ecology, water quality, nature, climate, greenhouse effect, industrial waste, treatment facilities, environmental education, forest resources, etc.	22
12	Infrastructure (transport, communications, Internet)	Mobile operator, online store, 5G, scooter, bicycle, track, vehicle, train, road, bridge, airport, car, etc.	28

Source: compiled by the authors based on Google Trends.

Table 2

Impact on social comfort of a decrease in interest in words of a positive and negative worldview

	Growth of interest (increase in search queries)	Decrease in interest (decrease in search queries)
Words of a positive worldview	Increase social comfort	Increases social comfort. Interest in words of a positive worldview can be reduced due to the achievement of a certain level of comfort that suits the individual in relation to this process, characterized by a search query. Example: the decline in searches for the word «internet» is related to the availability and good quality of the internet in recent years
Words of negative worldview	Decrease social comfort	Increase social comfort

Source: compiled by the authors based on Google Trends.

a Seasonal-Trend Decomposition Procedure Based on Loess Method (STL) — a method for decomposing a time series into seasonal and trend components, as well as residuals using a local regression method.

The STL method decomposes the time series into the components of the additive model:

$$Y_t = T_t + S_t + E_t, \quad (5)$$

where T_t — the trend component; S_t — seasonal component; E_t — the remainder.

Elimination of seasonality occurs by subtracting the seasonal component S_t from the time series.

As a result of sequential execution of the listed iterations of analysis and data processing, 475 words were selected (out of 574 words before processing) for the period January 2010–January 2021 (frequency — 1 month).

The proposed methodology for keyword search and Google Trends processing is implemented in Python code. It allows you to build statistical series in accordance with the basic principles that ensure the quality of statistics — comparability, consistency, accuracy and homogeneity of data.

BUILDING INTEGRATED SOCIAL COMFORT INDICATORS: OFFICIAL STATISTICS AND GOOGLE TRENDS

Large amounts of information require the use of special methods of aggregation and dimensionality reduction. The most popular are factor analysis and principal component analysis. In our study, we will use a modified principal component analysis, presented in more detail in the work of S.A. Ayvazyan [35]. According to this methodology, indicators within each of the 12 blocks[3] of social comfort are combined into block indicators, which are subsequently combined into a consolidated integral indicator of social comfort. Since the study used two types of data, respectively, at the output we got block indicators and

[3] The substantiation of the block indicators of social comfort is given in more detail in the study [19].

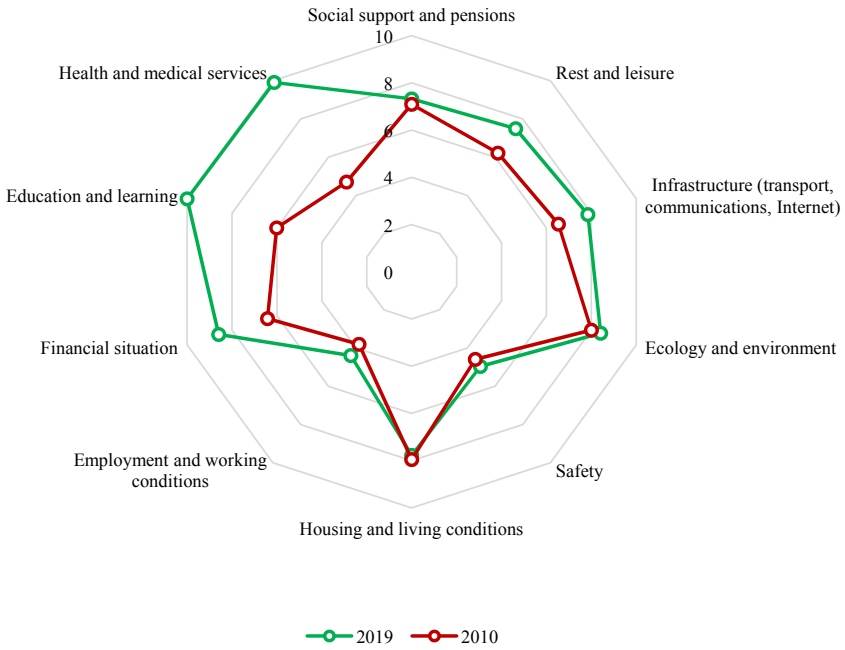

Fig. 1. **Block indicators of social comfort in Moscow for 2010–2019**

Source: compiled by the authors.

a composite integral indicator of social comfort, built according to Google Trends data and official statistics.

In order to harmonize and interconnect information resources of various types: GT and official statistics data presented by Rosstat, it is proposed to use normalization for all data, performed according to formulas (1) and (2), and for GT data, apply the smoothing processing procedures described above, trend exceptions, etc.

Further, we will discuss the results of modeling social comfort, obtained using various types of data, and assess the prospects for using GT in relation to complex latent categories (using the example of social comfort).

