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Risk Modeling and Connectedness Across Global and Industrial US Fintech Stock Market: Evidence from the COVID-19 Crisis

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ABSTRACT

The main **purpose** of this paper is to test the performance of GARCH models in estimating and forecasting VaR (value at risk) of the US Fintech stock market from July 20, 2016, to December 31, 2021. In addition, this study examines the impact of COVID-19 on the risk spillover between the adequate VaR series of the US global KFTX index and the five Fintech industries. Specifically, we compare different VaR estimates (862 in-sample daily returns) and predictions (550 out-of-sample daily returns) of several GARCH model specifications under a normal and Student-t distribution with 1% and 5% significance. The Backtesting results indicate that I-GARCH with Student-t distribution is a good model for estimating and forecasting VaR of the US Fintech stock market before and during COVID-19. Moreover, the total connectedness results suggest that global and each Fintech industry increases significantly under turbulent market conditions. Given these considerations, this paper provides policymakers and regulators with a better understanding of risk in the Fintech industry without inhibiting innovation.

Keywords: value at risk; fintech stock market; GARCH model specifications; COVID-19; VaR series; connectedness

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INTRODUCTION

The financial technology (Fintech) industry invests in innovations by allowing firms to offer new products, new business processes, and new business models in order to support evolving investor preferences. The wide application of technological networks has developed an original financial model that has greatly affected both economic and financial dimensions [1, 2]. Even though these new technologies are changing the world of the US financial industry by creating huge rewards, they also give rise to huge risks [3].

Since the global financial crisis in 2008, markets have experienced a series of turbulences, namely, the outbreak of the coronavirus's (COVID-19) health crisis that gave rise to various shock waves affecting financial stock markets [4–6]. In this vein, the existence of several confirmed cases of the COVID-19 pandemic in the USA* helped the rise of digital adoption due to social distancing. In fact, this rapid development, along with the rise of uncertainties and volatility, might be the reason behind the increase in the risk of the Fintech stock market. For this reason, it is important to evaluate the risk of the US stock market based on the technological area before and during the COVID-19 pandemic.

The COVID-19 outbreak aggravated risk in stock markets, which made investors more prudent regarding the risk measurement of the Fintech industry. This research aims to investigate the best accurate VaR models and to study the impact of COVID-19 on the dependence among value at risk of the global US Fintech stock market and each Fintech industry. Using three important measures of Value at Risk models: integrated GARCH (1, 1); standard GARCH (1, 1), and component standard GARCH (1, 1) based on normal and student-t distributions with 1% and 5% significance levels, we apply two steps of VaR backtesting test: Kupiec's unconditional and Christoffersen's conditional coverage procedures. Following this, we examine the volatility spillover effects among the predictive abilities of the selected VaR models by using the index of [7].

Therefore, the present study provides three major contributions to the risk of the Fintech industry. Firstly, this paper investigates the Value at Risk of the Fintech stock market in order to understand the market's risk

management, especially, during the COVID-19 pandemic. Secondly, it provides evidence that widely used methods give reliable VaR estimates and forecasts for calm periods (before COVID-19) and turmoil periods (during COVID-19), respectively. Thirdly, the risk spillovers analysis between the global US Fintech index and each Fintech industry allows a deep explanation of whether there is a change in the strength of system spillovers between pairwise VaR series from pre- and mid-COVID-19.

To the best of our knowledge, no previous study was made to investigate the performance of the accurate VaR model for estimating and forecasting the risk of the US Fintech index and each Fintech industry before and during COVID-19. Moreover, the connectedness analysis between different risks helps policies preserve financial stability, investment and hedging strategies for the benefit of investors, portfolio managers and risk managers.

Our purpose can be pressing for portfolio risk managers, policymakers, and regulators because of its central impact on managing risk in the context of financial instability. The remainder of this study is organized as follows: Section 2 provides a literature review. Section 3 states the methodology. Section 4 presents data and descriptive statistics. Section 5 consists of empirical findings. The final part is a conclusion to our study.

LITERATURE REVIEW

A growing number of research studies are dealing with the estimation and forecasting of stock market risk by using different VaR models.

For instance, Assaf [8] analyzed the out-of-sample performance of VaR models based on four MENA equity markets using the APARCH model. The study shows that the APARCH model with student distribution is the optimal model for the estimation of VaR compared to those with a normal distribution. Tabasi et al. [9] implemented GARCH models in order to model the volatility-clustering feature. They concluded that the use of the t-student distribution function was better than using the Normal one in that it updated the model VaR parameter estimation.

Recently, Emenogu et al. [10] stated that while GARCH models are robustly persistent, only IGARCH and EGARCH models are unstable. In addition, S-GARCH and GJR-GARCH models underestimated VaR with student-t innovation. Ben Ayed et al. [11] explored the performance of Value at Risk models for North Africa and Middle East Islamic indices by using risk metrics and other GARCH models. They suggested using risk metrics in calm periods and both GARCH and APARCH in turbulence periods. Amiri et al. [12] used GARCH models to estimate VaR with various return distributions of different industries in the Tehran Stock Exchange and they found that the GJR-GARCH model with NIG distribution is the best accurate model. Haddad et al. [13] investigated the predictive performance of the Value at Risk model by using several GARCH specifications in order to estimate and forecast the Value at Risk of six major cryptocurrencies. Among principal results, they found that the I-GARCH model outperforms other models in both the in-sample and out-sample frameworks. Shaik and Padmakumari [14] used various VaR models in order to predict their performance based on the backtesting test in the case of the BRICS and US stock market indices from 2006 to 2021. The results exhibited that EWMA performs better VaR estimation than N and HS estimation models for all indices. Moreover, a limitation of the accurate predictive VaR models occurred during the COVID-19 period. Mrkvička et al. [15] analyzed the accuracy of five VaR methods for small and medium-sized enterprises to estimate future exchange rate losses during one year. Backtesting results revealed that parametric-VaR is the most accurate for estimating future losses in a given period.

METHODOLOGY

GARCH Model Specifications

In this paper, we employ robust GARCH models to estimate and forecast the Value at Risk in financial markets. In this section, different GARCH models are described.

Standard GARCH Model (sGARCH)

The standard GARCH model proposed by Bollerslev [16] is expressed as follows:

$$\sigma_t^2 = \left(w + \sum_{j=1}^{m} \zeta_j v_{jt} \right) + \sum_{j=1}^{q} \alpha_j \varepsilon_{t-j}^2 + \sum_{j=1}^{p} \beta_j \sigma_{t-j}^2 \quad (1)$$

σ_t^2 denotes the conditional variance, where w is the constant term and v_{jt} denotes exogenous variables and

* World Health Organization. Novel Coronavirus (2019-n CoV): situation report, 19. World Health Organization. 2020. URL: https://apps.who.int/iris/handle/10665/330988 (accessed on 05.06.2023).

ε_t^2 are the residuals from the mean filtration process discussed previously.

Integrated GARCH model (iGARCH)

The integrated GARCH model proposed by Engle and Bollersev [17] can be briefly expressed as follows:

$$I_t = \varphi_t \varepsilon_t \text{ With } \varphi_t^2 = \alpha_0 + \beta_1 \varphi_{t-1}^2 + (1-\beta_1) I_{t-1}^2, \quad (2)$$

where $0 < \beta_1 < 1$; $\alpha + \beta = 1$.

This model is specified by the occurrence of unit-root in the variance and the persistence of the effect of squared shocks.

The Component Standard GARCH (Csgarch)

The component standard GARCH model of Lee and Engle [18] decomposes the component of the conditional variance into a permanent and transitory component to investigate the long- and short-term movements of volatility. The component model can be written as:

$$\sigma_t^2 = q_t + \sum_{j=1}^{q} \alpha_j \left(\varepsilon_{t-j}^2 - q_{t-j}\right) + \sum_{j=1}^{p} \beta_j \left(\sigma_{t-j}^2 - q_{t-j}\right), \quad (3)$$

where the permanent component of the conditional variance q_t is calculated as follows:

$$q_t = w + \rho q_{t-1} + \varphi\left(\varepsilon_{t-1}^2 - \sigma_{t-1}^2\right). \quad (3.1)$$

Where, the intercept of the GARCH model is time-varying following first-order autoregressive type dynamics.

Backtesting Test: Model Evaluation and Statistical Accuracy of VaR

A backtesting test is the process of comparing losses predicted by the value at risk (VaR) model to those experienced over the sample-testing period. Thus, there are two main tests generally used by researchers to select the most suitable VaR model.

The Kupiec Test

P. Kupiec's [19] test (UC test) is based on the proportion of Failures (POF) test, which examines whether the observed frequency of exceptions is statistically equal to the expected frequency of exceptions implied by the VaR confidence level. The likelihood ratio is given by:

$$LR_{POFF} = -2\log\left(\frac{(1-p)^{N-x} p^x}{\left(1-\frac{x}{N}\right)^{N-x}\left(\frac{x}{N}\right)^x} \sim \chi_1^2, \right. \quad (4)$$

$$P\_value = 1 - F\chi_1^2\left(LR_{POFF}\right), \quad (4.1)$$

where x is the number of failures, N is the number of observations. $F\chi_1^2\left(LR_{POFF}\right)$ is the cumulative distribution of χ_1^2.

The Christoffersen Test

Christoffersen [20] test (CCI) is based on the test of independence that measures whether the probability of observing an exception on a given day depends on the occurrence of an exception. The likelihood ratio is given by:

$$LR_{CCI} = -2\log\left(\frac{(1-\pi)^{n00+n10} \pi^{n01+n11}}{(1-\pi_0)^{n00} \pi_0^{n01} (1-\pi_1)^{n10} \pi_1^{n11}} \sim \chi_1^2 \right. . \quad (5)$$

Diabold and Yilmaz Index

In order to capture the volatility dynamic connectedness between different VaR series, we used the spillover connectedness index method proposed by Diebold and Yilmaz [7]. This method is based on the decomposition of the forecast-error variance of a variable under a generalized vector autoregressive (VAR) model introduced by [21] and [22]. Taking into consideration the covariance of the stationary VAR with order (p) and M-dimensional vector, the endogenous variables Y_t of is defined as follows

$$Y_t = \varphi_1 Y_{t-1} + \varphi_2 Y_{t-2} + \varphi_3 Y_{t-3} + \ldots\ldots\ldots + \varphi_p Y_{t-p} + \varepsilon_t, \quad (6)$$

where $\varphi_1, \varphi_2, \varphi_3, \ldots, \varphi_p$ is a vector of M × M autoregressive coefficient matrix, and ε_t is the M-dimensional vector matrix of error terms that are independently and identically distributed. Thus, by reason of covariance stability, we can present the Moving Average of (1) as follows:

$$Y_t = \sum_{i=0}^{\infty} C_i \varepsilon_{t-i}, \quad (7)$$

where C_i is a vector of $M \times M$ coefficient matrices calculated by the below formula:

$$C_i = \sum \varphi_p C_{i-k}, \quad (7.1)$$

where $k = 1, \ldots, p$.

The H-step generalized for forecasting the error variance decomposition from variable i to variable k is expressed as follows:

$$\theta_{ik}(H) = \frac{\sigma_{kk}^{-1} \sum_{h=0}^{H-1} \left(e_i' C_h \sum e_k\right)^2}{\sum_{h=0}^{H-1} (e_i' C_h \sum C_h' e_i)}, \quad (8)$$

for $i, k = 1, 2 \ldots, M$,

where σ_{kk}^{-1} is the k^{th} element diagonal of the error term, e_i is an $M \times 1$ selection vector with 1 as the i^{th} element and 0 otherwise, and H represents the forecasted horizon.

Based on the $M \times M$ matrix of variance decomposition (spillover index) $\theta_{ik}(H)$, which indicates the volatility shock effect of variable k on the forecast error variance of variable i, we have $\sum_{i=k}^{N} \theta_{ik}(H) \neq 1$. Thus, $\theta_{ik}(H)$ can be normalized as:

$$\bar{\theta}_{ik}(H) = \frac{\theta_{ik}(H)}{\sum_{k=1}^{M} \theta_{ik}(H)}, \quad (9)$$

where $\sum_{k=1}^{M} \bar{\theta}_{ik}(H) = N$ and $\sum_{i=1}^{M} \bar{\theta}_{ik}(H) = 1$.

According to this basic foundation of Diebold and Yilmaz [7], the total spillover connectedness index is given as:

$$TSCI(H) = \frac{\sum_{i,k=1,\ k \neq i}^{M} \bar{\theta}_{ik}(H)}{\sum_{k=1}^{M} \bar{\theta}_{ik}(H)} \times 100 =$$

$$= \frac{\sum_{i,k=1, i \neq k}^{M} \bar{\theta}_{ik}(H)}{N} \times 100. \quad (10)$$

DATA AND DESCRIPTIVE STATISTICS

In this paper, we use daily returns from the KFTX (KBW Financial Technology) Index in the US, which contains 48 companies classified into five industry sectors: Capital Markets, Financial Services, Computer Services, Professional Services, and Software. We obtained the data from the investing.com website. The full sample is divided into a sample size T that contains observations for the period July 20, 2016, to December 31, 2019, and a sample size H that contains observations for the period January 2, 2020, to December 31, 2021. For the KFTX index and all five industries, we compute daily logarithmic returns as follows:

$$r_t = 100 * \left(\log P_t - \log P_{t-1}\right).$$

Figure 1 depicts the daily returns of the US Fintech stock index and the US Fintech industries from 20.07.2016 to 31.12.2021. Since the outbreak of COVID-19, we can detect a sudden change in early 2020, compared to the rest of the period. *Table 1* presents the daily descriptive statistics of the return series. It shows that the average daily returns record a positive mean close to zero. In addition, all return series are negatively skewed and all Kurtosis values were greater than 3, implying that the distribution has heavier tails than the normal distribution. The Jarque-Bera statistics accepted the non-normality of all returns. In addition, the Ljung-Box Q-statistics on the square returns with 5 and 10 lags indicated significant serial autocorrelation. Engle's [23] ARCH Lagrange Multiplier (ARCH-LM) test with 2 and 5 lags and Ljung and Box's [24] Q-statistics assert the existence of an ARCH effect (volatility clustering). Then, the ADF unit root tests (Dickey and Fuller [25]) affirm the stationarity of all return series.

Figure 2 shows the QQ plots based on the empirical distribution for the normal and Student's t distributions. As illustrated, all return series are linear only in the student-T distribution, proving that the returns of the Fintech stock market and each Fintech industry have adopted a non-normal distribution and tapered fat tails.

EMPIRICAL RESULTS

Table 2 and *Table 3* shows the results of the in-sample (out-of-sample) backtesting test to estimate (predict) VaR before COVID-19 (during COVID-19) for the KFTX index and each Fintech industry.

VaR Backtesting Test before COVID-19

The first part of *Table 2* shows that the results of the expected and actual VaR exceeded the 1% and 5% significance levels and it is clear that all of the "Actual

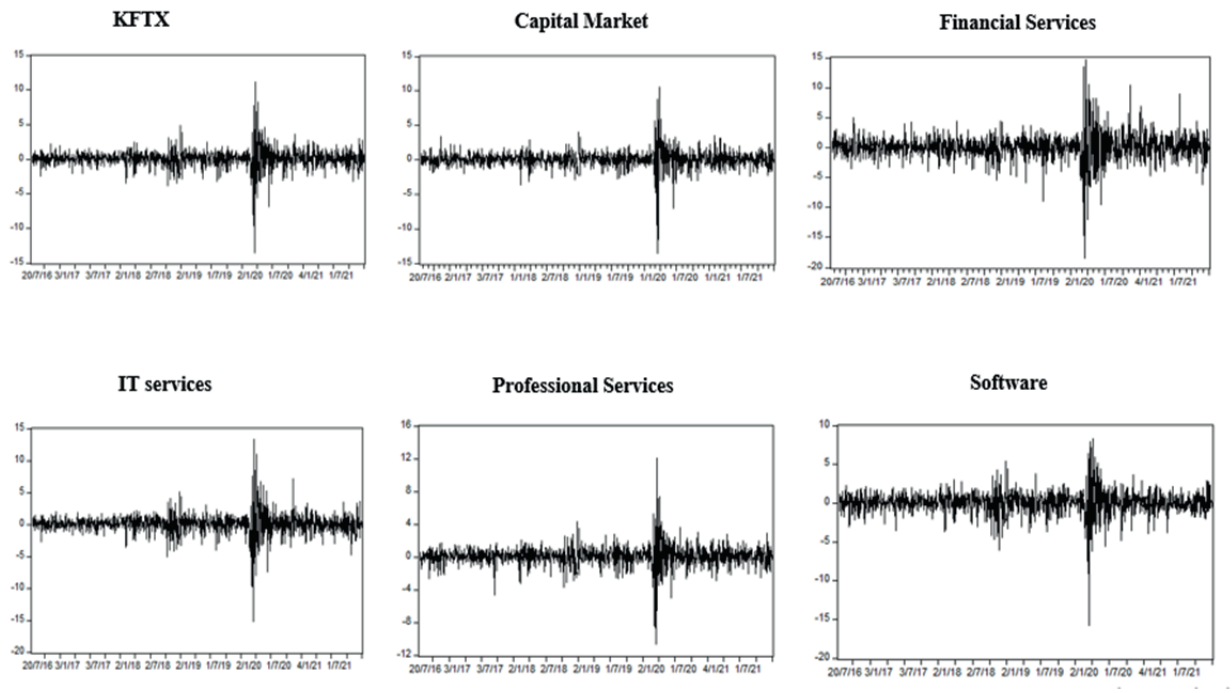

Fig. 1. **Stock Return of KFTX Index and Fintech Industries from July 2016 to December 2021 Period**

Source: Compiled by the authors.

VaR exceeded" values are greater than the "Expected VaR exceeded". This finding reveals that each GARCH model in this study underestimates the Va R.

Following *Table 2,* the results of Kupiec's POFF test indicate that GARCH models based on a normal distribution with α = 5% are satisfactory for the KFTX index and most industries except Professional Services and Software. Similarly, the existence of high levels of p-values means that the GARCH models perform better than the others. Thus, we can prove that the S-GARCH (1, 1) and I-GARCH models can produce a correct number of exceedances at the 5% level in some cases, but this is still insufficient. Then, with α = 1%, the results show that the GARCH models based on the normal distribution provided poor performance among the value-at-risk estimations. Therefore, concerning the student-t distribution, we can notice that the S-GARCH and CS-GARCH models with α = 5% and α = 1% perform well in correcting the exceedances referring to the outcomes of the capital market and financial services industries. Notably, the performance of the I-GARCH model based on the student-t distribution was found to be exceptionally faithful to the models with α = 1%, such that the Kupiec's Poff test failed to reject the null hypothesis of correct overshoots with high p-values in most outcomes. Therefore, we can conclude that the I-GARCH model with student-t distributions produces the correct number of exceedances. Second, the Christoffersen test allows us to perceive whether the estimated GARCH models suffer from volatility clustering or not. Accordingly, the results prove that the S-GARCH model based on the student-t distribution with α = 5% and α = 1% is appropriate to capture volatility clustering in the KFTX index. Moreover, in most cases, GARCH models can quickly accept the combined assumption of correct overshoot coverage and overshoot independence, especially the I-GARCH model based on the student-t distribution with α = 1%. Therefore, the I-GARCH model can be considered an appropriate VaR model for estimation during the pre-COVID-19 period.

In light of these results, the backtesting test indicated that the GARCH model specifications with the student-t distribution generally yield more adequate measures compared to models based on the normal distribution. Furthermore, these results are endorsed by the qq plots in *Figure 2*, which indicate that the fintech stock market is not normally distributed.

VaR Backtesting Test during COVID-19

The objective of this step is to perform a comprehensive evaluation of the quality of VaR forecasts for the KFTX

Table 1

Descriptive Statistics

Fintech index and industries	Starting Date	Nb. Of obs	Mean	SD	Skewness	Kurtosis	J–B	K–S	ARCH(2)	ARCH(5)	Q(5)	Q(10)	ADF
KFTX	20.07.2016	1375	0	1.3533	–1.0023	18.6544	20137.619 [0 .00]	0.0858 [0.00]	0.7623 [0 .00]	0.59 [0 .00]	86.0213 [0 .00]	244.1484 [0 .00]	–11.6504 [0 .00]
Capital Market	20.07.2016	1375	0.0629	1.2982	–1.0794	23.3299	31427.078 [0 .00]	0.0769 [0 .00]	0.606 [0 .00]	0.5441 [0 .00]	128.9838 [0 .00]	321.2845 [0 .00]	–10.0564 [0 .00]
Financial services	20.07.2016	1375	0.0558	2.2031	–0.4696	11.3581	7436.202 [0 .00]	0.121 [0 .00]	1.8022 [0 .00]	1.5515 [0 .00]	31.6524 [0 .00]	85.8605 [0 .00]	–14.0381 [0 .00]
IT services	20.07.2016	1375	0.0447	1.5799	–0.6795	16.9851	16621.992 [0 .00]	0.062 [0 .00]	0.8971 [0 .00]	0.6028 [0 .00]	59.2129 [0 .00]	193.7611 [0 .00]	–9.76498 [0 .00]
Professional services	20.07.2016	1375	0.0754	1.2574	–0.4778	16.1129	14916.002 [0 .00]	0.0863 [0 .00]	0.5915 [0 .00]	0.4587 [0 .00]	35.5169 [0 .00]	133.5615 [0 .00]	–9.7947 [0 .00]
Software	20.07.2016	1375	0.0689	1.5152	–1.1694	13.5427	10813.059 [0 .00]	0.0668 [0 .00]	1.0597 [0 .00]	0.7646 [0 .00]	56.66516 [0 .00]	137.96249 [0 .00]	–12.3851 [0 .00]

Source: Compiled by the authors.

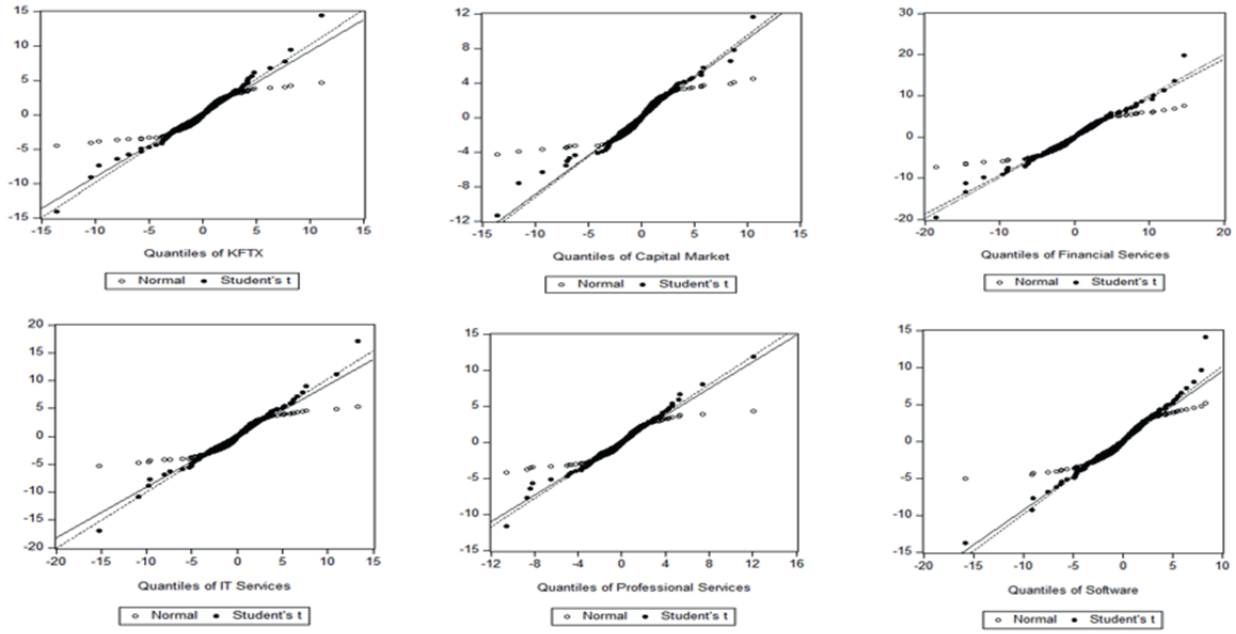

Fig. 2. **QQ Plots of KFTX Index and Fintech Industries for Both Normal and Student Distributions**

Source: Compiled by the authors.

index and Fintech industries during COVID-19: one day in advance by applying an iterative procedure from the estimation window to the end of the period. *Table 3* presents the results of Kupiec and Christoffersen's tests of the out-of-sample assessment during COVID-19 to capture the appropriate VaR forecasts at the 5% and 1% levels.

First, we show that the GARCH models in the out-of-sample procedure underestimate Va R. In general, results from *Table 3* indicate that the models with the student-t distribution give a better prediction of the one-ahead VaR than the models with the normal distribution for both 5% and 1%. In particular, the S-GARCH, I-GARCH, and CS-GARCH models based on the normal distribution with $\alpha = 5\%$ show poor forecasting performance for the trading position in the KFTX index and across all industries, except for the I-GARCH model, which performs consistently in the Capital Market, Financial Services, and Software industries. Subsequently, with an $\alpha = 1\%$, the results of the Kupiec test of all GARCH models based on the normal distribution give unsatisfactory results, referring to the rejection of the null hypothesis in the global Fintech stock market. Concerning student-t distribution, it appears that almost GARCH models with $\alpha = 5\%$ do not perform correctly due to their small p-values, especially in Capital Market, Professional Services and Software industries. Besides, we can infer that S-GARCH, I-GARCH and CS-GARCH models have an exceptional job of producing correct exceedances at the 1 percent level in the majority of returns. Especially, I-GARCH model offered the best performance in the KFTX index and five Fintech industries for predicting the one-day VaR forecast. Results from the Christofferson test were similar to those obtained from the Kupiec Poff test. Therefore, we can say that these models produce a correct coverage of exceedances and are independent of failures. With these results, we can confirm the importance of incorporating the I-GARCH model with the student-t distribution for VaR prediction of the Fintech industry in the US, due to its persistent variance. Thus, this property allows the existing evidence to have a significant effect on forecasting conditional variance.

Our results are consistent with those of Chu et al. [26], who selected twelve GARCH-type models in order to represent the volatility of seven major crypto-currencies. They concluded that I-GARCH and GJR-GARCH were the best-fitting volatility models in the case of the crypto-currency market. In addition, Naimy et al. [13] used six famous crypto-currencies, namely Bitcoin, Dash, Dogecoin, Litecoin, Monero, and Ripple. The results show that I-GARCH (1, 1) is the best model for Monero.

Volatility Spillover Effects

Table 4 presents the VaR-based descriptive statistics of the KFTX Index and each Fintech industry before and

Table 2

Summary of Backtesting Results of before COVID-19 Period

Backtesting tests	SGARCH-N		SGARCH-ST		IGARCH-N		IGARCH-ST		CS GARCH-N		CS GARCH-ST		SGARCH-N		SGARCH-ST		IGARCH-N		IGARCH-ST		CS GARCH-N		CS GARCH-ST	
	5%	1%	5%	1%	5%	1%	5%	1%	5%	1%	5%	1%	5%	1%	5%	1%	5%	1%	5%	1%	5%	1%	5%	1%
KFTX													**Financial services**											
Expectedexceeded	46.2	9.2	46.2	9.2	46.2	9.2	46.2	9.2	46.2	9.2	46.2	9.2	46.2	9.2	46.2	9.2	46.2	9.2	46.2	9.2	46.2	9.2	46.2	9.2
ActualVaRexceeded	53	24	60	18	48	21	57	10	58	24	62	19	47	24	49	18	49	23	47	16	52	29	53	17
Actual%	5.7	2.6	6.5	2	5.2	2.3	6.2	1.1	6.3	2.6	6.7	2.1	5.1	2.6	5.3	2	5.3	2.5	5.1	1.7	5.6	3.1	5.7	1.8
LR. UC stat	1.02	16.57	4.01	6.589	0.08	11.1	2.61	5.29	2.97	16.569	5.19	8	0.016	16.57	0.182	6.889	0.182	14.7	0.016	4.114	0.751	27.29	1.02	5.292
(p-value)	-0.3	0	0	-0.01	-0.8	0	-0.1	-0.8	-0.1	0	0	-0.005	-0.9	0	-0.671	-0.01	-0.67	0	-0.9	-0.143	-0.39	0	-0.31	-0.02
Reject H0	NO	YES	YES	YES	NO	YES	NO	NO	NO	YES	YES	YES	NO	YES	NO	YES	NO	YES	NO	NO	NO	YES	NO	NO
LR. CCI stat	2.32	16.771(0)	4.24	7.432	1.28	11.6	3.32	6.23	3.55	16.771	5.57	8.665	0.204	16.77	0.266	7.306	0.977	14.9	1.108	4.68	0.757	27.31	1.02	5.89
(p-value)	-0.3		-0.1	-0.024	-0.5	0	-0.2	-0.4	-0.2	0	-0.1	-0.013	-0.9	0	-0.876	-0.03	-0.613	0	-0.58	-0.196	-0.69	0	-0.6	-0.05
Reject H0	NO	YES	NO	NO	NO	YES	NO	NO	NO	YES	NO	NO	NO	YES	NO	NO	NO	YES	NO	NO	NO	YES	NO	NO
Capital Market													**IT services**											
Expectedexceeded	46.2	9.2	46.2	9.2	46.2	9.2	46.2	9.2	46.2	9.2	46.2	9.2	46.2	9.2	46.2	9.2	46.2	9.2	46.2	9.2	46.2	9.2	46.2	9.2
ActualVaRexceeded	54	25	54	13	45	24	44	10	54	15	59	13	58	23	64	21	55	21	58	11	59	24	75	20
Actual%	5.9	2.7	5.9	1.4	4.9	2.6	4.8	1.1	5.9	1.6	6.4	1.4	6.3	2.5	6.9	2.3	6	2.3	6.3	1.2	6.4	2.6	8.1	2.2
LR. UC stat	1.34	11.06	1.34	1.38	0.23	10.1	0.11	5.06	1.34	3.064	3.48	1.38	2.972	14.67	6.52	11.14	1.688	11.1	2.972	3.064	3.475	16.57	16.1	9.518
(p-value)	-0.2	0	-0.3	-0.24	-0.6	0	-0.7	-0.8	-0.2	-0.438	-0.1	-0.24	-0.85	0	-0.011	-0	-0.194	0	-0.06	-0.781	-0.06	0	0	-0
Reject H0	NO	YES	NO	NO	NO	YES	NO	NO	NO	NO	NO	NO	NO	YES	YES	YES	NO	YES	NO	NO	NO	YES	YES	YES
LR. CCI stat	1.57	11.41	1.57	7.851	0.71	9.41	0.49	8.72	2.38	8.406	4.77	9.274	3.49	14.94	8.002	11.59	1.716	11.6	4.452	4.453	3.891	16.77	16.3	10.09
(p-value)	-0.5	0	-0.5	-0.02	-0.7	0	-0.8	-0.5	-0.3	-0.015	-0.1	-0.197	-0.18	0	-0.01	-0	-0.424	0	-0.11	-0.408	-0.14	0	0	-0.01
Reject H0	NO	YES	NO	NO	NO	YES	NO	NO	NO	NO	NO	NO	NO	YES	YES	YES	NO	YES	NO	NO	NO	YES	YES	YES
Professional services													**Software**											
Expectedexceeded	46.2	9.2	46.2	9.2	46.2	9.2	46.2	9.2	46.2	9.2	46.2	9.2	46.2	9.2	46.2	9.2	46.2	9.2	46.2	9.2	46.2	9.2	46.2	9.2
ActualVaRexceeded	62	28	68	20	63	28	64	16	63	30	75	21	63	24	64	18	55	25	65	16	57	24	66	20
Actual%	6.7	3	7.4	2.2	6.8	3	6.9	1.7	6.8	3.3	8.1	2.3	6.8	2.6	6.9	2	6	2.7	7	1.7	6.2	2.6	7.2	2.2
LR. UC stat	5.2	24.99	9.56	9.518	5.84	25	6.52	4.11	5.84	29.66	16.1	11.139	5.842 (0.016)	16.569 (0)	6.52 (0.011)	6.789 (0.01)	5.688 (0.011)	18.555 (0)	7.232 (0.007)	4.141	2.506	16.596 (0)	7.977(0.005)	9.518 (0.002)
(p-value)	0	0	0	-0.002	0	0	0	-0	0	0	0	-0.001								-0.043	-0.11			
Reject H0	YES	YES	YES	YES	YES	YES	YES	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	NO	NO	YES	YES	YES
LR. CCI stat (p-value)	8.5	26.22	16.1	10.09	8.86	26.2	9.27	4.68	10.5	30.556	20	11.589	10.526 (0.005)	18.64 (0)	7.097(0.02)	9.306 (0.026)	7.426 (0.027)	20.387 (0)	13.043 (0.001)	5.3	4.181	16.771 (0)	10.223 (0.006)	10.405(0.006)
	0	0	0	-0.006	0	0	0	-0.1	0	0	0	-0.003								-0.071	-0.12			
Reject H0	YES	YES	YES	YES	YES	YES	YES	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	NO	NO	YES	YES	YES

Source: Compiled by the authors.

Table 3

Summary of Backtesting Results of COVID-19 Period

Backtesting tests	SGARCH-N		SGARCH-ST		IGARCH-N		IGARCH-ST		CS GARCH-N		CS GARCH-ST		SGARCH-N		SGARCH-ST		IGARCH-N		IGARCH-ST		CS GARCH-N		CS GARCH-ST	
	5%	1%	5%	1%	5%	1%	5%	1%	5%	1%	5%	1%	5%	1%	5%	1%	5%	1%	5%	1%	5%	1%	5%	1%
	KFTX												Financial services											
Expectedex-ceeded	25.2	5	25.2	5	25.2	5	25.2	5	25.2	5	25.2	5	25.2	5	25.2	5	25.2	5	25.2	5	25.2	5	25.2	5
ActualVaRex-ceeded	36	20	39	15	34	17	37	6	37	20	40	17	38	14	39	9	27	13	35	7	33	13	33	8
Actual %	7.1	4	7.7	3	6.7	3.4	7.3	1.2	7.3	4	7.9	3.4	7.5	2.8	7.7	1.8	5.3	2.6	6.9	1.4	6.5	2.6	6.5	1.6
LR. UC stat	4.28	25.61	6.81	12.959	4.35	14.1	5.07	6.5	5.07	25.605	7.76	17.685	5.91	10.8	6.807	2.53	0.125	8.81	3.56	1.478	2.29	8.81	2.29	1.48
(p-value)	−0	0	−0	0	−0	0	−0	−0.8	−0	0	−0	0	−0	−0	−0.01	−0.1	−0.72	−0	−0.06	−0.52	−0.1	−0	−0.1	−0.2
Reject H0	YES	YES	YES	YES	YES	YES	YES	NO	YES	YES	YES	YES	YES	YES	YES	NO	NO	YES	NO	NO	NO	YES	NO	NO
LR. CCI stat	4.438 (0.191)	27.05	6.81	13.508	6.42	17.5	5.3	7.6	5.3	27.048 (0)	8.34	18.685	7.48	14.5	8.124	4.68	3.698	13.1	4.56	4.062	3.77	13.1	3.77	4.06
(p-value)		0	−0	−0.01	−0	0	−0.2	−0.6	−0.1		0	0	−0	−0	−0.02	−0.1	−0.16	−0	−0.1	−0.13	−0.2	−0	−0.2	−0.1
Reject H0	NO	YES	YES	YES	YES	YES	NO	NO	NO	YES	YES	YES	YES	YES	YES	NO	NO	YES	NO	NO	NO	YES	NO	NO
	Capital Market												IT services											
Expectedex-ceeded	25.2	5	25.2	5	25.2	5	25.2	5	25.2	5	25 .2	5	25.2	5	25.2	5	25.2	5	25.2	5	25.2	5	25.2	5
ActualVaRex-ceeded	34	14	35	10	31	11	31	7	31	13	35	10	41	17	41	12	38	13	41	11	41	17	45	14
Actual %	6.7	2.8	6.9	2	6.1	2.2	6.1	1.4	6.1	2.6	6.9	2	8.1	3.4	8.1	2.4	7.5	2.6	8.1	2.2	8.1	3.4	8.9	2.8
LR. UC stat	2.89	10.81	3.56	3.813	1.29	5.07	1.29	0.7	1.29	8.812	3.56	3.813	8.77	17.7	8.772	6.97	5.908	8.81	8.77	5.298	8.77	17.7	13.3	10.8
(p-value)	−0.1	−0	−0.1	−0.051	−0.3	−0	−0.3	−0.4	−0.3	−0.003	−0.1	−0.051	−0	0	−0	−0	−0.02	−0	−0	−0.12	−0	0	0	−0
Reject H0	NO	YES	NO	NO	NO	YES	NO	NO	NO	NO	NO	NO	YES	YES	YES	YES	YES	YES	YES	NO	YES	YES	YES	YES
LR. CCI stat	2.94	11.61	3.65	4.218	5.37	6.3	1.87	0.9	1.87	9.5	3.65	4.218	9.5	20.1	9.495	21.7	6.224	13.1	9.5	6.743	9.5	20.1	14.8	14.9
(p-value)	−0.2	−0	−0.2	−0.121	−0.1	−0.1	−0.4	−0.6	−0.4	−0.009	−0.2	−0.121	−0	0	−0.01	0	−0.04	−0	−0.01	−0.04	−0	0	−0	−0
Reject H0	NO	YES	NO	NO	NO	YES	NO	NO	NO	YES	NO	NO	YES	YES	YES	YES	YES	YES	YES	NO	YES	YES	YES	YES
	Professional services												Software											
Expectedex-ceeded	25.2	5	25.2	5	25.2	5	25.2	5	25.2	5	25.2	5	25.2	5	25.2	5	25.2	5	25.2	5	25.2	5	25.2	5
ActualVaRex-ceeded	30	13	36	10	30	12	32	5.5	33	12	36	10	32	15	37	12	29	14	35	8	31	15	37	11
Actual %	5.9	2.6	7.1	2	5.9	2.4	6.3	1.1	6.5	2.4	7.1	2	6.3	3	7.3	2.4	5.7	2.8	6.9	1.6	6.1	3	7.3	2.2
LR. UC stat	0.089 (0.846)	8.812	3.28	3.813	5.32	6.97	1.76	3.8	2.29	6.97 (0.008)	3.28	3.813	1.758 (0.185)	13	1.375	6.97	0.561	10.8	3.56	3.813	4.3	13	3.06	5.29
(p-value)		−0	−0.4	−0.051	−0	−0	−0.2	−0.9	−0.1		−0.1	−0.051		0	−0.24	−0	−0.45	−0	−0.1	−0.65	−0	0	−0.1	−0
Reject H0	NO	YES	NO	NO	YES	YES	NO	NO	NO	YES	NO	NO	NO	YES	NO	YES	NO	YES	NO	NO	YES	YES	NO	NO
LR. CCI stat (p-value)	1.35	9 .5	4.36	4.218	7.01 (0.03)	17.5	2.48	4.2	3.16	9.55	4.36	4.218	3.51	13.9	5.695	7.56	3.314	11.6	4.56	4.218	6.76	13.9	5.66	5.79
	−0.1	−0.01	−0.1	−0.121		0	−0.3	−0.1	−0.2	−0.006	−0.1	−0.121	−0.2	−0	−0.06	−0	−0.19	(0 .003)	−0.1	−0.12	−0	−0	−0.1	−0.1
Reject H0	NO	YES	NO	NO	YES	YES	NO	NO	NO	YES	NO	NO	NO	YES	NO	NO	NO	YES	NO	NO	YES	YES	NO	NO

Source: Compiled by the authors based on backtesting test.

Note: Accept (Reject) of null hypothesis: if LR value is lower (higher) than critical value; H0 (Poff test): correct exceedances with critical value for 5% (1%) = 3.841 (6.635); H0 (Christoffersen test): correct and independence of exceedances with critical values for 5% (1%) = 5.991 (9.21).

Table 4

Descriptive Statistics of Var Oof KFTX and Fintech Industries before and during COVID-19

Summary statistics	KFTX	Capital Market	Financial Services	IT Services	Professional Services	Software
Before COVID-19						
Mean	−2.3483	−2.2793	−4.0565	−2.6816	−2.3917	−2.9624
Std. Dev.	0.9651	0.8105	1.0420	1.1191	0.8978	1.0356
Skewness	−1.5860	−1.8143	−0.3943	−1.6250	−1.9971	−2.4714
Kurtosis	5.8720	8.0673	2.6239	6.1015	9.3807	11.772
Jarque–Bera	663.0135	1406.550	27.6404	730.7853	2051.865	3671.418
Probability	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
During COVID-19						
Mean	−3.6705	−3.5988	−6.7916	−4.5261	−3.4692	−4.0987
Std. Dev.	2.8754	3.0262	3.7512	3.20241	2.7054	2.7736
Skewness	−3.1512	−3.9478	−2.2353	−2.5847	−3.3743	−2.7826
Kurtosis	14.1313	20.5667	8.1473	10.0023	15.1954	11.2734
Jarque–Bera	3442.929	7804.952	978.0325	1593.215	4087.816	2091.975
Probability	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Source: Compiled by the authors.

during COVID-19. As a result, we highlight a significant increase in the average VaR series during COVID-19 compared to the pre-COVID-19 period. Similarly, we observe the same increase in the values of standard deviation, skewness, kurtosis, and Jarque-Bera during the COVID-19 period. These results explain that during the COVID-19 period, we can observe higher levels of risk in the US Fintech stock market.

Next, we study the spillover volatility between the VaR series of the global index (KFTX) and Fintech industries before and during the COVID-19 pandemic. The results are presented in *Table 5*. First, the total volatility spillover index during the COVID-19 period (72.30%) is much higher than the values in the pre-COVID-19 period (39.30%). This increase can be explained by the intensive volatility of various factors based on the uncertainties caused by the spread of COVID-19, such as investor irrationality and a decline in labor productivity (Goodell [27]). Second, results indicate the existence of several changes in the level-indices connectedness. Especially before COVID-19 period, services were the industry that received risks from others, with values equivalent to 75.3%, while during COVID-19 period, software was the most important industry that received the most risks from others, with values equal to 91.1%. In addition, before COVID-19, the KFTX index (197.8%) and Capital Market industry (11.7%) had the highest risk contribution to the system's Va R. During COVID-19, the global index and professional services industry had the highest risk contribution to others, with respective values equal to 324.6% and 70.6%, respectively. As concerning the results of net spillovers, the main net transmitters of risks during COVID-19 are the global index with a value equal to 270.8%, followed by the professional services industry (31%). Further, before COVID-19 period, services were the main net receivers of risks from others, with values equal to −69.8%; subsequently, capital markets (−35%) and professional services (−34.2%), and Software became the most important net receiver of risks from others, with values equal to (−89.2%). Therefore, this total connectedness analysis suggests that during this period of turbulence, there is evidence of high-risk distress among global and industry VaR series in the US Fintech industry. For example, Baker et al. [28] reveal that COVID-19 is the cause of several turbulences that caused high instability in global financial markets.

Table 5

Spillover Volatility Effects Among Var Series before and during COVID-19

Before COVID-19							
	KFTX	Capital Market	Financial Services	It services	Professional services	Software	From Others
KFTX	90.9	1.9	2	1.4	2.3	1.6	9.1
Capital Market	42.3	53.3	1.8	0.6	0.7	1.4	46.7
Financial Services	18.9	5	72.5	1.4	0.5	1.6	27.5
It services	70.2	0.3	0.6	24.7	2.5	1.6	75.3
Professional services	35.7	3.5	1.3	1.4	57.4	0.7	42.6
Software	30.7	1.1	0.1	0.7	2.3	65.1	34.9
Contribution to others	197.8	11.7	5.9	5.5	8.4	6.8	236
Contribution including own	288.8	65	78.4	30.2	65.7	71.9	39.30%
Net spillover	188.7	−35	−21.6	−69.8	−34.2	−28.1	
During COVID-19							
	KFTX	Capital Market	Financial Services	It services	Professional services	Software	From Others
KFTX	74.7	3.6	1.1	1.4	18.7	0.4	25.3
Capital Market	62	16.1	1.5	1.1	18.7	0.7	83.9
Financial Services	58.6	1.4	23.1	2.7	14	0.1	76.9
It services	68.1	1.8	0.7	10.8	18.5	0.1	89.2
Professional services	53.4	10.3	1.7	1.3	32.8	0.5	67.2
Software	53.9	4.7	2.3	2	28.3	8.9	91.1
Contribution to others	296.1	21.8	7.3	8.5	98.2	1.9	433.7
Contribution including own	370.7	37.9	30.4	19.3	130.9	10.8	72.30%
Net spillover	270.8	−62.1	−69.6	−80.7	31	−89.2	

Source: Compiled by the authors based on Diabold and Yilmaz index.

Figure 3 shows the dynamic connectedness among the VaR series of the US global index and each industry Fintech before and during COVID-19. Before COVID-19, the total volatility connectedness index decreased gradually from July 2016 between 50% and 40% until it achieved a minimum value equal to 34%. Accordingly, this decrease can be explained by the high tensions of the trade war between China and the USA in February 2018. From this point, the index returns to be stable between values equal to 50% and 45% until attaining a maximum value equal to 65% in September 2019. In addition, during COVID-19, the total spillover index presents a major rise in the first period of 2020, with level values nearly reaching 77%, indicating that this strong risk interaction was mentioned by the outbreak of COVID-19. Afterward, it started to decline and continued this decrease in the presence of calm and stressful moments until it achieved a minimum value of 48% at the end of 2021.

CONCLUSION

The main objective of this paper is to test the accuracy of GARCH models to estimate and forecast the VaR of the US Fintech global stock market from July 20, 2016, to December 31, 2021. In addition, this study examines the impact of the COVID-19 crisis on the connectedness between the adequate VaR of each US global KFTX index and five Fintech industries. Specifically, we compare the different VaR estimates (862 in-sample daily returns) and one-day-ahead forecasts (550 out-

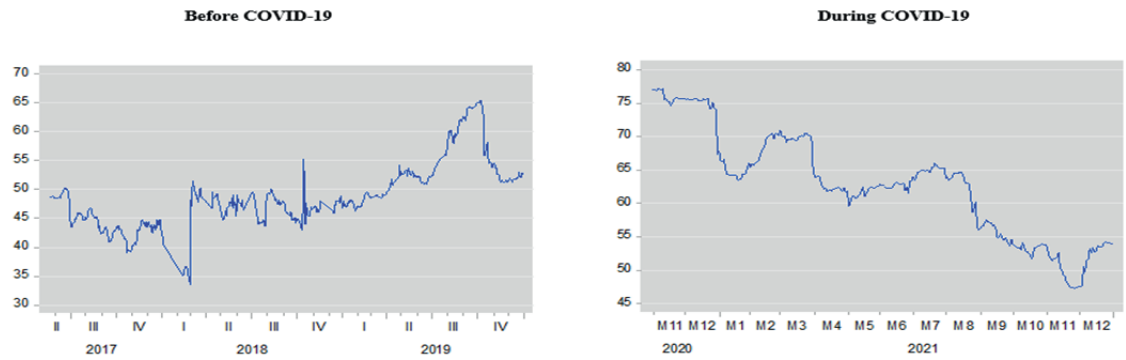

Fig. 3. **Correlogram Plot of Pairwise Correlation Among Var of Global and Industrials Series Before and During COVID-19**

Source: Compiled by the authors.

of-sample daily returns) of several GARCH model specifications under a normal distribution and Student-T distribution with 1% and 5% significance levels. We estimate the I-GARCH, S-GARCH, and CS-GARCH models using a backtesting test based on the procedures of Kupiec and Christoffersen.

The empirical results show that the GARCH models under the student-t distribution perform better than the normal distribution before and during the COVID-19 periods. Moreover, the backtesting results before (during) COVID-19 do not reject the null hypothesis of the complementary tests for all GARCH models under student-t distribution with $\alpha = 1\%$ and $\alpha = 5\%$ (only with $\alpha = 1\%$) in most cases. Then, by comparing the occurrence of exceedances between these models before and during COVID-19, we can state that the I-GARCH model outperforms the other GARCH specifications based on the Student-t distribution with $\alpha = 1\%$. This model gives superior results for its accuracy in correct exceedance coverage and failure independence. Therefore, this model performs best in both calm and crisis periods in the US Fintech industry. Finally, to capture the effect of COVID-19 on the connectedness between the VaR series (I-GARCH), we study the volatility spillover index between the VaR of the US Fintech index and each industry before and during COVID-19. The empirical results revealed a sharp increase in the volatility spillover index among the VaR series during COVID-19. In addition, the main net transmitters of risks during COVID-19 are the global index with a value equal to 270.8%, followed by the professional services industry (31%). While software was the main net receiver of risks from others before COVID-19.

Therefore, our results indicate that VaR is a suitable indicator to manage and measure the risk of the global US Fintech index and individual US Fintech industries. In addition, our results highlight the best performing I-GARCH-VaR model in both calm and crisis periods, which can satisfy investors' requirements. More precisely, the estimation and forecasting of VaR results could be helpful for investors and portfolio managers where their portfolio VaR could be greatly affected by the COVID-19 pandemic. On one hand, investors aim to diversify their investment decisions' portfolio in Fintech market risk by purchasing the titles that reduce the portfolio risk (VaR) and selling the titles that raise the portfolio risk (VaR), especially, during financial crises. On the other hand, portfolio managers could hedge their portfolio risk by managing their portfolio dynamically during a crisis period. In addition, our results give insights for risk regulators who may consider earlier the extreme connectedness among the US Fintech industries and its potential change in stress periods.