Simulation results based on Rosstat data

The information base for filling in the blocks of social comfort was the indicators of the socio-economic situation of the regions of Russia for 2010–2019, taken from the Rosstat website.[4] When choosing indicators, we were guided by the approach to the analysis of the contextual conditions of the Russian Federation and its regions (described in more detail in the study [19]), as well as the requirements for a set of particular criteria for the synthetic latent category [35]. Much attention was paid to the degree of conformity of the socio-economic content of the indicator to the directly measured hidden category ("Safety", "Housing and medical services", etc.), reliability, accessibility in the official source. In this regard, such blocks of social comfort as "Ethical norms and values", "Political stability" remained empty due to the high share of the subjectivity of the indicators included in them and the lack of information on the official resource of state statistics. The empirical base of the study includes a panel of 100 indicators for 2010–2019. The collected indicators are measured on a quantitative scale in accordance with a unified methodology and basic principles of statistical observation, which ensure the consistency and comparability of the objects of observation.

Since the normalization of the indicators included in the panel was carried out

[4] Federal State Statistics Service of the Russian Federation (Rosstat). URL: https://rosstat.gov.ru/ (accessed on 02.09.2021).

on a 10-point scale, then as a result of calculations using a modified analysis of principal component at the output, the values of the block indicators of social comfort will also belong to the interval from 0 to 10.

Let us consider, for example, the results of modeling the social comfort of Moscow for 2010–2019 (*Fig. 1*).

The consolidated integral indicator for Moscow in 2019 amounted to 6.815, which is the maximum value in 2019 among other regions of Russia and is 13% higher than the level of 2010. Such dynamics are explained by a slight change in the weight coefficients by the growth of block integral indicators.

For the analyzed period 2010–2019 Moscow has improved its position in eight out of ten presented components of social comfort. The most significant changes occurred in the components "Financial Situation" (+1.3 points), "Infrastructure" (+2.1 points), "Rest and Leisure" (+4 points), "Social Support and Pensions" (+ 5.2 points). There are no dynamics in the blocks "Health" and "Safety".

The reasons for the changes are as follows:

• "Financial Situation" block: the gross regional product per capita in Moscow is one of the highest in absolute terms and during the analyzed period has increased by about 2 times. In addition, the share of the population with monetary incomes below the subsistence level has significantly decreased (from 10 to 4%). At the same time, the structure of Moscow's GRP over 50% is formed at the expense of the service sector;

• "Infrastructure" block: Moscow is the first region of Russia where the use of mobile high-speed Internet LTE and 4G is widely used among the city's population, which in general contributed to the growth of digitalization of socio-economic processes. In particular, the share of the population using the Internet on a daily basis increased from 60% in 2014 to 82% in 2019;

• "Rest and Leisure" block: there are more than 18 thousand sports facilities in Moscow, which is 2 times higher than the level of 2010, and the all-Russian level increased by 11%;

• "Social Support and Pensions" block: 8.5% of the population of Russia lives in Moscow, this figure in the period 2010–2019 practically did not change, and the share of execution of the budgets of the Pension Fund and the Social Insurance Fund under the item "expenses" of Moscow in the structure of Russia increased by 1.5 and 4.2%, respectively.

According to the approach used for the convolution of multidimensional categories [35], the value of the aggregate integral indicator of social comfort will be determined by the formula:

$$Y_{t,ag.} = 10 - \sqrt{\sum_{j=1}^{12} v_j (y_{j,t} - 10)^2}, \qquad (6)$$

where v_j — these are normalized non-negative weights determined by the fraction of the explained variance of the first principal component of each of the 12 blocks;[5] $y_{j,t}$ — a block indicator of social comfort in year t.

The higher the weight of the block indicator, the more influence it has on the composite indicator of social comfort. Based on this method, it is possible to determine the priorities of socio-economic policy in order to improve social comfort.

We will analyze the performance of this method based on comparing the values of the block indicators and their weight in the composite indicator for two regions (the Republic of Buryatia and the Tula region).

Let us consider the growth rates of the values of block indicators of social comfort for 2010–2019 (*Fig. 2*), as well as the weight of each component in the composite indicator.[6] It can be noted that the priority areas for increasing social comfort are infrastructure

[5] According to official statistics, 10 blocks were built due to the lack of information on the blocks "Ethical norms and values", "Political stability", and according to Google Trends — 12 blocks.

[6] The weight of the block indicators is the average for 2010–2019 and constant for each object of observation.

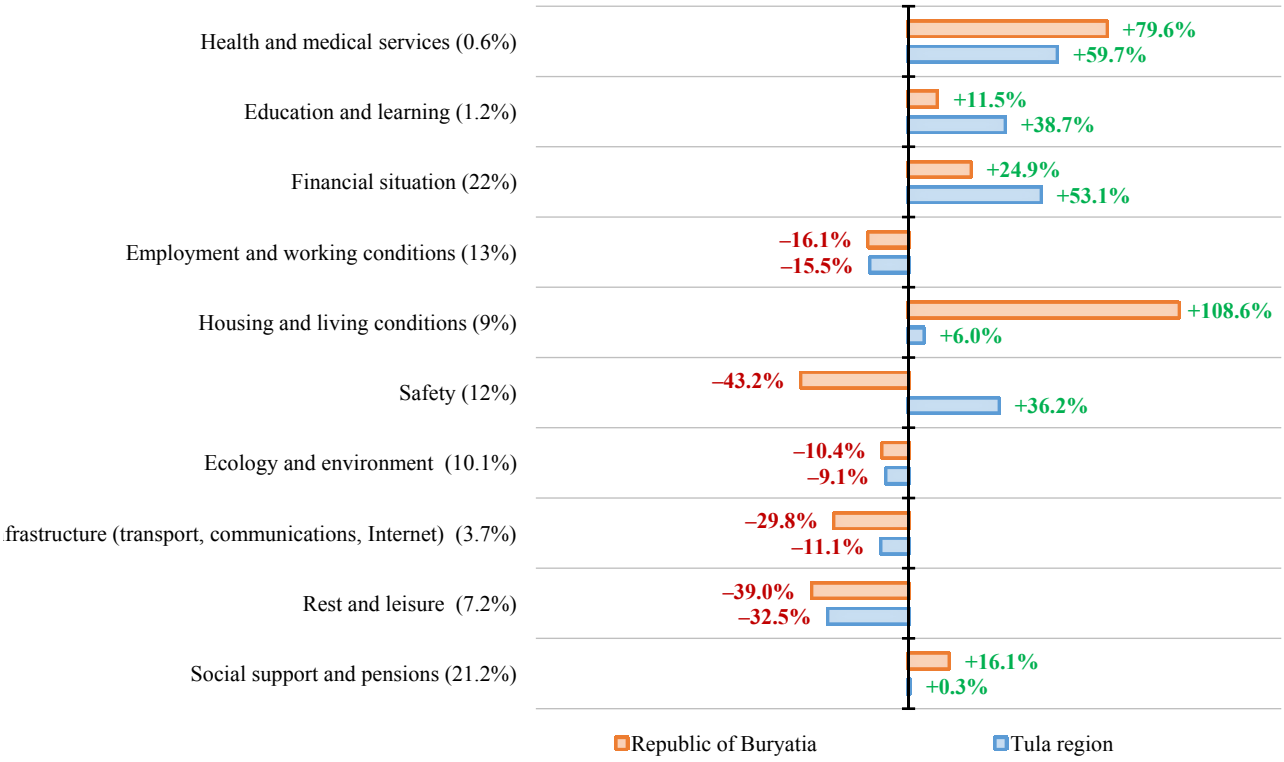

Fig. 2. **Composite indicator of social comfort in regions**

Source: compiled by the authors.

(weight in the aggregate indicator — 22%); health and medical services (21.2%); ecology and the environment (13%); housing and living conditions (12%). At the same time, the aggregate indicator of social comfort in the Tula region increased by 8.4%, and in the Republic of Buryatia — by only 0.5% due to the outstripping growth of block indicators of social comfort in the Tula region, which are a priority (infrastructure, housing). The data obtained can become the basis for monitoring social comfort and subsequent adjustments to the ongoing socio-economic policy of the region within the framework of priority factors.

Comparison of simulation results based on GT data and official statistics

According to the results of modeling based on Google Trends data, the composite integral indicator for Russia from 2010 to 2019 increased by 54% and amounted to 4.631 points. The subjective estimate of the population, aggregated based on search queries, is lower than the estimate based on Rosstat data (5.371).

Using the developed methodology for processing Google Trends (1)–(5), the values of block indicators of social comfort were calculated and a comparative analysis was carried out with similar indicators according to official statistics. *Table 3* shows correlations for block indicators of social comfort.

According to the analyzed table, a significant correlation of all block indicators of social comfort is obvious. At the same time, a stable positive linear relationship is observed for seven out of ten compared blocks of social comfort. There was a **strong** positive correlation of indicators of the block "Social support and pensions", "Ecology and environment"; **moderate** positive correlation — "Health and medical services", "Employment and working conditions",

"Infrastructure", "Housing and living conditions", "Financial situation".

"Financial situation", according to calculations, is formed mainly by such words as "credit", "deposit", "profit", "inflation", "accumulation", "cash", etc. Thus, the block "Financial situation" is determined mainly by words characterizing the processes of receipt of funds by the population.

At the same time, a similar component of social comfort in official statistics is assessed by the following indicators: "consumer spending", "fund ratio", CPI, the share of expenditures on food, etc. In general, official statistics primarily considers the population from the standpoint of forming the expenditures of the range of goods and services.

It is possible to increase the correlation by supplementing the list of indicators of official statistics that characterize the financial situation of the population in terms of the formation of its income, for example, the average profitability on bank deposits, income received from transactions in financial markets, the structure of the formation of disposable money income of the population, etc.

The debatable issue is the strong negative correlation of the blocks "Education and Learning", "Safety", "Rest and Leisure". Further, we will discuss the possible causes of existing dependencies.