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Development of Decentralized Finance in Comparable Indicators of the Financial Sector of the Economy

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ABSTRACT

The sphere of decentralized finance is the subject of widespread debate as the ways of providing services in the financial market. Using distributed registry technologies, smart contacts and a decentralized format of cooperation, it is capable, to a certain extent, of replacing traditional financial intermediaries in some product segments of the financial market. The authors set the **task** of identifying possible markers of liquidity flow into the sphere of decentralized finance, as well as assessing the scale and dynamics of its development compared with segments of the financial sector of the economy. The **purpose** of the study is to form a system of comparable indicators, based on which national regulators will be able to objectively assess the scale and dynamics of development of the DeFi sector. To achieve the goal, the article conducted a quantitative analysis of the relationship between changes in the money supply and the total value locked of crypto assets in the DeFi sector; a comparative analysis of various segments of the DeFi sphere and the financial sector of the economy was carried out. As the main **methods**, the authors used methods of regression analysis, systemic and logical methods, induction and deduction, methods of economic statistics, which made it possible to identify tendencies in the development of the sphere of decentralized finance against the background of indicators of development of the financial sector of the economy. The source data consisted of statistical databases on key indicators of the development of the financial sector of the economy at the international level, as well as databases on services provided by participants of decentralized finance. As a **result** of the study, the impact of changes in money supply on total value locked in DeFi is evaluated, as well as tendencies and scale of development of the sphere of decentralized finance in comparable indicators of the financial sector of the economy are identified. It is **concluded** that the scale of the current development of decentralized finance is not significant. However, according to a number of comparable indicators, this sphere already represents a certain parity with the financial sector of the economy. First of all, this applies to the trading turnover of decentralized exchanges and the volume of trading in crypto derivatives. The results of the study can be used by national regulators when assessing the scale of development of the sphere of decentralized finance under certain monetary and financial conditions.

Keywords: decentralized finance; traditional finance; financial sector of the economy; payments; crypto loans; crypto deposits; infrastructure; scale of development

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INTRODUCTION

With the development of blockchain technology, a whole ecosystem of decentralized finance (DeFi) has emerged, which, unlike traditional finance (TradFi[1]), focuses on providing an analogue of already familiar financial services in a decentralized cryptographic system using smart contracts, decentralized applications, and digital tokens [1–3]. Decentralized protocols for crypto loans, digital asset placement, insurance, payments and transfers, asset management, as well as decentralized applications are among the most widely discussed new technological developments in global finance [4]. Several papers emphasize the reliability and transparency of DeFi services [1], their composability, that is, the ability to interact between protocols and create new (composite) services using various tokens [5].

The technological component of the DeFi sphere, which ensures reliability and transparency in the transaction process, is of practical interest to traditional financial intermediaries as well. In Russia, blockchain technology is already being applied in the circulation of digital financial assets [6]. At the same time, such close attention to the DeFi sector by national regulators is driven by the need to obtain an objective assessment of the impact of this sector on the activities of traditional financial intermediaries, non-financial organizations, and the well-being of the population. It is quite possible that the DeFi sphere opens up new opportunities in terms of providing financial services, while excluding a certain circle of intermediaries and ensuring the transparency of all transactions, their high speed, and cost reduction. However, the DeFi sector can simultaneously amplify existing risks in the financial market and generate its own risks: smart contract risks, transactional risks, oracle risks, and others[2] [7–9]. The national regulator is particularly concerned about the processes of replacing the national currency with crypto-assets. Such a redistribution of assets in the portfolios of economic agents can lead to increased price risks due to the high volatility of crypto-assets. Crypto-assets are issued in a decentralized manner. And in the DeFi paradigm, there is no central institution responsible for ensuring the circulation of digital currency.[3] In its analytical reports, the Bank of Russia repeatedly emphasizes the thesis that the DeFi sector is constantly evolving, scaling its services.

Currently, there is a substantial amount of scientific research addressing issues related to the functioning of the DeFi sphere. However, for the most part, they only reveal individual aspects, which can conditionally be grouped into the following directions:

- description of the theoretical aspects of potential problems, advantages, and the potential of the DeFi sector [10–12];
- consideration of types of DeFi protocols and security issues [1, 13–14];
- analysis of the risks of scaling the DeFi sector [7–9, 15];
- highlighting the common and the unique aspects between the DeFi and CeFi sectors [16];
- possible inefficiencies of the DeFi market [17].

Recently, studies related to conducting quantitative analysis in the DeFi sector have been emerging. Within the framework of scientific research, individual key indicators of DeFi are analyzed [18–21]. The comparison of the development of the DeFi sector with the financial sector of the economy (hereinafter — FSE) is not based on a systematic approach,

[1] Traditional finance (TradFi) is a system of traditional finance based on familiar non-digital assets, tools, and financial intermediaries. URL: https://cbr.ru/Content/Document/File/141992/report_07112022.pdf (accessed on 15.01.2024).

[2] Traditional finance (TradFi) is a system of traditional finance based on familiar non-digital assets, tools, and financial intermediaries. URL: https://cbr.ru/Content/Document/File/141992/report_07112022.pdf (accessed on 15.01.2024).

[3] Cryptocurrencies: trends, risks, measures 2022. URL: https://storage.consultant.ru/ondb/attachments/202201/21/Doklad_eXS.pdf (accessed on 17.04.2024).

but is fragmented — by individual indicators.[4] From an institutional perspective, the FSE represents a set of economic institutions providing financial services to companies and households.

With the development of the DeFi sector, central banks are paying increasing attention to studying the transmission of monetary impulses to changes in the structure of household balances associated with the increase in the share of crypto assets. In addition, as noted by the Bank of Russia, there is a need to develop a system for assessing the scale of DeFi development at the macro level. The solution to these tasks forms the basis of the current research.

SOURCE DATA

As initial data describing the DeFi sector, we propose using quantitative and qualitative indicators that can be grouped by various dimensions: financial (*finance data*), market (*market data*), "commodity" (*GMV data*), and user (*alternative data*). Regarding the FSE, economic statistics on monetary indicators, deposit and credit operations, and the development of financial markets at the global level are traditionally provided by the Bank for International Settlements (hereinafter — BIS), the European Central Bank (hereinafter — ECB), the International Monetary Fund (hereinafter — IMF), and the World Bank Group (hereinafter — WBG).

RESULTS

The DeFi sphere offers services across various product sectors (segments): asset management, liquid staking, cross-platform transfer facilitation (*bridges*), derivatives, decentralized exchanges (*DEXs*), data exchange, stablecoin issuance, and others. *Fig. 1* shows the structure of product segments in the DeFi space. From the graphical material, it follows that the largest DeFi segments by the TVL (Total Value Locked) indicator are: liquid staking, crypto loans, cross-platform transfers, and decentralized exchanges. Drawing an analogy with the FSE, it can be said that the most in-demand services in the DeFi sector are those for earning interest on funds, providing loans in crypto assets, "cross-border" (cross-platform) money transfers, and exchange activities.

Fig. 2 shows the dynamics of TVL from 2019 to 2023 inclusive. The graph shows that the number of major projects in the DeFi sector is growing unevenly. In 2019, there were only two major projects involving liquid staking: *Compound* and *MakerDAO*. At the same time, the total locked value of crypto assets in 2019 amounted to only 0.26 billion dollars in equivalent. The *Compound* project specializes in providing crypto loans, while the *MakerDAO* project focuses on the decentralized issuance of stablecoins, which are introduced into circulation based on a credit model. These projects still remain the largest in the DeFi space, but now in terms of individual product segments. The maximum TVL value, equal to 120 billion dollars, was reached in 2021. That is, the growth over 3 years was 462 times.

The number of DeFi projects has also increased exponentially. In the following years, the total value of locked crypto assets decreased along with the capitalization of the entire crypto market, although the number of projects steadily increased. The leader among the largest DeFi projects became *Lido Finance*, specializing in liquid staking. The TVL at the end of 2023 amounted to over 21 billion dollars in equivalent.

ANALYSIS OF THE INTERRELATIONSHIP BETWEEN MONEY SUPPLY AND THE TOTAL LOCKED VALUE OF CRYPTOASSETS

Given that fiat money serves as the source of liquidity for decentralized crypto assets, we assume that during periods of monetary

[4] Why Decentralised Finance (DeFi) Matters and the Policy Implications. 2022. URL: https://www.oecd.org/finance/why-decentralised-finance-defi-matters-and-the-policy-implications.htm (accessed on 25.03.2024).

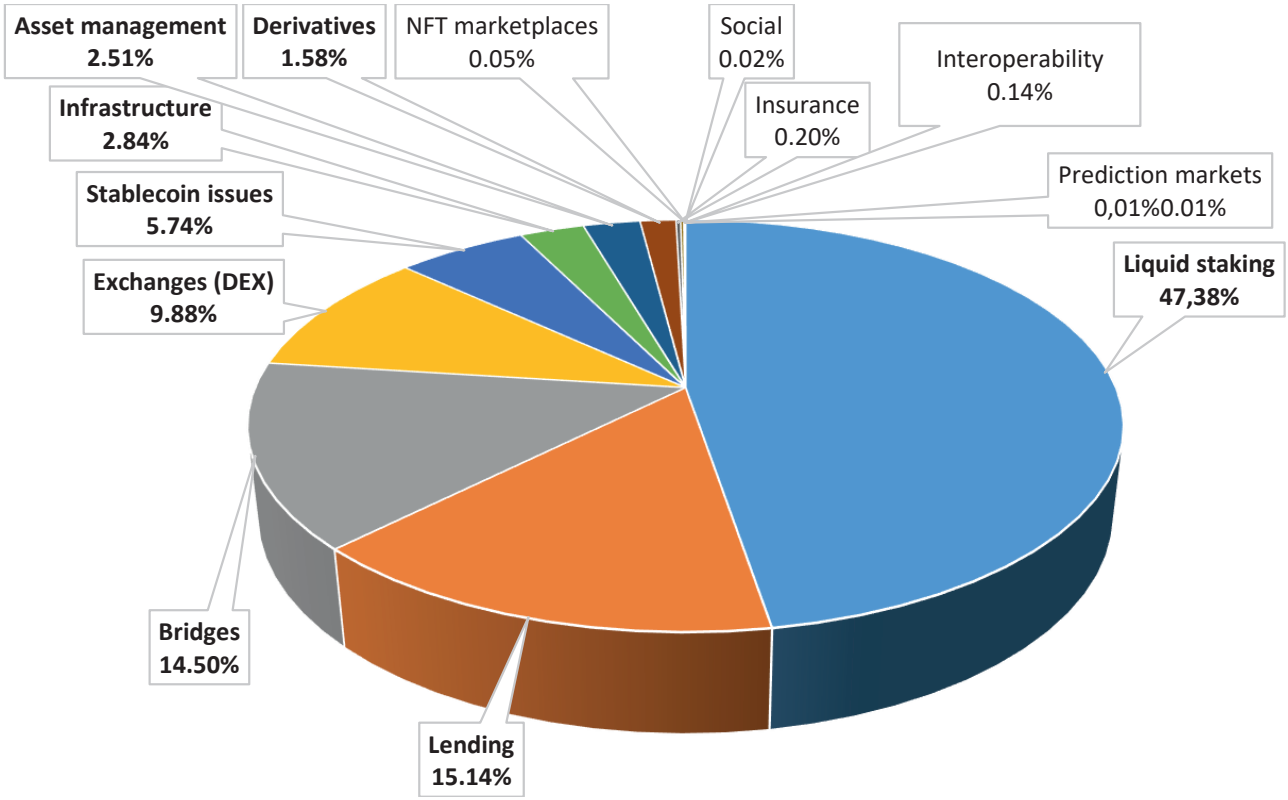

Fig. 1. **Structure of DeFi Product Segments by TVL Indicator (March 2024)**

Source: Author's calculations from data platform "Token terminal". URL: https://tokenterminal.com (accessed on 14.03.2024).

and/or fiscal easing, accompanied by an increase in the money supply, there may be a redistribution of assets in the portfolios of economic agents, with an increase in the share of crypto assets. In particular, the rapid growth in the capitalization of the first cryptocurrency, Bitcoin, occurred precisely against the backdrop of monetary and fiscal stimulus measures in the economies of countries with developed financial markets. The subsequent formation and development of the DeFi sector also exhibits cyclicality in its capitalization.

For the purpose of analyzing and assessing the impact of changes in the money supply on the value of digital assets circulating in the DeFi space, we formalize an economic model. As an endogenous variable reflecting the formed liquidity in the DeFi sector, we will consider the total value locked (TVL) of digital assets. This indicator is calculated in market values. Moreover, the steady growth of the total value locked against the backdrop of an increasing number of users and the frequency of decentralized protocol usage indirectly reflects the formation of demand for DeFi services.

In the context of J. Tobin's portfolio theory, crypto-assets can be considered an alternative source of income [22]. The actual demand for this type of asset depends on the expected rate of return associated with investing in it and the economic agent's risk tolerance. A natural limitation on the amount of investment is the total income available to the economic agent, as well as the possibility of attracting credit resources with a servicing cost lower than the expected return from investing in the crypto-asset. Economic agents prefer to form their portfolios not only with reliable securities (government bonds) but

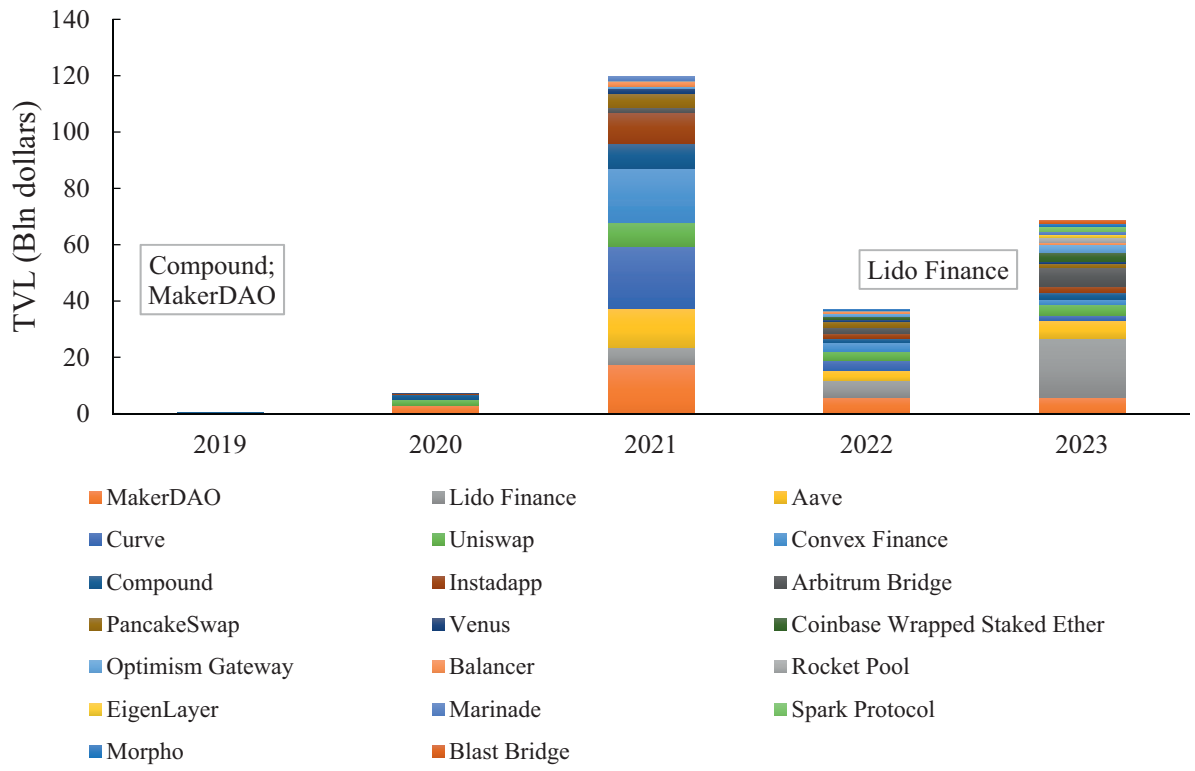

Fig. 2. **Dynamics of the Largest DeFi Projects by TVL**

Source: Author's calculations from data platform "Token terminal". URL: https://tokenterminal.com (accessed on 14.03.2024).

also by including risky assets. By investing in crypto-assets, the investor aims to maximize the portfolio's return at a given risk level. Therefore, the increase in the money supply, which may be driven by non-cash money issuance amid monetary and fiscal easing, is expected to prompt economic agents to revise their portfolios, increasing or decreasing the share of crypto-assets while adhering to the previously mentioned conditions and constraints.

Also, as an exogenous variable, we propose to consider the market capitalization of Bitcoin. Changes in its capitalization may reflect changes in overall market sentiment in the global crypto asset market. Accordingly, the model can be presented in the following form:

$$TVL = \beta_0 + \beta_1 M2^{(r.)} + \beta_2 M2^{(r.f.)} + \beta_3 B^{(r.cap.)}, \quad (1)$$

where TVL — the total blocked value of crypto assets in the DeFi; $M2^{(r.)}$ — the growth rate of the M2 money supply in the largest institutions representing central monetary authorities (for example, the USA, Europe, Japan, and China); $M2^{(r.f.)}$ — the growth rate of the M2 money supply under a fixed exchange rate; $B^{(r.cap.)}$ — the growth rate of Bitcoin's market capitalization.

Taking into account the exchange rate factor in model (1) allows for the identification of a stable component in the changes in the money supply across the world's largest economies. The initial data for assessing the relationships were taken from the period from May 2019 to March 2024 with a monthly breakdown. Moreover, since model (1) uses growth indicators in annual terms, the final data formed a sample from May 2020 to March 2024 and consisted of 47 observations. Prior to calculating the growth rates, all economic indicators were pre-logged.

Table 1 presents the correlation matrix of the analyzed indicators.

Table 1

Correlation Matrix

Model	*TVL*	$M2^{(r.)}$	$M2^{(r.f.)}$	$B^{(r.cap)}$
TVL	1.00	0.94	0.79	0.70
$M2^{(r.)}$	0.94	1.00	0.80	0.71
$M2^{(r.f.)}$	0.79	0.80	1.00	0.33
$B^{(r.cap)}$	0.70	0.71	0.33	1.00

Source: Author's calculations from data MacroMicro. URL: https://en.macromicro.me/charts/3439/major-bank-m2-comparsion (accessed on 15.03.2024).

Table 2

Regression Results

Model	Coefficients	Std. Error	t-statistics	P-value
Constant (β0)	–0.56	0.68	–0.82	0.42
M2(r.)	14.62	0.80	18.22	0.00

Source: Author's calculations from data MacroMicro. URL: https://en.macromicro.me/charts/3439/major-bank-m2-comparsion (accessed on 15.03.2024).

From *Table 1*, it follows that changes in demand for DeFi services are closely related to changes in the money supply and the market capitalization of Bitcoin. Currency devaluation also has a certain contribution to the identified relationship. However, its influence can be considered moderate, with a correlation coefficient of 0.79. To a greater extent, the exchange rate factor is reflected in the market capitalization of Bitcoin, the value of which is expressed in fiat money.

Subsequent analysis using specialized data analysis software led to the conclusion that the most common determinant among those analyzed in model (1), which has a significant impact on TVL, is the growth rate of the money supply $M2^{(r.)}$. The evaluation results are presented in *Table 2*.

The estimated model can be considered adequate for the analyzed data (the F-value of Fisher's statistic was 332.0 with P = 0.00; the coefficient of determination $R^2 = 0.94$). The dependence of the growth rate of the total locked value of crypto assets in the DeFi sector on the growth rate of the M2 money supply can be expressed directly, excluding the constant. In other words, the overall demand for DeFi services is elastic with respect to the M2 money supply: for every unit increase in the M2 money supply, there is a corresponding increase of 14.62 units in TVL.

Fig. 3 presents the dynamic indicators of the development of the DeFi sector and the monetary indicator.[5]

The economic conclusion is that as a result of the easing of monetary and/or fiscal policy, it appears that part of the assets in the portfolios of economic agents is being replaced by crypto-assets related to the DeFi sector. The concerns of central banks in this regard are quite justified, as the value of crypto-assets is subject to significant fluctuations and can affect the real returns of investors' portfolios and their wealth.

At the same time, it is necessary to objectively understand how large the DeFi

[5] According to the Federal Reserve of the United States, the European Central Bank, the Bank of Japan, and the People's Bank of China.

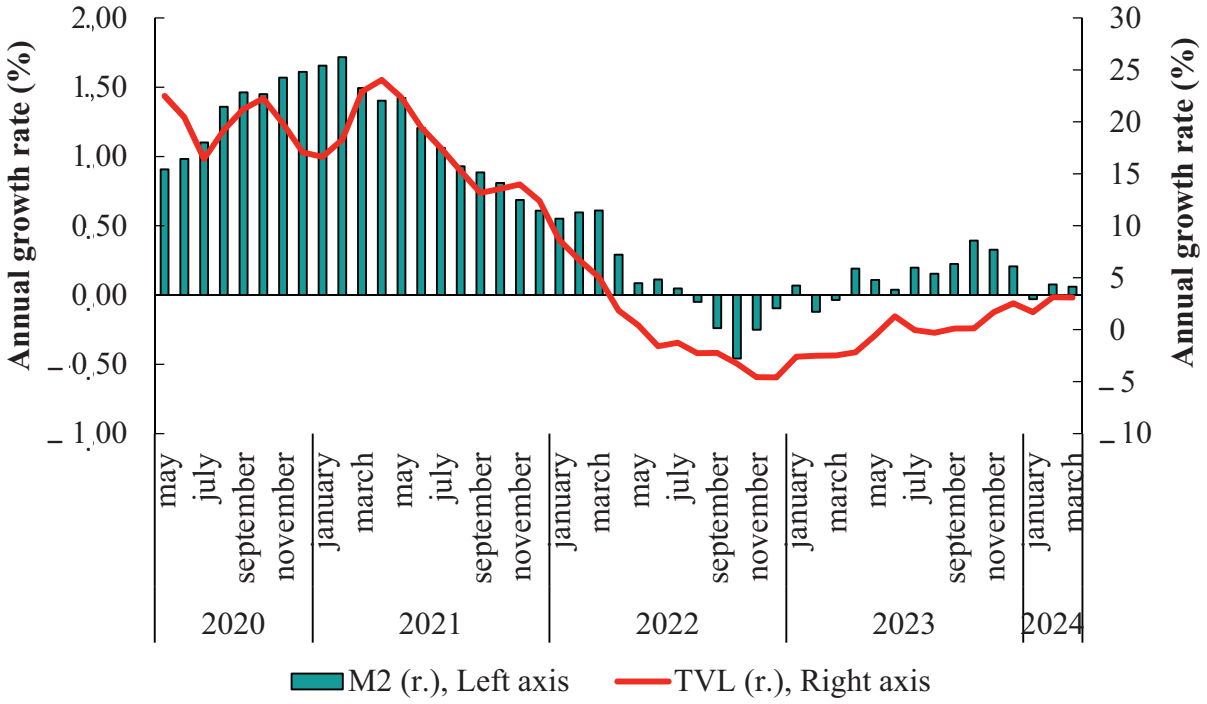

Fig. 3. **M2 Supply of Four Major Central Banks (USD, YoY, R.) and Total Value Locked (TVL) in DeFi (USD, YoY, R.)**
Source: Author's calculations.

market is and whether it poses a threat to the national or global economy. In this regard, we propose to establish a system of comparable indicators for the DeFi and FSF sectors. The connecting elements in this system will be the product segments through which FSE services and DeFi services are provided.

SCALE AND DEVELOPMENT OF THE DEFI SECTOR

For the purpose of analyzing the scale and development of the DeFi sector in comparison with the FSF, a system of comparable indicators has been established. As key indicators, metrics from the DeFi sector were selected that describe the most significant product segments of DeFi by the TVL metric, including market indicators and commodity volume indicators (see *Table 3*).

To analyze and assess the scale of the DeFi sector, one can use the market capitalization indicator known in traditional finance. However, in the DeFi sector, it represents the total market value of crypto assets that are decentralized and traded on blockchains. *Table 4* presents data on the market capitalization of the DeFi sector and public companies whose shares are traded on centralized exchanges. The statistics on companies are taken at a global, worldwide level. The source of the data is the macro statistics of the World Bank group.

The analysis of *Table 4* allows us to draw the following conclusions:

1. The first DeFi projects related to infrastructure development appeared in 2012. In the following 10 years, the market capitalization of the DeFi sector rapidly grew and by the end of 2023 amounted to 83.9 billion dollars in equivalent. However, the scale of the DeFi sector in terms of capitalization significantly lags behind that of public companies in the FSE, whose total capitalization at the global level amounted to approximately 106.6 trillion dollars. The share of the DeFi sector in this total capitalization was only 0.08%.

2. The average annual growth rate of the market capitalization of public companies over

Table 3

Economic Content of Comparable Development Indicators of DeFi and the Financial Sector of the Economy (FSE)

Group of indicators	Indicators	Contents of DeFi indicators	Comparable indicators
Market	**Market scale**		
	Market capitalization	Market value of circulating crypto assets	Market value of outstanding shares
	Means of payment		
	Outstanding supply of stablecoins	Average value of outstanding stablecoin supply (digital currency)	Monetary aggregate M1 (national currency)
Gross market value	**Loans**		
	Active loans	Outstanding borrows on the protocol	Loan debt on bank credits to the non-financial sector of the economy
	Deposits		
	Net deposits	Value deposited to the protocol	Bank deposits of non-financial companies and households
	Infrastructure		
	Trading volume (exchanges)	The total volume of crypto asset trading on DEX	The total volume of buying and selling of company shares on stock exchanges

Source: Author's development.

Table 4

Market Capitalization DeFi and FSE Companies, bln $ US

Years	DeFi	Global Crypto	Public companies	Market cap ratio of DeFi to public companies (%)
2013	0.2	10.0	64 367.8	0.0003
2014	0.8	5.2	67 177.3	0.0011
2015	0.2	6.9	62 268.2	0.0003
2016	0.2	16.0	65 117.7	0.0004
2017	89.4	456.8	79 501.9	0.1124
2018	15.2	102.9	69 028.2	0.0220
2019	9.4	163.3	79 412.2	0.0118
2020	23.7	671.1	95 197.4	0.0248
2021	118.6	1730.5	111 159.3	0.11
2022	35.8	583.1	93 688.9	0.04
2023	83.9	1352.1	106 631.7	0.08
Dynamic characteristics (2019–2023)				
CAGR	1.32	1.30	1.04	1.27
CV (%)	84.03	70.05	12.77	75.96

Source: Compiled by the authors.

Note: CAGR — compound annual growth rate; CV — coefficient of variation.

Table 5

DeFi Payment Instruments and FSE (Eurozone, USA), bln $ US

Year	DeFi Stablecoins	Money aggregate (M1)		Ratio of DeFi stablecoins to M1 (Eurozone + USA), (%)
		(Eurozone)	(USA)	
2019	0.07	11541.0	17812.8	0.0002
2020	1.15	12960.6	20434.1	0.0035
2021	14.01	13461.5	19756.4	0.042
2022	5.56	11984.9	18022.0	0.019
2023	5.58	11295.9	18889.2	0.018
Dynamic characteristics (2019–2023)				
CAGR	1.73	1.00	1.01	1.72
CV (%)	104.07	7.59	5.89	100.12

Source: Compiled by the authors.

the past 5 years (2019–2023) was 1.04, while the DeFi sector grew at a faster pace with an average annual growth rate of 1.30. However, such growth was uneven. The coefficient of variation in the market capitalization of the DeFi sector is almost 5.5 times higher than that of public companies. This once again highlights the susceptibility of crypto asset values to high volatility.

Table 5 presents data on the size of assets used as a means of payment in the DeFi sector and in traditional financial systems (TradFi).

The largest issuer of stablecoins in the DeFi sector is the MakerDAO project. Its share of all issued stablecoins in the DeFi sector is approximately 94%. These crypto assets can be used not only within the DeFi sector. In global trade, the number of transactions where digital services, services, and even physical goods can be purchased with stablecoins is gradually increasing. However, a question arises: how comparable is the volume of issued stablecoins in the DeFi sector with the amount of cash and non-cash money, which traditionally serve as a means of payment? Let's consider the economies of the Eurozone and the USA as an example.

The analysis of *Table 5* allows us to draw the following conclusions:

1. By the end of 2023, the amount of issued stablecoins in the DeFi sector amounted to 5.58 billion dollars in equivalent, while the M1 money supply in the Eurozone was 11.3 trillion dollars in equivalent. That is, the differences in scale amounted to more than 2000 times. If we compare the most liquid part of the money supply in the Eurozone and the USA to the amount of circulating stablecoins, the share of the latter was 0.018%. It is known that the transactional demand for money is directly dependent on the volume of goods, works, and services produced. Analyzing the obtained results, it can be said that the circulation of stablecoins

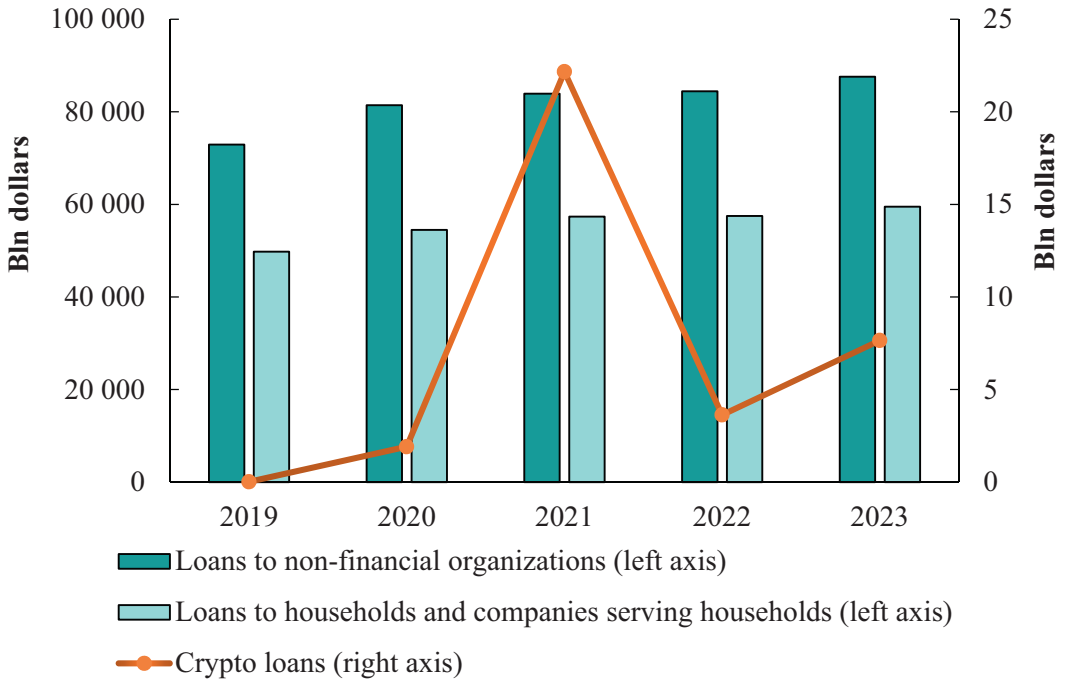

Fig. 4. **Total Credit to the Non-Financial Sector and Crypto Loans**

Source: Author's Calculations.

is largely related to gaining access to services in the DeFi sector.

2. Unlike the market capitalization indicator, the average annual growth rate of the total value of stablecoins in the DeFi sector is higher, amounting to 1.73 over the past 5 years. At the same time, the M1 money supply in the Eurozone and the United States has hardly changed. Drawing further parallels between DeFi and the FSB, one can note a more pronounced demand for stablecoins as a means of payment in the DeFi sector. Undoubtedly, this is related to the active development of this sector.

In our opinion, the overall prospects for the use of crypto-assets in e-commerce look quite interesting. Thus, according to the latest report "Global payments methods", cryptocurrency is already being used in the field of e-commerce. And in 2023, its share among other payment methods was 0.2% or about 11 billion dollars in equivalent.[6]

[6] Global payments methods. URL: https://worldpay.globalpaymentsreport.com/en?utm_medium1=RTW#download-report (accessed on 01.06.2024).

Fig. 4 shows the dynamics of the total amount of crypto loans in the DeFi sector and the total volume of bank loans provided to the non-financial sector of the economy. The statistics on bank loans are taken at a global, worldwide level. The source of the data is the Bank for International Settlements database.

From the presented graphical material, it follows that the share of all crypto loans provided in the DeFi sector in the total volume of loans granted to the non-financial sector of the economy at a global level is extremely low. Specifically, when compared to non-financial corporations at the end of 2023, it amounted to 0.009%, and when compared to households and the companies servicing them, this value was 0.013%. The total cumulative amount of loans at the end of 2023 was over 147 trillion dollars, while the total amount of crypto loans was 7.66 billion dollars in equivalent. The scales of the DeFi and traditional financial sectors in terms of lending are simply incomparable. At the same time, when analyzing the dynamics of crypto loans, it is necessary to note the strongest fluctuations in their magnitude. In the analyzed period,

Table 6

DeFi Crypto Deposits and Deposits of Non-Financial Sector of Economy in Eurozone and USA, bln $ US

Year	Crypto deposits	Deposits of non-financial sector		Ratio of crypto deposits to deposits of non-financial sector, (%)
		(Eurozone)	(USA)	
2019	0.30	11 670	18 440	0.0010
2020	10.36	12 956	21 602	0.0300
2021	126.99	12 079	24 836	0.344
2022	39.93	11 555	24 548	0.111
2023	78.75	12 175	26 244	0.205
Dynamic characteristics (2019–2023)				
CAGR	2.00	1.01	1.05	1.94
CV (%)	101.77	4.57	13.49	101.18

Source: Compiled by the authors.

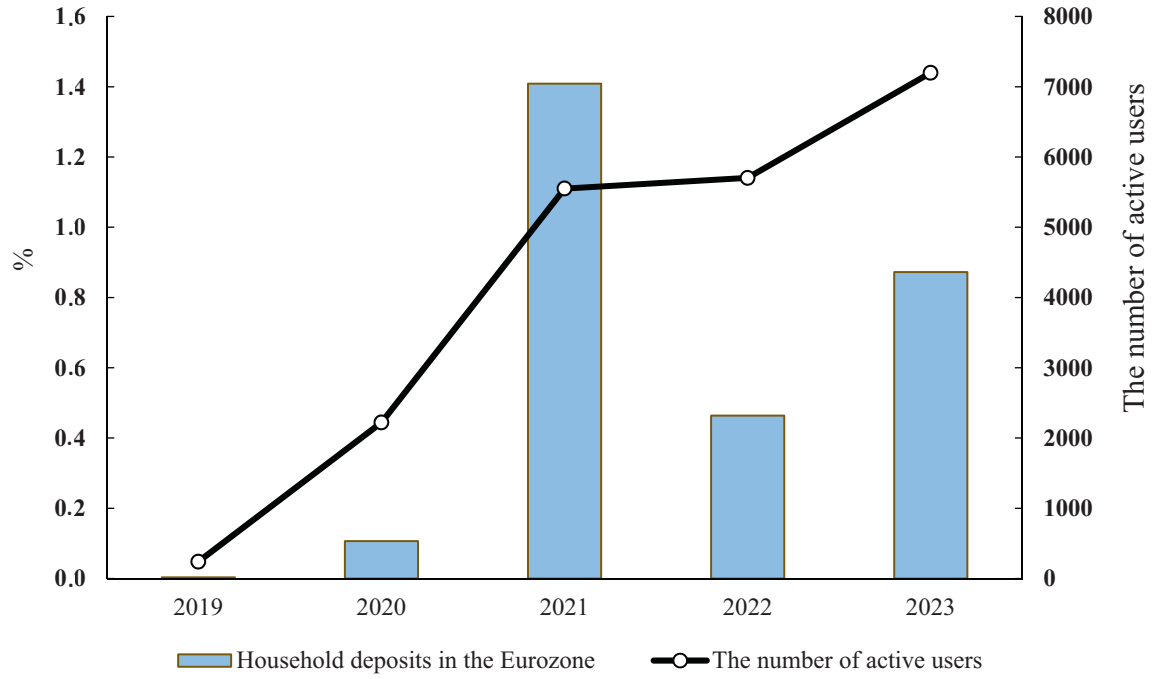

Fig. 5. **Ratios of DeFi Crypto Deposits to Bank Deposits, Number of Active Users of DeFi Lending Platforms**

Source: Author's calculations.

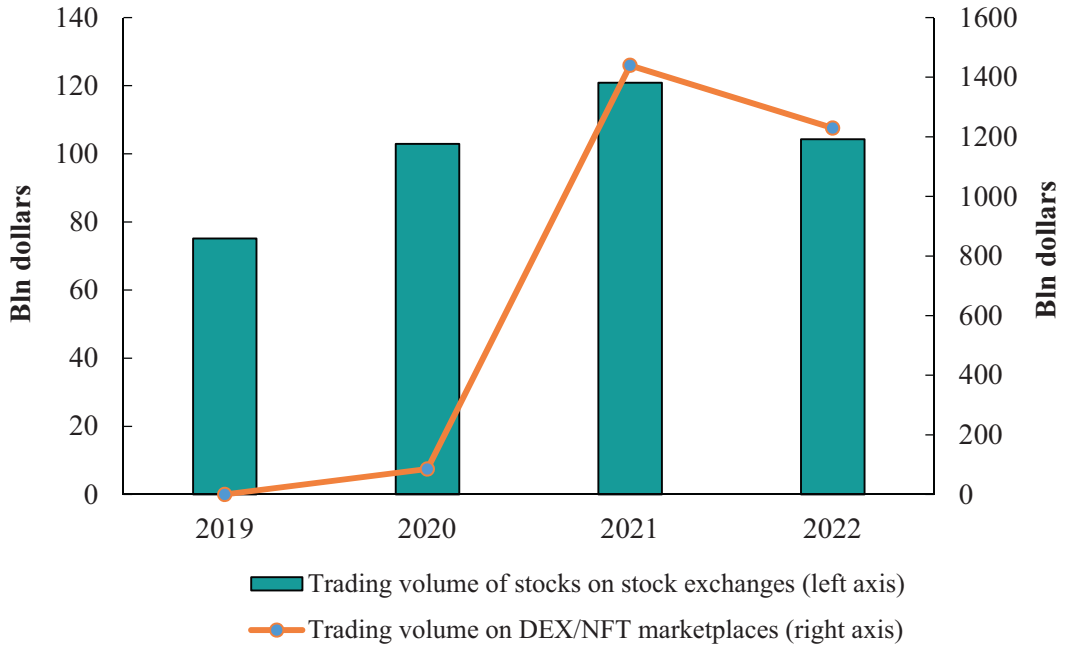

Fig. 6. **DeFi and Stock Trading Volumes on Traditional Stock Exchanges**

Source: Author's calculations.

2021 stands out particularly, when the market capitalization of the global cryptocurrency market significantly increased after many countries "emerged" from the COVID-19 pandemic.

It is known that crypto loans are a profitable operation. Each user of the lending protocol can provide loans in crypto assets. Moreover, one of the sources of funds for these operations can be the national currency. And if the yield from providing crypto loans is higher than the yield from alternative investment avenues, users will direct part of their savings into crypto assets. In our opinion, the problem of capital outflow from the country's economic turnover into the DeFi sector, into its lending protocols, is not yet so serious due to the extremely small scale of this sector.

Table 6 presents data on the size of crypto deposits in the DeFi sector and in the FSA. The economies of the Eurozone and the USA are considered as examples.

The analysis of tabular data reflects a steady demand for DeFi services in terms of placing free funds. Over the past 5 years, the average annual growth rate of crypto deposits has more than doubled the corresponding growth rate of deposits in the non-financial sector of the economy. However, the scale of the DeFi sector in terms of crypto deposits is extremely insignificant when compared to the scale of the FSE in the analyzed countries. By the end of 2023, the total crypto deposits amounted to 78.75 billion dollars in equivalent. In the Eurozone alone, the most liquid component of the money supply (M1) on the same date amounted to 12.175 trillion dollars in equivalent.

In the context of analyzing the scale of the DeFi sector, let's highlight another aspect. As seen in *Table 6*, the growth in crypto deposits over the years is uneven. This follows from the fact that a significant portion of circulating crypto assets does not have a strict peg to fiat currencies (*non-backed crypto's*). Therefore, their value is quite volatile and partly depends on the overall market sentiment in the global crypto market. This assumption is also based on the analysis of the dynamics of active users in the DeFi sector (see *Fig. 5*).

The decrease in the share of the DeFi sector in the total volume of bank deposits did not occur due to a reduction in the number of active users of DeFi services, but rather was

Table 7

Compound Annual Growth Rates of the DeFi and FSE for 2019–2023

Activities	Growth rates	
	FSE	DeFi
Market scale	1.04	1.32
Means of payment	1.01	1.73
Credit activity	1.05	4.22
Deposit activity	1.05	2.00
Infrastructure (exchange)	1.12	21.32

Source: Author's calculations.

caused by a decline in the capitalization level of the global crypto market in 2022. At the same time, it is fair to note that by the end of 2022, the number of active users did not see a significant increase compared to the corresponding period in 2021.

Next, let's analyze decentralized exchanges (DEXs) and traditional stock exchanges. As a comparable metric, we consider trading volume. In the DeFi sector, trading volume reflects the total "traded" value of crypto assets on decentralized exchanges and NFT marketplaces. The source of data for analyzing the trading volumes of public company shares is the macro statistics from the World Bank Group. The results are presented in *Fig. 6*.

Analyzing the obtained results, we note that the scale of the DeFi sector in terms of trading volumes on DEX and NFT marketplaces is insignificant when compared to the trading volume of stocks on traditional stock exchanges. At the same time, changes in the aggregate trading volumes on DEX and NFT marketplaces are characterized by a high positive trend. The compound annual growth rate (CAGR) over the period from 2019 to 2022 was 21.32. By the end of 2022, the trading volume in the DeFi sector exceeded 1.2 trillion dollars in equivalent. Of course, it is still difficult to compare this figure with the trading volume of stocks at 104.3 trillion dollars in equivalent as of the end of 2022. Nevertheless, considering the pace of development in the DeFi sector, the gap no longer seems so vast.

However, the main conclusion is not even this. Such rapid growth in trading volumes on DEXs and NFT marketplaces indicates that an increasing number of economic agents are seeking alternative ways to save and accumulate the value of their assets. How critical the identified scale of the DeFi sector for trading crypto assets is for the national economy is objectively difficult to determine. To answer this question, in our opinion, it will require conducting more than one study. But it is obvious that the DeFi sector is still outside the scope of regulation by national regulators. It is also obvious that economic agents converting fiat currency into crypto assets and trading on DEXs and NFT marketplaces are outside legal protection.

Table 7 presents the summary results on the dynamics of the development of the DeFi and FSF sectors.

Based on the tabular data, it follows that during the analyzed period, the FSE developed

quite steadily, without significant fluctuations. The highest average annual growth rate was shown by exchange activities in terms of trading shares of public companies. The DeFi sector, for its part, is characterized by quite high growth rates in the segment of lending in crypto-assets, as well as a significant increase in trading volumes on decentralized exchanges and NFT marketplaces.

CONCLUSION

Thus, as a result of the conducted research, it has been revealed that changes in monetary and/or fiscal conditions, accompanied by significant changes in the money supply, have a substantial impact on the total value of digital assets in the DeFi sector. It is likely that economic agents revise ("optimize") their asset portfolios, reducing or increasing the share of crypto assets depending on their risk appetite and budget constraints. For monetary regulators, including the Bank of Russia, it is becoming evident that the transmission of monetary impulses will be reflected in the structure of household savings, where a new form of wealth preservation is emerging in the form of crypto-assets. Therefore, in order to protect the savings of Russian citizens, the Bank of Russia, together with the Ministry of Finance of Russia, should promote the development of new instruments in the financial market that will be attractive from an investment perspective for citizens. An example of this is the long-term savings program, which will be implemented starting in 2024.

Regarding the scale and development of the DeFi sector, the conducted research showed that in terms of deposits, lending operations, and total market capitalization, the DeFi sector has an extremely low ratio compared to the corresponding indicators of the traditional financial system. We are talking about hundredths of a percent. A certain exception is exchanging activity. Here, the share of trading volumes on decentralized exchanges and NFT marketplaces amounted to just over 1%. We consider that such a scale does not yet pose a serious threat to the economy. However, the DeFi sector is quite dynamic and has the potential for further growth. The development of the conducted research, in our opinion, is a systematic study of the issues of opportunities and prospects for the integration of DeFi and the sphere of traditional finance (TradFi). A certain synergy is possible here. And it needs to be systematically researched.

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O. V. Lunyakov — study of the features and principles of DeFi, generalization of the basic conceptual apparatus.
A. B. Fiapshev — preparation of the initial draft of the study, article concept development, theory evaluation, description of the results and formation of conclusions of the research.

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Empirical Analysis of the Effectiveness of the Inflation Channel of Monetary Policy in the Russian Federation

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ABSTRACT

Currently, researchers are particularly interested in studying the influence of the dynamics of various financial variables on the pace of economic development. In this regard, an important stage of the analysis is the study of the transmission of monetary impulses through the transmission channels of monetary policy to the real sector of the economy. The purpose of this article is to identify the features of the functioning of the inflation channel in the Russian Federation from 2013 to 2022 based on the construction of VAR models (vector autoregression), as well as to evaluate the function of impulse responses of variables. Through the application of this algorithm of computational and analytical actions, the mechanisms of interaction of the following variables within each of the considered chains of the inflationary channel of monetary policy were investigated: the volume of money supply, the deflator index of gross domestic product (GDP), average monthly nominal accrued wages, and gross domestic product (GDP). As a result, a consistent element of the inflation channel was highlighted, namely, the relationship between the average monthly nominal accrued wages, on the one hand, and the rates of inflation and GDP, on the other. However, the relationships between the other links of the transmission channel remain contradictory, indicating the need for further research aimed at clarifying the quantitative characteristics and direction of the relationships between the variables.

Keywords: money supply; inflation; wages; gross domestic product (GDP); monetary policy; economic growth; VAR model; impulse response

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INTRODUCTION

The current stage of development of the Russian Federation and its territorial entities is characterized by unprecedented sanction pressure from unfriendly countries, which may ultimately lead to an acceleration of inflation rates in the country. In this regard, authorities and management structures need to conduct constant monitoring of indicators reflecting the state and development of all spheres of societal activity, as well as take measures to mitigate the effects of macroeconomic instability factors and ensure sustainable economic development rates, taking into account the prevailing levels of inflation [1–3]. It is also important to note the significance of continuous monitoring of the effectiveness of the monetary policy of the Central Bank of the Russian Federation, which allows for the adaptation of managerial decisions to new conditions and minimizes the negative consequences of shocks on the socio-economic sphere of the country and its territorial entities [4–7].

The purpose of this study is to identify the mechanisms of the functioning of the inflation channel, that is, linking changes in the money supply, inflation, wages, and gross domestic product (GDP) in the Russian Federation during the period from 2013 to 2022. To achieve the set goal, the authors implemented the following algorithm of computational and analytical actions: construction of VAR models for the corresponding chains of the inflation channel (vector autoregression) and estimation of the impulse response function of the considered variables.

This algorithm will clarify the mechanisms of interaction between the considered macroeconomic variables, taking into account the inflation component, as well as identify the features and channels of transmission of inflationary impulses to the real sector of the economy [8, 9].

The theoretical basis for constructing the author's algorithm of computational and analytical actions was provided by scientific publications that describe the mechanisms of the impact of the Central Bank's decision to reduce the money supply or increase interest rates on changes in inflation rates and economic development in the country.

It should be noted that within the framework of monetary policy, the Central Bank of the Russian Federation strives to maintain a balance between combating inflation, reducing socio-economic tension, and influencing the pace of economic development. In this regard, the evaluation of the results of constructed VAR models of individual elements of the inflation channel ("Money Supply — Inflation — Wages — Gross Domestic Product (GDP)") and the analysis of the impulse response function of the considered variables will allow for the identification of coherent chains of the impact of the decisions made by the Central Bank of the Russian Federation on the real sector of the economy.

MATERIALS AND METHODS

The assessment and analysis of the viability of the transmission channel "Money Supply — Inflation — Wages — Gross Domestic Product (GDP)" can be carried out using various statistical and econometric methods, such as correlation-regression analysis; principal component analysis; hypothesis testing; time series analysis, modeling, and forecasting, etc. — both separately and in combination [10].

VAR models are a fairly reliable tool for analyzing and modeling time series. They allow for forecasting and assessing the impact of one variable in the system on others, taking into account the interaction between various economic indicators and contributing to more accurate estimates of the effects of changes in one variable on others. In VAR models, each variable is defined as a linear combination of its past values and the past values of other model variables, meaning it takes into account the dynamics of indicators over time, as well as the magnitude and direction of

their mutual influence. Moreover, VAR models allow for forecasting future values of variables, testing various scenarios and conditions of socio-economic dynamics, as well as analyzing impulse response functions that assess the magnitude and direction of the impact of one model variable on another and the effects of different management decisions.

Thus, VAR models can be adapted to various scenarios and used to analyze a range of transmission mechanisms, as well as to assess the effects of macroeconomic shocks, making them a flexible tool for analyzing economic processes. For example, the results of VAR model estimation are used to analyze the potential recovery timelines of the economy after a crisis or to identify variables that may be most sensitive to changes in global markets [11–19].

A special role and significance in the study of the viability of the transmission channel "Money Supply — Inflation — Wages — GDP" is assigned to the methodology of estimating Impulse Response Function in the VAR model, particularly the construction of impulse response graphs of variables to a unit shock of another variable [20].

However, it should be noted that VAR models have a number of limitations; in particular, they cannot account for all the factors that influence the economic processes under consideration: some variables may be implicitly related through other indicators that were not included in the model. Therefore, when interpreting the results of impulse response analysis, it is necessary to consider the specific socio-economic situation and context within which the analysis is conducted, as well as the model's limitations.

The authors conducted a study on the viability of the inflation channel within the framework of the following algorithm of computational and analytical actions:

1. Selection of variables for modeling: growth rates of the money supply (M2) and average monthly nominal accrued wages of employees in organizations (in % to the previous period), indices of the physical volume and deflator of gross domestic product (GDP) (in % to the previous period).