The indicators of the **"Education"** block, according to official statistics, are formed by quantitative indicators of the coverage of secondary, secondary professional, and higher education. Most of the indicators of this block (for example, "The share of university students in the working-age population", "The number of graduate students", etc.) demonstrate negative dynamics. A similar trend, which began in 2010, is typical for most regions of Russia [36] and is associated with demographic problems in the country. In this regard, there is a negative dynamic of the block indicator "Education", which contradicts the dynamics of the indicator "Education" according to GT data. It should be noted that a significant drawback of the data on this block published by Rosstat is that they do not fully reflect the level of the intellectual development of the region/country, which ensures competitiveness, changes the standard of living and the level of social comfort. In this regard, the indicators of enrollment in education

Table 3

Pearson correlation coefficients of block indicators of social comfort based on official statistics and Google Trends data

	Pearson correlation coefficient	P-value
Health and medical services	0.59	0.0700
Education and learning	−0.90	0.0003
Social support and pensions	0.88	0.0007
Financial situation	0.46	0.0176
Employment and working conditions	0.58	0.0813
Housing and living conditions	0.35	0.0317
Safety	−0.77	0.0100
Rest and leisure	−0.76	0.0104
Ecology and environment	0.70	0.0250
Infrastructure (transport, communications, Internet)	0.41	0.0208

Source: compiled by the authors.

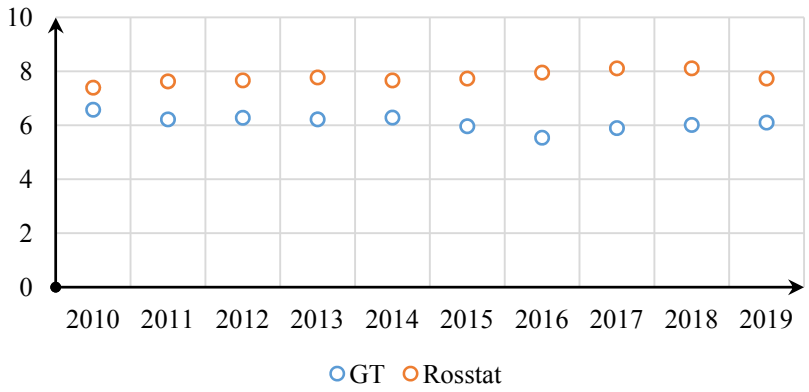

Fig. 3. **Comparative dynamics of the "Safety" block indicators based on official statistics and Google Trends data**
Source: compiled by the authors.

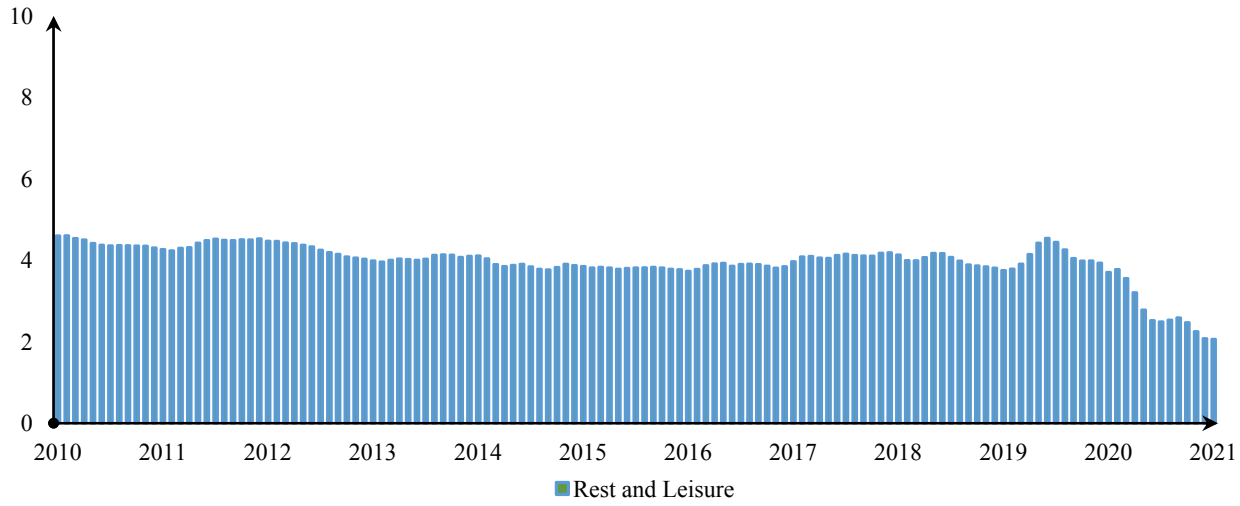

Fig. 4. **Dynamics of the component "Leisure and free time" based on Google Trends data**
Source: compiled by the authors.

should be supplemented with indicators characterizing the performance of schoolchildren, students, the quality of final/entrance exams, international tests (GMAT, IELTS, etc.); the number of academic competition winners; indicators of the attractiveness/openness/prestige of the university; availability of education (preschool, secondary, higher).

The work [37] details the advantages and objectivity of using a new approach to assessing the level of the country's intellectual capital based on the use of new indicators for assessing the level of education in the country. Using other sources of information: polls, GT data allow expanding the indicators of enrollment in education in Russia by qualitative characteristics.

An example of a strong inverse correlation indicates the need to expand education statistics with qualitative indicators, in particular, to consider the possibilities of using alternative sources — GT data, which will increase the objectivity and quality of the information provided. Thus, the analysis showed that the most popular and significant search queries in the "education" block are the words "remote learning", "English", "mathematics", "academic performance". The growing interest of the population on these topics indicates the growth of the intellectual capital of the population.

For the **"Safety"** block, the correlation is –0.77. The indicators of this block of social comfort should characterize the level of risk to the life and health of the population, and not the success of the law enforcement system. Hence, the safety indicators provided by Rosstat cannot be considered as sufficiently valid from the point of view of the characteristics of social comfort, since they are represented by the number of crimes of a different nature, robberies, and causing grievous bodily harm.

In [38], it is noted that the self-awareness of the safety of citizens is influenced by the personal attitudes of citizens and everyday practices (whether they have to carry weapons, gas canisters, etc.), and not the number and disclosure of crimes. In addition, in [39] it is shown that crimes that fall under the article "Murders" have a latency coefficient in Russia of 2.3. This means that the real number of crimes is 2.3 times higher than the indicators of official statistics. Данный факт подтверждается результатами проведенного исследования. This fact is confirmed by the results of the study. The numerical safety score according to GT data is much lower than the estimate according to official statistics: 6 points against 8 points (*Fig. 3*).

If we analyze the dynamics of the two indicators of the block in *Fig. 3*, it can be noted that during the unfavorable economic situation in 2014–2016, caused by the imposition of sanctions, the escalation of the geopolitical conflict, and, as a consequence, the depreciation of the national currency, there is a deviation of the indicator of the "Safety" block according to GT data. This is due to the concerns of citizens, a decrease in the sense of security and comfort. But the graph, built according to official statistics, in the period 2014–2016 demonstrates strong growth, which is contradictory. There is reason to believe that for an adequate assessment of the level of safety of the population, it is also advisable to integrate safety indicators based on GT data into crime statistics.

Block indicators "Rest and Leisure" also show an inverse linear relationship. The statistics of this block are represented by only three indicators: the number of sports institutions; the number of vouchers sold through travel agencies, and the number of Russian tourists served by travel agencies. At the same time, according to GT data, the analyzed block included about 54 indicators reflecting various aspects of an individual's rest and leisure (*Fig. 4*).

The dynamics of the analyzed component of GT are quite adequate to the realities of economic life: the consequences of the COVID-19 pandemic negatively affected the rest of the Russians, since they had to change their travel preferences. The consequence of this is a decrease in the values of this component by 31% within one year. Since the composite indicator of social comfort "rest" has a significant contribution — 10%, more attention should be paid to the development of new tourist destinations, active recreation of the population. The significant role of the indicator of the "Rest and Leisure" block in the formation of social comfort, as well as its weak representation in official statistics, justifies the need to use Google Trends in the development of a methodology for accounting for tourism and recreation statistics.

Thus, the components of social comfort, built on the basis of GT data and having a significant positive correlation with the components of official statistics, can be used to conduct operational monitoring of the living conditions of the population. For the components "Education and Learning", "Safety", "Rest and Leisure", a serious methodological study of options for integrating alternative sources of information into official statistics is required due to inconsistency of results and a poor reflection of the level of social comfort of the population.

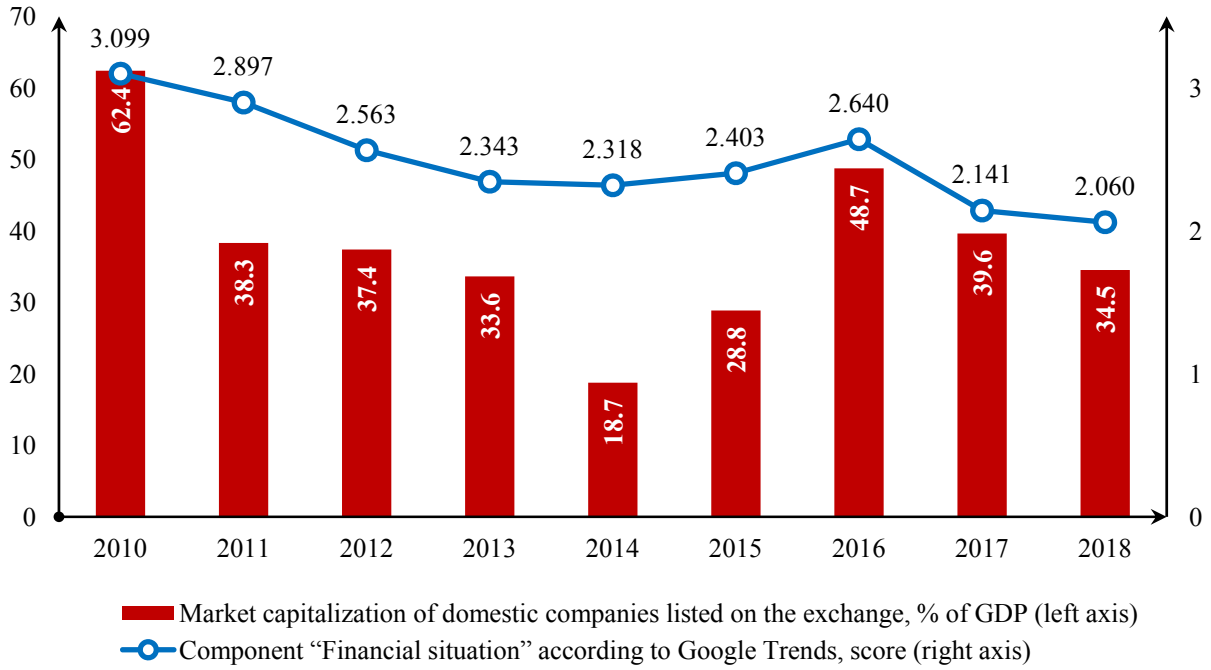

Fig. 5. **Dynamics of the component "Financial situation" and market capitalization of listed domestic companies**