To assess the inflation component of the transmission channel, the authors used the GDP deflator instead of the consumer price index, as its calculation covers the prices of all goods and services produced within the country, whereas the CPI is based on measuring the price level of goods and services purchased by households. Moreover, the calculation of the GDP deflator takes into account any changes in the structure of nominal GDP, meaning that this indicator can essentially be called a more comprehensive index of inflation. Considering that the final element of the inflation channel is the gross domestic product, and its deflator represents a "broader" indicator of economic development with regard to the inflation component, its use in this analysis can provide additional information for characterizing the studied transmission mechanism.

2. Application of the augmented Dickey-Fuller test to check the stationarity of the time series of the studied variables.

Determination of the optimal lag order of a VAR model based on the Schwarz Information Criterion (SIC), which allows for the selection of a model with the best balance between accuracy and complexity, making it preferable for determining the optimal lag order for a VAR model.

3. Estimation of the VAR model parameters using the least squares method, allowing to determine the degree of influence between each variable and their lagged values and the values of other variables.

4. Calculation of the impulse response function, which is a graph that shows the change in each variable in the system due to a unit shock in another variable.

5. Testing the statistical significance of impulse responses using the bootstrap test and constructing confidence intervals for each variable.

6. Substantive interpretation and analysis of the transmission channel mechanism.

The authors used quarterly data (from 2013 to 2022) on the dynamics of the money supply (M2), GDP deflator index (DEF_GDP), average monthly nominal accrued wages (WAGE), and gross domestic product (GDP) from the official databases of the Federal State Statistics Service (Rosstat)[1] and the Central Bank of the Russian Federation[2] [21, 22].

These indicators most accurately reflect the dynamics of the variables under consideration in the study of the viability of the inflation channel; moreover, they are publicly available and published at regular intervals, ensuring the completeness and reliability of the research being conducted.

RESULTS AND DISCUSSION

As part of the extended Dickey-Fuller test (with a constant and trend), non-stationarity of the time series of the studied variables was identified. In this regard, the authors transitioned to their first differences, and the test results indicated the need to reject the hypothesis of a unit root at the 0.01 significance level; consequently, the time series of the first differences of the variables turned out to be stationary.

The next step in the study of the viability of the inflation channel is to determine the optimal lag order for VAR models based on the Schwarz Information Criterion (SIC). As a result, we have the following lag values: for the channel element "Growth rates of the money supply (M2) — GDP deflator (DEF_GDP)" — 1, for the channel elements "GDP deflator (DEF_GDP) — Growth rates of average monthly nominal accrued wages (WAGE)" and "Growth rates of average monthly nominal accrued wages (WAGE) — Physical volume index of GDP (GDP)" — 4 lag order.

Next, we will proceed to construct VAR models based on the optimal lag orders found using the Schwarz Information Criterion (SIC).

The results of estimating the first-order VAR model between the differences of the variables "Growth Rates of Money Supply" and "GDP Deflator Index" allowed us to draw the following conclusions:

- equation (1) describes the dependence of changes in the first differences of the money supply on the first differences of its past values and changes in the first differences of the GDP deflator index. The coefficients of equation (1) indicate that an increase in the previous values of the first differences of the money supply (d_M2_1) by 1% leads to a decrease in the current values of the first differences of the money supply by 0.46%. At the same time, changes in the values of the first differences of the GDP deflator index do not have a statistically significant impact on changes in the first differences of the money supply values;
- equation (2) describes the dependence of changes in the first differences of the GDP deflator index on the first differences of its past values and changes in the first differences of the money supply volume. The coefficients of equation (2) indicate that an increase in the previous values of the first differences of the money supply (d_M2_1) by 1% leads to a decrease in the current value of the first differences of the GDP deflator by 0.10%, but this coefficient is not statistically significant. At the same time, changes in the first differences of the GDP deflator index in the past (d_DEF_GDP_1) and current periods do not have a statistically significant impact on changes in the first differences of the GDP deflator index.

The results of estimating the VAR(4) model between the first differences of the variables "GDP Deflator Index" and "Growth Rates of Average Monthly Nominal Accrued Wages of Employees in Organizations" showed the following results:

- the first equation of the model relates the change in the first differences of the GDP deflator index values to the first differences

[1] Website of the Federal State Statistics Service (Rosstat). URL: https://rosstat.gov.ru/ (accessed on 01.07.2023).

[2] Website of the Central Bank of the Russian Federation. URL: https://cbr.ru/ (accessed on 01.07.2023).

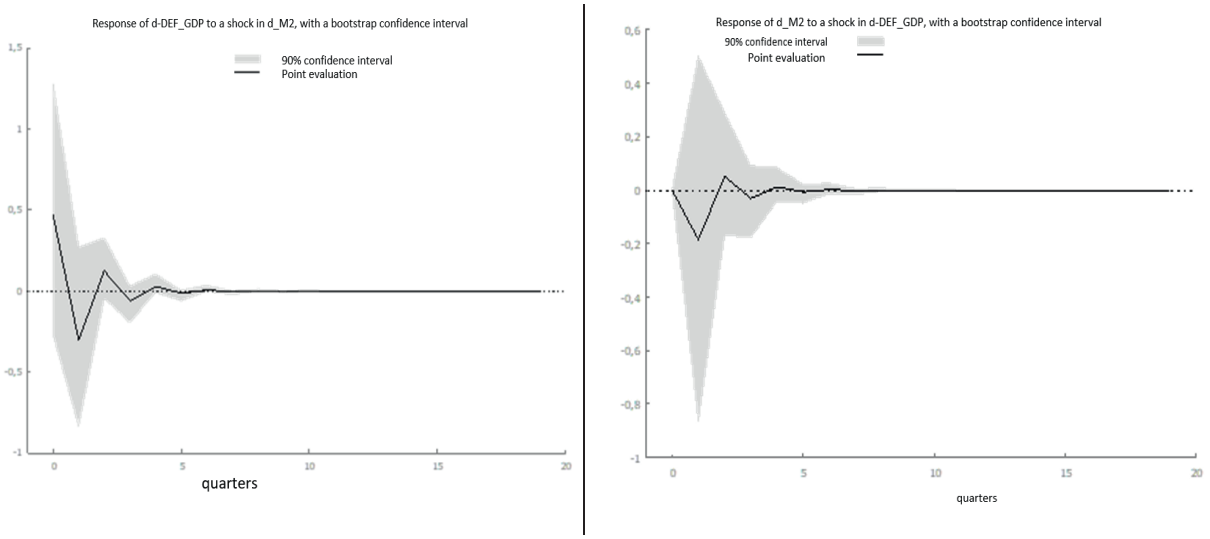

Fig. 1. **Graphs of the Impulse Response Function for the First Differences of the Variables "Monney Supply Growth Rate" (d_M2) and "GDP Deflator Index" (d_DEF_GDP)**

Source: Author's calculations.

of this variable over the previous four quarters, as well as to the changes in the first differences of the average monthly nominal accrued wages of employees in organizations for the same periods. The estimate of the GDP deflator coefficient at lag 4 is statistically significant at the level of $p < 0.001$. However, all coefficient estimates for the changes in the first differences of the average monthly nominal accrued wages are not statistically significant, except for the coefficient for the variable d_WAGE_3.

• The second equation of the model relates the change in the first differences of the average monthly nominal accrued wages to the values of the first differences of this variable over the previous four quarters, as well as to the change in the first differences of the GDP deflator index over the same periods. The estimates of the coefficients for the variable d_DEF_GDP for all considered lags are not statistically significant at the $p < 0.05$ level. However, all coefficient estimates for the variable d_WAGE are significant at the $p < 0.001$ level, except for the coefficient for the variable with a lag of 4.

Analyzing the results of the VAR (4) model estimation between the first differences of the variables "Growth rates of the average monthly nominal accrued wages of employees of organizations" and "Index of physical volume of GDP", the following conclusions are:

• in the first equation, the significance of the coefficients for all lags of the variable d_WAGE is confirmed, except for the last one. Speaking of the significance of the parameter estimates for the coefficients of the variable d_GDP, it can be noted that the coefficient is significant only for the variable with a lag of 3. The R-squared value of 0.97 indicates the high quality of the constructed model;

• a significant contribution to explaining the changes in the variable d_GDP is made by all lags of the variable d_WAGE and the last lag d_GDP_4, which is the only significant one.

Next, we will proceed to analyze the impulse response function for the first differences of the variables "Growth Rates of Money Supply" (d_M2) and "GDP Deflator Index" (d_DEF_GDP) (see *Fig. 1*).

Based on the data from *Fig. 1*, it is evident that the dynamics of the variable d_DEF_GDP in response to a one standard error shock of the variable d_M2 in the first period is positive and amounts to 0.47 (an increase in the money supply will lead to higher inflation,

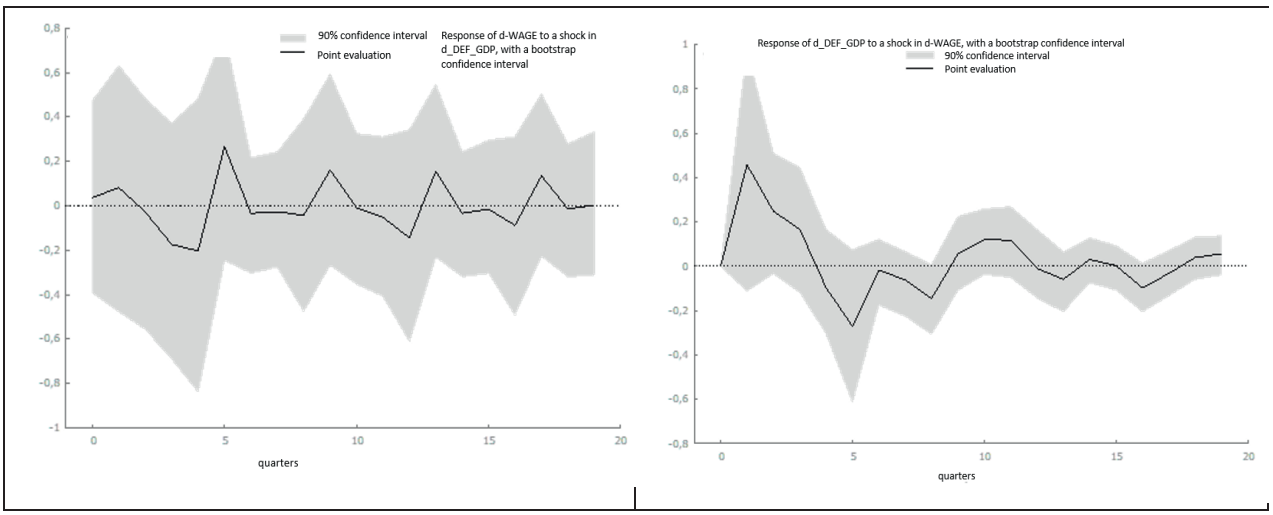

Fig. 2. **Graphs of the Impulse Response Function for the First Differences of the Variables "GDP Deflator Index" (d_DEF_GDP) and "Growth Rates of Average Monthly Nominal Accrued Wages" (d_WAGE)**

Source: Author's calculations.

as a greater amount of money available for consumption increases the level of demand for goods and services, which, in turn, can lead to a rise in price levels). In subsequent periods, a stepwise nature of the impulse response function changes is observed, which may indirectly indicate the presence of nonlinear effects in the dynamics of the inflation level, which slows down in periods 7–8, meaning that the inflation level stops reacting sharply to changes in the money supply and "dampen" starting from period 12.

In turn, the dynamics of the variable d_M2 in response to a shock of one standard error of the variable d_DEF_GDP in the first period is equal to 0 (the dynamics of the inflation rate do not affect the change in the money supply), then it becomes negative (an increase in the inflation rate leads to a decrease in the money supply). At the same time, it can be noted that the amplitude of changes in this function is lower compared to the one considered earlier. Next, the response begins to oscillate around 0 after the 6th period.

Let's consider the impulse response function graphs between the first differences of the variables "GDP Deflator Index" (d_DEF_GDP) and "Growth Rates of Average Monthly Nominal Accrued Wages" (d_WAGE). (d_WAGE) (see *Fig. 2*).

Based on the data from *Fig. 2*, it is evident that the dynamics of the variable d_WAGE in response to a shock of one standard deviation of the variable d_DEF_GDP in the first period is positive and amounts to 0.038 (an increase in the inflation rate causes a rise in wage levels, which may be related to an increase in the prices of goods and services, leading to higher income levels for enterprises and organizations, as well as an increase in the demand for labor). In subsequent periods, an intermittent of the impulse response function changes is observed, which may be explained by the presence of a seasonal component in this time series.

In turn, the dynamics of the variable d_DEF_GDP in response to a shock of one standard error in the variable d_WAGE in the first period is equal to 0 (a change in the wage level does not affect the dynamics of the inflation rate), then becomes positive up to the 4th period (an increase in the wage level leads to a rise in the prices of goods and services). At the same time, it can be noted that the amplitude of the fluctuations in the values of

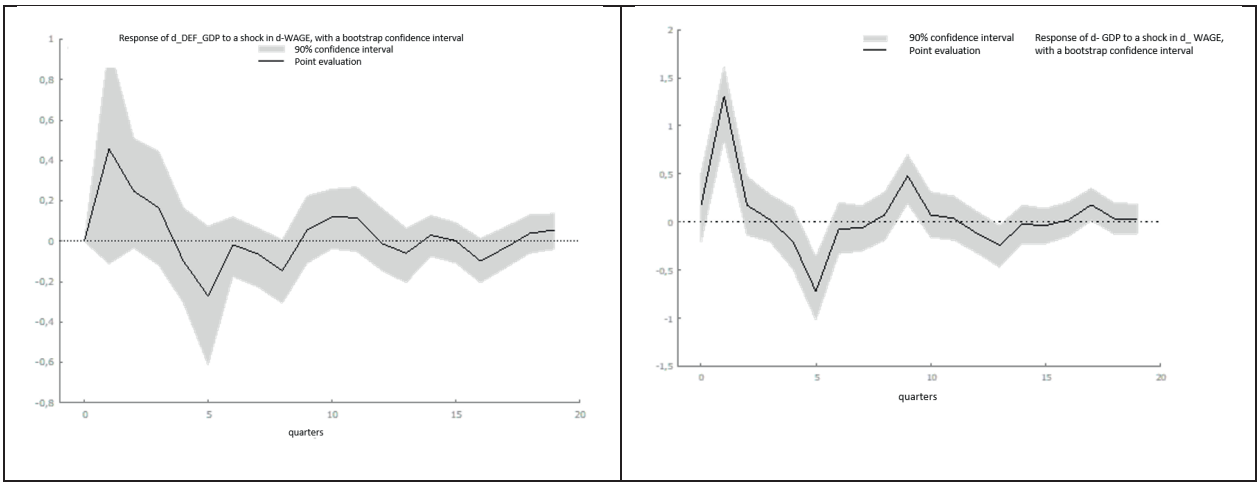

Fig 3. **Graphs of the Impulse Response Function for The First Differences of the Variables "Growth Rates of Average Monthly Nominal Accrued Wages" (d_WAGE) and "GDP Volume Index" (d_GDP)**

Source: Author's calculations.

Table

The Results of the Analysis of the Mechanisms of Functioning and Effectiveness of the Inflation Channel

Inflation Channel Component	Outcome of Vector Autoregression (VAR) Model Estimation	Outcome of the Period 1 Impulse Response Function Assessment
Money supply — Inflation	insignificant	Positive feedback
Inflation — Money supply	insignificant	0, then negative feedback
Inflation — Wages	insignificant	Positive feedback
Wages — Inflation	significant (lag 3)	0, then negative feedback
Wages — GDP	significant	Positive feedback
GDP — Wages	significant (lag 3)	Positive feedback

Source: Compiled by the authors.

the impulse response function subsequently varies between –0.2 and 0.26.

However, it should be noted that the interdependence between the level of inflation and the wages is quite complex and is determined by specific conditions in the labor market and the economic situation in the country.

Let's consider the graphs of the impulse response function between the first differences of the variables "Growth rates of average monthly nominal accrued wages" (d_WAGE) and "Index of physical volume of GDP" (d_GDP) (see *Fig. 3*).

Based on the provided data, the dynamics of the variable d_GDP in response to a shock of one standard error in the variable d_WAGE

is positive up to the 4th period (an increase in wage levels stimulates an increase in the consumption of goods and services, as well as the amount of investments in various types of capital, which in turn leads to an increase in production volume and, ultimately, GDP, due to the fact that a higher level of income for workers in enterprises and organizations increases their ability to consume goods and services, thereby supporting sustainable economic growth rates). The response value becomes negative from periods 5 to 8 inclusive, and then its fluctuations begin to gradually "dampen" after period 13.

The dynamics of the variable d_WAGE in response to a one standard error shock of the variable d_GDP clearly contain a seasonal component, leading to a high amplitude of its fluctuations throughout the entire period under consideration.

Thus, the analysis of impulse response function graphs allows for the identification of coherent chains in the inflation channel: a large amplitude of curve changes indicates a sufficiently strong impact of one variable on another.

However, it should be noted that to obtain more accurate results, it is necessary to use several different methods to assess the impact of monetary policy on real economic dynamics and to conduct an analysis based on the aggregate of the obtained results.

CONCLUSION

The results of the conducted research showed that VAR models allow for a sufficiently deep study of the functioning of various transmission mechanisms and the assessment of the effects of macroeconomic shocks, identifying variables that are most sensitive to changes in specific factor markets, as well as determining the key factors of economic growth and the direction of their response to changes in external conditions [23–24].[3]

Overall, VAR models provide a tool for a deeper understanding of economic processes, their interconnections, and responses to various events and shocks. They allow for analysis and forecasting, which helps authorities and management make more informed decisions and develop effective policies for stable economic development.

According to the conducted analysis of the viability of the inflation channel based on the construction of VAR models and the analysis of impulse response functions, the following conclusions can be drawn (see *Table*).

Thus, the significance of the following elements of the inflation channel has been confirmed:

- "Wages — Inflation" (the increase in the average monthly nominal accrued wages in the first quarter does not affect the inflation growth rates, but in subsequent periods, there is a positive response);
- "Wages — GDP" (an increase in the average monthly nominal accrued wages leads to an increase in the physical volume of GDP in the first quarter);
- "GDP — Wages" (the growth of the physical volume of GDP leads to an increase in the average monthly nominal accrued wages in the first quarter).

The growth of the average monthly nominal accrued wages contributes to an increase in the inflation rate. At the same time, the increase in the average monthly nominal accrued wages stimulates the growth of economic activity and production volume, which is reflected in the positive dynamics of GDP. However, if the rate of economic growth outpaces the growth rate of the money supply or wages, a decrease in inflationary pressures may be possible. It is also worth noting that the increase in economic activity and production volume, expressed in GDP growth, contributes to the rise in wages.

At the same time, based on the conducted computational and analytical actions, it was found that the dynamics of the money supply does not have a statistically significant impact on the change in the inflation rate.

[3] Main Directions of the Unified State Monetary Policy for 2023 and the Period of 2024 and 2025. Moscow: Bank of Russia; 2022. 159 p. URL: https://cbr.ru/Content/Document/File/139691/on_2023(2024–2025).pdf (accessed on 01.07.2023).

Thus, when analyzing the mechanisms of the inflation channel of monetary policy in the Russian Federation, it is necessary to consider the interconnections between macroeconomic indicators and their impact on the socio-economic situation in the country and its regions, which will allow determining the feasibility and effectiveness of various managerial decisions for stabilizing the economic situation in the Russian Federation and ensuring sustainable rates of non-inflationary economic growth.

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G.A. Bondarenko — carrying out calculations, interpreting and describing the obtained results.
G.V. Pavlenko — collection and primary processing of data arrays, as well as graphically visualizing the calculation results.

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Improvement of Methods for Assessing the Shadow Economy in Agricultural Enterprises for the Purpose of Preventing Threats to Food Security

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ABSTRACT

The **subject** of the research is methods for assessing the shadow economy in the field of agricultural production. The **purpose** of the study is to propose methods for identifying the shadow economy in agricultural enterprises, which negatively affects economic growth and the balanced development of regions and the country as a whole. The **objectives** of the study were scientific and methodological substantiation of indirect methods for assessing the indicators of the shadow economy in agricultural enterprises; an objective assessment of possible financial losses from unaccounted-for activities; and development of methods for a comprehensive assessment of the shadow economy in the field of agricultural production to timely identify and address the causes and conditions that have a destabilizing effect on the country's food security. The study used an analytical method to identify cause-and-effect relationships between the studied process of unaccounted-for agricultural production, financial losses and threats to food security. It is **concluded** that in order to effectively combat the shadow economy in the agricultural sector, it is necessary to improve methods for assessing the level of informal production, which will not only objectively determine the actual state of affairs, but also develop effective measures to eliminate the causes and conditions conducive to the organization of this illegal activity. The **scientific novelty** of the study is the identification of imbalances between the indicators of financial and economic activity of agricultural enterprises, which indicate signs of unaccounted-for agricultural production. The author proposes to carry out a comprehensive analysis of all indicators of the results of financial and economic activities in this field of production, which allows us to calculate the actual volumes of products produced. It is also proposed to develop special government programs aimed at identifying threats and minimizing the risks of ensuring the stable functioning of agricultural enterprises through the introduction of modern accounting and control technologies. The article offers a comparative analysis of the results of financial and economic activities of the main stages of production and processing of agricultural products, which will reveal the facts of shadow production, calculate the amount of financial losses and promptly eliminate the causes and conditions conducive to shadow production in the agricultural sector.

Keywords: economic security; agro-industrial complex; shadow economy; analysis of indicators of financial and economic activity; assessment of the shadow economy in the field of agriculture; financial losses; financial and economic activity; financial stability

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INTRODUCTION

Practice shows that today, in the context of Russia's political and economic isolation, the agricultural sector of the national economy is becoming one of the main drivers of growth for the Russian economy, which is intended to ensure a stable supply of food products to the population [1].

According to Rosstat's data for 2022, due to the record grain harvest and increased export volumes, agricultural growth amounted to 6.7%.[1] The reorientation of agricultural production towards domestic consumption markets and the expansion of food exports allows Russia not only to overcome sanctions pressure but also to ensure food security at all levels and national security of the state as a whole. Considering the particular importance of this sector of the national economy, the state today faces the task of not only ensuring the stable development of this direction but also preventing the growth of informal, unaccounted agricultural production, which has a destabilizing effect on the state of food security in the country [2].

Over the past few decades, the scientific theory of economic security has significantly developed, becoming one of the most important scientific directions both at the international and national levels and one of the main priorities of any state. Without delving into the historical aspects of the formation and development of this scientific direction, it should be noted that economic security as an economic phenomenon emerged during the early days of statehood. It was aimed not only at helping society understand the level of its economic potential and its protection but also at assessing negative processes that have a destabilizing impact on the socio-economic development of the state [3].

In the current conditions of increasing political and economic isolation and military-political pressure on Russia, the country's economic security is becoming a leading factor in ensuring its stable socio-economic development [4].

In accordance with the Decree of the President of the Russian Federation in 2017, the "Strategy for Economic Security of the Russian Federation until 2030"[2] was approved, which outlines the main challenges and threats to economic security. The nineteenth point in this list identifies the "retention of a significant share of the shadow economy" as a threat. It is also worth noting the point "high level of criminalization and corruption in the economic sphere". As we can see, these threats have been elevated to the state level and require fundamental research to develop a scientifically grounded strategy for minimizing the risks of their manifestation.

MATERIALS AND METHODS OF RESEARCH

Informal activities that are fully or partially exempt from fiscal control are commonly referred to as the "shadow economy" (underground economy, black economy). During the Soviet period of Russian history, this term began to be actively used in connection with the ongoing struggle against "guards" (workers in underground production). In the late 1960s, using, as a rule, raw materials stolen from the state, they launched various types of unregistered underground production, mainly of consumer goods, thereby substituting the state in meeting the growing needs of citizens and obtaining unaccounted income from this activity. During this same period, the first scientific (mainly in departmental, law enforcement research institutes) criminological and legal studies appeared, focusing on the investigation of the causes and conditions of the emergence of the

[1] Rosstat presents the second estimate of GDP for 2022. URL: https://journal.open-broker.ru/research/rosstat-dal-pervuyu-ocenku-vvp/ (accessed on 23.04.2024).

[2] Decree of the President of the Russian Federation from 13 May 2017, No. 208 "On the Strategy for Economic Security of the Russian Federation for the Period up to 2030". URL: https://www.garant.ru/products/ipo/prime/doc/71572608/ (accessed on 22.04.2024).

shadow economy, as well as the development of methods for identifying and documenting facts of illegal, underground production. The most active research on the shadow economy began to develop with the emergence of a new scientific field — "economic security", which arose under the influence of institutionalism within the frameworks of economic and sociological theories. Among Russian scholars, it is worth noting the works of V.I. Avdiyskiy et al. [5, 10], Yu.V. Truntsevsky [6, 10], M.A. Bulgakova and P.V. Samolysov [7], V.M. Bezdenezhnykh [10] and others.

According to the authors, **the shadow economy is a complex socio-economic phenomenon that permeates all spheres of social relations, manifested in the deliberate (intentional) activities of economic entities to withdraw the results of their financial and economic activities from fiscal or other forms of state control and accounting, regardless of ownership forms and their capitalization levels, with the aim of obtaining unaccounted income.**

At the same time, the removal of certain sectors of production and various types of services, including in the agricultural sector, from fiscal control is nothing more than a peculiar illegal form of protection of entrepreneurs' own economic interests, which, due to certain socio-economic, political, national, and regional characteristics, often oppose public interests.

A clear example of the flourishing shadow economy in the agricultural sector (according to "FederalPress") can be seen in the widespread criminal schemes for purchasing raw materials from producers without VAT through intermediary companies, followed by the resale of this product through a chain of shell companies with the issuance of corresponding fictitious documents. The aim of such a scheme is to avoid paying VAT. The deal is concluded through a real export company, which legally claims VAT reimbursement from the state. According to expert estimates, as a result of these criminal schemes, the state lost up to 80% of the money from such transactions. According to the Federal Tax Service (FTS), the annual losses to the state in the grain and sunflower market reached up to 65 billion rubles in the export market and up to 100 billion rubles in the domestic market.

In the fight against such criminal schemes, law enforcement agencies have inspected almost all major agricultural producers in the country: the enterprises of the "Rusagro", "Cherkizovo", "Chelyabinsk Poultry Factory", "Bogdanovich Compound Feed Plant", "Nastyusha" Group of Companies, Magnitogorsk Poultry Factory, and several others. The result of the large-scale inspection of agro-industrial complex enterprises was the signing in 2017 of the agricultural charter in the field of agricultural product turnover. According to this document, which has been signed by about 4 000 companies to date, agricultural producers have committed not to use such criminal schemes in their activities.

Stable, sustainable food supply for the population of Russia is a priority task for the agricultural sector of the economy, which represents a complex interconnected, deeply integrated system [8–12].

The agro-industrial complex consists of three main sectors:

- industry for the production of means of production;
- agriculture;
- food and processing industry.

At the same time, it should be noted that the level of interaction between these spheres depends not only on the state of economic security in the agricultural sector but also on ensuring a high level of its competitiveness, the ability to withstand modern challenges and threats, including ensuring food security at all levels of the Russian state.

Moreover, practice shows that to ensure the stable functioning of the agro-industrial complex, a number of other subsystems are involved, covering a wide range of national issues — investments, labor resources, raw

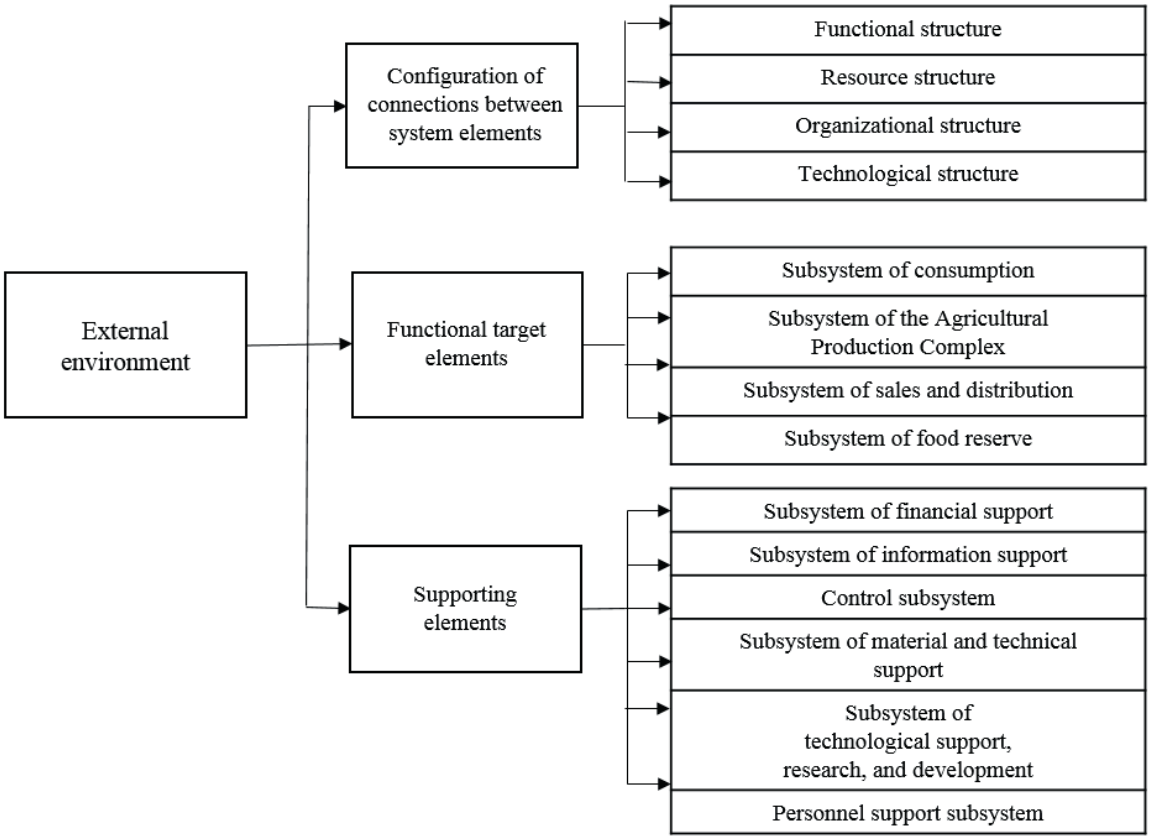

Fig. 1. **The Food Security System of the State**

Source: Compiled from the materials [10, p. 87].

materials, energy supply, consumption, and others.

The complex of main subsystems shown in *Fig. 1* was developed under the guidance of one of the authors of the article [10].

Analysis of the data from the Russian statistical yearbook of the Federal State Statistics Service over the past few years shows that it presents the main indicators of the performance of the agricultural sector of the economy, including in terms of the designated subsystems. However, this statistical yearbook does not contain statistical indicators of the level of the shadow economy, not only for Russia as a whole but also for this sector of the national economy. At the same time, conducted research shows that a quantitative and qualitative analysis of the main indicators of the subsystems allows for an objective assessment of the real state of the agricultural sector of the economy, its share in the overall structure of agricultural production, and the determination of the effectiveness of its development, as well as the presence or absence of signs of unaccounted — shadow production.

The methods for calculating the scale of shadow activities vary. Many experts include not only tax-hidden income in their calculations, as researchers from the World Bank, Rosstat, and the Ministry of Finance of the Russian Federation do, but also all other undeclared cash flows, including bribes and funds earned from the production of counterfeit goods, etc. Thus, based on the analysis of the activities of an economic entity, it can be concluded that the understanding of the shadow economy is largely determined by the choice of the main criteria for classifying economic relations to the shadow sector, including in the agro-industrial complex.

Thus, according to the data from the International Monetary Fund (IMF), today the size of the shadow economy in Russia has reached 38% of GDP, which is 136 trillion rubles. However, it is impossible to determine on what basis such conclusions were made, how objective they are, and whether they correspond to reality. An analysis of the statistical reporting of the Russian Federation also shows that it is quite difficult to give an objective assessment of the level of the shadow economy today, as it is exclusively latent in nature and tries to avoid any assessment (this fact is confirmed by the differing figures in the reports of various government agencies and experts). At the same time, it should be noted that all data available in open sources is presented exclusively within the range of 2018–2020. And, as mentioned above, there is no such data at all in the Russian statistical yearbook of Rosstat for 2022.[3] In open sources, it is indicated: according to Rosstat, in 2018, the non-observed economy of Russia accounted for 11.6% (including the shadow economy for the purpose of tax evasion — 4% of GDP). Unfortunately, today in Russia, it is very difficult to analyze and provide an objective assessment of the level of the shadow economy as a whole across the country and in individual sectors of the national economy, including the size of hidden money from tax control. According to media reports, last year the volume of Russia's shadow economy was about 20% of the country's GDP (over 20 trillion rubles). Rosfinmonitoring noted that this indicator was over 25%. The provided statistical data clearly show that there is no unified standard for calculating the volumes of the shadow economy in Russia, including for individual sectors of the national economy, taking into account their sectoral specifics.

At the same time, a number of experts note that as a result of the economic crisis of 2020 in Russia, due to insufficient support for small and medium-sized businesses, many entrepreneurs, including those in the agricultural sector, were forced to go «underground» to avoid paying taxes, and this significantly affected the GDP level. According to internet sources, this "...will most likely lead to a sharp increase in the shadow economy in 2021–2023 (especially in relation to the reduced GDP), and positive dynamics will only be restored by 2025".[4] To support these conclusions, one should refer to the work of scholars R.I. Nigmatulin and B.I. Nigmatulin, who note that in 2021 in Russia, "the value of goods and services as a share of GDP produced by small and medium-sized enterprises was the lowest, amounting to only 20%, which is 2.4 times less than in the USA (48%) and 3.0 times less than in China" [13].

The shadow economy in the agro-industrial complex (AIC) not only poses a significant threat to economic growth and the well-being of the population but also negatively impacts the food security of our state. Based on the results of the conducted research, the author concluded that among the traditional factors influencing the formation of the shadow economy in the agro-industrial sector are:

- destructive, antisocial behavior of a person, ineffective management of economic processes to ensure a high level of production relations in the interests of all citizens of the country;
- the presence of uncontrolled circulation of goods, through which their secondary redistribution is carried out;
- the presence of a discrepancy between the consumer and exchange value of goods;
- the lack of sufficient working capital for agro-industrial enterprises, as well as a stable financial market, which is particularly relevant due to the significant impact of seasonality on agricultural production;

[3] Russian Statistical Yearbook. 2022: Statistical Collection. Rosstat. Moscow, 2022. 117, 322, 398 pp. (accessed on 23.04.2024).

[4] The shadow economy in Russia. URL: https://rusind.ru/tenevaya-ekonomika-v-rossii.html (accessed on 23.04.2024).

- the presence of a criminal environment that compels the production of unaccounted agricultural products;
- an ineffective and illegitimate tax system that is not aimed at ensuring the development of agricultural production or the formation of a conscientious taxpayer.

The factors mentioned cannot be considered exhaustive. Taking into account the industry-specific nature of agricultural activities, as well as regional characteristics, there may be other reasons for the organization of unaccounted agricultural production.

RESULTS

The presence of the shadow economy in the agricultural sector can be viewed from various aspects. On the one hand, informal production meets the demand for food and creates a certain number of jobs, but at the same time, as practice shows, it serves as a basis for the formation of a criminal environment and as a foundation for the exploitation of informal workers who receive no social or legal guarantees. Moreover, by using shadow employment, many companies obtain additional unaccounted income by evading the payment of various social taxes and contributions stipulated by current legislation. Shadow employment, including in the agro-industrial complex (AIC), leads not only to the distortion of the labor market but also to its degradation in Russia as a whole, including significant losses for budgets at all levels, which are compensated by conscientious taxpayers. The conducted analysis shows that the presence of unaccounted employment in the AIC sector is one of the serious threats to ensuring food security at the federal and regional levels. The presence of these negative manifestations, along with the lack of an objective assessment of their scale, does not allow for a clear determination of the threshold values for ensuring food security at the federal and regional levels, including for certain socially significant food products [14–16]. This negatively affects the minimization of risks in the development of targeted state programs for the country's economic development, which should ensure food security for the population (i.e., the availability, accessibility, use, and assimilation of food), and create conditions for investing in agricultural production to ensure the stable functioning of the industry. In this regard, the question of an objective analysis of methods for assessing the level of the shadow economy in the AIC, and primarily at the micro level (enterprise, organization, household, family, individual), becomes quite relevant.

One of the most problematic aspects of studying the shadow economy, as already noted above, is the development of a methodology for assessing key indicators that indicate the concealment of shadow agricultural production from accounting and control. Such indicators and characteristics must be taken into account to establish the signs of the presence and volumes of agricultural products removed from fiscal control. There is a certain classification for measuring the shadow economy:

1) according to the source of information:
- direct (surveys, tax audits);
- indirect (monetary, balance sheet, employment indicator);

2) by the scope of research units:
- macro methods;
- micro methods;

3) by the nature of the materials studied:
- integral;
- differential.

However, direct and indirect methods have become the most widespread. The former are based on surveys and observations; the latter rely on the analysis of statistical data and indicators provided by financial government bodies and tax services.

Taking into account the specifics of agricultural production, it seems reasonable to use micro-methods for the objective measurement of the shadow economy level in agricultural enterprises (at the micro level),

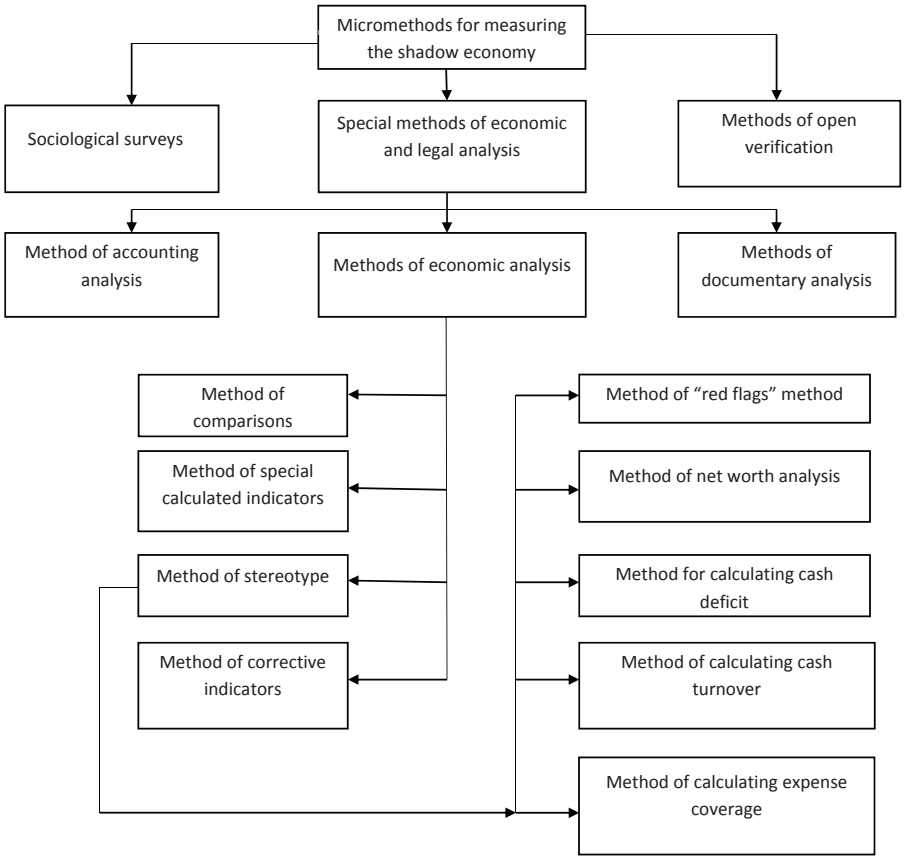

Fig. 2. **Micrometers for Measuring the Shadow Economy of Agricultural Enterprises**

Source: Author's development.

which, in the author's opinion, allow for capturing and calculating the actual volumes of produced goods at the main stages of production activities in this field.

Currently, there is a positive practice of using three direct micro methods of analysis, which are presented in *Fig. 2*.

Sociological surveys — through this method, information is collected by surveying the following categories of citizens (respondents):

1. Individuals who are directly engaged in illegal (shadow) activities or involved in them understand this and consciously participate in it. At the same time, they condemn this type of illegal activity, are ready to assist in exposing all participants in illegal agricultural production, and reveal the true scale of unaccounted agricultural production.

2. Individuals who are directly involved in the production of unaccounted (shadow) agricultural products, i.e., those who possess insider knowledge, but do not intend to disclose their participation in this illegal activity.

3. Individuals who possess information about facts indicating the presence of signs of unaccounted agricultural production, but deliberately treat this information passively or simply do not respond to it.

4. Individuals who were not only witnesses to the shadow economy but also genuinely suffered from this activity, including from the organizers of unregistered agricultural production, their patrons, criminal structures, etc.

The information obtained from all four categories of respondents is necessary and of great importance when conducting research on an agricultural enterprise to form its characterization. In this case, to assess the quality and level of reliability of the obtained information, preference should be given to

individuals (respondents) who are directly engaged in illegal (shadow) activities or are involved in them, as well as those who are directly involved in the production of unaccounted (shadow) agricultural products, i.e., those who possess reliable information about the real state of affairs at the facility from the inside. To form an objective characterization of the research object, it is necessary to carefully develop the questions to be asked to the respondents, taking into account the industry specifics of the agricultural producer and regional features.

The questions should take into account the organizational and legal form of the agricultural producer (legal entity or individual), the level of capitalization (large company, small or medium business), farm, individual entrepreneur, etc. The questions should be formulated in such a way that the respondent cannot determine the real purpose and direction of the survey. And most importantly, it is necessary to eliminate the possibility of providing false information, hiding the fact of their participation in the production of unaccounted agricultural products, or the respondent having such information.

Analysis of foreign experience in collecting statistical data to identify signs of the shadow economy shows that in many countries, the household survey method is widely used to determine the volumes of labor resources and actual working hours in production. The application of this method guarantees the disclosure of illegal economic activities only to the extent that it allows for the identification of the subject being examined.

The method of open inspection — the application of this method falls within the competence of specially created bodies that monitor the activities of agricultural producers, which are tasked with identifying and preventing violations of currency, customs, banking, tax, antitrust legislation, trade rules, fire safety, sanitary norms, and so on, as part of their functional duties. Practice shows that the aforementioned and other economically oriented offenses are generally the result of organizing informal, unaccounted production activities. Moreover, when these violations are identified, factors indicating the presence of signs of the shadow economy are often revealed, which may serve as a basis for conducting a more in-depth inspection of the agricultural producer's activities using the method of economic and legal analysis.

The special method of economic and legal analysis consists of three main components:

- accounting analysis;
- documentary analysis;
- economic analysis.

The application of this method, using all three components in a comprehensive manner, allows for the confirmation (recording) of the existence of unaccounted agricultural production, as well as the calculation (assessment) of the actual volumes of shadow production.

Thus, through accounting analysis, the examination of primary documents reflecting the results of the financial and economic activities of agricultural producers is carried out, including the balance sheet, synthetic accounts, calculations, and other primary accounting documents to identify any discrepancies in accounting data, as well as deviations in production activities. In practice, accounting analysis is widely used to identify and document instances of tax evasion, intentional distortion of accounting entries to conceal taxable objects, understatement of the tax base, etc.

The main objective of document analysis is to examine all documents that reflect information about the results of the financial and economic activities of agricultural producers, in order to establish their authenticity and compliance with legally established requirements (i.e., the presence of required details). It is also determined

whether the information displayed in the documents corresponds to their status and how comprehensive it is, etc.

Economic analysis (microeconomic) of agricultural production enterprises represents an analysis of all their production and economic activities, which will be the subject of the study. Through the economic analysis of specific economic indicators of the agricultural enterprise, it is possible to most fully and objectively investigate not only all economic and production business processes, development trends of the entire enterprise, identify both positive and negative phenomena that have a destabilizing impact on its economic security, but also accurately establish the fact of the presence or absence of illegal agricultural production, the main causes and conditions contributing to its manifestation.

To conduct a qualitative economic analysis of the activities of an agricultural enterprise, it is necessary to consider:

1. Comparison of indicators;
2. Special calculation indicators;
3. Stereotypes;
4. Corrective indicators.

1. Comparing the performance indicators of an enterprise is one of the effective forms of research aimed at identifying reserves that can be used for organizing informal agricultural production, which allows for calculating the volumes of products that are off the fiscal record, etc. Comparability can only be achieved by comparing qualitatively homogeneous indicators. For example, comparing industry-wide and regional yield indicators with those recorded in the reports of a specific agricultural producer makes it possible to calculate the actual amount of produced products that are off the record. When comparing approved consumption norms, such as fuel, electricity, water, and other raw materials, it also makes it possible to determine the presence of shadow agricultural production and calculate its volume.

2. Special calculation indicators. Practice shows that the method of special calculations is widely used to identify facts of tax evasion, income concealment, the presence of a shadow economy, money laundering of proceeds obtained through criminal activities, and other economic offenses. The main focus of these calculations is to obtain analytical indicators that can clearly indicate the presence of discrepancies (gaps) between the actual financial condition of the agricultural producer, recorded in their reporting indicators, and the current benchmark values for this category of enterprises. Typically, data on production turnover, balance and net profit, the number of employees, labor productivity, and others are used to obtain a special calculation indicator. Thus, the obtained value of this indicator may indicate the absence or presence of signs of illegal economic activities that require further detailed investigation.

3. Stereotypes. In the field of agricultural production, stereotypes represent meaningful stable patterns of production and economic processes, as well as human behavior in the production of agricultural products. This allows for determining whether an agricultural enterprise corresponds to a certain stereotype (positive or negative, with or without unaccounted agricultural production) through the assessment of its compliance with existing economic norms, regulatory acts governing the activities of agricultural producers, and protecting the interests of entities involved in agricultural production.

For the effective application of the stereotype method in practice, the following are used:

- method of "red flags". The essence of the method lies in developing a special system that ensures the analysis of a large volume of information about the results of the financial and economic activities of an agricultural enterprise, transforming them into concrete facts that cannot be ignored, as this information contains data on signs of offenses committed by the enterprise's employee.

"Red flags" are usually set for those financial and economic operations and production areas that require increased attention from regulatory bodies and the management of the agricultural enterprise;

- method of net worth analysis. The calculation of net worth is a complex economic component through which the total value of a product is considered, minus tax payments to the consolidated budgets at all levels and other additional costs associated with the production of agricultural products (purchase of raw materials, wages, electricity, fuel and lubricants, etc.). This method allows for the establishment of the fact of production and sale of unaccounted agricultural products. A comparative analysis of the declared income from agricultural production with the increase in the wealth of the agricultural producer over a certain period (acquisition of expensive real estate, other assets, etc.) may indicate that the value of the newly acquired property does not correspond to the declared income and, therefore, may serve as evidence of the sale of agricultural products that have been removed from fiscal control;
- method of calculating cash deficit. The application of this method in agricultural production is ineffective, as, generally, unaccounted agricultural products obtained as a result of production activities and removed from fiscal control (for example, unaccounted sown areas) are sold for cash without being recorded in the cash book. Often, in order to avoid inspection checks, farmers sell unaccounted agricultural products for cash in bulk to resellers, whose activities contribute to the development of the shadow economy in agricultural production.
- method of calculating cash turnover and the method of calculating expense coverage are essentially similar and are based on the comparison of indicators. However, due to industry specifics, their application in the study of agricultural producers is not very effective.

4. Corrective indicators. This method is an integral part (element) of the system of methods used for conducting an economic and legal analysis of agricultural producers' activities to identify instances of production (shadow economy) of unaccounted agricultural products. It is based on a comparative analysis of the economic indicators of the results of agricultural enterprises' activities with indicators characterizing the state of the external environment in which they operate. For example, by comparing economic indicators for the costs of conducting agricultural work that do not correspond to the season in which they are carried out, it may indicate the writing off of these costs for work that was not performed with the aim of deliberately underreporting the taxable base and evading taxes. Similar operations related to unjustified cost write-offs can be conducted for the purpose of embezzling material assets — consumables (fuel and lubricants, raw materials, etc.). Through the analysis of corrective indicators, it is easy to establish facts of fictitious registration ("dead souls") of seasonal workers for the purpose of underreporting the taxable base, embezzling funds from the payroll fund, etc. [17–20].

CONCLUSION

The conducted research shows that with the increasing complexity of production and economic ties, the process of assessing the shadow economy and identifying signs of informal production becomes significantly more complicated. Over the past decades, with the development of information technologies, not only has there been an increase in the level of the fight against the shadow economy and timely identification of signs of informal activities in agricultural enterprises, but also the active use of information technologies to evade fiscal control over significant volumes of production activities for the purpose of obtaining unaccounted profits and laundering proceeds obtained through criminal activities. To eliminate these negative phenomena, it is

necessary to develop a comprehensive state program to address the main causes and conditions contributing to the formation of the shadow economy, thereby ensuring food security and national security of the country as a whole.

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Models for Creating Price Politics of a Company Entering the Market for Speech Analytics Technologies

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ABSTRACT

The article is devoted to adapting general mathematical models of the software markets for describing the market of the specific product. These are the technologies of artificial intelligence in speech analytics. The **purpose** of this study is to create a modeling instrumentation for pricing the technologies of speech analytics in companies which enter this market. The purpose also includes recommendations provided with the price politics. The object of the study is the Russian market of speech analytics technologies. The subject of the study are the prices of this product in companies which enter the market being explored. In this studying the authors use classical **methods** of economical and mathematical modeling the markets with different competitive levels (monopoly, duopoly, oligopoly, monopolistic competition). The **results** of the study are the foundations of prices for the companies which enter the speech analytics market. These prices are based on three kinds of economical mathematical models: regression, rating and marginal indicators. All three kinds of models lead to one recommendation. A company which enters the speech analytics market should establish the prices with less orientation to the indictors of analytics' quality. Because in all three models this factor has very weak influence on a result. More important factor are the additional options. Their bigger quantity allows a company to establish a price which is nearer to the same one of the market leaders.

Keywords: artificial intellect; speech analytics technologies; software market; pricing; level of monopolization

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INTRODUCTION

Technologies based on artificial intelligence are currently a central component of all transformational processes in the business of both financial and real production profiles [1, 2, 3]. There are already many research results dedicated specifically to the application process of such technologies. However, the processes of the movement of these technologies as a market product from buyer to seller remain unexplored in the literature. The main quantitative characteristic of any such process is price. This paper presents the results of a study aimed at forming the primary principles of scientifically grounded pricing in the artificial intelligence technology market, using the example of a group that implements speech recognition and speech analytics functions.

The market for speech analytics technologies is developing quite intensively in Russia, which is generally happening within the framework of the currently established trend towards the rapid development of the information and communication infrastructure of the digital economy, increasing its integrity, and a strong focus on the deep qualitative transformation of all business processes [4, 5].

At the same time, the development of the speech analytics technology market is characterized by contradictory trends. On the one hand, in terms of the absolute number of participants, it can be considered highly competitive, as this number currently exceeds 100.[1] But on the other hand, a more detailed immersion into the state of affairs in this market in modern Russia provides an understanding that resources and opportunities among its participants are distributed extremely unevenly: the majority have been "pulled" by no more than five of the largest market players, while almost 100 others share a very small portion of it among themselves. From this, it follows that nothing prevents any new player from starting to capture a certain share of this market, but their actions must be very carefully thought out and scientifically justified to fit into this system, taking into account the already established distribution of roles between its largest players and a large mass of smaller ones. The relevance of this issue for firms striving to become participants in the modern Russian market of speech analytics technologies has determined the goal, objectives, and structure of this study.

The purpose is to develop a pricing recommendation system for speech analytics products for organizations currently entering this market in Russia. Within this purpose, the following tasks have been set:

1. Justify the choice of pricing methods for the considered type of products among the array of similar methods applied to products related to software, innovative, and intellectual products, information about which is available in specialized and scientific literature;

2. Evaluate the current state of prices for speech analytics technologies in the Russian market;

3. Consider an example of using selected pricing methods for an organization entering the market in question, taking into account the existing prices on it.

The paper consists of a description of the methods and materials used during the research, its results in the context of each of the previously set tasks, and the conclusions drawn from the obtained results.

METHODS

During the research, methods developed by three major domestic scientific schools in the field of mathematical modeling of market pricing processes in the context of the formation and development of an innovative, information-knowledge economy were applied: Lomonosov Moscow State University,

[1] Analysis of the speech technology and speech recognition market in Russia. 2021. URL: https://vc.ru/trade/640019-analiz-rynka-rechevyh-tehnologiy-i-raspoznavaniya-rechi-v-rossii (accessed on 28.03.2023).

the Central Economic and Mathematical Institute of the Russian Academy of Sciences, and the Financial University under the Government of the Russian Federation. The information base of the research consisted of data from the official websites of companies that are currently major players in the domestic speech technology market, reports on the financial and economic condition of these companies obtained from the "SPARK-Interfax" information system, and analytical reviews from business portals on the state of affairs in the domestic speech analytics technology market.

RESULTS

Result 1

The current developments in domestic scientific literature in the field of pricing for products in the area of software, information, and intellectual technologies have been analyzed. The analysis led to the following conclusions.

Overall, the issue of pricing for software products in general, and artificial intelligence in particular, cannot be considered sufficiently developed to meet the existing needs of the practicing business community in this field. To be more precise, there are currently no pricing methods specifically designed for artificial intelligence technologies (including those used in speech analytics) in the specialized literature. If we take a broader view — considering software products as a whole — then even here, the number of scientific and practical developments cannot be considered commensurate with the intensity at which this market is currently evolving. We can identify only three research directions in this field that have developed over the past 15 years in three educational and scientific organizations.

At the Central Economic and Mathematical Institute of the Russian Academy of Sciences, V.E. Dementyev and E.V. Ustyuzhanina, along with co-authors, are developing a system of pricing methods for markets of innovative and software products under conditions of high levels of imperfect competition (monopoly, monopsony, duopoly, oligopoly) [6–10]. However, the question of the applicability of the findings from these studies to our issues remains a topic of discussion. Because it is not entirely clear whether the market for speech analytics technologies in Russia can currently be considered a market with a high degree of oligopolization. It seems possible to use models developed in the works of the Central Economics and Mathematics Institute of the Russian Academy of Sciences to describe the behavior of a firm entering the speech analytics market, if we consider the set of already existing firms as a conditional "generalized first duopolist", and the firm in question as a new duopolist challenging it, but careful elaboration of the parameters of such an economic-mathematical model is required.

A fairly extensive study on the issues of software pricing was conducted in the doctoral dissertation of V.I. Soloviev (Financial University) from 2010 [11] and in his subsequent publications, where this research is further developed [12, 13]. However, his practical findings are only oriented towards cases where the firm is introducing a completely new software product to the market, and therefore, the firm's behavior regarding this type of product is modeled as purely monopolistic. For an average company operating in the Russian speech analytics technology market, this approach is generally not applicable, but it should be considered as a potential option in case any participant in the market creates a completely new and unique product and starts promoting it.

During the same period, a comprehensive study on this issue was conducted in the doctoral dissertation and related publications of O.N. Antipina (Moscow State University), which, unlike the two previously described, is oriented towards a more universal picture of the market regardless of the degree of its monopolization. Among the results of this study, the systematization of normative-parametric pricing methods, viewed through

the lens of the peculiarities of the software market (in this paper, they are considered using antivirus software as an example), deserves particular attention. Three methods are identified: specific indicators, regression, and scoring [14–17].

In this paper, these three methods are chosen as the basis for pricing recommendations in the speech analytics technology market. This is because they are characterized, on the one hand, by ease of application, and on the other, by the ability to encompass the entire array of available information about the current pricing situation in the market under consideration.

Result 2

The data on the current state of affairs in the field of pricing for speech analytics technologies in Russia has been systematized. In general, it should be noted that the search for empirical information related to the issue under study, as well as the search for theoretical literary works on it, represents a very complex task.

At the initial stage of the research, a direct search for information on prices offered by major market players on their official websites was conducted. However, a problem was discovered: most of the companies reviewed do not provide detailed explanations of their pricing policies in open access on the internet, instead offering potential clients to get in direct contact to discuss pricing issues on an individual basis. When modeling the purchase situation using the "mystery shopper" method, researchers faced a lack of input data to build a simulation model of an individual typical business representative — a potential system buyer.

Next, an attempt was made to determine the prices of the products of these same companies indirectly, by dividing their annual revenue in rubles by the volume of information in bytes processed according to customer orders during the same period. The calculations of this kind were proposed to be based on data from the largest database in Russia today on the financial and economic condition of legal entities and individual entrepreneurs — SPARK-Interfax. However, the analysis of the business condition reports of the nine companies[2] under consideration obtained from this system also did not yield any significant positive results. It turned out that among the companies reviewed, only the group of companies Speech Technology Center (STC) has all the quantitative data necessary for calculations according to the proposed algorithm — i.e., revenue volumes and processed client traffic information. Among the other eight companies, there is no data on processed client traffic information from previous years at all, and for some of them, there is not even data on financial performance from previous years (which is why, according to its rules, the SPARK system itself has marked these companies with "Suspicious Activity" due to very small turnover volumes according to official reports). The obtained results are due to the historically established features of how Russian business structures provide official reporting to the Federal Tax Service and other authorized bodies (and the SPARK system accumulates information exclusively from such documents). Among the companies examined, only STC is a large business structure. Moreover, it is related to Sberbank of Russia through subsidiary relationships, which is why only its official reporting across all areas of activity is complete and detailed. The other eight firms in the examined sample do not provide their official documentation with the transparency that would allow for a complete picture of their financial and economic condition, including in terms of product pricing.

As a result, the only available and sufficiently informative source of data on the existing pricing practices in the speech

[2] Information and Reference System SPARK-Interfax. 2023. URL: https://spark-interfax.ru/ (accessed on 28.03.2023).

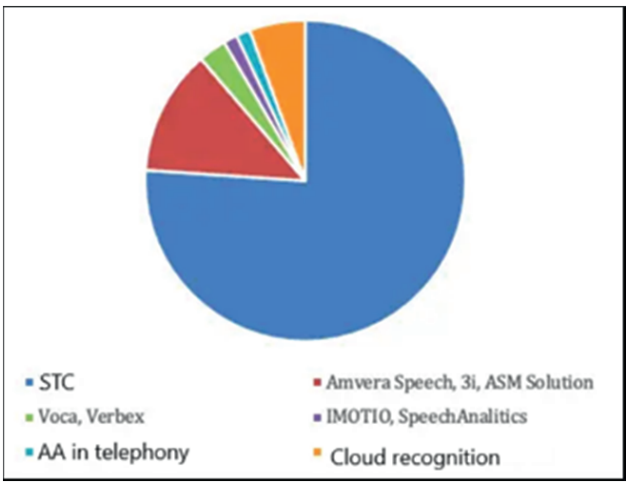

Fig. **Distribution of Incomes between the Leaders of Russian Speech Analytics Market in 2020**

Source: VC net edition. URL: https://vc.ru/trade/640019-analiz-rynka-rechevyh-tehnologiy-i-raspoznavaniya-rechi-v-rossii (accessed on 28.03.2023).

analytics market in Russia turned out to be specialized analytical reports available online. The analysis of websites with such reports led to the selection of four of them as the basis for further research (all other websites, as the content analysis showed, ultimately use data from these same four resources). Among the selected internet resources, the most comprehensive is the report by the online publication *VC*,[3] which is used as the primary source in the study. For additional verification of the results, the study uses data from reports prepared by the information portals *Sales of Artificial Intellect (SalesAI),*[4] *Just Artificial Intellect (Just-AI)*[5] and *It-World.*[6]

First and foremost, the report by the online publication *VC* contains a diagram that provides a complete overview of the power distribution in the domestic speech analytics technology market at present (*Fig.*). The power distribution is presented in the format of company shares in the total revenue earned by this sector in 2020.

The diagram shows that the undisputed market leader is the previously mentioned subsidiary of Sberbank — STC, which accounted for ¾ of the revenue earned in the sector as a whole in 2020. This is consistent with data from another report presented on the *Just-AI* portal,[7] according to which the total revenue in the sector under consideration in 2020 amounted to 3.2 billion rubles, of which 2.7 billion rubles were attributed to STC. In second place on the chart is the share of the company Amvera, and in third place is the cloud technologies from Yandex Cloud. Thus, the presented diagram provides an initial overview of the current top three leaders in the market under consideration.

Next, this choice is confirmed by the analysis of the technical specifications of the products from the companies presented in the *VC* report. The most significant among them is the word error rate (WER), which is the proportion of incorrectly recognized words in their total volume processed over a certain period. This indicator is better the lower it is (*Table 1*). The indicator is calculated separately for analyzing speech over a telephone line and recorded on an audio badge (i.e., noisy speech).

The calculated error percentages are converted into scores from 1 to 5, where a score of 5 is awarded to the company with the lowest error percentage for each type of speech, and a score of 1 to the company with the highest error percentage. As a result, for telephone speech recognition, the highest score is awarded to Yandex, and the lowest

[3] Analysis of the speech technology and speech recognition market in Russia. 2021. URL: https://vc.ru/trade/640019-analiz-rynka-rechevyh-tehnologiy-i-raspoznavaniya-rechi-v-rossii (accessed on 28.03.2023).

[4] Analysis of the Russian Speech Analytics Market. 2022. URL: https://blog.salesai.ru/russian-market-of-ci (accessed on 28.03.2023).

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[7] The market for conversational AI in Russia 2020–2025. The conversational AI market in Russia 2020–2025. Analytics, forecast. Trends. Research Just AI. URL: https://just-ai.com/wp-content/uploads/2021/08/russianmarket2021-justai.pdf (accessed on 28.03.2023).

Table 1

WER Indicators for the Results of Using Speech Analytics Technologies of 5 Market Leaders, %

Company	Yandex	Tinkoff	STC	Google	Amvera Speech
WER for telephone speech	19	22	27	32	24
WER for noisy speech	73	80	56	80	38

Source: Compiled by the authors according to VC. URL: https://vc.ru/trade/640019-analiz-rynka-rechevyh-tehnologiy-i-raspoznavaniya-rechi-v-rossii (accessed on 28.03.2023).

Table 2

Comparing the Technical Characteristics for the Speech Analytics Products of 5 Market Leaders

Company	Yandex	Tinkoff	STC	Google	Amvera Speech
Cloud version	Yes	Yes	Yes	Yes	Yes
The possibility of installation in the circuit	Yes	No	Yes	No	Yes
The ability to adapt the system to the acoustics and linguistics of a specific task	No	No	Yes	No	Yes
The possibility of working on the CPU	No	No	Yes	No	Yes
The possibility of working on a GPU	Yes	Yes	No	No	No

Source: Compiled by the authors according to VC. URL: https://vc.ru/trade/640019-analiz-rynka-rechevyh-tehnologiy-i-raspoznavaniya-rechi-v-rossii (accessed on 28.03.2023).

to Google. For the quality of recognizing noisy speech, Amvera receives the highest score of 5 points, while Tinkoff and Google receive 1 point each. The scores received by the companies for the quality of recognition of both types of speech are summed up, and their final ranking looks as follows:

- Yandex — 8 points;
- Amvera — 8 points;
- STC — 6 points;
- Tinkoff — 5 points;
- Google — 2 points.

The WER indicator is the main one, but not the only one; in addition to it, the five companies considered in the *VC* report are compared based on five other technical characteristics (*Table 2*).

The result is close to the final analysis of the WER indicators. Here, the leaders are CRT and Amvera, who have four out of five indicators in the "green zone", with Yandex slightly trailing behind with three green indicators. That is, in the end, the top three leaders remain the same as with the WER indicator. And Google and Tinkoff once again end up as outsiders.

Thus, the conducted analysis of the technical characteristics of speech analytics products confirmed the previously formulated decision to use data on the three leading market players — STC, Amvera, and Yandex — as the basis for modeling in further research.

Here in the *VC* report, data is provided to calculate the average price of their services in

Table 3

Data for Calculating the Price of the Speech Analytics Product According to the Method of Regression

Company	Price (P), ₽	Word error rate (WER), score	Additional options (AO), score
Яндекс	0.60	8	3
STC	1.20	6	4
Amvera	1.25	8	4

Source: Compiled by the authors.

rubles per minute of recognized conversation time. For STC and Yandex, the report provides rates in rubles per stream; the authors of the report define a stream as 50 000 minutes of speech per month. For STC, the monthly price for the stream is 60 000 rubles, for Yandex it is half that, i.e., for the first company the price per minute is 1.2 rubles, for the second it is 0.6 rubles. A slightly more challenging task was calculating the cost of 1 minute for the Amvera. According to the *VC* report, clients of this company can use two payment options for services. When using the "in contour" version of the product, the client pays 1.9 million rubles per year for 12 streams per year, each stream, as mentioned earlier, is considered equal to 50 000 minutes. However, the company also "gifts" the client an additional 3 000 minutes each month and 300 minutes each day. Thus, for the aforementioned amount, the client receives a total number of minutes per year equal to 12 * 53,000 + 300 * * 365 = 769 500 minutes. Then the price per minute is 1900 / 769.5 = 2.47 rubles. When using the cloud version, the client pays 24,000 rubles per year, and then the price per minute is 24 / 769.5 = 0.03 rubles. If we assume that among the company's clients there are approximately equal numbers of users of the cloud and "contour" versions, then the average price of services at Amvera is equal to the arithmetic mean of the two obtained prices and amounts to 1.25 rubles per minute. The result seems plausible, as it is close to the corresponding indicator of the STC company, whose product has similar technical characteristics to those of Amvera's product from *Table 2*, and even surpasses it in terms of the WER indicator. Thus, the conclusion from the analysis of the pricing policies of the three leading market players is as follows:

- Yandex — 0.6 rubles/min.;
- STC — 1.2 rubles/min.;
- Amvera — 1.25 rubles/min.

These results, calculated based on the *VC* report data, are consistent with the data from the *SalesAI* and *It-World* reports, where such detailed indicators as in the VC report are not provided. But on the *SalesAI* portal, the standard range for the price of speech recognition services is given as 0.45 to 1.5 rubles/min, while on the *It-World* portal, the average value of such a price in the modern Russian market is indicated as 0.98 rubles/min. Thus, the calculated prices of the product under consideration for the three selected companies for analysis are taken as the basis for building mathematical pricing models, which are proposed for use by new firms entering this market.

Result 3

The third result essentially integrates the two previous ones. The methods chosen in obtaining result 1 are used to build prices based on the data obtained during the process of obtaining result 2.

Table 4

Data for Calculating the Price of a New Company's Product According to the Method of Rating if a Speech Analytics Product has 4 from 5 Additional Options

Company	Price (P), ₽	Word error rate (WER), score		Additional options (AO), score	
		Score	Weight	Score	Weight
Company base for comparison	1.22	7	0.5	4	0.5
New company	P	6	0.5	4	0.5

Source: Compiled by the authors.

Table 5

Data for Calculating the Price of a New Company's Product According to the Method of Rating if a Speech Analytics Product has 3 from 5 Additional Options

Company	Price (P), ₽	Word error rate (WER), score		Additional options (AO), score	
		Score	Weight	Score	Weight
Company base for comparison	0.6	8	0.5	3	0.5
New company	P	6	0.5	3	0.5

Source: Compiled by the authors.

The regression method consists of constructing an equation that establishes the dependence of the product price *P* on a number of factors, with the number of factors needing to be one less than the number of companies being considered. Because otherwise, the system of equations constructed to calculate the constant coefficients of the derived mathematical model will not have a solution. To achieve this, within the framework of the present study, the other options presented in *Table 2* are combined into a single factor, rated on a scale from 1 to 5, based on the number of indicators that each company falls into the green zone. Thus, STC and Amvera each receive 4 points for this indicator, while Yandex receives 3 points. The initial data for constructing the regression model is presented in *Table 3*.

Thus, the sought regression coefficients are found from the system of equations:

$$\begin{cases} 0.6 = a*8 + b*3 + c \\ 1.2 = a*6 + b*4 + c \\ 1.25 = a*8 + b*4 + c \end{cases}$$

We obtained a system of three equations with three unknowns (that's why the number of factors must be less than the number of companies considered) and using the MS Excel function "Data Analysis — Regression" we find the coefficients of the mathematical model:

$$P = 0.025 * WER + 0.65 * AO - 1.55.$$

The resulting model provides a basis for calculating the price of a similar product for a new company entering the market in question. Let's consider a hypothetical company whose recognition quality for both phone and noisy speech is rated at 3 points (the average of

Table 6

Data for Calculating the Price of a New Company's Product According to the Method of Marginal Indicators

Company	Price (P), ₽	Additional options (AO), score	Marginal price per 1 score
Yandex	0.60	3	0.20
STC	1.20	4	0.30
Amvera	1.25	4	0.31
Average unit price per point for additional options evaluation			0.27

Source: Compiled by the authors.

Table 7

Resulting Table of the Prices Accounted According to All the Three Methods

Method	New company's product has 4 of 5 additional options	New company's product has 3 of 5 additional options
Regression	1.20	0.55
Scoring	1.11	0.50
Specific indicators	1.10	0.80
Price averaged across all three methods	1.14	0.62

Source: Compiled by the authors.

possible options). Thus, in total, it has a WER score of 6 points. As for the other options, two scenarios should be considered here. In the first scenario, the new company can offer customers four out of five possible additional options, then it can set the price of its product at P = 0.025 * 6 + 0.65 * 4–1.55 = 1.2 rubles per minute. That is, it can afford to set a price at the level of market-leading companies, but it should be set at the lowest of the two possible leader price options, since the company is still new to the market. In the second scenario, if the company can offer clients only three out of five possible options, its price will be P = 0.025 * * 6 + 0.65 * 3–1.55 = 0.55 rubles per minute. That is, its price in this case should be lower than the lowest of the three considered during the model construction.

The scoring method, unlike the regression method, is based on the fact that the price of a product from a new company is evaluated based on not several, but only one basis for comparison. And here, just like in the case of regression, two scenarios for the company's product parameters should be considered. If the new company has a speech recognition quality level of 6 points and can offer customers four out of five possible additional options, then the conditional company, "averaged" from STC and Amvera, should be considered as its benchmark for comparison. The data for calculating the price of the new company using the point method in the first scenario is presented in *Table 4*.

In the case of the scoring method, unlike the regression method, the multipliers for scoring

factor evaluations are not coefficients calculated by special algorithms, but weights determined by a competent team of experts based on personal knowledge and experience. In this case, the expert group identified two factors as equally influencing the formation of the product price. The sought value — the price of the product from a new company entering the market — is calculated using the "cross" rule of proportion:

$$P = 1.22 * \frac{(6*0.5+4*0.5)}{(7*0.5+4*0.5)} = 1.11 \text{ rubles/min.}$$

In the second of the possible scenarios, the product of the new company is similar in characteristics to the analogous product of Yandex, and here it serves as a basis for comparison (*Table 5*).

The price of the product in this case:

$$P = 0.6 * \frac{(6*0.5+3*0.5)}{(8*0.5+3*0.5)} = 0.5 \text{ rubles / min.}$$

The method of specific indicators is similar to the regression method in that it takes into account data from all other companies included in the analysis, but only one factor, evaluated in points, is considered in the calculations. In this study, the factor of additional options was chosen, as calculations based on the previous two methods showed that it contributes more significantly to the differences in pricing under various product operation scenarios in the new company. The calculations using this method are presented in *Table 6*.

Let's also consider two options for additional features of the product from the new company entering the market. If it offers its clients four out of five additional features, its price will be 4*0.27 = 1.10 rubles per minute of recognizable speech. With three out of five features available, the price will be 3*0.27 = 0.80 rubles per minute.

The results of the calculations using all three methods under both possible scenarios are summarized in *Table 7*. The last row of the table shows the average price for each option of having additional features in the developed software product.

CONCLUSION

The presented calculations form the basis of recommendations regarding the price range for speech analytics technology for an organization entering this market in Russia at the current time. Further research directions are planned to be linked to the following issues:

1. Consider pricing options for a specific company with precisely measured WER values for telephone and noisy speech.
2. Consider the possibility of modeling the price of speech analytics technology for a company entering the market, if the other companies are considered as a single hypothetical duopolist according to the methodology of V. E. Dementyev and E.V. Ustyuzhanina,
3. Consider models for pricing speech analytics technologies with unique properties, such that the company implementing such a product can be regarded as a monopolist.

At this stage of the research work, the tasks set have been solved, and the goal has been achieved.

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Impact of Working Capital on Corporate Performance: Evidence from India

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ABSTRACT

The subject of this study is to empirically investigate the relationship between working capital and firm performance in India. **The purpose of the study** is to test the impact of optimal working capital on a firm's market value and profitability. **Methodology:** The Generalised Method of Movement is employed to study the impact of working capital on a firm's performance, measured as Return on Capital Employed and Enterprise Value to Sales. **The results** indicate a U-shape relationship between RoCE and the working capital component. On the contrary, the inventory turnover ratio has an inverted U-shape relationship with the market value of the firm. **This study concludes** that tight inventory management adds value at the initial stage, but strict inventory control erodes market value. **The findings** of the study support the optimum level of inventories to increase the firm's performance, both in accounting terms and market value.
Keywords: GMM Method; working capital; nonlinear relationship; Enterprise value to sales

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INTRODUCTION

Efficient Working Capital Management (WCM) is vital for seamless business operations. A significant portion of a company's assets, such as inventories and account receivables, lies in current assets [1]. Accounts payable serves as a key financing source. Effective WCM yields competitive advantages. There are two perspectives on working capital management. On one hand, boosting inventory to meet demand, adopting a liberal credit policy to enhance sales, and timely supplier payments for discounts enhance profitability — known as a conservative WCM approach [2]. Conversely, excessive stock mitigates disruptions, ensures timely supply, cuts transportation costs, and stabilizes raw material prices [3]. However, surplus working capital inflates financing costs, bankruptcy risks [4], and underwhelming returns on investment [5].

Conversely, the aggressive working capital policy aims to minimize inventories and enforce a strict credit policy for shareholder value. Just-In-Time (JIT) theory redirects excess stock investment for higher returns [6]. A stricter credit policy can reduce bad debt and boost profits [7]. Large firms manage working capital better than small ones due to skilled managers and advanced methods [8]. However, tight policies may halt production if delivery is delayed [9], causing sales loss and competitor takeover. A strict credit approach might hinder new customer acquisition due to info gaps [10] and ignore trade credit's sales benefits [1]. Low working capital hurts profitability.

Working capital is a two-edged sword, offering costs and benefits, with an optimal level for max gains. Literature usually explores linear links between working capital and profit [11–15], but [9, 16] found nonlinearity. N. Altaf and F.A. Shah [1] revealed a U-shaped link via quadratic equations, while [17] identified shifting optima based on operations and leverage.

However, [18, 19] explored working capital's influence on market value. But only a few studies attempted to investigate the nonlinear relationship between working capital and firm's market value. To capture the non-linear relation, we used Enterprise Value to Sales (EV/S) ratio as firm's performance metric and studied its nonlinear link with the working capital components. On the other side, [20, 21] found economic shifts affect working capital and profit. Downturns elevate working capital through higher inventory, delayed receivables, and reduced payables [22]. Hence, economy's state matters for optimal working capital and profitability. In this study, GDP growth rate

is added to capture the impact of economy's state on firm performance.

The prior research demonstrates a mixed association between working capital and company performance. Furthermore, working capital policies are vulnerable to regular adjustments, with the potential for reversible choices over time [23, 24]. As a result, the purpose of this research aims to examine the link between WCM and firm performance to provide valuable information for different stakeholders. It specifically assists investors in identifying the finest firm for investment. Policymakers may develop working capital policies based on the company's prior performance and industry trends. Scholars may be fascinated by the long-term success or failure of the firm's working capital policy.

In this context, earlier studies employed accounting indicators as a proxy for business performance while ignoring the market reaction to the firm's working capital strategy. Therefore, the purpose of this research is to assess the influence of working capital policy on the financial performance of the business, proxied by RoCE, as well as the market performance of the firm, proxied by EV/S.

This study comprises five sections. The current one is the first. The second section reviews previous literature on working capital management. The third section covers data and methods. Part four presents' findings, and section five offers recommendations and conclusions.

REVIEW OF LITERATURE

Earlier research categorizes working capital into conservative, aggressive, and optimal policies. Prior literature strongly links working capital with firm profitability [15]. A. K. Sharma, S. Kumar and O. O. Akinlo [7, 11] advocated for an extended CCC time to take advantage of strong sales and profit growth. A. A. Moussa [19] discovered a positive association between working capital and company performance, especially evaluated using Return on Assets (RoA) and Q. Tobin's, A. Raheman and M. Nasr [5] discovered that inventories and accounts receivable had a positive association with company performance, but M. Deloof and A.M.A. Eljelly [2, 25] discovered a positive link between firm profitability and account payables. R. Kieschnick et al. [4] investigated the link between working capital and shareholder wealth in US corporations and found that credit sales offered more value to the investor than inventory investment. Furthermore, they discovered that for the typical business, a dollar invested in net operational working capital underperforms a dollar kept in cash.

A.M.A. Eljelly, I. Lazaridis and D. Tryfonidis, T. Ren et al [25–27] discovered evidence in favour of aggressive working capital. P. Juan García-Teruel and P. Martínez-Solano [3] discovered that Small and Medium Enterprise (SME) managers in Spain may gain value by reducing inventory investment and collecting accounts receivable quickly. C.C. Chang [28] studied the association between CCC and company performance from 1994 to 2011, utilising 31,612 firms from 46 countries. He used pooled ordinary least squares regression to discover a negative association between CCC and corporate profitability. In the Indian context, S. Bhatia and A. Srivastava [12] discovered the negative relationship between profitability and working capital. He contended that adopting a stringent credit policy would restrict the deployment of cash in working capital due to the cheap cost of financial borrowings and inventory upkeep. This may greatly assist the corporation in pocketing profit by reducing working capital expenditures. S.G. Mun and S.C.S. Jang [29] investigated the working capital and profitability of restaurant businesses in the United States. They used the Generalized Method of Moments model (GMM) and found working capital had a detrimental impact on the firm's performance. J. Enqvist et al. [20] found that, regardless of the economic condition, the accounts payable period is not strongly connected with a firm's performance. P. Juan García-Teruel and P. Martínez-Solano [3] discovered a negative association between ROA and accounts receivable for MSME enterprises in Spain. I. Soukhakian et al. [30] discovered in Iran that the CCC is adversely associated with return on assets. Using a panel data model, K. Akoto [31] discovered a negative link between profitability and working capital in Ghana. S. Bhatia and A. Srivastava [12] discovered a negative association between company profitability and debtors' collection period in an Indian environment using a sample of publicly listed firms. This study output supports the firm's cautious working capital to boost its profitability.

Few researchers, however, tried to identify a non-linear link between company performance and working capital policy (WCP) by considering the cost and benefit of working capital policy. Notably, using the GMM model, S. Baños-Caballero et al. [9] discovered an inverted

U-shaped link between WCP and performance in the UK. Because there is a nonlinear link between working capital and business profitability, N. Altaf and F.A. Shah [1] advocate optimal working capital to Indian firms for improved performance. M. Singhania and P. Mehta [16] investigated the influence of working capital management on profitability in Asian countries using the two-step generalised technique of moments and discovered a non-linear link between firm profitability and WCM for 11 Asia Pacific nations. A.K. Panda and S. Nanda [32] discovered a convex link between working capital and profitability in the chemical, construction, and consumer goods sectors from an Indian viewpoint. The machinery, metal, and textile sectors, on the other hand, exhibited an inverted U-shape connection between working capital and profitability for Indian enterprises. L. Rey-Ares et al. [33] used dynamic panel data techniques to support the optimal level of inventory and accounts receivable for higher profitability in 377 Spanish fish canning firms. They discovered a convex link between Spanish fish canning firms' working capital and profitability. V. Tauringana and G. Adjapong Afrifa [34] discovered that inventory and CCC had little effect on profitability.

There is conflicting empirical evidence about the ideal link between working capital components and profitability. A.K. Panda and S. Nanda [32] discovered, for example, that the optimal amount of working capital varies by industry. The convex link between inventory and profitability of Spanish fish canning enterprises was discovered by [33]. On the other hand, for Ghanaian SMEs [35] and Spanish fish canning enterprises [33], an inverse U-shaped association between the receivables collection period and corporate profitability was found. T. Ren et al. [27] discovered a negative association between CCC and profitability for non-state-owned enterprises in China.

Prior research confirms working capital's diverse impact on business performance. Optimal working capital management adds value and boosts profitability [36]. However, companies with higher earnings pay suppliers promptly and extend consumer credit; unprofitable firms delay payments and reduce credit sales [37]. J. Enqvist et al. [20] discovered that the importance of WCP varies depending on the time of the economic cycle, industry, and nation in which it operates. As a result, the natural influence of WCP on profitability is dynamic, necessitating constant study on the subject.

This study establishes and assesses the following hypotheses drawn from literature:

1. Working capital lacks substantial influence on company performance, measured via RoCE and Enterprise Value to Sales.
2. Firm-specific factors (size, asset turnover, short-term liquidity, long-term financial leverage) have no notable impact on company performance.
3. Macroeconomic conditions do not affect firm performance.

DATA AND METHODOLOGY

The sample firms were chosen from the BSE 100 index (2009–2019), excluding 18 banks/financial institutions and 11 firms excluded due to data constraints. Ultimately, 71 firms with 710 yearly data comprised the sample. Firm-specific indicators were obtained from trendlyne.com and cross-verified 30% with respective firm's annual reports. GDP growth rate data was from Reserve Bank of India.

The sample is a balanced short panel dataset (71 firms, 10 years), suitable for panel data models like OLS, FEM, and REM [38]. Yet, OLS ignores time, while FEM/REM don't address delayed dependent variables. Hence, to handle endogeneity, a generalized method of moments (GMM) is employed.

Working capital variables with quadratic forms were used by [1, 9] to highlight the nonlinear relationship between working capital and profitability. Accordingly, the following equations were used to tests the hypotheses in this study:

$$ROCE_{it} = \beta_0 + \sum_{i=1}^{4} \beta_i \gamma_{it} + \beta_5 \delta_{it} + \beta_6 \delta_{it}^2 + \beta_7 GDPGR_t + \varepsilon_{it}, \quad (1)$$

$$EV / S_{it} = \beta_0 + \sum_{i=1}^{4} \beta_i \gamma_{it} + \beta_5 \delta_{it} + \beta_6 \delta_{it}^2 + \beta_7 GDPGR_t + \varepsilon_{it}, \quad (2)$$

where $ROCE_{it}$ refers to the Return on Capital Employed for the firm i at t time. EV / S_{it} stand s the Enterprise Value to sales of the firm i at time t; β_0 is the intercept of the model. β_1 to β_7 indicate the coefficients of the respective explanatory variables. γ_{it} refers to the selected firm-specific variables namely, current ratio (CR), Debt- Equity Ratio (DER), size of the firm, Assets turnover Ratio (S/TA). δ_{it} represents the components of working capital, i.e., Debtors Turnover Days (DTD), Inventory Turnover Days (ITD), Creditors Turnover

Days (CTD), and Cash Conversion Cycle (CCC). Gross Domestic Product Growth Rate (GDPGR) refers to the GDP growth rate of India at time t. ε_{it} is the error term off model.

RELATIONSHIP BETWEEN FIRM PERFORMANCE AND WORKING CAPITAL COMPONENTS

Return on Capital Employed (RoCE)

Previous research used ROE to gauge working capital's effect on firm profitability [14]. However, ROE omits borrowed capital; hence, [7] replaced it with return on assets and [11] noted excessive fixed or working capital investment may affect ROA. Moreover, developing nations rely heavily on current assets and trade credit [1]. Thus, RoCE is preferred over ROE and ROA to fully assess profitability generated by the firm from the capital invested in.

Enterprise Value to Sales (EV/S)

EV/S ratio gauges a firm's market value against annual sales. It combines stock and debt market values, minus cash, and investments. Given India's inactive debt market, we used the book value of debt, as market value doesn't affect financial liability on debt. Rising EV/S multiples signify investor's willingness to pay a premium price, while falling ones suggest insufficient value relative to sales of the firm.

Inventory Turnover Days (ITD)

Inventory decisions are complex due to costs and benefits associated with them. Hence, crafting an inventory strategy requires caution to balance the costs and benefits. The inventory turnover ratio shows sales speed. Fewer days imply faster sales, while more days indicate tied-up investments in working capital. Conservative management backs substantial investment in stocks to have smooth production and to meet the demand timely, but this comes with storage costs rising. Hence, the advantage of investment in stock gets countered by costs.

Debtors Turnover Days (DTD)

Debtor turnover days indicate cash collection speed, efficient recovery matters more than sales growth. Falling sales days with expanding debtor days signal poor credit management. Liberal credit may boost sales, profits, but extends credit-to-cash gap. This leads to cash shortage, harming operations [9]. Liberal policy correlates with higher bad debt from riskier customers [39]. Shorter collection means stronger debt recovery or market clout, pressuring timely payments. Conversely, abundant credit can boost sales as an incentive and grants time to the customers to assess goods and aid in tackling the competition and market share [1].

Creditors Turnover Days (CTD)

Creditors Turnover Day (CTD) represents days to settle a credit purchase. Longer repayment boosts profits by lowering transaction costs, enabling goods inspection, utilizing cash to extend the credit sales, maintaining inventory, and gaining liquidity from creditors [12, 15].

On the contrary, elongating creditor repayment duration may harm liquidity, increase borrowing costs, tamper with creditworthiness, and eventually decrease profits [2, 7].

Cash Conversion Cycle (CCC)

The Cash Conversion Cycle (CCC) describes the time taken to convert cash into inventory and then back into cash [25]. Despite its high prices, trade credit is a prominent financing alternative in the developing market. Several studies have shown that the CCC has influence on a company's performance [25, 26, 40]. These findings endorsed an active working capital strategy, stressing benefits of reduced trade credit, improved debt collection, and lower working capital expenses.

Contrarily, A.K. Sharma, S. Kumar [7] propose conservative working capital management for higher profits. Deloof M. [2] asserts longer CCC boosts earnings via more credit sales, streamlined production, and timely payment discounts. A. Bhunia and A. Das, B. Chaklader [41, 42] all found evidence supporting this viewpoint. These results, in contrast to earlier results, support the costs and advantages of working capital.

Current Ratio (CR)

The current ratio captures the short-term liquidity of a company. A higher ratio commits more assets for short-term needs, which comes with opportunity cost. On the other hand, low deployment in current assets affects short-term liquidity and overall profit.

The company that can earn more cash sales and get credit from its suppliers may manage its short-term liquidity without putting more money in current assets. R.M. Yunos et al. [43] underlines the need of effective

management of current assets and current liabilities to generate a profit while maintaining short-term liquidity.

Debt Equity Ratio (DER)

The debt-equity ratio indicates the proportion of a company's financing that comes from debt compared to equity. A ratio of more than one suggests greater reliance on debt for funding. In this case, if gain from debt fund exceeds its cost, equity holder profits more. However, over reliance on debt financing damages profitability when firm fails to meet its debt obligation. As a result, we anticipate that business performance will be favourably or adversely related to the debt-equity ratio.

Size

The size of the firm is proxied with the logarithm of the revenues. Companies with bigger market share, more resources and economies of scale used to outsell their smaller competitors. As a result, large firms often make big profits. J. Lee [44] gives empirical evidence in support of the idea that a company's size contributes to its performance.

Sale/Total Assets

Sales to total assets is a measure of a company's efficiency in generating revenue from its resources. The company's bottom line will gain more in the long run when the assets are effectively utilised. As a result, we estimate that the sales to assets ratio will boost the company's performance.

GDP Growth Rate

The rate of growth in gross domestic product is a widely used indicator for assessing economic health. Increasing GDP growth rates indicate a broad trend of rising consumer demand because of robust economic progress. Alternatively, if the GDP growth rate falls, we may expect weak economic activity in the country and, as a result, low sales for the firm. An increase in GDP has a positive impact on a company's financial metrics and a more optimistic outlook for its stock price [11]. As a result, a positive link between business success and GDP growth is expected.

Based on the theoretical concepts discussed, the expected empirical relationship between firm performance and explanatory variables is presented in *Table 1*.

RESULTS AND DISCUSSION

The variables used for the research were originally evaluated using univariate statistics. The mean, standard deviation, skewness, kurtosis, minimum and maximum values for business performance, working capital indicators, and macroeconomic factor are reported in *Table 2*. The comparatively low standard deviation for the specified variable implies that the data is consistent. The positive skewness, on the other hand, suggests that the series has a lengthy right tail. This might be because WCP varies from industry to industry [13]. Further examination of Kurtosis showed that RoCE, EV/S, ITD, CCC, CR, and ATR were leptokurtic (peaked) as the Kurtosis vales exceeded three.

The correlation between the variables is shown in *Table 3*. RoCE, an accounting ratio-based performance measure, inversely relates to working capital elements, implying profit rise through reduced working capital. This contrasts market response as EVS positively relates to ITR and CCC, hinting investors favor high CCC and substantial inventory stocks.

Conversely, a notably strong positive correlation (0.938) between CCC and inventory turnover days implies significant inventory influence on working capital. A negligible negative link between CCC and creditors turnover days indicates larger enterprises can manage capital with less supplier reliance. Furthermore, the correlation coefficient between the independent variables chosen was less than 0.80. This demonstrates that multicollinearity is unlikely to be an issue [38]. Variance Inflation Factor (VIF) analysis confirmed this, with chosen variables having VIF below 1.491, well under the thresholds of 10. As a result, multicollinearity is unlikely to be an issue.

Table 4 presents the results of the two-step GMM model as per equation (1). The Saragan test yields an insignificant p-value, indicating no link between instrument variables and error term. Likewise, an insignificant p-value for second-order serial correlation dismisses such correlation. The U-shaped trend is confirmed by negative ITD and CCC coefficients, and positive coefficients for their squares. Also, CTD's negative coefficient, with positive but insignificant squared variables, implies shorter payable time boosts earnings and is consistent with the results of [3, 7, 26]. Quick payment to creditors helps to get cash discounts and improves credit scores. Large firms meet short-term obligations promptly due to ample resources

Table 1

Expected Relationship between Firm Performance and Explanatory Variables

Variable	Equations	Expected Relationship
Firm Performance		
RoCE	$\frac{Earnings\ Before\ Interest\ and\ Tax}{Equity\ Capital + Debt\ Fund}$	
EV/S	$\frac{Market\ value\ of\ Equity + Book\ Value\ of\ Debt - Cash}{Net\ Sales}$	
Working Capital Components		
DTD	$\frac{Accounts\ Receivables}{Sales} \times 365$	+/–
ITD	$\frac{Average\ Inventory}{Cost\ of\ Goods\ Sold} \times 365$	+/–
CTD	$\frac{Accounts\ Payables}{Cost\ of\ Sales} \times 365$	+/–
CCC	$CCC_{it} = ITD_{it} + DTD_{it} - CTD_{it}$	+/–
Firm Specific Variable		
CR	$\frac{Current\ Assets}{Current\ Liabilities}$	+/–
DER	$\frac{Long\ Term\ Debt}{Equity\ Sharholders\ Funds}$	+/–
SIZE	Log(sales)	+
ATR	$\frac{Sales}{Total\ Assets}$	+
Macroeconomic Variable		
GDP	GDP growth rate	+

Source: Compiled by the authors.

[45]. Negatively significant CR and DER coefficients confirm the impact on RoCE inversely, implying liquidity reduction and long-term debt trimming increase profitability. Conversely, positive correlation between the Assets Turnover Ratio (ATR) and GDP growth signals more turnover and rising economic activity enhance return on capital employed. Size positively influences profitability, albeit not statistically significant.

Table 5 presents two-step GMM estimate outcomes as per equation (2). Insignificant Sargan test p-value and second-order (D 2) serial correlation reveal lack of correlation between instruments and error term, and second-order serial correlation, respectively. One period lagged EV/S significantly impacts firm valuation. Absence of direct availability of CCC in the financial statement renders it insignificant for market value. Conversely, inventory turnover days, debt collection period, and creditors payment period affect market value, as these metrics are readily available for investors' access. Thus, readily accessible financial data influences share price. Whereas to get CCC needs extra efforts and eventually has the least impact on enterprise value. This indicates that how a business manages components of working capital has an impact on the firm's market value.

Table 2

Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Skewness	Kurtosis	Min	Max
ROCE	710	23.20	17.30	2.42	8.73	−0.25	126.63
EV/S	710	3.58	2.74	1.57	3.81	0.2	19.3
DTD	710	43.77	34.21	0.93	0.39	1.52	193.09
ITD	710	62.27	109.43	7.27	61.16	0	1216.67
CTD	710	60.31	35.87	1.24	2.03	0.36	221.28
CCC	710	45.73	114.46	5.60	43.15	−186.33	1176.92
CR	710	1.66	0.96	2.01	5.94	0.3	7.5
DER	710	0.55	0.68	1.58	2.24	0	3.4
SIZE	710	9.76	1.43	0.30	−0.36	5.86	13.32
ATR	710	141.64	368.37	9.36	93.27	10.62	4720
GDP	710	5.01	4.50	−2.32	4.06	−7.97	8.26

Source: Compiled by the authors.

Table 3

Correlation between Selected Variables

Variable	ROCE	EVS	DTD	ITD	CTD	CCC	CR	DER	Size	ATR	GDP
ROCE	1										
EVS	.277*	1									
DTD	−.186*	0.012	1								
ITD	−.093*	.098*	.153*	1							
CTD	−.118*	−0.014	.358*	.204*	1						
CCC	−.108*	.102*	.333*	.938*	−0.012	1					
CR	.092*	.285*	.240*	0.072	−.250*	.219*	1				
DER	−.408*	−.231*	0.003	−0.028	.228*	−.097*	−.452*	1			
Size	−.252*	−.486*	−.173*	−.117*	−0.032	−.153*	−.237*	.370*	1		
ATR	0.025	.281*	0.044	−.080*	0.004	−0.064	−0.056	.131*	−.091*	1	
GDP	.081*	−0.007	0.007	−0.014	−0.007	−0.009	0.002	−0.001	−.085*	−0.001	1

Source: Compiled by the authors.

Note: * denote 5 per cent level of significant.

Moreover, both inventory turnover days and creditors' payment days exhibited positive coefficients, indicating that higher inventory and delayed creditor payments signal positively to investors. Conversely, the negative significance of CTD's coefficient suggests prompt debt collection is favorably perceived by Indian investors. Notably, squared ITD and DTR coefficients imply optimal values. Surpassing ideal inventory levels negatively impacts the market value, while stricter credit policies above the optimum level dampen firm value.

When utilizing DTD and CCC as proxies for working capital, the current ratio demonstrates an adverse significance. A negative current ratio implies investor favor for reduced current asset investment, relying on trade credit as funding. This perspective gains further support in model 3, where credit turnover days negatively relate to enterprise value. Insignificant debt-equity ratio

Table 4

Result of Two-step GMM (Dependent Variable ROCE)

Model	(1)		(2)		(3)		(4)	
Variable	Coeff	z-stat	Coeff	z-stat	Coeff	z-stat	Coeff	z-stat
ROCEt – 1	0.687	35.17*	0.704	34.36*	0.672	32.38*	0.7208	38.21*
ITD	–0.088	–5.21*						
ITD^2	4.6E-05	4.58*						
DTD			–0.050	–0.94				
DTD^2			–3.6E-04	–1.28				
CTD					–0.083	–2.29*		
CTD^2					1.12E-04	0.51		
CCC							–0.043	–4.46*
CCC^2							2E-05	3.81*
CR	–3.814	–9.12*	–3.547	–9.49*	–3.873	–8.99*	–3.319	–7.76*
DER	–1.445	–3.04*	–1.206	–2.02*	–1.819	–3.4*	–1.323	–2.48*
Size	0.517	1.18	1.283	2.47*	1.470	3.29*	0.708	1.36
ATR	0.002	2.96*	0.004	5.79*	0.004	4.02*	0.002	3.61*
GDP	0.157	9.47*	0.190	8.8*	0.186	8.43*	0.167	9.00*
Cons	11.543	2.76*	1.325	0.27	2.219	0.49	5.047	1.03
Sar –Chi^2	39.231	0.286#	41.039	0.223#	42.745	0.173#	40.415	0.243#
D 2 –Z Value	0.815	0.415#	0.879	0.380#	0.720	0.472#	0.833	0.405#

Source: Compiled by the authors.

Note: * and ** denote 1per cent and 5 per cent level of significant, respectively. # Denote the p-value. $ROCE_{t-1}$ is the return on capital employed with one time lagged. Sar is the Sargan test for overidentifying restrictions distributed asymptotically under the null hypothesis of validity of instruments. D_2 refer to the serial correlation of second order using the residuals of first difference. The dependent variable is RoCE.

suggests minor leverage influence on value, indicating established enterprises handle debt well even during downturns. Debt composition lacks impact on market value. Conversely, a notable positive coefficient for size signifies larger size elevates market value. Favorable correlation of the Assets Turnover Ratio (ATR) with enterprise value affirms effective asset utilization for shareholder wealth creation [46]. Macroeconomic factors, like GDP growth rate, wield significant influence on Indian market value. Heightened GDP growth attracts global equity investors, driving greater investment, ultimately elevating market value.

CONCLUSION

This study examined the impact of working capital management on business performance using a dataset encompassing 71 firms over the period from 2009 to 2019. Results indicate a U-shaped relationship between working capital and firm performance, as gauged by RoCE. Thus, early-stage profit enhancement is probable through reduced initial working capital expenditure. However, surpassing the optimal threshold leads to negative performance effects. Conversely, the inverted U-shaped association between EV/S and ITD demonstrates initial inventory growth attracts

Table 5

Result of Two-step GMM (Dependent Variable EV/S)

Model	(1)		(2)		(3)		(4)	
Variable	Coeff	z-stat	Coeff	z-stat	Coeff	z-stat	Coeff	z-stat
EV/S –1	0.3108	17.58*	0.2920	16.71*	2.49E-01	13.51*	0.3097	18.27*
ITD	0.0077	4.31*						
ITD^2	–1.63E-06	–1.71**						
DTD			–0.0349	–5.44*				
DTD^2			0.0002	6.46*				
CTD					0.016	3.22*		
CTD^2					–4.55E-05	–1.58		
CCC							0.0020	1.23
CCC^2							1.52E-06	1.7**
CR	–0.0672	–1.56	–0.0911	–2.51**	–0.0211	–0.47	–0.1053	–2.54**
DER	0.0516	0.76	–0.1047	–1.13	0.0567	0.95	0.0832	1.32
Size	0.3995	4.8*	0.5307	4.11*	0.4660	4.82*	0.3061	3.14*
ATR	0.0013	40.75*	0.0015	33.87*	0.0014	36.42*	0.0014	43.09*
GDP	0.0259	6.43*	0.0228	5.89*	0.0195	4.67*	0.0256	6.59*
Cons	–2.39	–2.92*	–2.0031	–1.52	–3.1284	–3.19*	–1.0794	–1.16
Sar -Chi^2	41.013	0.224#	43.553	0.152#	42.801	0.171#	41.583	0.206#
D 2 -Z Value	–0.775	0.439#	–0.808	0.419#	–0.567	0.571#	–0.611	0.541#

Source: Compiled by the authors.

Note: * and ** denote 1per cent and 5 per cent level of significant, respectively. # Denote the p-value.

investors, reflecting early-stage capacity expansion. Yet, crossing the optimal threshold and excessive inventory hints at sales inefficiency, prompting investor disinterest. In essence, adopting a conservative working capital approach initially boosts firm market value, but subsequent decline follows post-optimal levels of working capital.