Source: compiled by the authors based on Google Trends and World Bank Datebase.

PROSPECTS FOR USING BIG DATA TO FORECAST FINANCIAL PERFORMANCE

The calculations presented earlier demonstrate the good potential of using big data to predict 7 out of 10 components of social comfort, including the component "Financial situation". In connection with the deterioration of the financial situation of the population in Russia, the prospects for using search queries reflecting the financial mood of economic agents for forecasting economic indicators remain extremely relevant.

The financial sentiments of economic agents, aggregated in one indicator using Google Trends search queries, are becoming an important source of information about their preferences and behavior. To determine the prospects for using the calculated component as a proxy for indicators of financial condition, let us calculate the correlation with the indicator "Market capitalization of national companies whose shares are traded on the stock exchange". According to the published information of the World Bank, the banking system and the stock market are directly related to economic growth, which is the main factor affecting poverty reduction, which, in particular, is considered in the financial component of social comfort.

The high correlation with market cap indicates that search queries can be used to extrapolate financial health indices without using financial statistics resources, making the calculation easier and faster.

The reaction of Internet users' interest in relation to financial market indicators in response to changes in the economic indicator (GDP, MICEX capitalization index, inflation, deposit rates, etc.) social comfort depending on changes in the indicators of the financial situation of the population and the expected trends in economic growth.

CONCLUSIONS

Big data has more detailed statistical assessments of various phenomena and processes in society, which is a necessary argument in developing the provisions of the concept of the quality of life of the population as one of the most important categories of social and economic science. The introduction of the latent category of "social comfort" into

the scientific use deepens the theory of the quality of life of the population in terms of studying a person from the point of view of his inclusion in society, expanding the subjective aspect of measurement, which is explained by the need to use Google Trends.

In the proposed study, an integral assessment of social comfort is carried out using two sources of information: official statistics and Google Trends. The integral assessment of social comfort allows, in turn, to see a bigger picture of the development of the phenomenon in time, as well as to assess the ongoing socio-economic policy.

To minimize the author's subjectivity in assessing social comfort, according to Google Trends, a new approach to semantic search for information about the components of social comfort is used, based on the use of a specialized dictionary, which contains classifications of various processes and phenomena, as well as an analysis of the validity of each search query in terms of disclosure of social comfort and correlation with the realities of Russia.

In the process of modeling, the problem of harmonization and interconnection of different types of resources is solved: a set of econometric methods is used to diagnose data for the presence of a time trend, sharp jumps in the popularity of a query, the presence of a zero-search volume, extreme seasonality and bringing time series to a comparable form not only among themselves within the same information resource. The method used to standardize search queries allows for reliable estimates and modeling of composite categories based on different types of data.

On the basis of the applied methodology, in the analysis of social comfort, 475 Google Trends search queries and 100 indicators taken from official statistics were used, which were aggregated into block indicators of social comfort. Correlation analysis of block indicators showed a stable positive correlation between the components of social comfort built on the basis of GT and official statistics (7 out of 10 components), which indicates good prospects for using alternative sources of information (for example, GT) to assess social comfort for real-time monitoring without resorting to official statistics. There is a strong negative linear relationship for the three components "Education and Learning", "Safety", "Rest and Leisure", which is mainly explained by the weak reliability of statistical indicators for assessing social comfort and determines the primary need to integrate big data in these areas for sharing various sources of information in order to obtain more reliable estimates.

Thus, we can conclude that the use of big data in assessing latent categories gives good results, comparable to the data of official statistics, which opens up opportunities for their use in monitoring and forecasting the financial situation. However, the integration of the two data sources should be carried out sequentially when conducting possible verification with other sources, for example, with the data of opinion polls.

ACKNOWLEDGEMENTS

The reported study was funded by RFBR, project No. 20–310–70037 "Stability". Lomonosov Moscow State University, Moscow, Russia.