Our research carries practical implications as follows: Firstly, it recommends maintaining an optimal inventory quantity to optimize both accounting profit and market value. Secondly, it reveals that readily accessible data from financial reports like DTD, CTD, etc., significantly influences market value compared to not readily available information like CCC. Therefore, our study proposes that accounting regulatory bodies advise companies to incorporate essential data, otherwise not directly available like CCC, in their financial reports alongside other ratios. However, investors should scrutinize financial statements for concealed insights such as CCC, necessitating cautious analysis.

Two limitations are notable in this research. Firstly, the study solely focused on large corporations, overlooking potential operational disparities with medium or small enterprises. Secondly, industry categorization was omitted, limiting the depth of the working capital analysis. Therefore, future exploration incorporating industry and size categories holds promise for more comprehensive insights and academic exploration.

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Corporate Resilience to Recover from Shocks: The Role of Corporate Social Responsibility and Corporate Reputation

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ABSTRACT

The main **objective** of this study is to investigate the effect of Corporate Social Responsibility (CSR) disclosure on corporate resilience. Furthermore, this study also analyzes the mediating effect of corporate reputation on the effect of CSR disclosure on corporate resilience. This study used a sample of all companies listed on the Indonesia Stock Exchange from 2017 to 2020. The sample in this study was 222 companies with a total of 444 observations. Ordinary Least Square (OLS) was used as a data analysis technique. The results indicate that corporate reputation was vital in mediating the effect between corporate social responsibility and corporate resilience. It reveals that investors in Indonesia considered the company's reputation in times of crisis in addition to CSR. Other findings show that CSR and corporate reputation negatively affect the loss severity and recovery time. It demonstrates that investors in Indonesian stock markets are more concerned with CSR disclosure and the company's reputation when experiencing a shock. Companies with good CSR and a superior reputation have better corporate resilience than companies with bad CSR and an unfavorable reputation. Good CSR can be one of the factors that can increase company resilience; however, CSR must be carried out continuously to build an excellent corporate reputation so that, in the long term, that cannot be determined when shocks occur. The role of corporate reputation can help companies rise more quickly and suffer fewer losses than other businesses.

Keywords: corporate reputation; corporate resilience; corporate social responsibility; ordinary least square

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INTRODUCTION

Corporate management seeks to pursue short-term survival or improvement and develop strategies that create enduring competitive advantages. Intention, satisfaction, loyalty and reputation reflect the consumer's predisposition towards the brand and the company, whether positive or negative. All largely depends on the consumer's perceptions. CSR affects purchase intention as a function of the consumer's motives for this initiative. According to the study, purchase intention is enhanced by values-driven or strategic motives and undermined by selfish motives. At the same time, there is no significant effect if the motive is stakeholder driven.

The sudden major changes brought about by the pandemic have drastically altered the world, substantially impacted the survival and expansion of business, and decimated the global economy [1]. Corporate resilience is a company's capability to rebound from crises and adjust to disruption, which serves an increasingly crucial role in the survival of organizations [2]. Organizations must develop resilience to cope effectively with unexpected occasions and bounce back from crises [3].

Corporate resilience as a corporation's capability to endure crises stems not only from the company's financial condition but also from the social side of a company's long-term investment, one of which is through Corporate Social Responsibility (CSR). Based on the efficient market theory, market prices represent all pertinent and new data about the company [4, 5]. During a recession, financial ratios often used to determine a company's worth are no longer believed [6]. Hence, investors resort to alternative ways and offer greater value to firms with better CSR ratings [7]. CSR practice can be a sign to provide additional information for stakeholders. Stakeholder Theory elaborates that a corporation does not only operate in its interests but is obliged to provide benefits to stakeholders.

Corporations with better social responsibility policies and actions before COVID-19 were more robust to the epidemic [6, 8]. Other studies indicated that a company with good CSR during pre-shock does not affect its stock price during the shock period [5]. Another study revealed that companies with excellent ESG ratings were not insusceptible to economic downturns or more resilient [9].

Previous research has analyzed the impact of CSR on corporate resilience during a crisis by considering various negative events. However, those studies presented inconsistent results. Research gaps show that CSR is not the only variable that can directly impact corporate resilience. Other factors are suspected of having an indirect impact on corporate resilience. The inconsistency of previous research results prompted researchers to use another variable. This study continues previous research by including a mediating variable: corporate reputation. Stakeholder perceptions form corporate reputation. Thus, social performance and disclosure will impact the corporate's reputation [10]. Implementation of CSR can improve company performance in line with increasing reputation and competitiveness [11]. Consequently, an organization can prevent crises and their deadly effects and have more time and room to deal with difficulties if crises are inevitable if it consistently maintains a high reputation [12].

This study takes place in Indonesia because Indonesia is one of the top four best countries to invest in 2020, namely during a pandemic and one of the largest stock markets in Asia. The Indonesian market characteristics can reflect an active reaction during the shock. Furthermore, this study analyses all company sectors to see corporate's resilience using criteria (resilient, adaptive, and surviving) in the face of shocks. Most corporate resilience research focuses on developed countries and is still uncommon in developing countries such as Indonesia, particularly when linked to CSR and corporate reputation. Thus, this study examines whether the company can increase its resilience by considering corporate social responsibility and corporate reputation during the shock period due to the pandemic.

LITERATURE REVIEW

CSR and Corporate Reputation

CSR reflects how businesses and investors incorporate environmental, social and governance concerns into their business strategies [13]. CSR was measured using CSR Disclosure by using the number of disclosures made by the company using the GRI indicator. The CSR score used in this model was the average CSR score from 2018 to 2019 as a representative score for the company's CSR performance level before the COVID-19 pandemic. Corporate involvement in CSR benefits all stakeholders, including employees, customers, suppliers, the government, and non-governmental organizations. It is applied to improve stakeholder trust and the company's reputation. According to signaling theory, CSR reporting is a way for a company to signal stakeholders that it is trustworthy. CRP is the outcome of 'facts, beliefs, images, and experiences an individual encounters over time' [14]. CRP is the cognitive evaluation of the quality of performance that the organization delivers over time [15]. High-quality CSR reports can help prevent and reduce negative public perceptions of the company and its dilutive impact on the corporate's reputation [16]. If a company does well in designing its corporate governance system and implementing good social and environmental responsibility practices, this will result in a good reputation [17]. Consequently, the hypothesis might be stated as follows:

H1: CSR has a positive effect on the corporate's reputation.

Corporate Reputation and Corporate Resilience

Reputation serves as a resilience source, enhancing the company's ability to adjust to external hardship and allowing it to recover from a performance decline [18]. A durable reputation increases a company's capacity to preserve its reputation. Instead, work towards its recovery in the post-crisis phase by collaborating with stakeholders both during and after the crisis [12]. A company's reputation for excellence mitigates the bad effects of adversity and supports or improves the company's ability to recover [18].

Corporate resilience is the capacity of a business to recover from crises and adjust to the challenges [2]. Therefore, we measured the resilience of corporations primarily on how stock values react to the COVID-19 pandemic regarding loss severity and recovery time [4, 5]. Both metrics show the organization's capacity to continue its basic operations and rebound from crises.

Loss severity is the largest economic loss experienced by a corporation during a crisis, and resilience stability corresponds to loss severity. Lesser losses imply stronger

corporate system stability, which boosts their capacity to absorb disruptions [19]. Calculated the loss severity as the proportion of decline in the value of a company's stock between the closing price before the COVID-19 pandemic and the lowest share value one year after. A one-year timeframe is a regular cut-off for related research, and it minimizes the possibility that a stock price decrease was caused by external factors [4, 5]. Therefore, the following hypothesis might be proposed.

H2: Corporate reputation has a positive effect on corporate resilience.

CSR and Corporate Resilience

CSR activities are very important in what products or services customers choose to purchase. Several surveys report that customers are influenced by the CSR activities of the organization [20]. Moreover, ethical and philanthropic CSR practices may create and foster customer beliefs that the organization adheres to high ethical standards and cares about society's wellbeing, which, in turn, positively impacts consumer assessment of corporate reputation [21]. If customers become aware of the ethical implications of the organization's behavior, they assure that the organization will maintain certain quality standards and or improve its corporate reputation [22]. Companies with high CSR must display better stock performance and corporate resilience than companies with low CSR [23].

The stability level manifests in degrees of loss. More severe losses indicate a lower level of stability a company can maintain during a crisis [8]. Investing in CSR is comparable to purchasing insurance since it generates sympathy and social assets for companies facing threat or uncertainty policies [24]. When a company has a blow caused by a negative incident, CSR measures assist stakeholders in keeping a positive mindset, resulting in a lesser decrease in cumulative anomalous stock returns. In this instance, they are expected to demonstrate higher stability shortly after the disruption, as companies have stronger relationships with stakeholders [5], which will be reflected in a less severe decline in share prices. Thus, the following hypothesis might be proposed:

H3: CSR has a positive effect on corporate resilience.

CSR, Corporate Resilience and Reputation

Corporate Resilience Companies implementing more CSR activities can benefit from customer satisfaction and brand awareness and increase their business because CSR is considered informative and persuasive [25]. A company obtaining a good reputation through CSR activities will generate positive evaluations from stakeholders and positively impact its profitability and help reduce risks, especially in an economic downturn when the company relies on a loyal customer base [26]. In CSR engagement, the company improves network ties with all other stakeholders so that the corporate's reputation will influence a competitive environment because stakeholders agree it serves a stronger business [27].

Not only does a high degree of reputation limit bad repercussions, but it also prevents crises, ensuring the organization's success [18]. Corporations with superior CSR practices experience less instability than those with inadequate CSR performance. It also shows bigger improvements in "resilience" and the capacity to recover rapidly from the effects of the crisis. In turmoil, a corporate CSR implementation might serve as a "cushion" and good insurance [28]. Therefore, the following hypothesis might be proposed:

H4: CSR affects corporate resilience through reputation.

METHOD

Ordinary Least Square was used as a data analysis technique. This study used Indonesian corporations registered on the Indonesian stock exchange from 2017–2020. This research collects data from several sources regarding the biggest shocks companies experienced at the start of the COVID-19 pandemic in Indonesia. First, stock development data on the website of the Indonesia Stock Exchange is related to the measurement of company's resilience, namely loss severity and recovery time. Second, CSR data via the ESGI database uses CSR Disclosure with GRI measurements. Third, data related to Corporate Reputation using the corporate image index obtained on the website (www.http://imacaward.com). The final sample of this research was 222 companies with a total of 444 observations.

RESULTS AND DISCUSSION

The analysis of data starts with an overview of the study variables. *Table 1* and *2* include descriptive data and Pearson correlations within variables.

The average description CSR score was 0.459, with a standard deviation 0.168. The lowest score was 0.067, and the best score was 1.011. The average value for the description of corporate resilience (loss severity) was –1.333, with a standard deviation of 0.186, and the lowest and highest values were –2.0 and –1.0, respectively. The corporate resilience (recovery time) description obtained averaged 103.518 with a standard deviation of 150.347 and obtained the lowest score of 0 and the highest value of 653. The firm size description got an average of 29.626 with a standard deviation of 2.147 and obtained the lowest value of 24.348 and the highest value of 37.980. The average age of a company's age was 40.829% with a standard deviation of 21.840%; the lowest value was five, and the greatest value was 125. The leverage description revealed a mean of 0.580 with a standard deviation of 0.568, a minimum value of 0.008 and a maximum value of 5.141. Description of corporate reputation: 144 companies, or 64.9 percent, had never received an honor of appreciation, and 78 companies, or 35.1 percent, had never received an honor of appreciation.

Correlation Analysis

Table 2 presents the correlation matrix. Correlation must be tested because there may be a relationship between variables mutually correlated and independent variables. The assumption is that there is no correlation if the correlation coefficient value is less than 0.8 [29]. According to *Table 2*, the correlation coefficient of all independent variables is less than 0.8. In other words, there is no correlation between the independent variables.

Hypothesis Testing

Following the study objectives, we developed two research models to verify the four fundamental hypotheses. Both models examined the relationship between CSR and corporate resilience with corporate reputation. The panel data set was analyzed using the STATA application program to verify the hypotheses.

The mediation of reputation was tested using a technique with the phases outlined below [30]: Regression of the independent variable to the mediator variable (H1), testing the influence of the mediator variable on the dependent variable (H2); evaluating the influence of the independent variable on the dependent variable (H3); and assessing the influence of mediation (H4). It is based on the criterion that, first, the independent variable influences the mediating variable; second, the mediating variable influences the independent variable; and third, the independent variable does not influence the dependent variable. This form of mediation is referred to as ideal mediation. Partial mediation is employed when the independent variable impacts the dependent variable [30].

Table 3 demonstrates the impact of CSR on the independent variable reputation and the dependent variable control. The estimation findings indicate that CSR has a favorable and substantial impact on corporate reputation. This data shows a fairly large positive influence, namely, the better the value of CSR, the better the company's reputation. Thus, H1 is confirmed.

This result is in line with several previous studies which stated that CSR significantly affects company reputation, indicating that the more effective a company's CSR is, the more excellent, its reputation [31]. CSR programs can help a corporate's reputation significantly. Proper CSR initiative implementation contributes to greater corporate reputation satisfaction [32]. The company's CSR development initiative effectively revived its reputation [31].

Table 3 presents the outcomes of evaluating the impact of company reputation and control variables on corporate resilience. The estimation findings indicate that reputation negatively and substantially impacts a company's resilience. These results imply that the bigger the company's reputation, the larger its effect on loss severity. The lighter the loss, the stronger the company's resilience. Thus, the greater the reputation of the company, the greater the resilience of the company. As a result, H2 is confirmed.

This study's findings are consistent with previous studies' findings that corporate reputation affects the level of corporate loss, as a proxy for corporate resilience [33, 34]. It can be concluded that the better the company's reputation, the lower its loss severity, reflecting its resilience. Company reputation can enhance an organization's responsiveness to unforeseen occurrences by facilitating the modification of unfavorable and inflexible tendencies [35]. In addition to other studies proving that image is a source of adaptive resistance, the author argues that companies with superior reputations often include above–average productivity for a prolonged period than those without a superior reputation [18].

Table 1

Descriptive Statistics

Descriptive					
Variable	**Obs**	**Mean**	**SD**	**Min**	**Max**
CSR Score	222	0.459	0.168	0.067	1.011
Loss Severity		−1.334	0.186	−2.000	−1.000
Recovery Time		103.518	150.347	0	653
Firm Size		29.626	2.147	24.348	37.980
Firm Age		40.829	21.840	5	125
Leverage		0.580	0.568	0.008	5.141
Frequency of Distribution					
Variable		Amount		%	
Reputation	0	144		64.9	
	1	78		35.1	
Total		222		100.0	

Source: Author's.

Table 2

Correlation Matrix

Variable	Loss Severity	Recovery Time	CSR	Reputation	Firm Size	Firm Age	Leverage
Loss Severity	1.000						
Recovery Time	−0.494**	1.000					
CSR	−0.089	−0.048	1.000				
Reputation	−0.203**	0.052	0.127	1.000			
Firm Size	−0.148*	0.131	0.109	0.424**	1.000		
Firm Age	−0.111	0.093	−0.014	0.256**	0.294**	1.000	
Leverage	0.020	−0.013	−0.132	0.002	−0.068	0.057	1.000

Source: Author's.

Note: * $p < 0.05$; ** $p < 0.01$.

Table 3 depicts the outcomes of examining the impact of CSR on the company's resilience. The better the CSR of a company, the worse is its resilience. The path coefficient for the effect of the CSR score on corporate resilience is −0.088, with a significance value of 0.003. These findings indicate a significant negative effect, implying that the higher the CSR score, the lower the value of loss severity. The lower the loss severity, the greater the company's resilience. These findings indicate that the higher the firm's CSR, the greater the firm's resilience. It means that H3 has been confirmed.

These findings align with previous findings that revealed the significant negative results, implying that the better a company's CSR, the lower the level of corporate losses when experiencing shocks. The decrease in corporate losses as a proxy for corporate resilience demonstrates strong corporate resilience. It can be concluded that the company's CSR will increase

Table 3

Path Test Results

The Effect of Reputation Mediation on CSR and Corporate Resilience							
No.	Variable	Reputation			Loss Severity		
		Coef.	P	Desc.	Coef.	P	Desc.
Independent variable							
1	CSR	0.765	0.001	Significant	−0.088	0.003	Significant
2	Reputation (m)	–	–	–	−0.170	0.000	Significant
Control variable							
1	Firm Size	0.083	0.000	Significant	−0.012	0.000	Significant
2	Firm Age	0.003	0.001	Significant	−0.001	0.150	No
3	Leverage	0.027	0.229	No	0.016	0.127	No

Source: Author's.

its resilience, as evidenced by a decrease in the level of loss (loss severity). In the Spanish and US markets, ESG-focused companies outperform the competition and have greater investor confidence [36, 37]. In countries with high ESG involvement, the share devaluation in the initial quarter of 2020 was less significant. Businesses with better CSR practices before the crisis will sustain fewer losses and take less time to rebound [8].

The impact of the control variables on the dependent variable also demonstrates statistical significance. Other control variables, including corporation age and leverage, show no significant result except corporation size [38].

In addition, the Sobel Test was used to establish the indirect impact of corporate reputation. *Table 4* gives data on the importance of the reputation's indirect effect (CSR → Reputation → Corporate Resilience) that has a significant value.

The estimation results demonstrate the influence of mediation to support Hypothesis 4. The estimation results highlight that reputation partially mediates the association between corporate social responsibility and resilience. The path coefficient for the relationship between the CSR score and a company's resilience via corporate reputation was −0.130, with a significance level of 0.005. These findings demonstrate a statistical significance of less than 0.05, thus indicating a significant negative effect. It shows that the greater the value of CSR, the greater the negative influence on the company's reputation, and indirectly has a significant effect on the lower the level of losses, which also shows the increasing resilience of the company. The mediating nature of the indirect effect of CSR on corporate resilience through corporate reputation is partial mediation because both the direct and indirect influences of CSR on corporate resilience is significant.

The robustness test is tested using another proxy for corporate resilience: recovery time. Time to recover indicates resilience adaptability, which assists businesses in adapting to environmental conditions and recovering from shocks more rapidly. We assess recovery time by the time the company returns to pre–shock levels.

Table 5 examines the influence of CSR as the independent variable and the control factors on the variable reputation. The estimation findings demonstrate that CSR has a favorable and statistically significant impact on a company's reputation. These results indicate that the better the CSR, the better the corporate reputation.

In addition, *Table 5* also displays the evaluation of the influence of corporate reputation in association with the control variables on business resilience using an alternative proxy, namely recovering time. The estimation findings indicate that reputation has a negative and statistically significant impact on recovery time. The effect of corporate reputation on recovery time is obtained by a path coefficient of −0.748 with a significance value of 0.01. These findings indicate a significant value smaller than 0.05, thus indicating a significant negative effect, implying that the greater the company reputation, the shorter the recovery period. A low recovery time indicates

Table 4

Hypothesis Testing Results

No.	Effect	Coef.	SE	t	p	Desc.
1	CSR –> Reputation	0.765	0.079	9.710	0.000	Significant
2	Reputation –> Corporate Resilience (LS)	–0.170	0.012	–13.819	0.000	Significant
3	CSR –> Corporate Resilience (LS)	–0.088	0.030	–2.958	0.003	Significant
4	CSR –> Reputation –> Corporate Resilience (LS)	–0.130	0.016	–7.931	0.000	Significant

Source: Author's.

Table 5

Robustness Path Test Results

The Effect of Reputation Mediation on CSR and Corporate Resilience							
No.	Variable	Reputation			Recovery Time		
		Coef.	P	Desc.	Coef.	P	Desc.
Independent Variable							
1	CSR	0.765	0.000	Significant	–0.467	0.002	Significant
2	Reputation (m)	–	–	–	–0.748	0.010	Significant
Control Variable							
1	Firm Size	0.083	0.000	Significant	3.117	0.019	Significant
2	Firm Age	0.003	0.001	Significant	0.181	0.178	No Significant
3	Leverage	0.027	0.229	No	17.309	0.000	Significant

Source: Author's.

the good corporate resilience, so that a good corporate reputation will increase corporate resilience.

The control variable's impact on the dependent variable also demonstrates statistical significance. Other control variables, especially firm size and leverage, have substantial values in addition to firm age.

Table 6 shows that CSR affects negatively on Corporate Resilience (RT) with a proxy for recovery time. The effect of CSR score on recovery time is obtained by a path coefficient of –0.467 with a significance value of 0.002. These results show a significant value lower than 0.05, thus indicating a significant negative effect, implying that the higher the value of CSR, the shorter the recovery time. The low recovery time shows good corporate resilience. So, the higher the CSR will increase the company's resilience.

The path coefficient for the influence of CSR score on recovery time via business reputation was –0.573, and the significance value was 0.013. These findings show a significance value smaller than 0.05, thus indicating a significant negative effect, implying the greater the CSR value, the greater the company's reputation, and indirectly have a significant effect on the lower the recovery time. A low recovery time indicates the good corporate resilience, so good CSR will enhance the corporate's reputation and also increase corporate resilience. The mediation nature of the indirect effect of CSR on recovery time through the corporate's reputation is partial mediation because the indirect consequence of CSR on the recovery period is significant. At the same time, the direct effect of CSR on recovery time is also significant.

The degree of flexibility represents the time required for the system to return to its usual condition [4]. This study indicates that organizations with a high level of CSR engagement are more likely to support stakeholder

Table 6

Robustness Hypothesis Test Results

No.	Effect	Coef.	SE	t	p	Desc.
1	CSR –> Reputation	0.765	0.079	9.710	0.000	Significant
2	Reputation –> Corporate Resilience (RT)	–0.748	0.289	–2.592	0.000	Significant
3	CSR –> Corporate Resilience (RT)	–0.467	0.146	–3.198	0.002	Significant
4	CSR –> Reputation –> Corporate Resilience (RT)	–0.573	0.230	–2.492	0.013	Significant

Source: Author's.

participation in problem-solving because they have created mutual trust and excellent collaboration via earlier activities [5]. High environmental performance allows companies to recuperate from crises substantially faster [39]. Stakeholder support will help reduce risk and, in turn, accelerate the company moving forward and recovering from a disruption [8].

The results of this study are consistent with *Table 3*. Significantly unfavorable results were found in the study examining the influence of mediating company reputation on the association between CSR and business resilience using loss intensity proxies, indicating that a greater CSR score will majorly impact lower loss severity value. The lower the loss severity, the stronger the company's resilience, so these results indicate that the higher the corporation's CSR, the greater the company's resilience. Robustness results using another proxy, namely recovering time to test corporate resilience, also show consistent results, namely a significant negative effect, meaning that the higher the CSR score, the lower the recovery time will be. The lower the recovery time indicates, the stronger the company's resilience, so these results indicate that the higher the firm's CSR, the greater the firm's resilience.

Robustness testing was also carried out for mediating variables using recovery time proxies to measure company resilience. The Sobel Test was also performed to validate the indirect impact of corporate reputation. *Table 6* displays data on the significance of reputation's indirect influence (CSR → Reputation → Corporate Resilience) that has a significant value.

The estimation results highlight that reputation partially mediates the association of CSR and corporate resilience. The path coefficient for the relationship between the CSR score and company's resilience via corporate reputation was –0.573, with a significance value of 0.013. These findings show a significance value of less than 0.05, thus indicating a significant negative effect, implying that the higher the CSR score will have a great influence on the greater the company's reputation, and indirectly have a significant effect on the lower the loss severity which also shows the increasing resilience of the company. The mediating nature of the indirect effect of CSR on corporate resilience through corporate reputation is partial mediation because the direct and indirect influence of CSR on corporate resilience is significant. The results shown using the recovery time proxy compared to those using the loss severity proxy show consistent results, namely partial mediation, indicating that the research model is robust.

The resilience of companies according to the industrial sector is a research area for the biggest shocks during the COVID-19 pandemic. Corporate resilience was assessed by regressing the same equation across sectors. The sectors used in this study refer to those listed on the Indonesian stock exchange, and the sectors with enough data to be analyzed are 9 of the 11 currently available. The matrix measured the level of corporate resilience for each company sector, allowing the identification of the company's level of organizational resilience, namely resilient, adaptive, and surviving. If the company's resilience is measured using loss severity proxies, recovery time shows significant results when associated with the company's CSR disclosure. When the company's CSR disclosure shows significant results in one of the proxies but insignificant results in the other, the adaptive level is the second level of corporate resilience. Finally, the surviving level represents the company's lowest level of corporate resilience with its CSR disclosure relationship. When the two proxies for the company's resilience have no significant effect, the surviving level is reached.

The results of the resilience of companies for each sector show that the basic materials sector, the consumer non-cyclical sector, the industrials sector, and the properties & real estate sector have adaptive resilience, the consumer cyclical sector, the energy sector, the financial sector, the healthcare sector have resilient type, and the infrastructures sector has resilience with the surviving type.

CONCLUSIONS

These results prove that corporate resilience produces significant positive results when CSR and corporate reputation are combined. When experiencing a shock, companies with good CSR and a superior reputation have better corporate resilience than companies with bad CSR and an unfavorable reputation, namely loss intensity and recovery duration.

The second finding demonstrates that reputation can mediate the connection between CSR and corporate resilience. CSR can increase corporate resilience if it is carried out continuously to build a good corporate reputation. Company reputation can help companies rise faster and minimize losses.

This study has several limitations, including the limited number of companies observed. This is due to the fact that several corporations have not disclosed the items used to measure CSR implementation in their published reports and the problem of report legibility caused by the use of currencies other than rupiah in several sources. This study investigates how CSR disclosure is related to firm resilience when facing shocks relatively quickly before shocks occur. Future research can measure CSR using data from databases such as Bloomberg or Thomson Reuters to complement company data. Furthermore, proxies for measuring corporate resilience that are not only related to stock market reactions but also financial conditions, such as net sales and market value, can be used. Future research will also compare the pre-shock, on-shock, and post-shock periods to see how the company's corporate resilience differs.

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Asset Allocation and Risk Assessment in the Securities Portfolio Management System

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ABSTRACT

The agro-industrial complex is an important component of the economy. However, this sector is characterized by a complex structure, limited resources and dependence on government actions. For these reasons, portfolio management in the agro-industrial sector requires special attention when developing the investment strategy. In this regard, the study of the strategy and methodology of managing the securities portfolio of the agro-industrial complex is an urgent topic in the context of restructuring of the Russian economy. The main task in managing the securities portfolio is to attract the financial resources of the company for the needs of organizations and to increase their economic activities. Investment portfolio in the market of financial instruments is an independent product, its implementation in full or in part brings profit to the investor when he makes investments of monetary resources on the stock exchange. As a rule, the securities market implements an asset portfolio with established proportions of profitability and risk, the indicators of which may improve or worsen during the management process. As part of structural asset allocation development and risk assessment, the authors set out to explore various approaches to developing mechanisms for managing securities portfolio in the agro-industrial sector in order to maximize profits for the investor. The subject of the study is approaches to managing securities portfolio in the agro-industrial sector, data analysis methods used in conducting the study, as well as possible investment strategies in this sector. The methodological basis of this work is the economic and statistical methods of information processing, as well as mathematical modeling. Based on the data obtained, it is concluded that new data in the field of securities portfolio management in the agro-industrial sector allow investors to make optimal and profitable decisions when choosing investment strategies based on a risk-based approach. As a result, the current state of the agro-industrial complex was studied and the risks of the securities portfolio of the agro-industrial complex of Russia were assessed, recommendations for the formation of a securities portfolio in the agro-industrial sector for the future were developed.

Keywords: profitability; risk; securities portfolio; strategy; optimal portfolio; investing; uncertainty

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INTRODUCTION

The development of the economy directly depends on investments, which are the main force for its growth. The state plays an important role in this, stimulating and supporting the main segments of the agro-industrial complex through various mechanisms [1, 2]. Last year was not easy for the stock market: sanctions imposed on Russia had a huge impact on financial indices, causing a collapse in prices on the stock exchange and the cessation of trading. The largest exporters of raw materials have lost important export routes for their products listed on the stock market. A number of organizations decided to refuse to pay dividends due to the ambiguity of the situation, but other companies, on the contrary, paid huge dividends. The number of transactions on the stock exchange has decreased significantly, trading is mainly conducted by individual investors and traders, and operations on the securities market are mainly speculative. Portfolio investments, in their essence, make it possible to optimize the investment of funds by giving securities those properties that are impossible when acquiring one asset, but only when combining them. The rationality of including financial assets of the foreign exchange market in securities portfolios is investigated when assessing the financial feasibility of structuring financial instruments based on the multidimensional scaling method [3, 4].

In a modern economy where market relations occupy a significant part of the decision-making process, securities portfolio management is an important tool for financial planning and investment [5–8]. Regardless of the size, type, or goals of investors, precise portfolio management can ensure optimal returns and reduce risks. The design of modern securities markets provides investors with the opportunity to invest in various sectors of the economy [9–11], including the agro-industrial sector. Investing in such a sector, against the background of growing globalization, is strategically important and provides an opportunity to receive high returns on investments.

The degree of scientific development of this topic lies in the fact that there are many studies and mathematical models related to portfolio investment. The main ideas in this area were laid down in the work of G. Markowitz "Portfolio Selection", published in 1952, which became the starting point for further research [12]. Other well-known foreign authors who have contributed to the development of portfolio theory include J. Tobin [13], W.F. Sharpe [14] and others. There were also many scientists in Russia who were engaged in research in the field of portfolio investment. Among them are O.Y. Vorobyov, T.A. Martynov, A.A. Novoselov, S. Ya. Shorgin, A.N. Ignatov, A.I. Kibzun, I.S. Menshikov, E.M. Bronstein, O.V. Kondratiev, V.I. Rotar, A.G. Sholomitsky, S.I. Spivak and others [15–21].

The empirical database of the research is open sources presented on the securities market, provided by the Federal State Statistics Service, as well as regulatory legal acts of legislative and executive bodies of Russia, reports of companies issuing securities prepared in accordance with the requirements. Articles from industry and territorial conferences, online resources and research results conducted by the authors were also used.

The Russian agricultural sector is one of the key sectors of the country's economy, which covers the production and sale of agricultural products, including cereals, vegetables and fruits, as well as livestock and fishing. In recent years, the agricultural sector has been steadily growing, creating prospects for development and investment.[1] Thus, investing in the Russian agricultural sector represents an opportunity to generate high returns

[1] Statistics. Information about Happy Valley Village hoziai in inland country. URL: https://ru.theglobaleconomy.com/rankings/share_of_agriculture / Statistics. Village hoziye in Russia. Federal Office of state statistics. URL: https://rosstat.gov.ru/enterprise_economy (accessed on 18.04.2023).

with relatively high risks. At the same time, making investments in this industry requires a conscious and analysis-based approach [22, 23] and strategy. It should be borne in mind that each company has its own characteristics that can affect their profitability and risks. A particularly important role in this industry is played by PJSC PhosAgro, PJSC RusAgro and PJSC Cherkizovo Group, which control a significant share of agricultural production and sales in Russia. However, each of these companies has its own characteristics that can affect their profitability and risks. For example, PJSC PhosAgro specializes in the production of mineral fertilizers and phosphate ores, which may affect the demand for their products depending on the global market conditions and the need for agricultural crops.[2] In turn, PJSC RusAgro is engaged in the production and processing of grain, butter, milk and meat, which carries risks associated with weather conditions and fluctuations in food prices.[3] Cherkizovo Group PJSC focuses on the production of meat products and poultry, but also has its own peculiarities[4] related to exchange rates, as a company with many assets abroad.

When investing in individual company shares, it is important to consider their potential profitability, level of risk, and relationship with other stocks in your portfolio. The evaluation of each company should be based on analysis of its financial performance, strategy, market position, and industry. While it's important to consider individual company shares, investing in the agriculture sector also means investing in a whole industry that is subject to both general and specific risks. To maximize profitability and minimize risk, we recommend including shares from different sectors in your portfolio, such as finance, technology, healthcare, transportation, and motor transport. We also recommend adding risk-free financial instruments to your portfolio to help mitigate risk and distribute returns evenly.

When managing a portfolio in the agricultural sector, it is important to be aware of the unpredictability associated with this industry which is associated with weather conditions and fluctuations in prices for raw materials and food. Portfolio management should be based on active monitoring of the market and asset redistribution in accordance with changes in the market, which is very dynamic [25]. It is important to pay attention to the strategies of companies and their positioning in comparison with competitors. Investors need to take into account that the agricultural sector is high-risk and requires a more active portfolio management strategy than sectors with more predictable dynamics. To reduce risks, it is important to create a balanced portfolio that takes into account both the potential for return and the level of risk. This should be done by considering factors such as seasonality and market forecasts for agricultural and food products.

METHODOLOGY FOR THE STUDY OF ASSET ALLOCATION AND RISK ASSESSMENT IN THE SECURITIES PORTFOLIO MANAGEMENT SYSTEM

Stock market quotations are publicly available, which means that investors have the opportunity to compare information and select assets that best match their investment strategies. Market conditions are constantly changing and a thorough analysis of quotes is essential to achieve the best investment results.

Based on the analysis of the share prices of RusAgro, Cherkizovo and PhosAgro groups for 2022, formulas are used to determine the optimal ratio of assets in the portfolio and

[2] Annual report. PJSC "PhosAgro". URL: https://www.phosagro.ru/investors/reports/year/#accordion-2022 (accessed on 03.27.2023).

[3] Annual report: PJSC "RusAgro". URL: https://www.rusagrogroup.ru/ru/investoram/otchety-i-publikacii/godovye-i kvartalnyyy-otchet/ (accessed on 03.26.2023).

[4] Accountability of PJSC Group "Cherkizovo". URL: https://cdn.financemarker.ru/reports/2022/MOEX/G/GCHE_2022_12_Y_\IFRS.pdf (accessed on 03.27.2023).

Table 1

Determination of the Expected Return and Risk of Shares as of 2022

Date	Share price, RUB.			The profitability of the stock, %		
	RusAgro	Cherkizovo	PhosAgro	RusAgro	Cherkizovo	PhosAgro
03.01.2022	1187.00	3063.5	5936.0			
31.03.2022	1083.00	3277.0	8045.0	–9.17%	6.74%	30.40
30.06.2022	863.80	2684.0	7880.0	–22.61%	–19.96%	–2.07
30.09.2022	711.00	2220.5	6305.0	–19.47%	–18.96%	–22.30
30.12.2022	660.80	2710.0	6390.0	–7.32%	19.92%	1.34
Expected profitability, %				–14.64	–3.07	1.84
Stock risk σ, %				7.54	19.69	21.71

Source: Compiled by the authors according to: Statistics. History of Russian stock market quotations. URL: https://ru.investing.com/equities/; https://rosstat.gov.ru/enterprise_economy (accessed on 12.05.2023).

Table 2

Covariance Matrix of Stock Returns

Indicator	RusAgro	Cherkizovo	PhosAgro
RusAgro	0.0042	0.0108	0.0075
Cherkizovo	0.0108	0.0290	0.0179
PhosAgro	0.0075	0.0179	0.0353

Source: Compiled by the authors according to: Statistics. History of Russian stock market quotations. URL: https://ru.investing.com/equities/; https://rosstat.gov.ru/enterprise_economy (accessed on 12.05.2023).

minimize risks. To determine the optimal ratio of shares of these companies, we will conduct a comparative analysis within the framework of the comparative content of price and profitability (*Table 1*).

An analysis of the tabular data on the market quotations of RusAgro, Cherkizovo and PhosAgro shares for 2022 showed that PhosAgro has the highest risk, but the expected return is the largest among these three companies. Cherkizovo has a high risk, but the expected return is negative. Interestingly, RusAgro has the least risk, but the expected return is as negative as possible compared to the other two companies.

From this we can conclude that if an investor has investment funds, then in order to obtain the highest profit, it is recommended to pay attention to PhosAgro.

Using the calculated data for 2022, we will construct a covariance matrix of asset returns, which is presented in *Table 2*.

Table 3

Correlation Matrix of Stock Returns

Indicator	RusAgro	Cherkizovo	PhosAgro
RusAgro	1.00	0.97	0.61
Cherkizovo	0.97	1.00	0.56
PhosAgro	0.61	0.56	1.00

Source: Compiled by the authors according to: Statistics. History of Russian stock market quotations. URL: https://ru.investing.com/equities/; https://rosstat.gov.ru/enterprise_economy (accessed on 12.05.2023).

PhosAgro has the strongest correlation with all other companies, which indicates the possible greatest impact of changes in PhosAgro's share price on the share prices of RusAgro and Cherkizovo.

A strong correlation was also found between RusAgro and Cherkizovo, which indicates a possible strong influence of changes in the share price of one company on the share price of another company.

On the whole, we can conclude that all three companies have a fairly strong relationship with each other. Thus, knowing the data on the average return and the average deviation of the return of each stock, we can analyze the risk of investing in a portfolio of stocks and make informed decisions when creating a portfolio. Next, we will calculate the correlation matrix of asset returns (*Table 3*).

RusAgro has the highest correlation with Cherkizovo (0.97), which indicates the proximity and interdependence of their share yield dynamics. The correlation between RusAgro and PhosAgro is much weaker (0.61). Cherkizovo has a strong correlation with RusAgro (0.97), as well as with PhosAgro (0.56), which indicates possible changes in the profitability of one company that will affect the other. The correlation between PhosAgro and RusAgro is also significantly stronger than between PhosAgro and Cherkizovo (0.61 and 0.56, respectively).

Thus, it can be concluded that the parameters are in acceptable values, and the profitability of these companies is moving in the same direction. Next, we need to distribute shares between the various assets in our portfolio in order to achieve the best balance between possible returns and risks. To do this, we need to effectively distribute our capital among various assets in the portfolio, taking into account the balance between potential profits and possible risks, using a hybrid recommendation system using the Sharpe ratio in order to diversify the investment portfolio [26].

To optimize a portfolio of securities consisting of several assets with minimal risk [27, 28], we will calculate the portfolio risk using a formula that will help minimize this risk in accordance with Markowitz theory. The formula we use is (1):

$$\sigma_q^2 = \sum_{i=1}^{n}\sum_{j=1}^{n}\theta_i\theta_j \operatorname{cov}_{i,j} \to \min, \qquad (1)$$

where σ_q^2 — is the risk (variance) of the portfolio; $\theta_i\theta_j$,— is the covariance of returns on assets *i* and *j*; $\operatorname{cov}_{i,j}$,— the specific weights of *i* and *j* assets in the portfolio.

Additional conditions that we use when allocating shares in the portfolio include the following: the sum of the shares of assets in the portfolio must be equal to 1, which ensures that we do not distribute more or less fixed capital between assets. The distribution of shares in the portfolio should ensure a return of at least 1%. This parameter is very important, as it ensures that the portfolio will bring a minimum level of profit, which also corresponds to investment goals.

Formulas (2) and (3) describe calculations that allow us to determine which shares of

Table 4

Distribution of Shares Between Assets Within the Portfolio, 2022

Indicator	Min. risk	Max. risk
RusAgro's share, p.p.	0.05	–
Cherkizovo's share p.p.	0.45	0.10
PhosAgros share, p.p.	0.50	0.90
Return on the securities portfolio, %	–1	1
Risk of the securities portfolio, %	15	18

Source: Compiled by the authors according to: Statistics. History of Russian stock market quotations. URL: https://ru.investing.com/equities/; https://rosstat.gov.ru/enterprise_economy (accessed on 12.05.2023).

capital need to be distributed among assets in order to ensure profitability. Thus, we can use these formulas to create an optimal portfolio that will meet investment goals and constraints.

$$\sigma_q^2 = \sum_{i=1}^{n} \sum_{j=1}^{n} \theta_i \theta_j = 1, \quad (2)$$

$$E(r_p) = E(r_1)\theta_1 + E(r_2)\theta_2 + \ldots + E(r_n)\theta_n \geq 1\%, \quad (3)$$

where $E(r_p)$ — the expected portfolio return; $E(r_n)$ — the expected return on the corresponding n-th asset; θ_n — the specific weight in the portfolio of the corresponding n-th asset.

As a result, the shares between the assets were distributed as follows (*Table 4*).

When RusAgro shares are included in the securities portfolio, the portfolio's risk decreases by 3%, but at the same time the portfolio's profitability becomes negative.

This can be explained by the fact that RusAgro shares are the most stable in this group, but their market price has higher volatility. By choosing the most risky portfolio, while removing RusAgro shares, we increase the risk of the portfolio, but at the same time the return is 1%. By investing in riskier assets, the investor earns greater returns.

The corresponding return on the portfolio is due to significant international pressure on the Russian Federation, especially in 2022. With a minimum level of risk, negative returns are possible, and with maximum risk, only insignificant returns can be obtained from the portfolio.

In general, the choice of a securities portfolio should be based on a balance between risk and possible return [29]. When investing in shares of agricultural companies, it is necessary to take into account the existence of links with shares of other companies in order to assess the impact of various economic and other factors on the share price. It is also necessary to take into account that there is a high degree of uncertainty inherent in this sector, possibly caused by changes in weather conditions and various economic factors.

Thus, it should be noted that the previously created industry portfolio of securities for the end of 2022 was suitable only for an investor willing to take on high risks. The return-risk ratio for this portfolio is risky and justified only if the income of the entire agricultural sector increases.

The profitability of the issuers included in the portfolio correlates with each other, which is usually a characteristic of companies from the same industry. Due to the sanctions, the pace of development of the agricultural sector decreased, stock prices and their profitability sank, which led to a drop in market indicators.

Table 5

Determination of the Expected Return and Risk of Shares as of 2023

Date	Share price, RUB.			The profitability of the stock, %		
	GLTR	NBPF	Sovcomflot	GLTR	NBPF	Sovcomflot
03.01.2023	278.6	293.5	37.96			
01.02.2023	322.95	315	47.3	14.77	7.07	22.00
01.03.2023	352.85	319	49.45	8.85	1.26	4.45
03.04.2023	430.7	391	59.59	19.94	20.35	18.65
02.05.2023	437.8	372.5	58.25	1.64	–4.85	–2.27
01.06.2023	462.15	390	84.1	5.41	4.59	36.73
Expected profitability, %				10.12	5.69	15.91
Stock risk σ, %				7.31	9.34	15.33

Source: Compiled by the authors according to: Statistics. History of Russian stock market quotations. URL: https://ru.investing.com/equities/; https://rosstat.gov.ru/enterprise_economy (accessed on 12.05.2023).

However, when assessing the financial condition of companies, it can be concluded that each of them may be of interest to a conservative investor interested in the long term.

When constructing a portfolio of investments, it is crucial to consider the importance of risk diversification. By including a variety of independent assets, the portfolio's volatility can be reduced. Given that the primary risks in the industry for the upcoming years are primarily related to logistics, it was decided to incorporate shares of companies involved in cargo transportation and logistics to spread out the risks and mitigate their impact on the portfolio.

According to the Moscow Stock Exchange Index, the fastest growing securities in the transport industry are: Globaltrans Investment PLC (hereinafter Globaltrans or GLTR) (with an increase of 62.1%), PJSC Novorossiysk Bakery Plant (hereinafter NBPF) (with an increase of 58.9%) and PJSC Sovcomflot (with an increase of 58.5%). Let's make a calculation table to determine the expected return and risk of the assets in question as of 2023 (*Table 5*).

The share prices of several companies (RusAgro, Cherkizovo, PhosAgro, GLTR, NBPF, and Sovcomflot) showed a steady upward trend during the period from 03.01.2023 to 06.01.2023. During this time, the profitability of these companies' shares also fluctuated. GLTR and Sovcomflot had the highest expected returns in 2023, while NBPF and Sovcomflot were associated with the highest risk.

Based on this data, it can be concluded that the securities market was quite volatile during this time period, and investors must be prepared to take risks and analyze each stock in their portfolio in order to minimize losses and protect their investments.

There is a positive correlation between stock returns within the range, which can help in building a diversified portfolio. The strongest correlation is observed between Cherkizovo and PhosAgro shares (correlation coefficient 0.8025) and between NBPF and RusAgro shares (correlation coefficient 0.7738).

A positive correlation was observed between Cherkizovo and Sovcomflot shares

Table 6

Correlation Matrix of Stock Returns

Indicator	RusAgro	Cherkizovo	PhosAgro	GLTR	NBPF	Sovcomflot
RusAgro	1	0.3169	0.3086	0.1535	0.7738	0.5511
Cherkizovo	0.3169	1	0.8025	0.1152	0.4180	0.6838
PhosAgro	0.3086	0.8025	1	0.4861	–0.0924	0.4539
GLTR	0.1535	0.1152	0.4861	1	0.5300	0.2938
NBPF	0.7738	0.4180	–0.0924	0.5300	1	0.5921
Sovcomflot	0.5511	0.6838	0.4539	0.2938	0.5921	1

Source: Compiled by the authors according to: Statistics. History of Russian stock market quotations. URL: https://ru.investing.com/equities/; https://rosstat.gov.ru/enterprise_economy (accessed on 12.05.2023).

Table 7

Portfolio of the "Conservative" Investor

Indicator	2023	Forecast	Changes in the indicator
RusAgro	0.27	0.23	–0.04
Cherkizovo	0.24	0.24	–
PhosAgro	0.20	0.20	–
GLTR	0.06	0.08	0.02
NBPF	0.03	0.03	–
Sovcomflot	0.20	0.22	0.02
Profitability of the securities portfolio, %	6.36%	6.70%	0.34%
Securities portfolio risk, %	1.85%	2.01%	0.16%

Source: Compiled by the authors according to: Statistics. History of Russian stock market quotations. URL: https://ru.investing.com/equities/; https://rosstat.gov.ru/enterprise_economy (accessed on 12.05.2023).

(correlation coefficient 0.6838). There are negative correlations between PhosAgro and NCCP stocks (correlation coefficient –0.0924). The GLTR stock is poorly correlated with other stocks.

Based on the above, the conducted research allows us to conclude that it is advisable to include shares of these companies in the securities portfolio, since this will minimize risks and increase the profitability of this portfolio. Using all the data that we have calculated, we can create asset portfolios based on their condition for the first 5 months of 2023 and make a forecast for 2025. A comparative assessment of these assets, based on a historical analysis of the profitability and risk of the compiled portfolio (*Tables 7–9*), allows us to build a forecast trend for a conservative investor's portfolio.

In 2023, RusAgro, Cherkizovo, PhosAgro and Sovcomflot hold the largest shares in the portfolio. NBPF and GLTR companies

Table 8

Portfolio of the "Aggressive" Investor

Indicator	2023	2026 forecast	Changes in the indicator
RusAgro	0.02	0.01	–0.01
Cherkizovo	0.02	0	–0.02
PhosAgro	0.03	0	–0.03
GLTR	0.38	0.48	0.1
NBPF	0.12	0.12	–
Sovcomflot	0.43	0.44	0.01
Profitability of the securities portfolio, %	11.60%	13.44%	1.84%
Securities portfolio risk, %	4.65%	6.97%	2.32%

Source: Compiled by the authors according to: Statistics. History of Russian stock market quotations. URL: https://ru.investing.com/equities/; https://rosstat.gov.ru/enterprise_economy (accessed on 12.05.2023).

Table 9

Portfolio of the "Moderate" Investor

Indicator	2023	2026 forecast	Changes in the indicator
RusAgro	0.20	0.11	–0.09
Cherkizovo	0.20	0.10	–0.10
PhosAgro	0.02	0.09	0.07
GLTR	0.20	0.33	0.13
NBPF	0.02	0	–0.02
Sovcomflot	0.36	0.37	0.01
Profitability of the securities portfolio, %	9.28%	10.24%	0.96%
Securities portfolio risk, %	3.15%	3.65%	0.50%

Source: Compiled by the authors according to: Statistics. History of Russian stock market quotations. URL: https://ru.investing.com/equities/; https://rosstat.gov.ru/enterprise_economy (accessed on 12.05.2023).

are also present in the portfolio, but occupy smaller shares. At the same time, the return on the portfolio for 2023 amounted to 6.36%, which is due to the overall increase in the securities market after last year's sanctions. However, it is predicted that by 2024, the yield will rise to 6.70%, which is 0.34% higher than the yield in 2023. The portfolio risk will increase slightly by 2023 to 0.16%, and the Russian stock market is gradually emerging from the difficulties caused by sanctions and COVID-19 [30].

It should be noted that this investment portfolio is focused on securities of companies

in the agro-industrial sector and companies related to cargo transportation. At the same time, in order to reduce the risk of the portfolio, it would be possible to add risk-free financial instruments to it, such as stocks, bonds of major companies and government loan bonds. Let's move on to the aggressive type of strategy (*Table 8*).

As presented in *Table 8*, in 2023, NBPF accounted for 12% of the portfolio, while Sovcomflot and GLTR accounted for 81%, and RusAgro, Cherkizovo and PhosAgro accounted for only 7%. In the projected 2026, the situation at NBPF will not change significantly and will amount to 12% of the total portfolio, RusAgro will occupy a small share, and Cherkizovo and PhosAgro companies will not be present in the portfolio at all. The projected portfolio risk will increase by 1.84% in 2026. It is worth noting that the forecast of the total portfolio return showed an increase from 11.60% in 2023 to 13.44% in 2026.

Thus, the portfolio of securities with a higher weight of Sovcomflot and GLTR is more promising in the future due to a slight increase in risks and an increase in profitability next year. However, it would be desirable to include more diverse companies in the portfolio in order to diversify risks.

For a portfolio with a more aggressive approach, the optimal strategy is to employ an active management approach that involves closely monitoring the securities market and regularly adjusting the portfolio composition in response to fluctuations in the value of the assets it contains. This approach allows for timely adjustments to the portfolio, ensuring that it remains well-positioned to capitalize on opportunities and mitigate risks.

Table 9 outlines a more conservative approach to portfolio management.

The return on the securities portfolio is expected to increase by 9.28% to 10.24% in 2026, an increase of 0.96%. This is good news for a moderate investor who is not willing to take on a lot of risk. The risk associated with the portfolio for 2026 is estimated to be 3.65%, an increase of 0.5% from 2023, which is within the acceptable range for a moderate investor.