REFERENCES

1. Liu J., Li J., Li W., Wu J. Rethinking big data: A review on the data quality and usage issues. *ISPRS Journal of Photogrammetry and Remote Sensing*. 2016;115:134–142. DOI: 10.1016/j.isprsjprs.2015.11.006
2. Algan Y., Beasley E., Guyot F., Higa K., Murtin F., Senik C. Big data measures of well-being: Evidence from a Google well-being index in the United States. OECD Statistics Working Papers. 2016;(03). URL: https://www.oecd-ilibrary.org/docserver/5jlz9hpg0rd1-en.pdf?expires=1629818036&id=id&accname=guest&checksum=7ED855395D5B778D71E405ED1925ECE3

3. Fantazzini D., Shakleina M., Yuras N. Big data for computing social well-being indices of the Russian population. *Prikladnaya ekonometrika = Applied Econometrics*. 2018;50:43–66. (In Russ.).
4. Carlquist E., Nafstad H.E., Blakar R.M., Ulleberg P., Delle Fave A., Phelps J.M. Well-being vocabulary in media language: An analysis of changing word usage in Norwegian newspapers. *The Journal of Positive Psychology*. 2017;12(2):99–109. DOI: 10.1080/17439760.2016.1163411
5. Curini L., Iacus S., Canova L. Measuring idiosyncratic happiness through the analysis of Twitter: An application to the Italian case. *Social Indicators Research*. 2015;121(2):525–542. DOI: 10.1007/s11205–014–0646–2
6. Prata D.N., Soares K.P., Silva M.A., Trevisan D.Q., Letouze P. Social data analysis of Brazilian's mood from Twitter. *International Journal of Social Science and Humanity*. 2016;6(3):179–183. DOI: 10.7763/IJSSH.2016.V6.640
7. Nguyen Q.C., Kath S., Meng H.-W., Li D., Smith K.R., VanDerslice J.A., Wen M., Li F. Leveraging geotagged Twitter data to examine neighborhood happiness, diet, and physical activity. *Applied Geography*. 2016;73(8):77–88. DOI: 10.1016/j.apgeog.2016.06.003
8. Yang C., Srinivasan P. Life satisfaction and the pursuit of happiness on Twitter. *PLoS ONE*. 2016;11(3):e0150881. DOI: 10.1371/journal.pone.0150881
9. Wang W., Hernancez I., Newman D.A., He J., Bian J. Twitter analysis: Studying US weekly trends in work stress and emotion. *Applied Psychology*. 2016;65(2):355–378. DOI: 10.1111/apps.12065
10. Liu P., Tov W., Kosinski M., Stillwell D.J., Qui L. Do Facebook status updates reflect subjective well-being? *Cyberpsychology, Behavior, and Social Networking*. 2015;18(7):373–379. DOI: 10.1089/cyber.2015.0022
11. LiKamWa R., Liu Y., Lane N.D., Zhong L. MoodScope: Building a mood sensor from smartphone usage patterns. In: Proc. 11th Annu. int. conf. on mobile systems, applications, and services (MobiSys). (Taipei, June 25–28). New York: ACM; 2013:389–402. DOI: 10.1145/2462456.2464449
12. Schwartz H.A., Sap M., Kern M.L., Eichstaedt J.C., Kapelner A., Agrawal M., Ungar L.H. et al. Predicting individual well-being through the language of social media. In: Proc. Pacific symp. on biocomputing (PSB). (Big Island of Hawaii, Jan. 4–8, 2016). Singapore: World Scientific Publishing Co.; 2016:516–527.
13. Da Z., Engelberg J., Gao P. The sum of all FEARS investor sentiment and asset prices. *The Review of Financial Studies*. 2015;28(1):1–32. DOI: 10.1093/rfs/hhu072
14. Singer E. The use of incentives to reduce nonresponse in household surveys. The University of Michigan. Survey Methodology Program. 2002;(051). URL: https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.611.1597&rep=rep1&type=pdf
15. Ginsberg J., Mohebbi M.H., Patel R.S., Brammer L., Smolinski M.S., Brilliant L. Detecting influenza epidemics using search engine query data. *Nature*. 2009;457(7232):1012–1014. DOI: 10.1038/nature07634
16. Upadhyaya S. Big data and official statistics. *Voprosy statistiki*. 2019;26(12):5–14. (In Russ.). DOI: 10.34023/2313–6383–2019–26–12–5–14
17. Oksenoyt G.K. Digital agenda, big data and official statistics. *Voprosy statistiki*. 2018;25(1):3–16. (In Russ.).
18. Plekhanov D.A. Bigdata and official statistics: A review of international experience with integration of new data sources. *Voprosy statistiki*. 2017;(12):49–60. (In Russ.).
19. Shakleina M.V., Volkova M.I., Shaklein K.I., Yakiro S.R. Theoretical and methodological problems of measuring social comfort: Results of empirical analysis based on Russian data. *Economic and Social Changes: Facts, Trends, Forecast*. 2020;13(5):135–152. DOI: 10.15838/esc.2020.5.71.8
20. Petrova D.A. Inflation forecasting based on Internet search queries. *Ekonomicheskoe razvitie Rossii = Russian Economic Developments*. 2019;26(11):55–62. (In Russ.).
21. Guzmán G. Internet search behavior as an economic forecasting tool: The case of inflation expectations. *Journal of Economic and Social Measurement*. 2011;36(3):119–167. DOI: 10.3233/JEM-2011–0342
22. Afkhami M., Cormack L., Ghoddusi H. Google search keywords that best predict energy price volatility. *Energy Economics*. 2017;67:17–27. DOI: 10.1016/j.eneco.2017.07.014