The weight of NBPF shares in the portfolio is expected to decrease to zero, indicating that this company will be excluded from the portfolio. Overall, the securities portfolio shows positive growth in profitability, but the slight increase in risk could cause some concern for the investor. Based on the analysis, a "moderate" investment strategy may be appropriate for this portfolio during the time period under review.

CONCLUSIONS

Based on the economic analysis, we can only offer recommendations for possible investment options. Experienced professional investors, on the other hand, use balanced strategies to form and manage a securities portfolio in the Russian market. This approach allows them to achieve higher returns with minimal risk, acting intuitively and considering existing risks.

In any case, decisions made by investors should be based on thorough analysis and risk assessment. The securities portfolio should be tailored to the individual needs and goals of each investor. Considering all factors and current market conditions, we can only provide guidance, and the final choice of strategy and portfolio remains up to each individual investor. Investors need to compare the fees and commissions of different brokers, as well as consider their ratings and reputation in the market.

In conclusion, it should be noted that the Russian agriculture sector is an important part of the economy, but it requires a more proactive portfolio management strategy due to its high level of risk. When considering investing in stocks of companies in this sector, it is essential to take into account their specific characteristics, potential profitability, and risk level. It is also crucial to create a portfolio that balances risk and potential return while considering seasonality and market forecasts.

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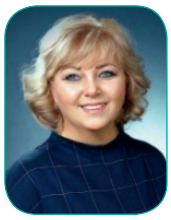

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Quality Aspects of Mobile Banking — Public and Private Sector Banks in India

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ABSTRACT

In response to the increased global competition within the banking industry, financial institutions are diligently exploring the deployment of new banking technologies to improve both the quality of their banking infrastructure and customer. **The purpose of this study** is to assess the quality aspects (information quality and service quality) of mobile banking on perceived satisfaction and word of mouth and the variation in the proposed relationship between public and private sector banks in India. **The research methodology**: for data collection, a survey was conducted on 230 mobile banking users by using a random sampling technique. For analysis we used partial least square structural equation modelling with the help of Smart PLS 4.0. The result depicts that perceived satisfaction is significantly impacted by service quality, and also the impact of perceived satisfaction on word of mouth is positively significant, which indicates the importance of quality parameters during the use of m-banking. Meanwhile information quality was found to have an insignificant effect on perceived satisfaction. The variation demonstrates that the impact of service quality on perceived satisfaction was stronger in the public sector banks than in the private sector banks. The findings of the study will help in improving retention rate of m-banking consumers and determining consumer preference in different sectors of banks.

Keywords: m-banking; information quality; Service Quality; Perceived Customer satisfaction; IS Success Theory; word of mouth; Public sector banks; Private sector banks; Delone and Mclean model

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INTRODUCTION

Mobile banking is an essential aspect of the bank's services and its proliferation allows it to become a preferred electronic method for daily life and business activities [1]. Today, almost all banks offer similar services, but the quality of service is the basis that makes a differentiation between them, and as a cutting-edge technology, mobile banking, helps banks attain those competitive goals [2]. Mobile banking allows banks to offer more competitive and value-added financial services including interactivity, convenience, availability, etc., overcoming geographical and time limits and reducing the cost of cash transactions which accounts for 1.7% of India's gross domestic product [3]. The proliferation of digital banking tools not only helps in enhancing digital financial inclusion but also facilitates cost-effective payment methods by reducing the costs of transactions to one-fiftieth of conventional banking costs, one-tenth of ATM costs, and half of internet banking costs, and thereby improving the quality of life for citizens.[1] It can also be substantiated through the Reserve Bank of India report [4] (2017–2018, 2022–2023) where the value of m-banking transactions in public and private sector banks have increased from rupees 935.8 million to rupees 22 522.9 million from 2017–2018 to 2022–2023 in India and helps the country to record total digital transactions of rupees 72 billion in the financial year 2022.[2]

Banks are accountable for the quality of service they provide and for any technical problems that affect not only the customers' experience with the bank's services but also the bank's reputation. From the consumer's point of view, the quality of m-banking services reflects the overall opinion of m-banking regarding the advantages and potential of mobile content delivery [5]. However, nowadays matching customers' expectations is no longer enough, banks should exceed those to retain customers for the long term [6]. Thus, retaining consumers of m-banking helps banks to streamline marketing activity, maintain client trust, and at last gain a competitive edge [7]. Ultimately, banks must give importance to their quality of services to promote the convenience of customers

[1] URL: https://www.rbi.org.in/Scripts/Statistics.aspx (accessed on 23.06. 2022).

[2] URL: https://www.statista.com.u (accessed on 15.06.2022).

which helps in anticipating an optimistic future in which offering a variety of technological options will boost customer satisfaction and competitiveness [8]. Several studies also suggest that different dimensions like quality aspects [8], information quality [9], competition [10], and word-of-mouth [10], security concern [11] are the areas that need more attention in m-banking.

Thus, the current study is an attempt to examine the service quality and information quality of mobile banking and its effect on customers' perceived satisfaction and how it affects word of mouth in the context of public and private sector banks in India. The findings of the study will help banks to gain a competitive advantage over the quality of services because improved service quality is a need of organizations of all sizes and eventually leads to enhance consumer satisfaction and also active participation in banking services through mobile banking which will foster service continuity and enriches consumers' perception that service providers have the ability and willingness to deliver as promised [12].

In this study, we are examining the perceived quality aspects of m-banking during the actual use of banking products and services, for this the information system (I/S) theory, De Lone & Mclean model (1992, 2003) which has been widely used in various m-banking studies [13–18] was found suitable for the study. Therefore, the novelty of this empirical study is first, to extend the theoretical foundation of quality parameters (information quality and service quality) of information systems by adding one more success dimension (word of mouth) that affects not only banks' reputation but also helps in attracting potential and retaining existing consumers m banking customers. Second, to assess the variation in the proposed quality parameters of m-banking between public and private sector banks in India to validate their impact on customer's perceived satisfaction and word of mouth to promote a healthy competition among financial institutions.

This is how the paper is structured down. The next section provides a theoretical background followed by a review of literature comprising a synthesis of prior work, in addition to the development of hypotheses and then the research methodology that is presented in further in detail. Lastly, the study concludes with discussion and conclusion, theoretical and managerial implications and the last limitations and scope for future studies.

THEORETICAL BACKGROUND

The original Delone and McLean model, 1992 [19] is based on six different aspects of the information system: "System Quality", "Information Quality", "Use", "User satisfaction", "Individual impact" and "Organizational impact". Since 1992, the De Lone and McLean Information system (IS) success Model has been widely used to assess the success of information systems in the context of m- banking studies [10, 12, 13]. In the year 2003, by incorporating service quality and clubbing the individual and organizational impact into net benefits, it was reformulated to set the benchmark for the specification and justification of the dependent variable's measurement in information system studies. The updated multidimensional D & M model (2003) [20] explained the proposed relationships between success dimensions in a procedural way. It means quality parameters affect user satisfaction in a process sense, resulting in some net benefits to the users. Thus, we used this model in a procedural sense, that is, how quality parameters affect perceived satisfaction and result in some WOM in a resultant manner. In this model, we use 'systems quality' and 'service quality' that examine the technical aspect of mobile banking success; 'information quality' assesses semantic; and 'use', 'user satisfaction', and 'net benefit' examine effectiveness success. The extension of the Delone and Mclean I/S Success model is important and admissible in the Indian reference [13] added trust as an extension of the I/S Success model and found satisfaction and intention to use stand as two important precedents of actual usage, and satisfaction mediates the relationship between service quality, information quality, and trust to use m-banking. We found Delone and McLean model appropriate in the study as compared to other models since it provides a better explanation of the quality aspects of information systems in terms of measuring the effectiveness of m-banking and has been widely used in information technologies such as e-banking,

KMS, mobile banking, e-government system, e-commerce websites [13]. This study includes three constructs from D & M model: service quality, information quality, and customer satisfaction as a success dimension, and added Word-of- mouth to the framework (*Fig. 1*). WOM is also an important aspect while making high-risk purchases, consumers trust word-of-mouth more because pre-purchase information

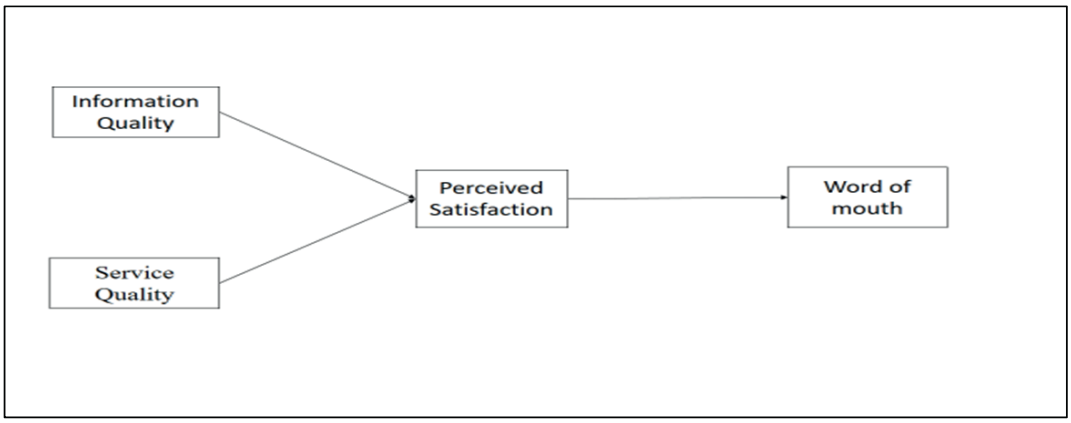

Fig. 1. **Research model for the study**

Source: Compiled by the authors (based on Delone & McLean model).

from others in the form of word-of-mouth either through social media or verbally or any other mode of communications reduces risk, especially for services while post-purchase word-of-mouth is used to help other consumers, prevent mistakes, express anger, or relieve anxiety [21].

LITERATURE REVIEW

Impact of Service Quality on Customer's Perceived Satisfaction

Consumers' service quality assessments are based on their expectations and how well service providers meet them effectively [22]. As customers' needs are changing, their service quality evaluations are also changing. Few studies have investigated service quality in the m-banking context [1, 5, 22–26]. C. Poromatikul et al. [27] found that service quality had a positive and significant impact on mobile banking customer satisfaction. C. Tam and T. Oliveira [12] confirm the importance of "service quality" in m-banking that leads to "customer satisfaction", "trust" and other factors of success. Mobile banking's service quality frame consumers' trust and satisfaction [16]. Service quality impacts the satisfaction and retention decision of customers. Customer satisfaction is a mental state that compares the results of customers' expectations before they buy something with their views after they buy it and banks arrange their business around these service gaps to stay competitive [26]. Customer satisfaction leads to continuation intention [27], Customer satisfaction and service quality strongly mediate the intention-to-use and actual-use relationship in m-banking [13].

Thus, we formulate the following hypothesis.

H1: There is a significant positive impact of perceived service quality on perceived customer satisfaction.

Impact of Information Quality on Customer's Perceived Satisfaction

M-Banking users are more satisfied and loyal if the information is high-quality. The quality of the information in m-banking is measured by the accuracy of the information provided [28]. Information quality includes relevance, sufficiency, accuracy, and timeliness [29, 30–32]. Mobile banking customer satisfaction is significantly affected by information quality [2]. Y. Chetioui et al. [33] found information quality affect users' attitudes toward technology. Information quality predicts satisfaction and intention for using mobile banking in Oman and found that service and information quality affects customer satisfaction and mobile banking adoption [15, 31, 34]. While some studies depict the contrary relationship between information quality on customer satisfaction, A. Trabelsi-Zoghlami [35] found a non-significant impact of information quality on the use of m-banking in Morocco during the pandemic. In the context of individual achievement in m-banking, users consider individual performance's importance and found that information quality affected satisfaction [34].

Thus, we proposed the following hypothesis.

H2: Information quality has a significant positive impact on perceived satisfaction.

Impact of Consumer Satisfaction on Word-of-Mouth

Nowadays offering a mobile application is not enough. Bank managers must invest in high-quality systems to

acquire their customers' trust and generate positive word-of-mouth (WOM) for the application and the bank [35]. The more loyal a brand's consumers are, the more likely they are to recommend it to others and make positive WOM [36]. Perceived satisfaction has a direct effect on users' recommendation to use technology [36]. To attain a positive attitude toward the use of mobile banking, word-of-mouth significantly affects factors that contribute to the adoption of mobile banking [11]. With the help of the Elaborated likelihood method, positive e-WOM (argument quality, valence, and consistency) significantly affect the intention to adopt m-banking [37]. In another study, it was found that information quality with other factors like ease of navigation, personalization level, and rewards had a significant relationship between the use of m-banking and e-WOM [38]. To improve brand image and positive word-of-mouth, banks should improve service quality because brand attachment is positively associated with positive WOM in m-banking apps [7].

Based on studies we hypothesize that.

H3: There is a significant positive impact of perceived satisfaction on word-of-mouth.

Moderator Variable (Public Sector Banks and Private Sector Banks)

There are various past studies in which comparisons between public and private sector banks' performance have been examined based on financial metrics. This study assesses the variation between public and private sector banks considering service quality, information quality, perceived satisfaction, and word-of-mouth. The main reason for considering major public and private sector banks in terms of perceived service quality [24] and perceived information quality is to identify the variation between them and enhance the scope of improvement in perceived satisfaction that leads to positive word-of-mouth. Few studies have considered m-banking service quality in public sector banks and private sector banks [24, 26] and customer satisfaction [39].

Based on studies we formulate the hypothesis:

H4(a) The relationship between perceived service quality and customer's perceived satisfaction varies in public and private sector banks.

H4(b) The relationship between perceived information quality and customers' perceived satisfaction varies in public and private sector banks.

H4(c) The relationship between customers' perceived satisfaction and word-of-mouth varies in public and private sector banks.

RESEARCH METHODOLOGY

Measurement Scale

To assess the relationship between the construct, a questionnaire was developed. A survey was implemented for data collection purposes, which is attached in the *Appendix*. We developed a suitable measurement scale by using different relevant studies in the area. We used a 5-point Likert scale, having measures from "strongly disagree" (1) to "strongly agree" (5) for measurement of the constructs (*Appendix*). Customer satisfaction and information quality, scales were adopted from [4, 14, 15, 40]. Service quality was adopted from [4, 15, 41, 42]. Word-of-mouth was adopted from [43].

Data Collection

Data was collected through an online Google form during March, and a survey was conducted in Delhi NCR due to its cosmopolitan nature. After a pilot test with 50 sets of responses, a final online questionnaire was circulated using the non-probabilistic snowball sampling technique and a total 325 responses were received, but only 230 responses with 70.77% response rate were used for further analysis (*Fig. 2*).

Data Analysis

To analyze the proposed research model, structural equation modeling (SEM) with the help of Smart PLS 4.0 was developed by [44, 45]. This study used a three-stage strategy to analyze the data. It examines measurement models, structural models, and multi-group analysis in the context of public sector banks and private sector banks and the complete sample using PLS–SEM [46].

Measurement Model

In the first step we check a common method biasness by [47, 48] (VIF values equal to or less than 3.3, considered free from CMB) and all the VIF values were less than 3.3. For the entire sample as well as for each subgroup, the measurement model was evaluated separately. All the constructs Cronbach's alpha coefficients and composite reliability were measured to test the construct reliability to meet the threshold limit, 0.708 [46]. The Cronbach

Descriptive Statistics		Frequency	Percentage
Gender	"Male"	143	39
	"Female"	87	24
Age	"Below 18 Years."	2	1
	18—25	192	52
	26—35	31	8
	36—45	4	1
	46—55	0	0
	Above 55	1	0
Education	"High school diploma or less"	33	9
	"Bachelor's degree"	102	28
	"Master's degree"	90	24
	"Doctoral Degree"	5	1
Employment	Student	64	17
	Working	157	42
	Unemployed	3	1
	Others	6	2
Banks	Public Sectors	105	28
	Private Sectors	125	34
Do you use mobile banking offered by Indian banks?	Yes	230	70.8
	No	95	29.2

Fig. 2. **Descriptive Profile of Respondents**

Source: Compiled by the authors.

alpha values and CR values were all greater than the suggested value of 0.708 (*Table 1*). Convergent validity is established by the Average Variance Extracted (AVE) for the constructs being higher than the 0.50 threshold limit [49]. The constructs' discriminant validity was examined using two approaches. Initially, we applied the Fornell-Larcker criterion to compare the square root of AVE with its correlation coefficients, the Results show (*Table 2*) that all square roots are higher than their respective correlation coefficient, and the HTMT criterion, as a more conservative approach, should be below 0.90 [50]. It shows HTMT results satisfactory as all constructs have values below the 0.90 value. Thus, the Fornell-Larcker criterion and HTMT 0.90 show the measurement model has sufficient discriminant validity.

Structural Model

After assessing the measurement scale's reliability and validity, we proceed with the VIF multi-collinearity assessment and the values of the VIF should be relatively near to 3 or lower [46]. In the next step, R^2 to assess the dependent constructs' explained variance, to evaluate the structural model's explanatory power [46]. The R^2 values are shown in *Table 3*. An R^2 score of 0.2 is considered to be acceptable [51, 52]. Using structural equation modeling (SEM), standardized estimates and t-statistics of each hypothetical path were analyzed to assess the significance of each hypothesis relationship. Customer satisfaction was predicted by 29% while WOM was predicted by 23.7% through the findings of this empirical study, making the model acceptable [51]. The result shows (*Fig. 3*) that there is a positive and significant effect of service quality on customers' perceived satisfaction while the effect of information quality is insignificant [33]. In addition, customer satisfaction exerts a positively significant effect on WOM. In the next phase, f^2, the size of the effect was evaluated. Next, we calculate the model's predictive relevance suggested by Stone-Geisser's Q^2 [46].

Table 1

Reliability and Convergent Validity

Variables	α	CR	AVE	α	CR	AVE	α	CR	AVE
INFO_	0.940	0.946	0.806	0.934	0.936	0.793	0.937	0.938	0.801
SERVQ_	0.930	0.944	0.827	0.901	0.902	0.772	0.92	0.921	0.806
Sat_	0.929	0.931	0.934	0.877	0.878	0.891	0.901	0.901	0.91
WOM	0.895	0.896	0.905	0.846	0.853	0.866	0.876	0.873	0.887

Source: Compiled by the authors.

Note: * $P < 0.05$, α — Cronbach's alpha, AVE — Average Variance Extracted, CR — Composite Reliability.

Table 2

Discriminant Validity Based on the Fornell-Larcker & HTMT Criterion

	Public Sector Bank				Private Sector Bank				Total			
	INFO_	SERVQ_	Sat_	WOM	INFO_	SERVQ_	Sat_	WOM	INFO_	SERVQ_	Sat_	WOM
INFOQ_	**0.898**	0.842	0.409	0.871	**0.890**	0.878	0.589	0.863	**0.895**	0.862	0.517	0.87
SERVQ_	0.79	**0.909**	0.562	0.864	0.807	**0.878**	0.578	0.900	0.800	**0.898**	0.586	0.886
Satisfaction	0.388	0.528	**0.966**	0.484	0.535	0.515	**0.944**	0.585	0.476	0.534	**0.954**	0.549
WOM	0.800	0.788	0.442	**0.952**	0.767	0.787	0.506	**0.931**	0.787	0.794	0.487	**0.942**

Source: Compiled by authors.

Note: * $p < 0.05$, The diagonal values represent the square root of the mean-variance and the values below the diagonal value (bold) are correlation, and values above the diagonal values are values of HTMT 0.90 criterion.

Multi-Group Analysis (MGA)

Before performing a multi-group analysis, we perform a MICOM analysis. To prove that latent variable differences explain the differences between the two groups. MICOM analysis consists of "configuration invariance"; next "compositional invariance"; and last the "equality of composite mean values" and "variances". First, configuration invariance is assessed. Before performing a multi-group analysis we perform a MICOM analysis [53]. The second stage is to analyze

Fig. 3. **Results of Hypothesis Testing on Research Model**

Source: Compiled by the authors.

compositional invariance, the original c is greater than or equal to 5% quantile, and measurement invariance is partial.

RESULTS OF MULTI-GROUP ANALYSIS

In the last step, we examined the significant differences between the two sector banks in respect of information quality and service quality and their impact on customers' perceived satisfaction & WOM. The results revealed that the difference between the association of service quality and customers' perceived satisfaction was significant, but the difference in the impact of "perceived customer satisfaction" on "WOM" was insignificant. In public sector banks, the impact of "perceived service quality" on "perceived satisfaction" has a stronger impact in contrast to private sector banks. Therefore, commercial banks must dedicate substantial effort to develop long-term relationships with consumer [26] (*Table 4*). While the impact of information quality on customer satisfaction was insignificant, thus it was dropped for multi-group analysis.

DISCUSSION AND CONCLUSION

Technology, rival branding, consumer education, security, and organization synchronization make it harder to retain and gain mobile banking customers, so to retain and expand their mobile banking consumer base, banks must improve and update their services. Customers always want convenience, security, and full control over the required financial services. New technologies in the financial industry gave the customers more freedom and convenience than ever. Innovative technology-based services not only satisfy the customers but also enable the financial institutions to become more cost-effective and sustainable [54]. This research supports past studies that considered service quality, information quality, customer satisfaction, and word-of-mouth [2, 55]. The purpose of the study is to examine the quality aspect of mobile banking on perceived satisfaction and word-of-mouth, and examine the variation in the proposed relationship between public sector and private sector banks in India. Quality makes the basis to make a difference between service providers, and when customers use competent mobile banking services, they may perceive banks as possessing the expertise and ethical standards necessary to ensure superior service quality. In this study we found that service quality was positively significant and similar to the findings like [2, 5, 12, 26, 56]. The findings pointed out that the improvement in service quality provided by mobile banking would accordingly enhance the perceived value to the consumers. Previous studies have found that "self-banking" is emerging to be the method of choice for customers [57]. Meanwhile information quality was found insignificant and consistent with the findings of [33]. Public sector banks are widely believed to possess extensive knowledge about their products in contrast to their counterparts in the private sector [26]. The service quality shows significant variation between public and private sector banks [2, 13]. As user experience is subject to variation due to intangible feature of service quality, customer satisfaction is based upon the attainment of their desired outcomes, and this satisfaction is positively associated with repeat

Table 3

Result of Hypothesis Outcome-Structural Model Evaluation

Relationship	B	T	P	Confidence interval 95%	R-square	Adjusted R^2	Q2predict	f2
Public Sector Bank								
INFO ->Sat	−0.078	0.529	0.298	[−0.331; 0.155]	0.281	0.267	0.235	0.003
SERVQ_ -> Sat_	0.59	4.022	0	[0.333; 0.823]				0.182
Sat ->WOM	0.442	4.889	0	[0.269; 0.571]	0.196	0.188	0.296	0.243
Private Sector Bank								
INFO ->Sat	0.342	3.074	0.001	[0.155; 0.517]	0.306	0.294	0.275	0.059
SERVQ_ -> Sat	0.239	1.917	0.028	[0.020; 0.430]				0.029
Sat ->WOM	0.506	6.839	0.000	[0.368; 0.615]	0.256	0.25	0.374	0.344
Complete								
INFO ->Sat	0.136	1.418	0.078	[−0.027; 0.291]	0.29	0.286	0.27	0.009
SERVQ_ -> Sat_	0.425	4.296	0	[0.256; 0.582]				0.092
Sat ->WOM	0.487	8.879	0	[0.390; 0.571]	0.237	0.234	0.363	0.311

Source: Compiled by the authors.

Table 4

Result of Multi-Group Analysis

Relationships	Difference (Public Sector Bank — Private Sector Bank)	p-value
H4a	0.351	0.033*
H4c	−0.064	0.591

Source: Compiled by the authors.

Note: * significance exists at 0.05 level, two-tailed.

purchases, brand loyalty, and the dissemination of favorable word-of-mouth recommendations (Khan et al. [25]). The result of the study shows the impact of customer satisfaction on WOM was significant in several related studies [35–37, 38, 58] but there was no significant variation between public and private sector banks.

Theoretical Implication

This study makes significant contributions to the IS success theory by introducing WOM as one of the dependent variables & also one of the success dimensions apart from satisfaction, loyalty, and net benefit. Numerous studies examine customer satisfaction in the context of pre-purchase, intention to purchase, or to adopt a new technology but only a few studies have considered perceived satisfaction and WOM after the purchase process or during the actual use process that affect WOM. The impact of perceived satisfaction on WOM during the actual use of mobile banking, and shows a significant and positive relationship between them. The findings will support future studies to find the other factors related to perceived satisfaction and word-of-mouth, and their relation to mobile banking. This study also finds the variation between public and private sector banks with regards to their m-banking quality aspects and their effect on perceived satisfaction and WOM to enhance the scope of improvement in m-banking and support the base theory to make a comprehensive mechanism of comparison and promote other factors to be included to analyze the other aspects for assessing variation.

Managerial Implication

It is quite important for any financial institution to assess the quality variables so that they can comprehend clients' needs and also recognize their psychology [2] and determine user preference among various services to improve the retention rate [59]. Furthermore, the impact of word-of-mouth not only

affects existing consumers but also potential consumers, so it must be improved with positive word-of-mouth. In emerging countries, people share information and advice with friends and family so banks must try to focus on positive word-of-mouth and enhancing customer satisfaction by improving the quality criteria of m-banking.

LIMITATIONS AND SCOPE FOR FUTURE STUDIES

This study also has some flaws that need to be pointed. First, a small portion of the Indian population, future research may examine the effect of various cultural and demographic aspects of respondents. Second, based on limited quality aspects of mobile banking, future studies may include other quality aspects of mobile banking like system quality, interface design quality, etc. Third, this study employed a cross-sectional approach, which limits an examination of changes in user behavior over some time, so the future studies may include a longitudinal approach to enhance the scope of the future studies. Fourth, future research may include pre and post-behavior of mobile banking consumers and their comparisons concerning other different types of banks and other financial institutions to make the study more effective.

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APPENDIX

Survey Data

Construct	Items	Reference
Information Quality	The information displayed on my mobile banking app is sufficient for my needs	T. li, 2014 [16]
	The information provided by the m-banking app is understandable	Urbach et al. (2010) [17]; Tam and Oliveira (2016) [4]
	The information provided by the m-banking app is useful	Urbach et al. (2010) [17]; Tam and Oliveira (2016) [4]
	The information provided by the m-banking app is up-to-date	Urbach et al. (2010) [17]; Tam and Oliveira (2016) [4]
	The information provided by the m-banking app is error-free and detailed information	Urbach et al. (2010) [17]; Tam and Oliveira (2016) [4]
Service Quality	The responsible service personnel provides services related to the m banking app at the promised time	Urbach et al. (2010) [17]; Tam and Oliveira (2016) [4]
	Does the m-banking app service responsible personnel show a sincere interest in solving problems when you face them?	Parasuraman et al. (1988a, p. 23) [43]
	M-banking applications protect information about my transactions	Parasuraman et al. (2005) [41]
	Are m-banking app personnel always willing to help you?	Urbach et al. (2010) [17]; Tam and Oliveira (2016) [4]
	Do the m-banking service personnel understand your specific needs?	Parasuraman et al. (1988a, p. 23) [43]
Customer Satisfaction	The experience that I have had with my mobile banking app has been satisfactory	T. li (2013) [16]
	I am satisfied with the manner in which mobile banking has carried out transactions	Anderson and Sullivan (1993) [42]

Appendix (continued)

Construct	Items	Reference
Word of mouth	I would recommend the mobile banking app to my friends and family to use it	Madan and Yadav (2016) [45]
	I have a worthy experience with mobile banking apps, I would recommend friends to download the apps of services	

Source: Compiled by the authors.

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Assessment of Investment Attractiveness of RF Entities Using Artificial Intelligence

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ABSTRACT

Difficult geopolitical situation in the world has made the issue of attracting private investment into the economy at the meso-management level relevant for Russia Currently, the solution of this problem is impossible without monitoring the investment attractiveness of the subjects of the Russian Federation. The purpose of the study is to develop an adequate methodology for assessing the investment attractiveness of Russian regions. Based on competitive benchmarking techniques, the investment attractiveness of territories (within the country) is assessed in dynamics over a number of years. The results of a retrospective assessment conducted using the index method are deepened by cluster analysis. Also, the authors' methodology allows us to assess not only the actual investment attractiveness of Russian regions, but also assumes the formation of a forecast. At the same time, the above tasks are solved with the help of artificial intelligence. The results of the retrospective assessment showed that in 2019–2022, Moscow and St. Petersburg were the pronounced leaders in the rating of investment attractiveness among the subjects of the Russian Federation. At the bottom of the rating (they did not rise above 71st place) on a regular basis were all the republics from the North Caucasus Federal District, as well as the Republic of Kalmykia and the Republic of Tyva, which are included, respectively, in the Southern Federal District and the Siberian Federal District. Based on the results of the cluster analysis, it can be seen that all Russian regions in 2019–2022 could be organized into three groups characterized by above-average, average and below-average levels of investment attractiveness. The quality of the formed cluster structure has improved over the entire analyzed period of time: the share of subjects of the Russian Federation with above-average investment attractiveness has almost doubled. The results of the (retro and prospective) assessment according to the authors' methodology allow us to conclude that there are significant reserves for the growth of investment attractiveness of all Russian regions without exception. Based on the decomposition of its results, the leadership of the constituent entities of the Russian Federation will be able to develop measures to improve the effectiveness of the regional investment policy.

Keywords: investment attractiveness; regions of Russia; balanced scorecard; index method; artificial intelligence; cluster analysis; forecasting

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INTRODUCTION

The complex geopolitical situation in the world due to the conflict between Russia and Ukraine (more precisely, the United States and the collective West) has made it difficult for our country to access investment resources. This affected the balance of payments of the Russian Federation. Thus, according to official statistical information,[1] foreign direct investment in the Russian economy amounted to USD 31.975, 9.479 and 40.450 million in 2019–2021, respectively. From the above data, it can be seen that periods of growth in the indicator's value alternated with years of sharp decline. Therefore, it is now becoming more important for the Russian leadership to ensure both the inflow of foreign direct investment into the economy from friendly countries (for example, BRICS and SCO partners) and the activation of private investors within the Russian Federation. In particular, the Minister of Finance of the country A. G. Siluanov has repeatedly spoken about the inability of the leadership of the Russian regions to attract investments.[2]

At the same time, a number of both Russian and foreign studies [1–7] allow us to draw an unambiguous conclusion that it is the managerial factor that plays a key role in increasing the investment attractiveness of the territory. Based on the above, the goal of this study is to propose an author's methodology that evaluates investment attractiveness at the meso-level of management using artificial intelligence. This goal involves solving several tasks: 1) a critical analysis of existing Russian methods for assessing the investment attractiveness of the region is carried out; 2) a proprietary index methodology is proposed for a retrospective assessment of the investment attractiveness of the subjects of the Russian Federation; 3) the results of the retrospective assessment are deepened by cluster analysis using the method of self-organizing maps by T. Kohonen, and 4) a forecast of the investment attractiveness of Russian regions is formed using a Bayesian ensemble of neural network models.

LITERATURE REVIEW

To date, quite a lot of scientific research has been accumulated on the assessment of investment attractiveness for various levels of management [8–16]. In [17], a not unsuccessful attempt was made to critically analyze a number of both Russian and foreign methods for assessing the investment attractiveness of enterprises and territories (country, region or municipality). Each of these methods was compared by the co-authors according to several criteria: 1) the main task to be solved; 2) the application of quantitative indicators and/or qualitative characteristics; 3) availability of the necessary background information for empirical research in the public domain and 4) ease of practical implementation of the approach. So, based on the second criterion mentioned above, all the variety of existing techniques can be combined into three groups: 1) statistical (index) approach; 2) point (expert) estimates; and 3) statistical-expert (mixed or hybrid) models. The first group is preferable from the point of view of ensuring the objectivity of the results of the final assessment, provided that the partial indicators (indicators) are equivalent. In the framework of this study, we will limit ourselves to considering several techniques.

The above-mentioned co-authors, based on the results of a critical analysis of existing approaches assessing the investment attractiveness of the territory, propose their own methodology for the constituent entities of the Russian Federation. The main difference between this methodology is the use of indicators that characterize the economic security of investment decisions made from the perspective of both the state

[1] Russian Statistical Yearbook. 2022: statistical collection. Moscow: Rosstat, 2022. URL: https://bigenc.ru/b/rossiiskii-statisticheskii-cd1a31?ysclid=m85hlhgk82687362424 (accessed on 10.10.2024).

[2] The habit of living on subsidies has not been eradicated. URL: http://www.pravda.ru/economics/rules/regions/27–03–2014/1202010-live-0 (accessed on 10.10.2024).

and entrepreneurs. At the same time, an evaluation scale with predefined interval boundaries based on the theory of fuzzy sets is used to distribute Russian regions by the level of investment attractiveness.

O. V. Loseva and M. A. Fedotova have developed a comprehensive methodology for assessing investment attractiveness for both enterprises and regions. In the second case, the co-authors understand the main components of such an assessment: 1) gross regional product; 2) intellectual capital; 3) resource potential and 4) socio-ecological indicators of the development of the subject of the Russian Federation [18]. At the same time, if the calculation of the generalizing indicator of the investment attractiveness of the region is carried out using the index method, then expert assessments can also be applied for individual of the above components. The latter circumstance increases the subjectivity of the final results obtained. However, it should be noted that the authors of [19] suggest certain ways to improve the traditional methodology of expert assessments: first, to verify the consistency of expert opinions (when assigning weights to components). Second, it is necessary to study the strength and closeness of the relationship not only between the resulting indicator and each of the factors, but also independent variables (based on the calculation and analysis of the values of paired correlation coefficients by K. Pearson).

The works [20, 21] present the author's methodology for assessing investment attractiveness at the meso-management level. A special feature of this methodology is the application of a system of balanced indicators for the regions of the country. At the same time, the works of R. Kaplan and D. Norton were taken as a basis. Quite a large amount of modern scientific literature is devoted to the development of the balanced scorecard concept [22–24]. However, until now, its use has been limited to the enterprise level [25–28]. For the first time, Russian scientists have adapted the concept for the subjects of the Russian Federation. However, in their research they limit themselves to a retrospective assessment and subsequent rating of the investment attractiveness of the constituent entities of the Russian Federation.

The deepening of a retrospective assessment of the investment attractiveness of a territory through cluster analysis using artificial intelligence (AI) remains a fairly rare phenomenon. At the same time, there are practically no studies devoted to the prospective assessment or forecasting of the investment attractiveness of a territory using AI. Thus, in [29] an attempt was made to fill the above gap in the scientific literature. This study is a logical continuation of the above scientific article. At the same time, its main methodological difference is the application of a system of balanced indicators for the regional management level.

EMPIRICAL RESEARCH: DATA, METHODS AND RESULTS

A retrospective assessment of the investment attractiveness of the constituent entities of the Russian Federation for 2019–2022 is carried out using the traditional index method. The information base of the empirical research is regional statistical data.[3] Taking into account the previously conducted review of scientific literature, a system of balanced indicators has been formed that make it possible to assess investment attractiveness at the meso-management level (*Table 1*).

The index (and sub-indexes) are calculated based on the following conditions: first, according to the simple arithmetic mean formula, i. e. with equal significance (without the use of weighting ratios) of all indicators. Second, for the purpose of data comparability, the normalization of indicator values is carried out in a minimax manner. Third, in order to ensure that information is

[3] Regions of Russia. Socio-economic indicators. 2023: statistical collection. Moscow: Rosstat, 2023. URL: https://bigenc.ru/b/regiony-rossii-sotsial-no-e-b75bfc?ysclid=m85ifu4dso252287392 (accessed on 10.10.2024).

Table 1

System of Indicators Assessing the Investment Attractiveness of Constituent Entities of the Russian Federation

Scorecard	Unit of measurement of the indicator	Assessment of the increase in the value of the indicator
I. Production and financial indicators		
1. The share of profitable enterprises	%	Positive
2. The ratio of revenue and expenditure parts of the consolidated budget of the subject of the Russian Federation	Ratio	Positive
3. The share of overdue accounts payable of organizations	%	Positive
4. The proportion of neutralized substances harmful to the atmosphere released by stationary sources 10. Profitability of goods, products, works and services sold by industrial organizations with manufacturing industries	%	Positive
5. The degree of depreciation of fixed assets	%	Positive
6. Profitability of assets of industrial organizations engaged in mining	%	Positive
7. Profitability of assets of industrial organizations with manufacturing industries	%	Positive
8. Profitability of assets of industrial organizations engaged in the production of electric energy, gas, steam and air conditioning	%	Positive
9. Profitability of goods, products, works and services sold by industrial organizations engaged in mining	%	Positive
10. Profitability of goods, products, works and services sold by industrial organizations with manufacturing industries	%	Positive
11. Profitability of goods, products, works and services sold by industrial organizations engaged in the production of electric energy, gas, steam and air conditioning	%	Positive
12. Profitability of the personnel of organizations	Thousand rubles/person	Positive
II. Development indicators		
13. The proportion of the employed population with higher education	%	Positive
14. The level (per 10,000 population) of university graduates	Person	Positive
15. The level (in the total volume of shipped goods, completed works and services) of the costs of innovation activities of organizations	%	Positive
16. Percentage of organizations using broadband Internet access	%	Positive
17. The coefficient of renewal of fixed assets	–	Positive
18. The coefficient of investment capacity of the sold products	–	Positive
19. The level (per 10,000 square kilometers of territory) of railway track length	Km of tracks	Positive
III. Natural resource indicators		
20. The level of participation in the workforce of the population	%	Positive
21. Electricity production per capita	KWh.	Positive

Table 1 (continued)

Scorecard	Unit of measurement of the indicator	Assessment of the increase in the value of the indicator
22. The level (per 100 people of the population) of active subscribers of mobile broadband Internet access	Units	Positive
23. The level (per 100 people of the population) of active subscribers with fixed broadband Internet access	Units	Positive
24. The ratio of autonomy for industrial organizations	%	Positive
IV. Political, socio-economic indicators		
25. Share of private enterprises and organizations	%	Positive
26. The share of small businesses in the turnover of organizations	%	Positive
27. Morbidity rate (per thousand people)	Units	Negative
28. The level (per thousand people of the population) of injuries of all types	Units	Negative
29. The level (per one thousand people of the population) of registered crimes	Units	Negative
30. The share of expenditures of the consolidated budget of the constituent entity of the Russian Federation on socio-cultural events	%	Positive
31. The proportion of the population with monetary incomes above the subsistence level (poverty line)	%	Positive
32. Unemployment rate	%	Negative

Source: Compiled by the authors.

subordinated to the law of normal distribution, if necessary, the normalized values of indicators are transformed by extracting the root of the (second-fourth) degree. Fourth, the cancellation of an abnormally high variation in indicator values is carried out as a result of the establishment of a standard (upper or marginal limit). And finally, fifth, the cost indicators and their derivatives are determined in comparable prices, taking into account both the inflationary processes in the country and the different purchasing power of the ruble in the regions. The results of the rating of the constituent entities of the Russian Federation by investment attractiveness in dynamics for 2019–2022 are presented in *Table 2*.

As presented in *Table 2,* while Moscow was the leader of the rating in the first three years of the analyzed period, St. Petersburg rose from 2nd to 1st place in 2022. It should be noted that only in these two subjects of the Russian Federation, in certain years of the analyzed period, the value of the investment attractiveness index exceeded 0.7. There was also a stable group of outsider regions in the rating — all the republics included in the North Caucasus Federal District, and two entities from the Southern Federal District and the Siberian Federal District (respectively, the Republic of Kalmykia and the Republic of Tyva) — ranked 71st to 82nd annually.

The results of the retrospective assessment are deepened by cluster analysis. Within the framework of this study, such an analysis is carried out using AI (using the method of self-organizing maps by T. Kohonen). Ensuring the adequacy of the procedure implemented in the demo version of the Deductor Studio Lite software product is confirmed by the data in *Table 3*.

Table 2

Rating of Investment Attractiveness of Constituent Entities of the Russian Federation

Territory (Russian region)	The value of the investment attractiveness index of the Russian region				Place of a constituent entity of the Russian Federation in the ranking of investment attractiveness			
	2019	2020	2021	2022	2019	2020	2021	2022
Belgorod region	0.653	0.659	0.690	0.653	9	4	4	11
Bryansk region	0.550	0.502	0.536	0.531	48	58	61	62
Vladimir region	0.544	0.545	0.580	0.606	53	47	45	27
Voronezh region	0.662	0.673	0.650	0.653	6	2	15	12
Ivanovo region	0.514	0.501	0.533	0.527	63	59	62	65
Kaluga region	0.567	0.529	0.562	0.533	39	54	52	60
Kostroma region	0.570	0.552	0.589	0.584	37	42	40	43
Kursk region	0.663	0.652	0.687	0.670	5	5	5	6
Lipetsk region	0.621	0.605	0.667	0.639	15	17	11	17
Moscow region	0.649	0.624	0.640	0.646	10	9	19	14
Oryol region	0.514	0.564	0.584	0.606	62	35	42	26
Ryazan region	0.567	0.575	0.580	0.584	40	29	44	42
Smolensk region	0.539	0.553	0.590	0.578	54	41	39	45
Tambov region	0.511	0.562	0.546	0.558	64	36	56	52
Tver region	0.501	0.491	0.558	0.565	68	63	54	48
Tula region	0.624	0.594	0.640	0.665	14	20	18	7
Yaroslavl region	0.560	0.546	0.571	0.595	44	46	49	37
The city of Moscow	0.719	0.696	0.725	0.698	1	1	1	2
The Republic of Karelia	0.559	0.544	0.576	0.579	45	48	46	44
Komi Republic	0.561	0.496	0.563	0.527	43	60	50	64
Arkhangelsk region	0.491	0.453	0.515	0.529	70	73	68	63
Vologda region	0.573	0.569	0.597	0.621	36	32	36	22
Kaliningrad region	0.608	0.582	0.617	0.602	22	26	29	30
Leningrad region	0.618	0.587	0.620	0.637	19	23	27	18
Murmansk region	0.618	0.652	0.686	0.653	20	6	6	10
Novgorod region	0.507	0.494	0.574	0.596	65	62	48	35
Pskov region	0.493	0.467	0.533	0.514	69	70	64	68
St. Petersburg	0.709	0.661	0.703	0.703	2	3	2	1
The Republic of Adygea	0.455	0.487	0.487	0.475	76	65	73	74
The Republic of Kalmykia	0.397	0.446	0.471	0.439	80	74	77	78
The Republic of Crimea	0.480	0.465	0.508	0.519	72	71	70	67

Table 2 (continued)

Territory (Russian region)	The value of the investment attractiveness index of the Russian region				Place of a constituent entity of the Russian Federation in the ranking of investment attractiveness			
	2019	2020	2021	2022	2019	2020	2021	2022
Krasnodar region	0.595	0.574	0.606	0.591	25	31	34	40
Astrakhan region	0.597	0.560	0.576	0.558	23	37	47	53
Volgograd region	0.580	0.559	0.545	0.543	33	38	57	58
Rostov region	0.582	0.578	0.621	0.614	30	28	26	24
The City of Sevastopol	0.506	0.478	0.495	0.560	66	68	71	49
The Republic of Dagestan	0.398	0.382	0.413	0.422	79	79	79	79
The Republic of Ingushetia	0.394	0.361	0.368	0.359	82	82	82	82
The Kabardino-Balkarian Republic	0.397	0.379	0.404	0.383	81	80	80	81
The Karachay-Cherkess Republic	0.477	0.416	0.478	0.449	73	78	76	77
The Republic of North Ossetia-Alania	0.487	0.461	0.466	0.480	71	72	78	73
The Chechen Republic	0.402	0.379	0.384	0.396	78	81	81	80
Stavropol region	0.577	0.587	0.622	0.598	34	24	25	33
The Republic of Bashkortostan	0.568	0.535	0.593	0.586	38	50	38	41
The Republic of Mari El	0.464	0.474	0.541	0.552	75	69	58	56
The Republic of Mordovia	0.549	0.531	0.550	0.558	49	53	55	51
The Republic of Tatarstan	0.662	0.605	0.667	0.681	7	16	10	3
The Udmurt Republic	0.552	0.531	0.561	0.560	47	52	53	50
The Chuvash Republic	0.536	0.483	0.514	0.526	55	66	69	66
Perm region	0.619	0.575	0.654	0.641	18	30	14	16
Kirov region	0.530	0.547	0.581	0.550	59	45	43	57
Nizhny Novgorod region	0.620	0.609	0.655	0.637	17	15	13	19
Orenburg region	0.563	0.555	0.615	0.599	42	40	30	31
Penza region	0.577	0.568	0.608	0.599	35	33	33	32
Samara region	0.620	0.601	0.659	0.612	16	18	12	25
Saratov region	0.596	0.550	0.599	0.565	24	43	35	47
Ulyanovsk region	0.530	0.495	0.538	0.556	58	61	60	54
Kurgan region	0.523	0.502	0.490	0.498	60	57	72	72
Sverdlovsk region	0.639	0.618	0.668	0.602	11	11	9	29
Tyumen region	0.629	0.595	0.643	0.653	13	19	17	9
Chelyabinsk region	0.612	0.614	0.644	0.642	21	13	16	15
Altai Republic	0.535	0.533	0.530	0.556	57	51	66	55

Table 2 (continued)

Territory (Russian region)	The value of the investment attractiveness index of the Russian region				Place of a constituent entity of the Russian Federation in the ranking of investment attractiveness			
	2019	2020	2021	2022	2019	2020	2021	2022
The Republic of Tyva	0.436	0.444	0.483	0.462	77	75	75	76
The Republic of Khakassia	0.504	0.440	0.630	0.648	67	77	23	13
Altai region	0.556	0.581	0.614	0.593	46	27	31	38
Krasnoyarsk region	0.691	0.645	0.698	0.660	3	7	3	8
Irkutsk region	0.669	0.642	0.672	0.674	4	8	8	4
Kemerovo region	0.536	0.483	0.635	0.636	56	67	21	20
Novosibirsk region	0.634	0.615	0.677	0.672	12	12	7	5
Omsk region	0.588	0.589	0.613	0.617	28	22	32	23
Tomsk region	0.584	0.526	0.595	0.603	29	55	37	28
The Republic of Buryatia	0.548	0.565	0.585	0.597	51	34	41	34
The Republic of Sakha (Yakutia)	0.548	0.543	0.563	0.574	52	49	51	46
The Trans-Baikal region	0.548	0.510	0.533	0.539	50	56	65	59
Kamchatka region	0.582	0.612	0.631	0.532	31	14	22	61
Primorye region	0.521	0.491	0.525	0.514	61	64	67	69
Khabarovsk region	0.592	0.593	0.623	0.595	27	21	24	36
Amur region	0.580	0.556	0.541	0.507	32	39	59	70
Magadan region	0.655	0.622	0.637	0.592	8	10	20	39
Sakhalin region	0.594	0.586	0.620	0.630	26	25	28	21
The Jewish Autonomous region	0.470	0.443	0.485	0.504	74	76	74	71
Chukotka Autonomous region	0.565	0.549	0.533	0.475	41	44	63	75

Source: Compiled by the authors.

As presented in *Table 3*, all the constituent entities of the Russian Federation can be correctly attributed to a specific cluster (with the individual approximation error not exceeding 5%).

The distribution of Russian regions by investment attractiveness and their cluster structure are shown in *Fig. 1* and *2*.

As presented in *Fig. 1*, all the constituent entities of the Russian Federation, based on the achieved index values, can be correctly grouped into three clusters characterized by above-average, average and below-average levels of investment attractiveness. In the analyzed period (with the exception of the reporting year), the Republic of Bashkortostan was consistently included in the second cluster, which is consistent with the results of the ranking of the country's territories. The specified region occupied almost the median position in the ranking, with the exception of 2020 (there was a failure, and the republic, with an index value of 0.535, fell back to 50th place).

Table 3

Assessing the Adequacy of Cluster Analysis Results

Year	Maximum error	Average error	Recognized, %
2019	$2.32 * 10^{-3}$	$3.63 * 10^{-4}$	100
2020	$2.65 * 10^{-3}$	$3.75 * 10^{-4}$	100
2021	$3.82 * 10^{-3}$	$3.61 * 10^{-4}$	100
2022	$7.19 * 10^{-3}$	$3.54 * 10^{-4}$	100

Source: Compiled by the authors.

As presented in *Fig. 2* over the entire analyzed period of time, there was an increase in the quality of the formed cluster structure (in terms of investment attractiveness) of the constituent entities of the Russian Federation.

Thus, there was a significant (almost twofold) increase in the share of Russian regions with an above-average level of investment attractiveness. For the above reason, the total share of the constituent entities of the Russian Federation included in the first and second clusters reached 87.8% by 2022. Despite this, there are currently no Russian regions characterized by high investment attractiveness. Further, using AI, also in the demo version of the Deductor Studio Lite software product, a promising assessment of investment attractiveness is carried out using the example of two regions-the leaders of the rating and the Republic of Bashkortostan. For this purpose, a Bayesian ensemble of neural network models of topology multilayer perseptron of different configurations is formed (*Table 4*).

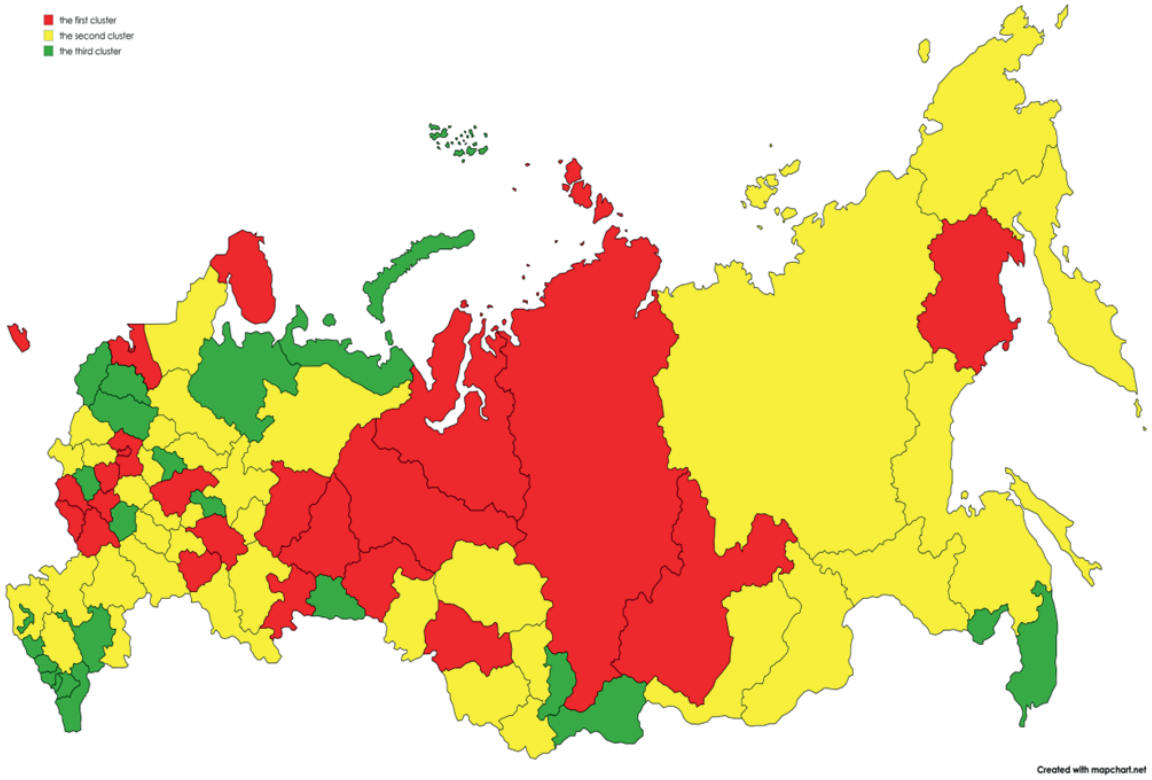
The output indicator of the models is the index value, and the input variables are the first and fourth sub-indexes. Due to the relatively small number (148) of observations, they completely constitute a training sample (without a teacher). The indicated number of observations included indicators for 2019–2022 for 36 regions from 3 federal districts (Central, Northwestern and Southern), as well as the Republic of Bashkortostan, which is part of the Volga Federal District.

Adequate neural network models were included in the Bayesian ensemble (*Table 5*).

As presented in *Table 5*, the average approximation error for the Bayesian ensemble was 2.6% and varied in the context of neural network models in the range from 2.2 to 2.8%. Most (three out of five) of the neural network models made it possible to correctly (with an individual approximation error within 8%) almost completely (over 98%) recognize all observations. About 83–93% of the "good" ones (the individual approximation error did not exceed 5%). The points were guaranteed by each of the neural network models included in the Bayesian ensemble. Hence, it allows you to obtain a promising assessment of investment attractiveness with a high degree of accuracy.

Fig. 3 shows the results of forecasting (for 2024–2025) for the leading regions and the Republic of Bashkortostan.

This forecast is based on the planned values (targets) of the first and fourth sub-index in the amount of 0.65 / 0.67 and 0.76 / 0.77; 0.7 / 0.71 and 0.73 / 0.75; 0.58 / 0.6 and 0.66 / 0.67, respectively, for the cities of Moscow, St. Petersburg and the Republic of Bashkortostan for 2024 / 2025. According to the results of the prospective assessment, the city of Moscow with an index value of 0.719 / 0.724 is expected to occupy a leading position with some margin from St. Petersburg (0.716 / 0.72). At the same time, the performance indicator for the Republic of Bashkortostan is also projected to grow by 3.6% in 2024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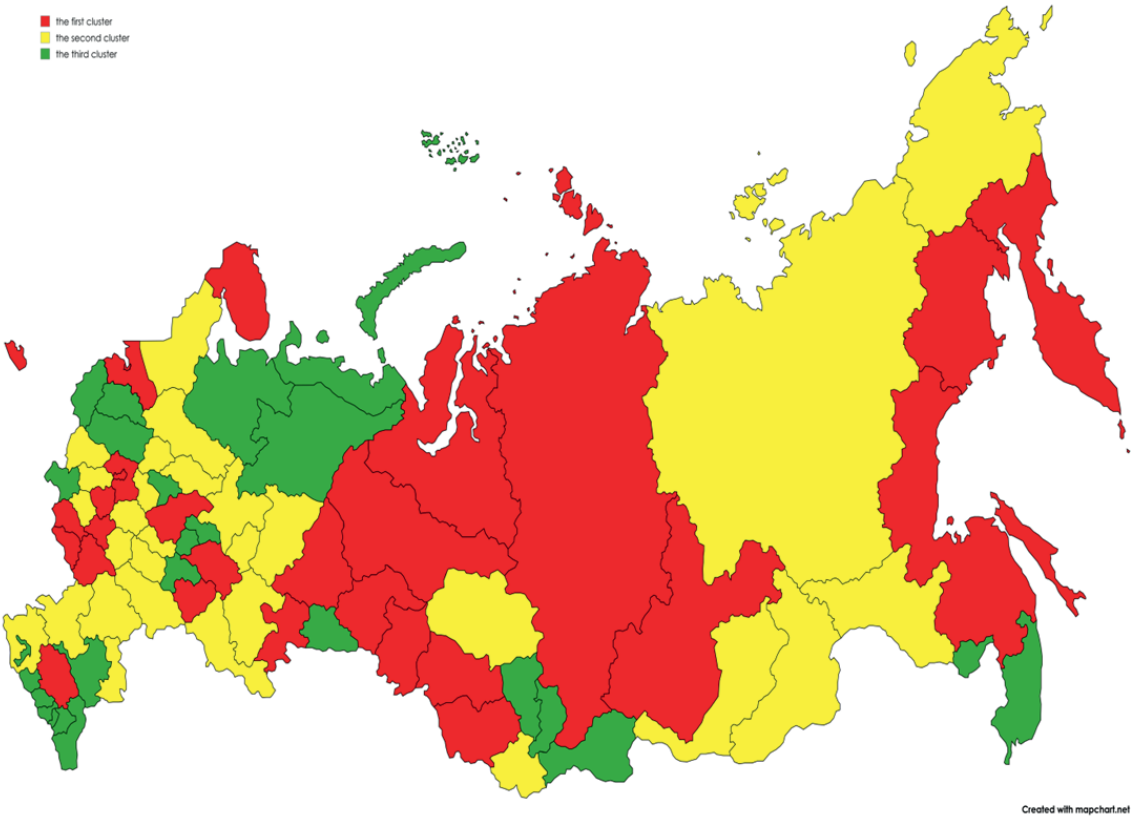
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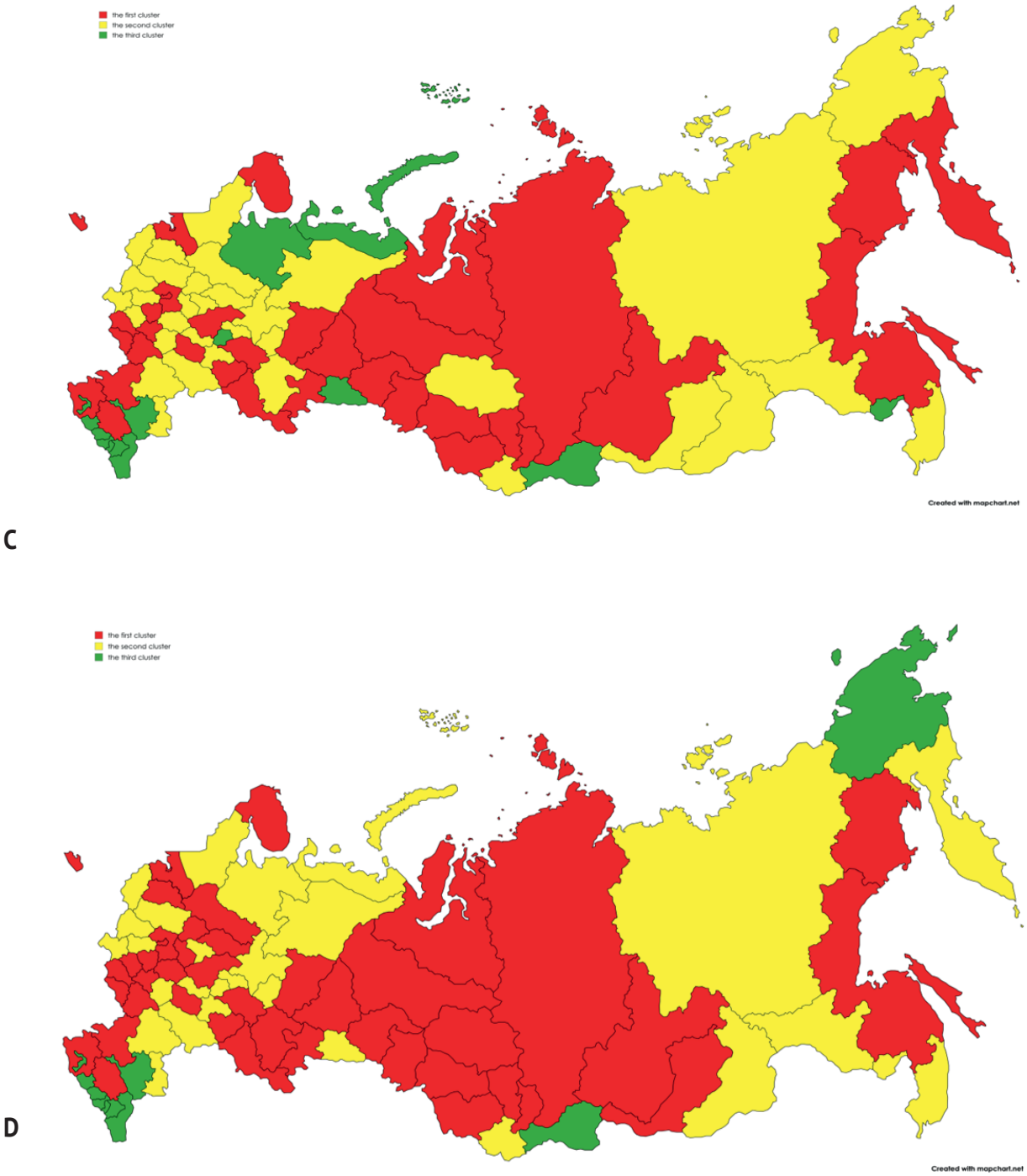

Fig. 1. **Distribution of Russian Regions by Investment Attractiveness in 2019–2022**

Note: The Republic of Crimea and the city of Sevastopol belonged to the 3rd and 2nd cluster in 2019–2021 and 2022

Source: Authors' calculations.

and by 2.8% in 2025. However, in 2024–2025, a significant gap in the index value between the cities of Moscow / St. Petersburg and the Republic of Bashkortostan is expected to remain.

Therefore, based on the results of the empirical study, the conclusion can be drawn that the leading regions currently have significant reserves for increasing investment attractiveness.

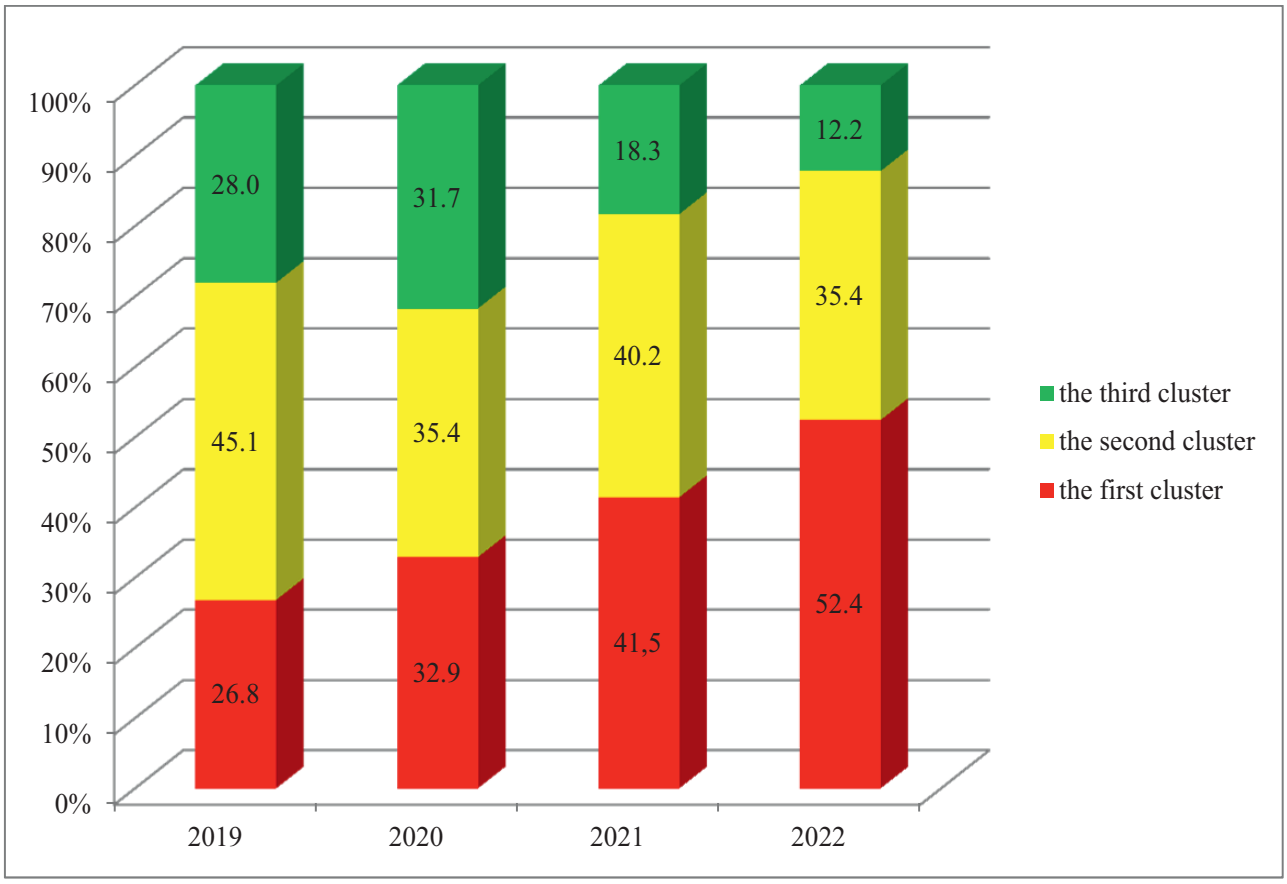

Fig. 2. **Cluster Structure of the Constituent Entities of the Russian Federation (by Level of Investment Attractiveness)**

Source: Authors' calculations.

Table 4

Configuration of Neural Network Models Included in the Bayesian Ensemble

Neuromodel number	Hidden layers	Number of neurons in 1st / 2nd hidden layer
1st	1	4 / –
2nd	1	6 / –
3rd	1	8 / –
4th	2	4 / 6
5th	2	6 / 8

Source: Compiled by the authors.

CONCLUSIONS

To date, a fairly large amount of scientific literature has been accumulated on assessing the investment attractiveness of a territory (country, region, or municipality). At the same time, only index (statistical) methods ensure the objectivity of the final evaluation results. The concept of the balanced scorecard by D. Norton and R. Kaplan is quite popular abroad. However, it is used exclusively for micro-level management. In the work of Russian scientists [20, 21], the concept was

Table 5

Assessing the Adequacy of Neuromodeling Results

Neural network model	Average approximation error, %	The number of correctly recognized observations		Percentage of correctly recognized observations, %		The largest approximation error, %
		ε < 5%	ε < 8%	ε < 5%	ε < 8%	
1st	2.8	131	88.5	142	95.9	11
2nd	2.6	127	85.8	147	99.3	9.4
3rd	2.8	124	83.8	146	98.6	9.5
4th	2.7	128	86.5	143	96.6	12.1
5th	2.2	138	93.2	148	100	7.4
The ensemble of neuromodels	2.6	130	87.6	145	98.1	9.9

Source: Compiled by the authors.

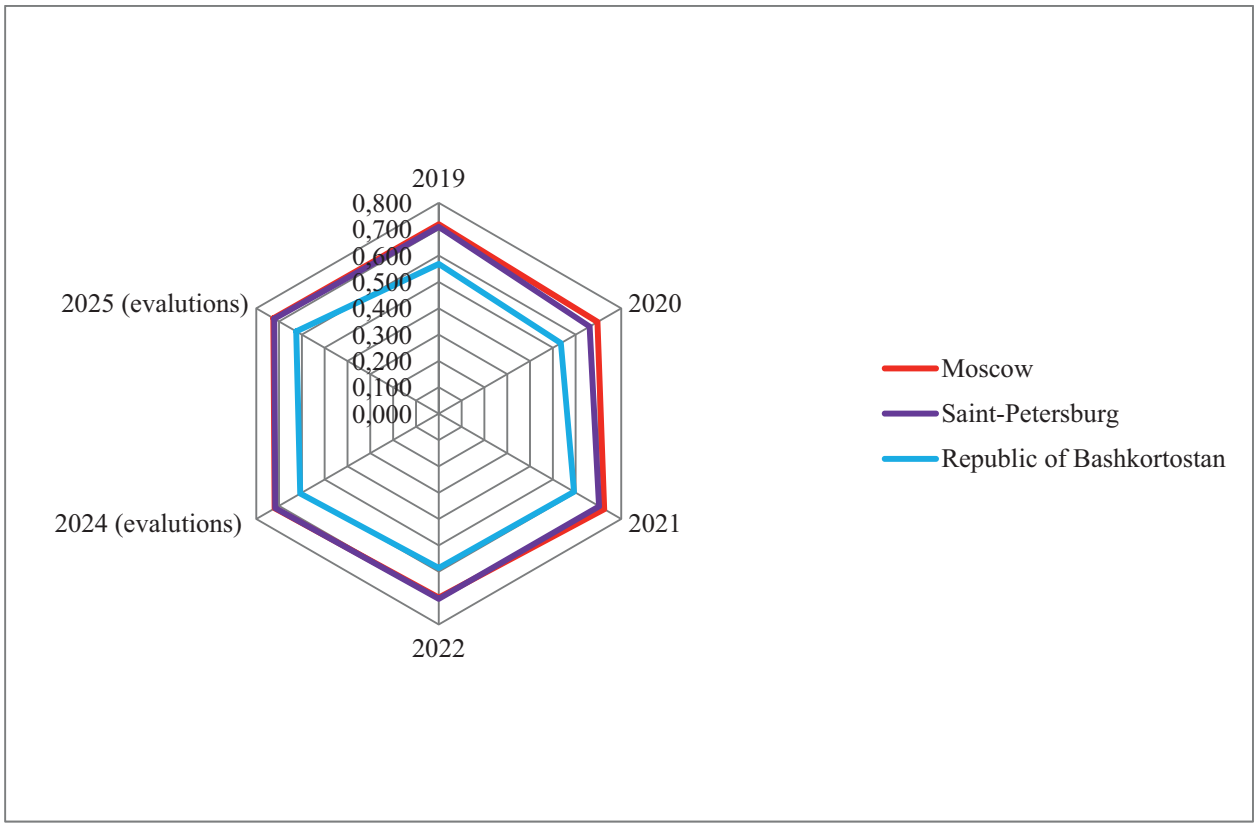

Fig. 3. **Prospective Assessment of the Investment Attractiveness of the Leading Regions and the Republic of Bashkortostan**

Source: Authors' calculations.

adapted to the specifics of the territory for the first time.

When constructing the index of investment attractiveness of Russian regions, a balanced data system is also used in this work. At the same time, the number of indicators is optimized (in the direction of decreasing) in comparison with the above work. In terms of the methodology for calculating the index, the current study takes into account the peculiarities of ranking the subjects of the Russian Federation by the level of innovative development proposed by the Higher School of Economics.[4]

In comparison with well-known methods, the author's approach is not limited to a retrospective assessment of the investment attractiveness of Russian regions. Thus, with the help of AI, clusterization and forecasting of the investment attractiveness of the subjects of the Russian Federation are consistently carried out. The results of the empirical study can serve as a scientific basis for improving the regional investment policy of any Russian region. The decomposition of the final assessment will make it possible to identify areas (on a differentiated basis) for increasing the investment attractiveness of almost every constituent entity of the Russian Federation.

[4] Rating of innovative development of constituent entities of the Russian Federation. Issue 7. Moscow: National Research University Higher School of Economics, 2021. URL: https://www.hse.ru/primarydata/rir2021?ysclid=m85jf5n9ej741632923 (accessed on 10.10.2024).

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R.V. Gubarev — literature review, general edition of the article.
E.I. Dzyuba — cluster analysis, prospective assessment of the investment attractiveness of the subjects of the Russian Federation.
R.S. Haziev — retrospective assessment of the investment attractiveness of the subjects of the Russian Federation.

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Digital Investment Toolkit: Improving the Conceptual Framework

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ABSTRACT

The article develops the issues of application in investment practice of a number of official terms related to the turnover of digital financial assets as a **subject of research**. Their economic and legal content in the focus of the **research objective** is achieved by solving scientific **tasks** — determining the functional purpose of monetary claims as one of the types of digital financial assets and critically evaluating the relevant conceptual apparatus available in the current regulatory framework. Combination of general scientific, private scientific and special methods of cognition is used on the **methodological basis** of materialistic positivism. The **doctrinal sources** were the relevant scientific works of domestic and foreign authors, the materials of the **official statistics** of the Bank of Russia, credit institutions, professional participants in the financial market, specialized companies-operators as of Q1 2025 were used as a statistical base. As a **result**, an empirical study of investment transactions made it possible to reveal the investment and economic content of digital financial assets in terms of their first variety — monetary claims. The **conclusions** were substantiated that the current regulatory provisions of Federal Law No. 259-FZ dated 31.07.2020 require adjustments in terms of clarification of both individual definitions and interpretations of a number of provisions concerning the conceptual apparatus. Based on the identification of the economic and legal nature and interpretation of type elements of the investment toolkit of digital financial assets, the authors propose relevant recommendations.

Keywords: digital financial assets; monetary requirements; digital bonds; investment technology

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INTRODUCTION

The classic methods of financial support for business activity, such as debt (bonds, promissory notes) and equity (shares, participation interests) financing, still prevail. At the same time, it is natural and expected that in the digital economy of modern Russia, these methods will be modernized and digitized. Along with this, an integral element of this modernization is the all-pervasive information and telecommunications network "Internet", the use of which undoubtedly reduces transaction costs, increases the speed, convenience, and security of operations.

Digital investment tools as a financial technique for investing capital and financing entrepreneurial projects through Internet communications are becoming a notable practice of economic relations. Thus, the Federal Law 'On Digital Financial Assets, Digital Currency and on Amendments to Certain Legislative Acts of the Russian Federation' dated 31.07.2020 No. 259-FZ (Federal Law dated 31.07.2020 No. 259-FZ)[1] came into force in 2021. Although the volume of transactions with digital financial assets in comparison with the exchange turnover of equity securities looks very modest, this investment technology is developing, further scientific development and improvement of its conceptual apparatus seem relevant.

The economic and legal nature of digital financial assets is expressed by the normatively

[1] Federal Law "On Digital Financial Assets, Digital Currency and Amendments to Certain Legislative Acts of the Russian Federation" dated July 31, 2020 No. 259-FZ. Collection of Legislation of the Russian Federation. 2020. No. 31 (Part I). Art. 5018.

regulated information technology of remote application of digital ways of fixing transactions and simultaneously four virtual constructions for remote investment and financial interaction of investment recipients and investors. As investment tools, digital financial assets are crypto-secured computer data accessible via Internet communications only to authorized users. Being simultaneously objects of investment, they, as legally significant equivalents, mediate four digital images of economic relations between the investor and the recipient of the investment (issuer): a liquid claim is a bearer obligation that allows for fragmentation; the equivalent of a classic equity security (a share of a non-public joint-stock company, a bond, an issuer's option, a Russian depositary receipt) with a fractional face value; a digital version of a share of a non-public joint-stock company that is created, exists, and is terminated in an information system; the equivalent of a classic depositary receipt with a variable number of equity securities received.

As a subject of research, the authors develop issues of applying a number of legitimate terms related to the turnover of digital financial assets in investment practice. The identification of their economic and legal content in the focus of the research goal is achieved by solving scientific problems — determining the functional purpose of monetary claims as one of the types of digital financial assets and critically evaluating the relevant conceptual framework available in the current regulatory framework. On the methodological basis of materialistic positivism, general scientific, private scientific and special methods of cognition are used in combination. The doctrinal sources were the relevant scientific works of domestic and foreign authors, and the materials of official statistics of the Bank of Russia, credit institutions, professional financial market participants, and specialized companies-operators as of the first quarter of 2025 were used as an empirical base.

LITERATURE REVIEW

The economic and legal nature and functionality of monetary claims as part of digital financial asset varieties are presented for the first time at the level of a research article, although scientists are continuously investigating many aspects of investment relations. The activation of investment dynamics is a determining factor of the new growth model of the Russian economy [1]. E.A. Vasin correctly notes that when evaluating development projects, it is necessary to take into account whether the investment direction corresponds to the adopted long-term economic development strategy of the country [2]. Thus, N.G. Ivanova defines the key role of long-term investments in ensuring stable economic growth and job creation, and attaches great importance to creating basic conditions favorable for long-term investments, including investments in infrastructure, small and medium-sized enterprises [3]. In the coming years, the most important requirement for economic dynamics is an increase in living standards with an outstripping increase in investments in fixed assets [4].

Currently, the development of the Russian financial market is one of the most important strategic tasks of the country's leadership [5]. As is known, financial markets contribute to economic growth [6, p. 14], but limited sources of financing for Russian companies hinder the development of their business and act as one of the important factors slowing down the national economy [7, p. 97]. We agree with the extensive involvement of the Bank of Russia's resources in the formation of investment funds, which was discussed by V.V. Maslennikov and M.R. Pinskaya [8, p. 36].

Y.M. Mirkin and others came to the conclusion that the "young" Russian stock market is developing today due to the influx of young investors, those who are receptive to everything new, despite the risks [9]. At the same time, financial innovations not only serve progress, but also act as important sources of instability and instability of both

finance and the economy as a whole [10]. At the present stage of development, a relevant part of financial resources is attracted through the issue of securities [11]. We agree that conservative investors who are not ready for risks can use federal loan bonds. Investors who are willing to take risks and expect higher returns can invest in stocks and corporate bonds [12, p. 35]. In this regard, of practical interest is the conclusion of N.V. Popova that at fixed values of the main parameters of the bond with increasing frequency of coupon payments the sequence of duration values is decreasing [13]. And also her conclusion that the yield to maturity determined by the method of nominal interest rate in studies can lead to incorrect results, unlike the yield to maturity in the form of effective interest rate [14].

A. G. Arakelyan correctly notes that the Russian financial system has traditionally relied on bank financing rather than financial markets or institutional investors [15]. We cannot support the position defended by A.N. Zubets that banks should make room for new players in the public investment market, such as cooperative investment communities, which have been given an impetus to development thanks to the Internet and other information technologies [16]. For example, PJSC "ALFA-BANK" has been leading the digital financial assets market for the past two years [17]. The development of fintech requires a fundamental shift in the skills of financial, banking, and business professionals. The spontaneous formation of digital society is not acceptable and could lead to the proliferation of alternative finance beyond legal frameworks [18]. The restructuring of the financial sector's architecture is due to the use of advanced financial technologies. Banks and financial institutions are creating their own unique ecosystems through these technologies [19].

L.P. Goncharenko and T.M. Gerashchenkova emphasize that the introduction of innovations, timely attraction in the required volumes and optimal use of investment resources in combination with the optimization of trade and investment regimes, improvement of financial market mechanisms, and development of infrastructure should not only ensure the successful implementation of the adopted innovation and investment strategy, but also stimulate in the long term the creation of new investment objects, the formation of a transfer of advanced technologies [20]. N.M. Sabitova correctly points out that in the Russian financial literature there is no consensus in views on the conceptual apparatus, although in recent years there has been a movement indicating the desire of the scientific community to change established views [21]. We support S.B. Pestov in that it is advisable to more widely involve leading scientists in the development and discussions of proposed changes to legislation in order to ensure adherence to fundamental economic and financial concepts and rules [22].

Russia's transition from the consumption of foreign technologies of the digital economy, to the paradigm of producing its own innovative products that can compete and even be beyond competition in the global market is necessary [23]. These models are a new focus for small and medium-sized enterprises and investors [24]. Financial technologies in Russia are developing rapidly, there are prospects for their further development through increased investment [25]. We agree with Academician of the Russian Academy of Sciences S. Yu. Glazyev that even in the catastrophic scenario of the global crisis, Russia has necessary resources not only for survival, but also for advanced development [26].

Digitalization is expressed 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 creation of new products and services in the financial market [27]. In 2018, V.A. Varnavsky spoke about the need for legal regulation of the circulation of digital units of account. The beginning of such legislation in Russia was laid in 2020.along with the regulation of digital currency, we can

talk about digital investment units [28]. We consider digital financial assets to be advanced technologies of the sixth technological order [29]. Professor D. A. Kochergin interprets stablecoins as a new hybrid type of digital financial assets: they are issued by identified issuers based on the blockchain in the form of circulating digital obligations or depositary receipts that can be used as a means of exchange, savings and payment [30]. A. O. Ovcharov and V. A. Matveev refers to cryptocurrencies as digital financial assets, however, the Russian legislator initially clearly distinguishes these categories in the very name of the basic regulatory act [31]. This is also confirmed in [32].

It was noted above that monetary claims have not been studied in the literature as a type of digital financial assets. Let us clarify that there are a number of scientific papers that reveal the legal constructions of monetary claims themselves and their assignment, for example, [33, 34], etc.

DEVELOPMENT OF INVESTMENT TECHNOLOGY OF DIGITAL FINANCIAL ASSETS

Only specialized organizations with a team of highly qualified specialists, powerful computer equipment with sophisticated software, and capital of at least 50 million rubles are allowed to issue digital financial assets. The Bank of Russia verifies such applicants by analogy with the licensing procedure for professional securities market participants, but instead of issuing a license, if the Mega-Regulator makes a positive decision, the company that meets all the requirements is included in the Register of Information System Operators that issue digital financial Assets. Therefore, in our financial market, the potential number of such, figuratively speaking, "emission centers" of digital financial assets is unlimited. The dynamics of admission of information system operators to the Russian financial market is reflected in *Table 1*.

As presented in *Table 1,* the preparation and understanding of innovative investment technology was carried out throughout 2021, and in 2022, LLC "Atomize", part of the "Rosbank" ecosystem, was registered as the first operator of the information system in which digital financial assets are issued on 02.03.2022, followed by PJSC "Sberbank" and LLC "Lighthouse" on 03.03.2022 (part of the ecosystem of PJSC "VTB") As of the first quarter of 2025, 7 of all 15 operators are commercial banks (both directly and as final beneficiaries). Credit institutions have always shown interest, conducted large operations, had a full range of licenses to work in the investment segment of the financial market, and new digital investment tools are also in the focus of their attention.

The amount of financial resources that are involved in business projects using digital financial assets so far looks like pilot operations. For example, let's pay attention only to classic bonds: in February 2024, the trading volume of corporate, regional and government bonds amounted to 1.6 trillion rubles. The average daily trading volume is 82.3 billion rubles; in February 2024, 70 bond loans totaling 3.2 trillion rubles[2] were placed on the Moscow Stock Exchange. The financial parameters of the careful use of digital financial assets are shown in *Table 2*.

As presented in *Table 2*, the efforts of recipients of investments in cooperation with information system operators have not yet reached the level of one-day exchange turnover for classic bonds on the Russian market for the entire year 2023. It should also be noted that by the end of February 2024, the number of individuals with brokerage accounts on the Moscow Stock Exchange had exceeded 30.7 million and they had opened 54.3 million accounts. In February, 4.1 million private investors made trades on the Moscow Exchange. The proportion of

[2] Moscow Exchange summed up the results of trading in February 2024. PAO Moscow Exchange: official website. URL: https://www.moex.com/n68094 (accessed on 18.03.2024).

Table 1

Dynamics of Admission of Information System Operators to the Financial Market

Year of inclusion in the Register of the Central Bank of the Russian Federation	Information System operators, in which the issue is carried out digital financial assets	Total in Russia
2021	no	0
2022	LLC "Atomize"	
	PJSC "Sberbank"	
	LLC "Lighthouse"	3
2023	JSC "ALFA-BANK"	
	LLC "Distributed Registry Systems"	
	LLC "Tokens — Digital Investments"	
	JSCB "EUROFINANCE MOSNARBANK"	
	PJSC "St. Petersburg Stock Exchange"	
	LLC "Blokcheyn Hub"	
	JSC "NGO National Settlement Depository"	7
2024	JSC "TBank"	
	LLC "Tokenik"	
	LLC "VTB Capital Trading"	
	JSC "Interregional Registrar Center"	4
2025 (1st quarter)	LLC "BKS Company"	1
2021–2025 (1st quarter)	TOTAL:	15

Source: Compiled by the authors according to the data of the Bank of Russia.

individuals in terms of stock trading volume was 76%, bond trading volume — 33%, spot currency market volume –12% and futures market volume –62%.[3] By its instruction, the Bank of Russia[4] has established the composition and procedure for submitting mandatory reporting on transactions with digital financial assets. Based on *Table 3,* compiled according to regulatory reporting data, it is possible to estimate the number and composition of investors investing in digital financial assets. The tabular data shows that the number of registered users at the end of 2023 exceeded 92 thousand individuals, and the number of active users on the specified date exceeded 24 thousand individuals. The number of legal entity investors has increased

[3] More than 4 million private investors concluded transactions on the Moscow Exchange in February. PJSC "Mosbirzha": official website. URL: https://www.moex.com/n68157 (accessed on 20.03.2024).

[4] Bank of Russia Instruction No. 6243-U dated September 21, 2022 "On the Procedure and Timeframes for Compiling and Submitting to the Bank of Russia Reports of Investment Platform Operators, Reports of Financial Platform Operators, Operators of Information Systems in Which Digital Financial Assets Are Issued, and Operators of the Exchange of Digital Financial Assets, the Form of Reports of Investment Platform Operators and the Composition of Information Included Therein, the Composition and Forms of Reports of Financial Platform Operators." Bank of Russia Bulletin. March 7, 2023. No. 14–15.

Table 2

Dynamics of Resource Attraction Based on Investment Technology of Digital Financial Assets for the Period 2023–2024

		January	December 2023	January	February 2024
No.	Operator of the information system	number of placements	volume of placement, billion rubles	number of placements	volume of placement, billion rubles
1	LLC "Atomize"	152	1.523 682	16	0.020 677
2	JSC "ALFA-BANK"	72	32.741 796	15	4.183 185
3	PJSC "Sberbank"	57	1.811 579	4	0.002 287
4	LLC "Distributed Registry Systems"	8	15.116 847	2	0.101 000
5	LLC "Lighthouse"	5	5.785 000	*	*
6	JSC "NGO National Settlement Depository"	4	0.425 000	*	*
7	LLC "Tokens — Digital Investments"	4	0.433 900	*	*
8	LLC "Blokcheyn Hub"	2	0.340 000	*	*
9	JSCB "EUROFINANCE MOSNARBANK"	1	0.100 000	1	0.515 200
10	PJSC "St. Petersburg Stock Exchange"	0	0	1	0.016000
	TOTAL:	305	58.277804	39	4.838 349

Source: Compiled by the authors according to the data of the operators indicated in the table.

Note: * no operations were performed in January-February 2024.

over the period 2023 more than 2 times — from 22 to 46. As a result, by the beginning of 2024, 56.049 people and 45 companies owned digital financial assets.

Next, we will discuss the financial and economic content of investment instruments, which are produced in the largest number by operators in their information systems. The operator of LLC "Atomize", for example, in March 2024 issued digital financial assets — monetary claims under the offer of LLC "Tochka Commercial Finance" in the amount of 200 units, each for 1 million rubles for the period until 28.12.2024. It provides for the monthly payment of additional income as a percentage per annum of the nominal value of digital financial assets in the amount of: the key rate of the Central Bank of the Russian Federation in the corresponding month plus 1 (unit).[5]

JSC "ALFA-BANK", as an information system operator, issued digital financial assets only in the form of monetary claims during March 2024.

[5] Decision on the issue of digital financial assets No. 1 (digital rights, including monetary claims) of LLC "Tochka Commercial Financing". LLC "Atomize": official website. URL: https://atomyze.ru/files/Reshenie-o-vypuske-CFA-NDM-TKF.pdf (accessed on 18.03.2024).

Table 3

Dynamics of Turnover and Number of Holders of Digital Financial Assets for the 2023

The name of the indicator	Unit of measurement	30.06.2023	30.09.2023	31.12.2023
The number of active issues of digital financial assets and other digital rights posted in the information system as of the end of the reporting quarter	Pcs.	35	106	252
The total value of current issues of digital financial assets and other digital rights hosted in the information system as of the end of the reporting quarter	Million rubles	17.065	30.089	56.362
The cost of contracts (transactions) concluded in the information system for the reporting quarter	Million rubles	17.061	14.266	32.415
acquisition upon release of an asset	Million rubles	17.061	14.066	31.873
asset sale	Million rubles	0	200	541
Number of registered users as of the end of the reporting quarter	People	46.571	61.748	92.494
individuals	People	46. 506	61. 645	92. 308
legal entities	People	65	103	186
Number of active users as of the end of the reporting quarter	People	5.091	26.817	24.843
individuals	People	5.069	26.789	24.797
legal entities	People	22	28	46
The number of holders of digital financial assets and other digital rights, as of the end of the reporting quarter	People	5.090	31.781	56.094
individuals	People	5.069	31.762	56.049
legal entities	People	21	19	45

Source: Compiled by the authors according to the data of the Bank of Russia.

Each decision states that "Each CFA certifies the Investor's monetary claim against the Issuer and grants the Investor the right to receive from the Issuer a monetary amount in the amount of the Purchase Price of the CFA upon their release within the maturity period and additional income stipulated in this Decision on the CFA issue".[6] We also note that the website of this operator highlights the types of digital financial assets, and monetary claims are highlighted

[6] Decision No. FSK-1-DT-092024–00001 on the issue of digital financial assets (right of monetary claim) dated 01.03.2024 LLC. "FSK Group of Companies". JSC "ALFA-BANK": official. website. URL: https://alfabank.ru/corporate/digital-assets/ See there: Decisions No. ALFB-1-DTD-122024–00072 and No. ALFB-1-DTD-092024–00073 on the issue of digital financial assets (right of monetary claim) dated 04.03.2024, No. ALFB-1-DTD-092024–00073 dated 13.03.2024 JSC "ALFA-BANK"; Decision No. LKMB-1-DT-092025–00001 on the issue of digital financial assets (right of monetary claim) dated 14.03.2024 by LLC 'Leasing Company of Small Business of the Republic of Tatarstan'; Decision No. KLS-1-DT-032025–00001 on the issue of digital financial assets (right of monetary claim) dated 19.03.2024 by LLC "KLS-Trade" (accessed on 19.03.2024).

as one type, stating that "This type of CFA is similar to ordinary bonds. Their owners receive a fixed income in the form of payments from the issuer. And on the repayment date, the initial cost is also returned to the investor. The investor knows the amount of payments in advance — they are calculated in% per annum".[7] In our opinion, the term type should not be used to distinguish monetary claims from all variants of digital financial assets, since it is the types of digital financial assets that are fixed in regulatory documents. An analysis of the mentioned solutions of the information system operator, JSC "ALFA-BANK", confirms that in all operations the investor invests his capital at an interest rate. For example, in the Decision dated 19.03.2024, LLC "KLS-Trade" stated that the obligation was given by this company for 1 year (until 25.03.2025), while specifying a schedule for the payment of additional income on digital financial assets once a month, starting on 26.04.2024 and ending on 25.03.2025 in the amount of 1.000 rubles nominal value 16–66 rubles (for example, 28.10.2024).[8]

On 16–21.03.2024, PJSC "Sberbank", under the offer of JSC "Perm Plant of Metalworking Centers Joint Technological Enterprise", issued digital financial assets — monetary claims — with a nominal value of 1.000 rubles, a maximum number of 20.000 pieces for a period up to 18–23.12.2024, on the terms that for 1 digital financial asset submitted for execution (repayment), due to be paid 1.150 rubles. As you can see, the recipient of the investment is thus provided with a loan of 20 million rubles at 15% for a period of 9 months.[9] Since the beginning of March 2024 three more issues of digital financial assets were also issued in the form of monetary claims.

On 11–14.03.2024, the operator of LLC "Distributed Registry Systems" issued digital financial assets under the offer of LLC "FINTEK" — monetary claims — nominal value of 100.000 rubles, maximum quantity of 100 pcs. for a period until 01.03.2030 with the payment of income of 17% per annum. In January 2024 and throughout 2023, LLC "Evolution" issued only monetary claims based on the decisions of the investment recipients.: LLC "TIM FORCE Management", JSC "INVEST-POLIS", LLC "Bitriver Rus", LLC "YFT System", JSC "Russian Railways", LLC "Inco-Energo".

During 2022, LLC "Lighthouse" carried out 4 issues, and during 2023–5 issues of digital financial assets, all in the form of monetary claims. For example, in accordance with Decision No. 9 on the issue of digital financial assets with payment in cash dated 12.26.2023, 100 units with a nominal value of 500.000 rubles were issued under the offer of JSC "Intersectoral Investment Agency" for a period until 25.12.2024. For every six months, additional income is provided as a percentage per annum of the nominal value of digital financial assets in the amount of the key rate of the Central Bank of the Russian Federation for the corresponding period plus 2.85.[10]

It should be noted that the Operator of LLC "Lighthouse", without any justification, writes the word "token" in parentheses after "digital financial assets" as an identical word, which is unacceptable.

The operator of NPOs, JSC "National Settlement Depository", carried out 4 issues during 2023, and 1 issue of digital financial assets in March 2024, all in the form of monetary claims. Thus, according to the offer of JSC "All-Russian Regional Development Bank" on 19.03.2024, 200.000 digital financial assets with a nominal value of 1.000 rubles were

[7] Digital Financial Assets. JSC "ALFA-BANK": official website. URL: https://alfabank.ru/corporate/digital-assets/ (accessed on 19.03.2024).

[8] Decision No. KLS-1-DT-032025–00001 on the issue of digital financial assets (right to monetary claim) dated 19.03.2024 LLC "KLS-Trade". JSC "ALFA-BANK": official. website. URL: https://alfabank.servicecdn.ru/site-upload/db/68/5053/reshenie_KLS-1-DT-032025–00001_19032024.pdf (accessed on 19.03.2024).

[9] Decision on the issue of digital financial assets. PJSC "Sberbank": official website. URL: https://www. sberbank.ru/common/img/uploaded/legal/docs/digital-assets/reshenie-o-vypuske-15032024.pdf (accessed on 21.03.2024).

[10] Disclosure of information. LLC "Lighthouse": official website. URL: https://www.cfa.digital/disclosure (accessed on 21.03.2024).

issued for 1 month. Repayment of obligations is provided for on 18.04.2024 in the amount of 1013–52 rubles for each monetary claim.[11] It is noteworthy that out of all 10 operators, only JSC "NSD" is systematically connected to the Operator of the exchange of digital financial assets, the Moscow Exchange.

LLC "Tokens — Digital Investments" has carried out 8 issues so far during its entire period of operation as an operator — only monetary claims. Interestingly, there have been attempts to link the additional income from digital financial assets with the prices of precious metals. The vast majority of issues involve borrowing at an interest rate. For example, on 18–20.03.2024, 300 thousand digital financial assets were issued — monetary claims with a nominal value of 10.000 rubles for the period until 19.06.2024 with payment of income: the key rate of the Central Bank of the Russian Federation for March 2024 plus 0.5% per annum.[12]

The operator of LLC "Blokcheyn Hub" issued offers in December 2023: "AFK Sistema" (for 1 year in the amount of 100 million rubles) and PJSC "MTS" (for 1 year in the amount of 240 million rubles) monetary claims. Also, on 14.03.2024, according to the offer of LLC "Devices", monetary claims were issued for 2 months until 14.05.2024 in the amount of 10 million rubles, 2 coupon periods for the payment of periodic income are provided: 13.04 and 14.05.2024. The yield is set as the sum of the key rate of the Central Bank of the Russian Federation for March 2024 plus 3% per annum.[13]

JSCB "Eurofinance Mosnarbank", as an operator, carried out 1 issue in 2023 and 5 issues of digital financial assets in 2024. For example, on 19.03.2024, monetary claims were issued under the offer of JSCB "Eurofinance Mosnarbank" for a period up to 25.03.2024 in the amount of 100 units with a nominal value of 1 million rubles with interest income accruing at a fixed rate of 15.75%. All other issues are also held in the form of monetary claims.[14]

PJSC "SPB Birzha" conducted its first pilot issue of digital financial assets in January 2024, but there is no decision on this issue on the operator's website. It is known that the issue in the form of hybrid digital rights was a test — in the amount of 16.2 thousand rubles. Investing in these investment objects gives the investor the right to receive "green certificates" and services for their further repayment, or to an alternative monetary claim. The issuer of these digital financial assets was "Carbon Zero", and "Sovcombank" was the buyer.[15]

Our empirical analysis suggests that for the past 3 years, 10 "issuing centers" have been doing almost the same thing, issuing digital analogues of non-documentary bonds. Despite this, we are convinced that the financial technology of digital financial assets is undoubtedly a step forward, because the properties of "digital bonds" are significantly better than classic stock debt instruments. Firstly, there is no need for a preliminary long-term financial and business history for the issuer; secondly, the issue prospectus and a package of other complicated documentation are not required.; thirdly, the process of issuing digital financial assets takes place within one working day; fourthly, there is no cumbersome accounting of depositories-registrars; fifthly, the entire lightweight investment structure entails a reduction in transaction costs. The small volumes of transactions reflect a lack of understanding by both issuers and investors

[11] Issue decisions. NPO JSC "National Settlement Depository": official website. URL: https://www. nsd.ru/services/tsifrovye-finansovye-aktivy/cfa/#0-widget-faq-1–0 (accessed on 21.03.2024).

[12] Issues of digital financial assets. LLC "Tokens — Digital Investments": official website. URL https://tokeon.ru/tpost/ed246ls5u1-bank-psb-2-ot-pao-promsvyazbank (accessed on 21.03.2024).

[13] Disclosure of information. LLC "Blockchain Hub": official website. URL: https://cfahub.ru/infomation (accessed on 21.03.2024).

[14] Digital financial assets. JSCB "Eurofinance Mosnarbank": official website. URL: https://evrofinance.ru/finassets/ (accessed on 21.03.2024).

[15] SPB "Birzha" is shaking up digital rights. JSC "Kommersant": official website. URL: https://www.kommersant.ru/doc/6479657 (accessed on 22.03.2024).

of the available advantages. In addition, we believe there is an inertial factor — financial market participants are accustomed to the fact that securities, even if they are non–documentary bonds, have always had a single origin center — at the lender of last resort — the Bank of Russia. In fact, the meager volume of transactions with basic digital financial assets in the form of monetary claims means that financial market participants are not at all enthusiastic about the proposed emissive decentralization, the technology needs to be modernized [35].

THE REGULATORY BASIS OF MONETARY CLAIMS AS A TYPE OF DIGITAL FINANCIAL ASSETS

In Federal Law No. 259-FZ, dated 31 July 2020, the legislator uses the rare figure of speech "digital rights, including ..." and the central definition of this law –digital financial assets — significantly depends on this expression. Digital financial assets are a legitimate type of digital rights that contain monetary claims. However, their legal interpretation is not found in the legislation, so we can metaphorically imagine a box containing digital financial assets (a type of digital right) with lollipops inside (monetary claims).

Analyzing the etymological content of the word "monetary", one can imagine that payments are expected by well-known and standard settlement means for economic relations — public money. For example, in the Explanatory Dictionary of V.I. Dahl, one can see quite informative and versatile characteristics for them. "...Money is better than a deal, i.e. give it back in cash... Bargaining is without eyes, and money is blind, for what you give, they do not see... There is a royal seal on the money... Friendship is friendship, but money counts".[16] Undoubtedly, the legislator thereby provides that at the end of the term of operation of the "digital financial assets" structure, the relationship between certain entities will end in monetary settlement. 128 of the Civil Code of the Russian Federation (Civil Code of the Russian Federation), we know that cash payments are possible — they are understood as things; non-cash payments (including digital rubles) are possible — they are understood as property rights. Considering the etymology of the word "demand", from the Explanatory Dictionary of V.I. Dahl, we note that this is a claim to a positive result of the relationship, expected in the form of an initially known outcome of the situation for the demanding: "... to harass; to seek urgently, imperiously, as a matter of course... They demand a debt from him, and for non-payment they demanded to go to court, to court. ... Written, official communication, requiring the legal release of money, supplies. The contractor releases supplies according to requirements or orders, submitting them for accounting" [36].

We come to the same conclusions by examining the general and special norms of the Civil Code of the RSFSR of 1922,[17] which state: "... the creditor (mortgagee) has the right, in case of default by the debtor of the secured claim, to receive ..." (art. 85); "... if the subject of the obligation is indivisible, debtors are recognized as joint debtors, and creditors as joint creditors, of which everyone has the right to make a claim in full". (art. 116). "A claim for defects may be submitted by the customer within six months ..." (art. 229). "Upon receipt of satisfaction from the surety, the creditor is obliged to transfer to the surety all the rights securing the claim against the debtor and the documents certifying this claim" (art. 247). Similarly, the Civil Code of the RSFSR of 1964[18] established: "By virtue of an obligation, one person (the debtor) is obliged to perform a certain action in favor of another person (the

[16] Dahl's Explanatory Dictionary online: official website. URL: https://slovardalja.net/ (accessed on 20.03.2024).