23. Tetlock P.C. Giving content to investor sentiment: The role of media in the stock market. *The Journal of Finance*. 2007;62(3):1139–1168. DOI: 10.1111/j.1540–6261.2007.01232.x
24. Brochado A. Google search-based sentiment indexes. *IIMB Management Review*. 2020;32(3):325–335. DOI: 10.1016/j.iimb.2019.10.015
25. Dunphy D.C., Bullard C.G., Crossing E.E.M. Validation of the general inquirer Harvard IV dictionary. Cambridge, MA: Harvard University Library; 1974. 158 p.
26. Kelly E.F., Stone P.J. Computer recognition of English word senses. Amsterdam: North-Holland; 1975. 269 p.
27. Zuell C., Weber R.P., Mohler P.P. Computer-aided text classification for the social sciences: The General Inquirer III. Mannheim: ZUMA, Center for Surveys, Research and Methodology; 1989.
28. Scott S.L., Varian H.R. Bayesian variable selection for nowcasting economic time series. NBER Working Paper. 2013;(19567). URL: https://www.nber.org/system/files/working_papers/w19567/w19567.pdf
29. Kapounek S., Deltuvaitė V., Koráb P. Determinants of foreign currency savings: Evidence from Google search data. *Procedia — Social and Behavioral Sciences*. 2016;220:166–176. DOI: 10.1016/j.sbspro.2016.05.481
30. Bokelmann B., Lessmann S. Spurious patterns in Google Trends data — An analysis of the effects on tourism demand forecasting in Germany. *Tourism Management*. 2019;75:1–12. DOI: 10.1016/j.tourman.2019.04.015
31. Google Trends help — how Trends data is adjusted. Google 2018. URL: https://support.google.com/trends/answer/4365533?hl=en&ref_topic=6248052 (accessed on 23.04.2018).
32. Cleveland R.B., Cleveland W.S., McRae J.E., Terpenning I. STL: A seasonal-trend decomposition procedure based on loess. *Journal of Official Statistics*. 1990;6(1):3–73. URL: https://www.wessa.net/download/stl.pdf
33. Petrova D.A. Trunin P.V. Revealing the mood of economic agents based on search queries. *Prikladnaya ekonometrika = Applied Econometrics*. 2020;(3):71–87. (In Russ.). DOI: 10.22394/1993–7601–2020–59–71–87
34. Parker J., Cuthbertson C., Loveridge S., Skidmore M., Dyar W. Forecasting state-level premature deaths from alcohol, drugs, and suicides using Google Trends data. *Journal of Affective Disorders*. 2017;213:9–15. DOI: 10.1016/j.jad.2016.10.038
35. Ayvazyan S.A. Analysis of the quality and lifestyle of the population. Moscow: Nauka; 2012. 432 p. (In Russ.).
36. Mindeli L.E., Pashinceva N.I. Russian education system and how it is reflected in statistics. *Voprosy statistiki*. 2016;(11):67–84. (In Russ.).
37. Chan K.L. Intelligence Capital Index. 2017. URL: http://www.kailchan.ca/wp-content/uploads/2017/04/KC_Intelligence-Capital-Index-full-results-and-methodology_Apr-2017_v2.pdf
38. Satarov G.A., Blagoveshchenskii Yu.N. Statistical comparison of Russia and other countries. Civil Initiatives Committee. INDEM Foundation. URL: https://komitetgi.ru/upload/iblock/3cf/3cfcb375eced922f253c446a4b37645b.pdf (In Russ.).
39. Inshakov S.M. Theoretical foundations of research and analysis of latent crime. Moscow: UNITY-DANA; 2011. 839 p. (In Russ.).

ABOUT THE AUTHORS

Marina V. Shakleina — Cand. Sci. (Econ.), Assoc. Prof., Moscow School of Economics of the Lomonosov Moscow State University, Moscow, Russia
shakleina.mv@gmail.com

Mariya I. Volkova — Cand. Sci. (Econ.), Head of the Laboratory “Modeling of socio-economic systems”, Plekhanov Russian University of Economics, Moscow, Russia
frauwulf@gmail.com

Konstantin I. Shaklein — Cand. Sci. (Econ.), Chief Specialist of Department of Economics OJSC "Russian Railways", Moscow, Russia
mrshaklein@gmail.com

Stanislav R. Yakiro — Chief Specialist of Department of Risk and Economic Performance Analysis JSC "SOGAZ", Moscow, Russia
yakirosr@yandex.ru

Authors' declared contribution:

Shakleina M.V. — introduction, relevance of the research topic and problem statement, analysis of literature sources, study of research problems, development of research methodology, interpretation of the results.

Volkova M.I. — justification of the choice of indicators for analysis; formation of conclusions and recommendations based on the results of the study.

Shaklein K.I. — statistical analysis of data, description of the calculation method used, analysis of the results, tabular and graphical representation of the results.

Yakiro S.R. — collection and processing of big data, assessment and forecasting.

The article was submitted on 13.05.2021; revised on 27.05.2021 and accepted for publication on 27.08.2021.
The authors read and approved the final version of the manuscript.