[17] Collection of laws and regulations of the Workers' and Peasants' Government, No. 71, November 25, 1922. JSC "Kodeks". URL: https://docs.cntd.ru/document/901808921 (accessed on 17.03.2024).

[18] Civil Code of the RSFSR of June 11, 1964. Bulletin of the Supreme Council of the RSFSR. June 18, 1964. No. 24. Art. 406.

creditor) ... and the creditor has the right to demand that the debtor fulfill his obligations" (art. 158). "Obligations must be fulfilled properly and on time in accordance with the instructions of the law, planning act, contract, and in the absence of such instructions — in accordance with the requirements normally imposed" (art. 168). "A joint obligation or a joint claim arises if it is stipulated by a contract or established by law, in particular, if the subject of the obligation is indivisible" (art. 180). "... A penalty (fine, fine) can only be provided for a valid claim ..." (art. 187). "A creditor who has assigned a claim to another person is obliged to provide him with documents certifying the rights of the claim ..." (art. 212). "A debtor who has delayed the fulfillment of a monetary obligation is obliged to pay three percent per annum on the overdue amount during the delay, unless a different amount of interest is established by law or contract" (art. 226). "In case of assignment of the claim ... the debtor has the right to set off against the claim of the new creditor his claim to the former creditor ..." (art. 231).

In the Civil Code of the Russian Federation, in Part One, the term "requirement" occurs at least 100 times in various contextual formulations, while "requirement" as the identity of the term "right" in the word formation "right (requirement)" we find at least 7 times. Further, by examining the norms of the code, we come to an understanding of the meaning of monetary claims. For example, in Article 25 of the Civil Code of the Russian Federation: "A citizen who is unable to satisfy creditors' claims for monetary obligations ..." In art. 147.1 of the Civil Code of the Russian Federation: "...warrant and registered securities certifying a monetary claim". In art. 149.3 of the Civil Code of the Russian Federation: "Undocumented securities certifying only the monetary right of claim...".[19] In Part Two of the Civil Code of the Russian Federation, at least 30 times we find "monetary claims", the term is revealed even more clearly. For example, in Article 824 of the Civil Code of the Russian Federation: "... to make monetary demands to debtors for payment, receive payments from debtors and make settlements related to monetary claims". 853 of the Civil Code of the Russian Federation: "The bank's monetary claims against the client related to the crediting of the account ... and payment for the bank's services ..., as well as the client's claims against the bank for the payment of interest for the use of funds ..."[20]

According to paragraph 1 of Article 382 of the Civil Code of the Russian Federation, the right (claim) belonging to the creditor on the basis of an obligation may be transferred by him to another person under a transaction (assignment of a claim). That is, first, the obligation itself is built, which will bind the debtor and the creditor. Namely, the debtor promised that he would pay a fixed amount of money within a certain period of time (transfer the goods, perform the work, provide the service, etc.), the creditor agreed to this and transferred his money (possibly not his own money, but a third party) to the debtor. After that, a claim belonging to the creditor appears — the right to receive what was promised from the debtor, and this right is ensured by the full force of the law and state coercion in case of non-fulfillment by the debtor.

From the presented hermeneutic analysis, it can be seen that in domestic legislation, in a very wide range of relations, the term "monetary claims" has been used for many decades as the creditor's legitimate right to receive a sum of money from the debtor. The modern legislator, in Federal Law No. 259-FZ dated 31.07.2020, establishes that monetary claims can be "packaged" in digital financial assets and used

[19] Civil Code of the Russian Federation (Part One) of November 30, 1994 No. 51-FZ (as amended on July 24, 2023) (as amended and supplemented, entered into force on October 1, 2023). Collected Legislation of the Russian Federation. December 5, 1994. No. 32. Art. 3301.

[20] Civil Code of the Russian Federation (Part Two) of January 26, 1996 No. 14-FZ (as amended on July 24, 2023) (as amended and supplemented, entered into force on September 12, 2023). Collected Legislation of the Russian Federation. January 29, 1996. No. 5. Art. 410.

in circulation as a type of digital rights. Digital financial assets certify a specific type of rights that the holder exercises by choosing this type at his discretion. But in pp. 10 of paragraph 1 of Article 3 of the law, we find the following expression: "... the fulfillment of obligations certified by digital financial assets, ... such obligations are secured by the property of the person issuing digital financial assets". Obviously, the legislator means exactly the same monetary requirements in this provision, but he correctly indicates that these are obligations that reveal the figure of the recipient of the investment, who issued them to attract financing. The expression of the legislator in paragraph 5.1 is erroneous and completely unsuccessful. The same article: "In the case of securing the fulfillment of obligations, the rights to which are certified by digital financial assets ...". We believe that the expression "obligations, rights under which ..." is impossible due to the obvious inconsistency, because only obligations are possible under an obligation (art. 307 of the Civil Code of the Russian Federation). In all likelihood, the legislator is again referring specifically to obligations certified by digital financial assets. The phrase from this rule should be changed: "In the case of securing the fulfillment of obligations certified by digital financial assets..."

According to the provisions of Federal Law No. 259-FZ dated 31.07.2020, a traditional debtor can reasonably be called a recipient of investments — it is a commercial organization, an individual entrepreneur, issuing monetary claims (as a type of digital financial assets) to attract monetary capital on a refundable, paid, urgent basis for the implementation of an interesting and profitable project for the production of goods, performance of work, provision of services. An investor is naturally identified with the identity of the lender — this is a person who transfers money to the recipient of investments for the purpose of incrementing them, and then receiving both investments and increments at a certain time, in a pre-calculated amount.

Using our metaphor, we note that both the business culture and the law provide that the very fact and content of the procedure for exchanging lollipops by the recipient of investments for the investor's money should be recorded. It is highly desirable that such a fixation be official, not cumbersome, fast, inexpensive and reliable. The existing structure of this procedure for digital financial assets is rational and clearly regulated. First, mutual entrepreneurial interest and contact are established between the investor and the recipient of the investment. Secondly, the amount of money, the duration and profitability of the investment are specified. Thirdly, the recipient of the investment is represented by his Decision to issue monetary claims (as a type of digital financial assets) on his own and on the website of the information system operator, which becomes a public offer of the recipient of the investment. Fourth, the investor's money is transited through the nominal account of the information system operator to the recipient of the investment. Fifth, an entry on the transfer of an asset belonging to an investor (digital monetary claims in the amount according to the transaction) by the operator is recorded in the information system (paragraph 1 of Article 2 of Federal Law No. 259-FZ dated 31.07.2020).).

RESULTS

The slender, as it may seem at first, construction of the first type of digital financial assets — monetary claims — is actually distorted, and twice. For example, the debtor wrote out a promissory note on paper — an unconditional promise to pay a certain amount and indicated in the text: the due date; the place where the payment will be made; the name of the person to whom or on whose order the payment will be made; the date and place of the bill; the signature of the drawee. Here there is a classical construction of a written monetary obligation, which has been used in circulation for centuries. A comparison of a promissory note and a digital monetary claim suggests an analogy and digitization of classic securities by the legislator with their simultaneous

qualitative improvement. Regarding a bill of exchange, the negotiable properties of a digital monetary claim are even better: firstly, paper is not needed; secondly, there is no need to write, observing the strictness of the form and all the details; thirdly, the amount can be divided and monetized in parts; fourthly, the debt can be obtained with goods. At the same time, the practice of many issues of digital financial assets by Russian information system operators in 2022–2024 confirms that promissory notes have indeed been replaced by digital financial assets. It is not difficult to identify such individual-situational operations for registration of investors' investments in short and strictly monetary obligations by several information system operators mentioned above.

Unlike the spontaneous issuance of a promissory note by the debtor for a single amount in demand at the moment, with the promise of strictly monetary debt coverage, bonds are issued in series, have the same face value within the issue, provide a yield calculated as a percentage of face value, and allow repayment by goods. The bonds are issued by the issuer, which becomes the debtor for these obligations. In our opinion, the economic and legal nature of digital financial assets — monetary claims — is most closely related to non-documentary bonds. However, it is obvious that if the lollipops are placed in a box by the recipient of the investment (the debtor), what are these requirements? As noted above, this is the first distortion. For an investor, yes, these are assets, he has invested money, has the legal right to demand their return on time, but it is not an investor who issues digital investment instruments. We believe that the term "digital bonds" fully covers the semantic aspirations of the legislator, even if he did not quite successfully apply the term "monetary claims" in Federal Law No. 259-FZ dated 31.07.2020. In our opinion, the emphasis on the strictly monetary content of this investment instrument is harmful, since it narrows down the options for settlements between the recipient of investments and the investor, however, flexibility is always useful in investment relations, settlements in non-monetary forms are quite acceptable and common. The term "digital bonds" instead of "monetary claims" could clarify and deepen the economic and legal content of the studied variety of digital investment instruments. It is familiar in the financial market; at the doctrinal level and in investment practice, corporate, discount, coupon, sub-federal, municipal, exchange-traded, federal loan bonds, mortgage-backed bonds, commodity-backed bonds, etc. are well known and widely used.

Taking the position of an investor, it can be argued that the first type of digital financial assets, monetary claim, in the course of paragraph 2 of Article 1 of Federal Law No. 259-FZ dated 31.07.2020, is an innovative digital right, which is an electronic equivalent — a certificate of an investor-creditor's claim to receive a sum of money from the debtor via Internet communication. Its innovative nature is that it is both an asset-liability (requirement-obligation) and an information token (identification code) combined. Following the spirit of the law, we come to understand that digital labeling is quite applicable to monetary obligations, and this, in turn, means that the term digital financial assets is one-sided and unsuccessful, since assets are the result of investor investments, but the recipient of investments forms liabilities.

In our opinion, without distorting the genesis of the formation of an investment relationship, namely from the first step — from the initial entrepreneurial idea of a potential recipient of investments, which at the next stages he wraps into a full-fledged business project, and then presents as a public offer to a wide range of investors, we come to understand that the recipient of investments issues digital goods and monetary obligations. The investor de facto invests precisely in the commodity-monetary obligations (promises) of the recipient of the investment, while de jure, becoming a creditor in relation to, receives a requirement corresponding to the debtor's

obligation to return the invested amount plus the payment of planned income. We believe that in paragraph 2 of Article 1 and throughout the entire text of Federal Law No. 259-FZ dated 31.07.2020, the term "monetary claims" should be replaced with "digital bonds" in appropriate places.

The second distortion of the studied terms of investment technology is seen in the phrase "digital financial assets". It's a stretch, but we can agree that the term "digital" covers computerized cryptographically secure data accessible to authorized users through Internet communications. The term "financial" irrationally tightens the possibilities of settlements based on the results of an investment relationship, however, in real business practice, quite often debt repayment calculations are carried out without money — through the transfer of goods, the performance of work, and the provision of services. This is confirmed by the legislator himself. We support his decision of 11.03.2024: "Digital financial assets can be used as a counter provision under foreign trade agreements (contracts) concluded between residents and non-residents, which provide for the transfer of goods, performance of works, provision of services, transfer of information and results of intellectual activity, including exclusive rights to them". (paragraph 11 Article 4 of Federal Law No. 259-FZ dated 31.07.2020).

We believe that the term "assets" reflects a skew in the investment attitude towards the investor's figure, although commodity-monetary obligations, in our interpretation — "digital bonds" — are issued by the recipient of investments. We consider a narrowly formal approach to clarifying regulations at the level of "monetary claims-obligations" and "digital financial assets-liabilities" unacceptable. Because over time, "digital financial assets-liabilities" will undoubtedly have to cover digital stocks, digital shares of participation in business companies, and digital certificates of participation in non-profit organizations, etc. In particular, a share of a joint-stock company is not a debt of the issuing company, but it provides for a number of obligations and rights of a shareholder. To eliminate the revealed distortion, we propose to change the term "digital financial assets" to "digital investment equivalents" throughout the text of Federal Law No. 259-FZ dated 31.07.2020. Thus, the economic and legal content of this investment technology becomes transparent and clear: the investor invests in certain digital objects, for example, bond equivalents; for the investor, these are assets, from the position of the recipient of the investment, these are commodity-monetary obligations, liabilities.

As a result, the logic of reasoning inevitably leads us to realize that there is no need for Federal Law No. 259-FZ dated 31.07.2020 to define digital investment equivalents as digital rights and obligations. It is impossible to formulate in the law the provision "digital investment equivalents are digital rights–obligations, including commodity-monetary claims-obligations — digital bonds" and so on. It is necessary to immediately disclose consistently the entire group of these digital investment equivalents by type: digital bonds; digital options; digital shares of a non-public (public) joint stock company; digital depositary receipts, etc. The category of "digital investment equivalents" must be recognized as independent within the framework of Article 128 of the Civil Code of the Russian Federation, and this category will be disclosed in detail in special legislation. Thus, the term "digital investment equivalents" quite correctly integrates both assets from the investor's perspective and liabilities from the recipient's perspective, but the identified distortions are eliminated.

CONCLUSIONS

In modern Russia, a very promising investment technology, called "digital financial assets" by the legislator, is still in an incubation state in the 5th year of its existence. Fifteen information system operators

that issue digital financial assets digitally create only the simplest debt instruments — monetary claims that are several thousand times smaller in volume than the turnover of classic non-documentary bonds. There is an inertial distrust of financial market participants towards a decentralized way of issuing digital financial assets by specialized companies. The holistic modernization of this investment technology is the topic of a separate scientific development. The current regulatory provisions of Federal Law No. 259-FZ dated 31.07.2020 require adjustments in terms of clarifying both individual definitions and interpretations of a number of provisions concerning the conceptual framework. Based on the identification of the economic and legal nature and interpretation of one of the specific elements of the digital investment toolkit — monetary requirements — the authors substantiate the relevant recommendations.

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Predicting Financial Market Volatility with Modern Model and Traditional Model

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ABSTRACT

The major **topic** investigates how classical methods (ARCH and GARCH) and well-known machine learning algorithms, support vector regression, and hybrid methods. This paper **aims** to predict and forecast volatility to develop a two-stage forecasting approach the volatility of the Amman Stock Exchange Index (ASE) effectively. Additionally, the effectiveness of the machine learning techniques' selection and utilization of information in stock data is evaluated. **Methods** the semiparametric estimating technique known as support vector regression (SVR) has been widely used for the prediction of volatility in financial time series. By integrating SVR with the GARCH model (GARCH-SVR) application with various kernels (Radial Basis Kernel Function (RBF), Polynomial Kernel Function (PF), and Linear Kernel Function (LF)). The suggested learning approaches are compared to two well-known statistical time series models, Autoregressive Conditional Heteroskedasticity (ARCH) and Generalized Autoregressive Conditional Heteroskedasticity (GARCH), in order to assess the assertion that they can properly anticipate ASE volatility. To compare their **results**, RMSE is employed as an error metric. There is evidence that the GARCH-SVR model performs best for predicting volatility time series, and classical volatility model techniques have an enormous predictive performance better than machine learning models.

Keywords: volatility forecasting; classical volatility models; ARCH; GARCH; machine learning models; support vector regression; hybrid model; GARCH-SVR

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INTRODUCTION

Volatility is an important factor in risk management, asset pricing, and portfolio selection since it measures how much a financial return fluctuates and acts as a proxy for risk [1]. The functional shape of the data generation process and the error distribution are presumptions made by both linear and nonlinear parametric generalized autoregressive conditional heteroscedasticity (GARCH) models. Additionally, empirical investigations [2–5] show that GARCH has poor predicting performance. Because of this, suggestions have been made for changes to the prediction assessment criteria [6], the model's design and estimate, and the use of different proxies for volatility. Since SVR can capture non-linear characteristics of financial time series, such as volatility clustering, leptokurtosis, and leverage effect, without making assumptions about the properties of the data distribution, it has been suggested in the literature as a way to overcome these limitations. Due to its capacity to capture the dynamic and nonlinear behavior of financial time series, SVR exhibits superior results on volatility forecasting compared to GARCH models, as demonstrated by [6–8]. The choice of kernel function has a significant impact on the SVR's forecasting performance because it is a kernel-based technique. It is feasible to build hybrid kernels by linear or non-linear combination of kernels in order to enhance the SVR learning and generalization capacity and benefit from multiple kernel functions [9]. According to empirical data, the hybrid kernel outperforms the SVR with a single kernel in terms of predicting accuracy [9]. Additionally, the Structural Risk Minimization Principle is implemented using the SVR, a machine learning approach based on statistical learning theory, which enhances generalization performance [10]. For the purpose of forecasting financial time series, researchers have recently coupled the GARCH model and artificial intelligence-based methods. [11] created the nonparametric model known as support vector machines (SVMs), which has been applied to financial forecasting [12, 13] based on the GARCH (1, 1) model and demonstrates that it can produce better volatility estimates than the traditional GARCH model. They substitute the SVR for the maximum likelihood (ML) estimation procedure as a nonlinear nonparametric tool. SVR has an advantage over ML estimation since it does not assume that a probability

density function exists across the return's series. The GARCH-based SVR approach is developed by [14] to study the relationship between information volume and trading volume volatility. The SVR-GARCH model is the way [15] models the conditional volatility in Turkish financial markets. Peng et al. (2018) [16] assess the SVR-GARCH model's ability to forecast the hourly and daily volatility of three different cryptocurrencies and three different exchange rates. The majority of the research on SVR-GARCH model parameter estimation has been concentrated on using the SVR model rather than the conventional ML approach to directly estimate the GARCH model parameters. The issue of financial time series volatility forecasting is complicated and time-varying, though. Any one model could have a limit on how well it can represent various time series aspects, leading to the associated inaccuracy. The main aim of the current research in this regard is to provide a two-stage strategy combining the GARCH-SVR estimate procedure to enhance the capacity to anticipate financial time series volatility. When compared to conventional volatility models, machine learning techniques can dramatically improve prediction accuracy, especially during periods of higher average volatility. The hybrid technique falls short and is significantly impacted by the market's quick fluctuations. Overall, the out-of-sample forecasting of volatility using learning approaches shows considerable promise for prediction and the extraction of significant information from additional data.

The remainder of this research is structured as follows. First, a methodology section is presented, which consists of an introduction to volatility, followed by statistical time series methods; the ARCH, GARCH, the machine learning methods; support vector machines, and finally the hybrid GARCH-SVR model with a kernel function. Furthermore, in this section the metric of root mean squared error (RMSE) and tests used to evaluate the data and the performance of the models are presented.

LITERATURE REVIEW

Volatility has been the focus of an extensive body of study for the past three decades due to its significance in finance and the difficulties associated with anticipating it. The distribution of volatility time series includes fat tails, and stock shocks have a significant influence on volatility, among other features that set them apart from other time series, according to research. Two qualities are particularly important for the study that was done for this thesis. Firstly, there is an enormous amount of evidence for volatility clustering, which is the concept that a high volatility period is probably to be followed by another high volatility period and vice versa for a low volatility period. Several investigations, including those by [17, 18], provide empirical support for this. Furthermore, the presence of volatility persistence in financial time series is supported by [19, 20], which means that the volatility in many future periods is influenced by the stock return today. Several models have been created and put into use to address the problem of forecasting volatility in an effort to take various stylized facts into account. The Autoregressive Moving Average Model, its extension ARIMA, and ARCH class models are suitable for estimating the conditional variance [20], some of the biggest contributions to the field after simple historical volatility models and linear regression. The parameters of the ARCH class models are often calculated using the parametric estimating approach, assuming that the return's series has a probability density function. Due to their capacity to detect volatility persistence or clustering, the ARCH class models are favorable [21]. To give superior forecasting performance, the ARCH class models must be changed, according to several current research studies [5]. For the purpose of forecasting financial time series, researchers have recently combined the GARCH model and artificial intelligence-based methods. Vapnik (1997) [11] created the nonparametric support vector machine (SVM), which has been used to financial forecasting [6]. Support vector regression (SVR) is a technique that [13] suggest and demonstrate may produce better volatility forecasts than the conventional GARCH model. It is based on the GARCH (1, 1) model. They substitute the SVR for the maximum likelihood (ML) estimation procedure as a nonlinear nonparametric tool. SVR has an advantage over ML estimation since it does not assume that a probability density function exists across the return's series. The GARCH-based SVR approach is developed by [14] to simulate the relationship between the volatility of trading volume and information volume. In order to predict the financial volatility of three important ASEAN stock markets, [22] fitted the least-squares support vector machine (LSSVM) based

on the traditional GARCH (1, 1), EGARCH (1, 1), and GJR (1, 1) models. A recurrent SVR method is suggested by [6] and used to predict the conditional variance equation of the GARCH model. The SVR-GARCH model is how [15] model the conditional volatility in Turkish financial markets. When the data are skewed Student-t distributed, employs the SVR-based approach to estimate and predict volatility in the asymmetric power ARCH type of model. In order to increase prediction accuracy, [23] offer a mixture of Gaussian kernels in the SVR based on GARCH (1, 1) (with a linear combination of one, two, three, and four Gaussian kernels). Peng et al. (2018) [16] assess the SVR-GARCH model's ability to forecast the hourly and daily volatility of three different cryptocurrencies and three different exchange rates.

To estimate the GARCH parameters, the SVR estimation method (SVR-GARCH) is used in place of maximum likelihood estimation. By integrating the GARCH model with SVR, [24] creates a two-stage forecasting volatility approach called GARCH-SVR. To examine the impact of innovations in various distributions, they offer the GARCH-SVR and GARCH-t-SVR models, based on the standard normal distribution and the standard Student's t distribution, respectively. To account for asymmetric volatility effects, they additionally consider the GJR-(t)-SVR models. The forecasting performance of the GARCH-(t)-SVR and GJR-(t)-SVR models is assessed using the daily closing price of the S&P 500 index as well as the daily exchange rate of the British pound versus the US dollar. The empirical results for one-period forecasts show that the GJR-(t)-SVR and GARCH-(t)-SVR models improve the accuracy of volatility forecasting. Given that empirical evidence shows that the stock market oscillates between several possible regimes in which the overall distribution of returns is a mixture of normal, [23] we attempt to find the optimal number of mixtures of Gaussian kernels that improve one-period-ahead volatility forecasting of SVR based on GARCH(1,1). The forecast performance of a mixture of one, two, three, and four Gaussian kernels is compared to SVR-GARCH with Morlet wavelet kernel, standard GARCH, Glosten-Jagannathan-Runkle (GJR), and nonlinear EGARCH models with normal, student-t, and generalized error distribution (GED) innovations using the mean absolute error (MAE), root mean squared error (RMSE), and robust Diebold-Mariano test. A variety of Gaussian kernels used in SVR-GARCH, according to out-of-sample predictions, can better capture regime-switching behavior and anticipate volatility. Nõu et al. (2021) [25] show which approach — econometric or machine learning — is more effective in forecasting the returns and volatility of the Baltic stock market. There hasn't been much study done on using econometric or machine learning models to forecast the Baltic stock market. However, there are no comparison studies that fairly compare the various strategies for the Baltic stock market. The findings show that the support vector regression model has a symmetric mean absolute percentage error of 61.90% compared to the autoregressive moving average model's symmetric mean absolute percentage error of 165.43%. The symmetric mean absolute percentage error of the GARCH-ANN model is 61.65%, while that of the GARCH model is 51.05%. Machine learning models outperform econometric models in most of the studied measures. However, the outcomes of the machine learning and econometric models are typically comparable.

The majority of the research on SVR-GARCH model parameter estimation has been concentrated on using the SVR model rather than the conventional ML approach to directly estimate the GARCH model parameters. The issue of financial time series volatility forecasting is complicated and time-varying, though. Any one model could have a limit on how well it can represent various time series aspects, leading to the associated inaccuracy. The major goal of the current research is to provide a two-stage strategy that combines the SVR procedure with the GARCH-ML estimate process to increase the accuracy of forecasting financial time series volatility.

METHODOLOGY

Firstly, it begins by describing the basic ideas of volatility, then goes on to cover the statistical techniques used as a benchmark, the machine learning techniques, and lastly the hybrid approach. The tests utilized and assessment metrics put in place to compare and evaluate the results are discussed at the end. In that it enables us to assess the uncertainty, volatility prediction is essential to comprehending the dynamics of the financial market. As a result, many financial models, particularly risk models, use it as an input. These details underline how crucial it is to estimate volatility accurately. In the past, parametric approaches like ARCH, GARCH, and their extensions have been widely employed; however, these models

have the drawback of being rigid. This study seeks to employ data-driven models, such as Support Vector Machines and the hybrid approach GARCH-SVR, in order to address this problem. It turns out that data-driven models perform better than parametric models.

Volatility Measures

Volatility plays a significant role in risk management, asset allocation, and derivatives pricing. The standard deviation or variance of returns from a financial instrument or market index is widely used to measure it. This section discusses realized volatility and implied volatility, the two historical measures of volatility. While implied volatility represents market expectations for a company's future price, previous volatility measures stock movement based on previous prices. It analyzes changes in a certain stock or index over a defined period of time. Implied Volatility in its purified state. The two sources of implied volatility, also known as the ex-ante measure of volatility (model-free estimate), are the Black-Scholes' options pricing model from Black and Scholes (model-based estimation) or the formula for the options market price. These metrics rely on a number of factors, including the number of days till expiry, the stock price, put options, the risk-free rate of interest, and the actual call/put price. As a result, changes in these factors will cause an adjustment in the implied volatility. According to [26], purified implied volatility (PV) is utilized to lessen the impact of stock price fluctuations.

By applying historical volatility (realized volatility) in this paper, which is calculated using the stock return standard deviation. Because it is a non-observable, the amount that cannot be accurately measured but can only be retrieved with an acceptable margin of error, volatility prediction remains a challenging issue. More proxies, such as realized volatility, might be used to better understand the use of machine learning and hybrid models in volatility forecasting. This measure of volatility is used in the literature [26].

$$R_t = \log\left(\frac{S_t}{S_{t-1}}\right), \tag{1}$$

$$R_m = \frac{\sum_{t=1}^{n} R_t}{n}, \tag{2}$$

$$HV = \sqrt{\frac{\sum_{t=1}^{n}\left(R_t - R_m\right)^2}{n-1}}, \tag{3}$$

where HV — historical volatility; R_t — stock return; R_m — average stock return; S_t — stock's price at current day: S_{t-1}: stock's price at previous day; n — number of listed companies. To calculate the return market, it takes the average stock return through dividing the sum of return companies by a number of listed companies.

Statistical Methods

In order to better understand and approach the uncertainty, modeling volatility is essentially modeling uncertainty. This allows us to have a good enough approximation to the actual world. We must compute the return volatility, sometimes referred to as realized volatility, in order to determine how well the suggested model captures the actual scenario. The square root of realized variance, which is the total squared return, is realized volatility. In order to determine how well the volatility prediction approach performs, realized volatility is employed. The reliability and quality of the related analyses are unquestionably impacted by how volatility is calculated. The purpose of this study is to demonstrate the superior prediction performance of ML-based models by discussing both traditional and ML-based volatility prediction strategies. We begin by simulating the traditional volatility models in order to compare the brand-new ML-based models. ARCH-GARCH is only one of several well-known classical volatility models.

Classical Volatility Models

1. ***ARCH model***

ARCH Model One of the early attempts to model the volatility was proposed by [27] and it is known as ARCH model. ARCH model is a univariate model and it is based on the historical asset returns.

Let ϵ_t represent the model's unexpected returns so that the model may be expressed mathematically. The error components are divided into a time-dependent standard deviation (σ) and a stochastic portion (z_t), which is a white-noise process. The error term is so defined as follows:

$$\varepsilon_t = \sigma_t z_t .$$

Since the previous squared error terms determine the current value of the model's variance of errors, the ARCH (*p*) model may be defined as the variance of the series, σ_t^2, and is modelled by:

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^{\ 2}. \quad (4)$$

where σ_t^2 is the current variance of errors, α_0 ; a positive constant, $\alpha_i \geqslant 0$ and $\varepsilon_{t-i}^{\ 2}$ represents the squared errors for the period $t - i$. where *p* denotes the number of included. With the knowledge that ARCH effects exist in the time series, an LM test for ARCH effect had been carried out.

All of these equations indicate that the ARCH model is univariate and non-linear and that volatility is calculated using the square root of historical returns. One of ARCH's most distinguishing characteristics is its ability to model the volatility clustering phenomenon, which is defined by [17] as the tendency for large changes to be followed by larger changes of either sign and for smaller changes to be followed by smaller changes. So, when a significant announcement reaches the market, there may be a lot of volatility. A positive shock has the same impact on the conditional variance as a negative shock of the same size since the ARCH model is symmetric.

Bollerslev in 1986 found that the ARCH model needed a long lag length to be able to capture and explain the financial data (the excess kurtosis in data), in which GARCH model allows for a more flexible lag structure.

2. ***GARCH Model***

GARCH model is an extension of ARCH model incorporating lagged conditional variance by [21]. So, ARCH is improved by adding p number of delayed conditional variance, which makes GARCH model a multivariate one in the sense that it is an autoregressive moving average model for conditional variance with p number of lagged squared returns and *q* number of lagged conditional variance. GARCH (*p, q*) can be formulated as:

$$\sigma_t^2 = \omega + \sum_{k=1}^{q} \alpha_k^2 \varepsilon_{t-1}^2 + \sum_{k=1}^{p} \beta_k^2 \sigma_{t-1}^2 , \quad (5)$$

where σ_t^2 is the current variance of errors, ω ; a positive constant, $\alpha_k \geq 0; \varepsilon_{t-1}^{\ 2}$ represents the previous squared errors for the period $t - 1$; σ_{t-1}^2 represents the previous variance of errors for the period $t - 1$ coefficient (β) is called the GARCH term.

p denotes the number of previous σ^2 terms and *q* denotes the number of previous ε^2 terms.

In order to have consistent GARCH, following conditions should hold:

$$\omega > 0; \beta \geqslant 0; \alpha \geqslant 0; \beta + \alpha < 1.$$

The restrictions for model parameters used level of persistence of volatility as was shown by Engle and Bollerslev (1986).

The ARCH model is unable to account for the effects of previous advancements. However, GARCH models are a denser model that may explain the change in historical inventions since they can be expressed as an infinite-order ARCH. Due to its symmetrical character, which is similar to the ARCH model, the GARCH model has the disadvantage of not allowing for different responses to positive or negative shocks.

The two main benefits of GARCH in modeling volatility are that it does not need independent returns, allowing modeling of the leptokurtic aspect of returns, and that returns are well fitted by the GARCH model in part as a result of volatility clustering.

Machine Learning Methods

The following paragraphs are structured as follows: first a short introduction on the machine learning framework is presented, followed by a description of Support Vector Machines selected machine learning method applied to forecast the volatility of the ASE.

Machine Learning Framework

The process of computer algorithms that can interact with and learn from their environment with the aim of improving predictions through structural adaptation is known as machine learning. These learning techniques are frequently used when it is challenging to develop precise forecasting models and are quite beneficial when dealing with high-dimensional data [28, 29]. These machine learning techniques excel at effectively modeling complicated patterns by choosing just the descriptive variables from highly dimensional data. A number of promising approaches are chosen to estimate the

ASE volatility with the aim of analyzing the forecasting ability of machine learning algorithms in financial time series. Contrary to the GARCH-type models that try to estimate volatility through the conditional variance σ_t^2, these machine learning methods try to predict the ASE volatility.

Support Vector Machines

Boser et al. (1992) [30] created the support vector machine (SVM), a supervised learning technique, for classification issues. The SVM algorithm's objective is to build a hyperplane with the greatest possible margin between data points from distinct classes in order to categorize them. When building the support vectors for the model using linear equations, these dividing hyperplanes may be thought of as decision boundaries that specify the categorization of the data points. The approach was further developed as support vector regression (SVR), which can be used with time series data, by [11] for the application on regression issues. By using kernel functions, support vector regression is anticipated to generate comparatively enormous advantages as compared to conventional models in terms of capturing the nonlinear dynamics contained in financial time series data [31]. With the help of these kernel functions, it is possible to convert data from a nonlinear decision plane to a linear equation in a higher dimension. The capacity of SVR to effectively choose information from extra data to improve predictive performance is another advantage of using SVR in volatility forecasting compared to previous approaches.

The kernel function, which is the essential component of SVM, is typically used to transform primitive characters and enhance their dimension in order to solve linear non-separable problems and improve the prediction accuracy of the model during the SVM modeling process. The optimum kernel function for model prediction should be chosen by testing each one and comparing the outcomes one at a time since different kernel functions have distinct benefits and drawbacks. There are three primary kernel functions in SVM:

1 — Polynomial Kernel Function (PF):

$$K\left(x,x_i\right)=\left[\left(x.x_i\right)+1\right]^q \tag{6}$$

In which, q is the parameter.

2 — Radial Basis Kernel Function (RBF):

$$K\left(x,x_i\right)=\exp\left\{\frac{x-x_i}{-2\sigma^2}\right\} \tag{7}$$

In which, σ is the real parameter.

3 — Linear Kernel Function (LF):

$$K\left(x,x_i\right)=\left(x.x_i\right). \tag{8}$$

The Hybrid Model

The GARCH and SVR models that were discussed in the preceding section fall under two categories of estimation methods: parametric estimation and nonparametric estimation. Several researchers have suggested utilizing the SVR model instead of the ML technique to estimate GARCH parameters (SVR-GARCH), taking advantage of nonlinear regression estimation. According to [32], the realized volatility matches more closely with the actual volatility theoretically during the day. Although it is conceivable that using a different proxy may change the findings provided here, this problem is outside the scope of the present research. In fact, predictions made using this type of model can be more accurate than those made using the ML method. The difficulty of predicting the volatility of financial time series is usually complicated, and it's possible that no single model will be able to accurately capture all of its various characteristics. In this study, we propose a two-stage method combining the SVR model and the GARCH model (GARCH-SVR) to forecast the returns volatility. The forecasting value can be obtained by combining the linear GARCH model and the nonlinear SVR model, rather than replacing the ML method directly with the SVR model to estimate the GARCH parameters.

Support Vector Regression-GARCH

The supervised learning method known as Support Vector Machines (SVM) may be used for both classification and regression. To identify a line dividing two classes is the goal of SVM. Although it seems simple, the following is difficult: The number of lines that may be used to separate the classes is practically unlimited. However, we have been looking for the best path that will allow for the most accurate classification of the classes. The hyperplane, also known as the best

line in linear algebra, maximizes the distance between the points that are closest to it but belong to different classes. Margin is the separation between the two points, or the support vectors. So, in SVM, our goal is to increase the space between the support vectors. Support Vector Classification, or SVC, is the name given to SVM used for classification. It is applicable to regression while maintaining all SVM properties. Once more, the goal of regression is to identify the hyperplane that maximizes margin while minimizing error. In this section, we will use the Support Vector Regression (SVR) approach to analyze the GARCH model. These two models are combined to form the SVR-GARCH.

Measuring Errors

Since the study focuses on predicting both the direction and the size of the realized volatility, we utilized the following metrics to evaluate each model.

Root Mean Squared Error (RMSE):

It is calculated by taking the square root of the square of the difference between the actual value and the target value that was predicted. It is also known as the standard deviation of errors.

$$RMSE = \sqrt{\frac{1}{N}\sum_{i=1}^{N}\left(\hat{Y}_i - Y_i\right)^2}, \quad (9)$$

where N is the number of observations.

$\hat{Y}_i$ and Y_i are the predicted and observed value of asset on the i day.

Results and Discussion

Volatility prediction is a difficult endeavor. Several theories have been developed in an effort to produce more precise projections due to the unique characteristics of volatility and its significant effects on financial markets. In the current study, some of them are contrasted. Machine learning was used because it can be used to do difficult regression problems and has been used well in the literature on the subject when paired with other models.

It is demonstrated that the algorithms do not outperform the conventional, while having minimal errors in the majority of forecast horizons and being able to capture the main structure of the series. This could be as a result of the algorithms' absence of volatility-specificity. It is possible that predictions would be more accurate if one took volatility time series features into account. Machine learning algorithms have the drawback of being taught to detect correlations between values in a series and will do so even in situations where there are none, which may lead to incorrect forecasts.

The ARCH model's accuracy is a little unexpected. Despite being a less complicated model than those used by the other methods, it generates the most accurate projections. This demonstrates the idea that model complexity does not always translate into increased forecast accuracy. The flexibility of ARCH is one of its benefits. The optimal sequence of parameters that reduce mistakes can be found by fitting the data. In contrast to machine learning methods, time series models have the drawback of making more assumptions about the incoming data. The forecasts generated if machine learning is adjusted for volatility and integrated with time series models would probably be more accurate than their independent predictions.

It is crucial to compare and evaluate the output of various techniques in order to use the learning machine algorithm to create the most accurate predictions possible. One of the important components in algorithms' success is evaluation using appropriate criteria.

Evaluation Data

Using Google Colab notebooks as financial instruments for analysis in the Amman Stock Exchange, the data was gathered from January 2nd, 2018, until October 6th, 2022. There are 1147 samples in the data. The first COVID-19 infection in Jordan happened on March 2, 2020. To study volatility before and during the COVID-19 pandemic, the full sample data from January 2nd, 2018, until October 6th, 2022. In addition, according to literature, Bezerra & Albuquerque (2016) and Sun & Yu (2019) used daily data in the volatility modeling of hybrid models (SVR-GARCH), so the author applies the daily price index in the Amman Stock Exchange.

Zero-valued data is removed using noise removal techniques, and the data is then normalized. Using validation techniques in line with research on financial series forecasting using machine learning algorithms, the assessment statistics are split into two groups: Algorithms are trained on the training set before being tested on the test set. You should be aware that in order to evaluate

Table 1

The Number of Train and Test Sample

Total sample	Train set	Test set
1147	917	230

Source: Compiled by the author.

the training amounts that result from train figures, the train set itself is divided into two categories: validation and train. Based on the results of the evaluation, only the best training set is selected. There is little doubt that the assumptions made from the study of training data won't apply generally.

However, the accuracy of the algorithm on forecasting samples that fall into the test set category is what is meant as a consequence of the algorithm precision evaluation. Each share's test and try sets are determined by allocating 20% of the data to the test set and 80% of the data to the training set, respectively (*Table 1*) according to study Gholamy et al, (2018) empirical studies show that the best results are obtained if we use 20–30% of the data for testing, and the remaining 70–80% of the data for training [32].

Series of realized volatility can be obtained, as shown in *Table 2* in details.

Figure 1 is a line chart illustrating the Price Index trend over time. The index declines from 2018 to early 2020, followed by a sharp drop in 2020. Subsequently, it begins to recover, showing volatility before reaching a peak in 2022, with noticeable fluctuations.

Stationarity, which is the state in which statistical parameters like mean and variance do not change over time, is typically required for time series modeling. The first step in figuring out whether the time series is stationary is to take a look at the information given for time-dependent characteristics like trend or seasonality. A test statistic, an essential value for varying levels of confidence, and a p-value are all included in the test result. The p-value must be less than the significance threshold of 0.05 and the time series must be assumed to be stationary in order for it to be significant. When the test is applied to the volatility dataset with the first difference, H0 has been ruled out since the p-value is below 0.05 and below the values for each confidence level. *Figure 2* shows the auto-correlation chart for the volatility. The actual scenario is as follows: Realized volatility has a very long memory, as seen by its autocorrelation characteristics, which are strong in the first step and positive throughout the first 30 steps. To do this, a realized volatility model based on the volatility's long memory attribute is created in order to generate forecasts for short-term volatility. The adoption of daily price limitations for stock prices on ASE may be the reason for the high autocorrelation levels (Chiang & Doong). 2001).

In *Table 3*, the maximized log-likelihood function value and information criteria values are presented. The results unanimously select the GARCH model as best fitted model to the training set by exhibiting the largest likelihood in combination with the lowest values of the information criteria. This finding is in line with the expectation that due to the asymmetrical behavior of the financial return series, the models that allow for asymmetry and leverage effects, which is the GARCH model, are likely to fit better to the series compared to the symmetrical ARCH model.

The models are fitted with daily volatility. In *Table 4* the estimated parameters are presented, where all parameters are significant for the ARCH-GARCH model all parameters are significant. This indicates that the GARCH model probably fits well to the data, which is coinciding with the previous results based on the likelihood and the information criteria.

From the practical standpoint, SVR-GARCH application with different kernels is not a labor-intensive process, all we need to switch the kernel name.

In *Table 5* the ARCH forecast shows some similarities to that of GARCH and the RMSE result obtained (ARCH

Table 2

Statistical Indicator Table for a Series of Realized Volatility

Mean Value	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis
0.610770	1.784991	0.003492	0.715778	0.462620	1.424129

Source: Compiled by the author.

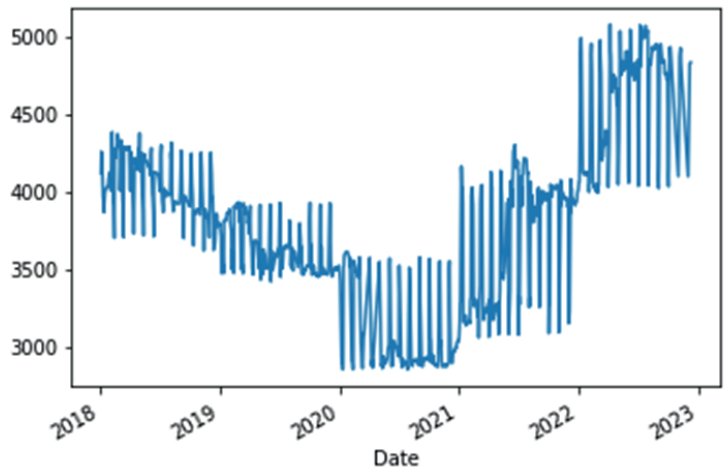

Fig. 1. **Price Index**

Source: Compiled by the author.

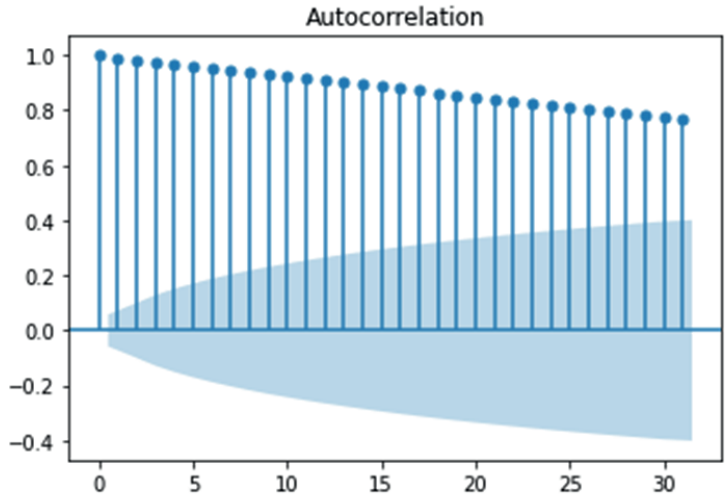

Fig. 2. **Auto-correlogram of the Realized Volatility**

Source: Compiled by the author.

Table 3

Log Likelihood and Information Criteria of the ARCH and GARCH Models

Log Likelihood and Information Criteria	ARCH	GARCH
Log L	−1001.46	−989.269
AIC	2014.92	1986.54
BIC	2045.19	2006.72

Source: Compiled by the author.

Table 4

Estimated Parameters of the ARCH and GARCH Models

Parameter	ARCH	GARCH
	Coefficient(p-value)	Coefficient (p-value)
ω	0.2355 (5.597e-24)***	0.0322 (5.104e-03)***
α	0.5301 (5.221e-08)***	0.2245 (1.102e-04)***
β		0.7136 (6.922e-27)***

Source: Compiled by the author.

Note: Three asterisks indicate significance at the 5% significance level.

Table 5

The RMSE Result Represented for Each Model

Model	RMSE
ARCH	0.0670
GARCH	0.0680
SVR kernel = "rbf"	1.150429603
SVR kernel = "linear"	0.887802733
SVR kernel = "poly"	0.701112386
SVR-GARCH kernel = "linear"	0.000784
SVR-GARCH kernel = "rbf"	0.001467
SVR-GARCH kernel = "poly"	0.001582

Source: Compiled by the author.

0.0670, GARCH 0.0680) in the sense that it underestimates the level of changes in volatility and regression realized volatility with the SVM under different kernel functions, the RMSE result obtained ("rbf" 1.150429603, "linear" 0.887802733, "poly" 0.701112386) subsequently traditional model outperform more machine learning model.

While RMSE score suggests that SVR-GARCH with linear kernel outperforms SVR-GARCH with RBF kernel. The RMSE of SVR-GARCH with linear and RBF kernels are 0.000784 and 0.001467, respectively. So, SVR with linear kernel does performs well. Lastly, SVR-GARCH with polynomial kernel is employed but it turns out that it has the lowest RMSE implying that it is the worst performing kernel among these three different applications.

In this case hybrid model outperform more both the machine learning model and traditional statistical time series model.

CONCLUSION

The aim of this research was to investigate the power of machine learning models as well as a novel hybrid model in the out-of-sample volatility forecasting of the ASE based on data of the period of January 2nd, 2018 to October 6th, 2022. The proposed methods are support vector regression, and the hybrid method GARCH-SVR. In order to assess not only their relative performance but also substantiate these findings the models are compared to the traditional statistical time series models of the ARCH, GARCH.

Hybrid model techniques can therefore perform better than more traditional statistical time series models when applied to extremely nonlinear and complicated time series. They demonstrate to be particularly appropriate during periods of significant market volatility, when both the machine learning model and traditional models perform less well. According to the empirical findings, the GARCH-(*t*)-SVR model enhances the capability of volatility forecasting. In the future, we may expand the number of volatility models we use and examine how alternative volatility proxies can influence our results. Furthermore, it would be beneficial to expand the historical data as much as possible because having more training data is frequently advantageous to both the traditional time series approaches and the learning methods stated. To the greatest degree possible, the features of multi-variable financial data should be thoroughly investigated, and the test methods of nonlinear mixed-pure characteristics (correlation dimension, annoyance, index calculation technique, etc.) should be improved on. We can do an accurate assessment and thorough research on the mixing features of multivariate financial time series by seeking an original method to identify their mixing characteristics. It is another element that requires research and discussion in the examination of financial time series in the future. The updating judgment method is used to find the closest points, and the fast neighborhood search method is used to search and calculate the neighborhood, which makes the local prediction method more useful in real-world engineering applications and reduces the computational complexity of local prediction. The performance of a support vector machine is primarily affected by the choice of kernel parameters, type of kernel function, and quadratic programming parameter. These criteria are often chosen by researchers based on their limited research and previous experience. How to select their optimal kernel function and a set of optimal parameters for particular application challenges is still a pressing issue that requires more research. Only low-frequency financial data may be used with the financial time series model that was examined in this article. Some volatility models are presented based on high-frequency data as high-frequency and ultra-high-frequency financial data become more prevalent. One of the next study objectives will be how to enhance the high-frequency data models' ability to predict the future.

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Problems of Ensuring Balanced Socio-Economic Development of Regions Under Sanctions

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ABSTRACT

The purpose of the study is to identify and analyze problems and develop recommendations to ensure a balance of social, economic, budgetary, credit and other aspects of the integrated development of the constituent entities of the Russian Federation under sanctions. The relevance of the study is due to the need to resolve issues of a rational relationship between ensuring social stability in society and the dynamism of investment and technological renewal of the territory's economy as the basis for its sustainable long-term development in the current conditions of sanctions pressure from unfriendly countries on the economy of Russia and its regions. In accordance with the results obtained of this study, the following **conclusions** were formulated: 1) based on the results of a review of scientific publications of domestic and foreign authors on the issues of balanced development of territories, the differences and interrelationships between balanced and sustainable development were highlighted, and the use of an approach to assessing balance based on criteria of economic security was justified; 2) a system of 26 indicators of economic security is proposed, characterizing the development of constituent entities of the Russian Federation in terms of social, economic, innovative and environmental components. Based on the use of **methods** of statistical analysis, standardization, spectrum-score and expert methods, an assessment and grouping of the regions of the Volga Federal District was carried out according to the level of balance, which made it possible to identify the presence of significant heterogeneity when comparing individual components of development and their distinctive features (problem areas) in different periods (pre-pandemic, pandemic, post-pandemic, sanctions); 3) based on the results of the study, the main problems of balanced regional development were identified and recommendations were proposed to improve it based on the principle of complementarity (mutual complementarity) of components as the basis for ensuring sustainable socio-economic development of territories and improving the quality of life of the population.

Keywords: socio-economic development; investment; public finance; region; balance; sustainability; economic security; complementarity; sanctions; COVID-19; spectrum-point method

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INTRODUCTION

In the context of modern challenges facing the economy of Russia and its regions (sanctions, demographic, personnel, budgetary, etc.), the relevance of research into the problems of ensuring their balanced socio-economic development is increasing. Due to the interconnectedness and interdependence of social and economic aspects from each other,[1] the long-term imbalance in the distribution of financial resources between them (including due to a significant outflow of profits generated in the economy abroad over the past 30 years in the amount of about $ 1 trillion[2]) leads to a decrease in the overall sustainability of territorial development and the formation of crisis phenomena. All this negatively affects both social stability in society and the pace of investment development, technological renewal of the territory's economy (taking into account compliance with environmental requirements), which form the basis of its sustainable long-term development.

In this regard, the role of public finance as a mechanism for redistribution of financial resources obtained as a result of economic activity into the social sphere is increasing. The problem of balanced development of regions in one form or another has been raised at the state level,[3] including in determining the main directions of the new Government of the Russian Federation[4] and the national development goals of the country until 2030 and in the perspective until 2036,[5] where its social orientation is among the most important components. The strategic planning documents of the constituent entities of the Russian Federation also pay increased attention to the issues of balanced development (as part of the tasks to reduce differentiation in various aspects of development between municipalities within the region).[6]

The analysis of publications devoted to the problem of balanced development of territories shows that research in this area is quite broad, multidimensional in nature, which is explained by the interdisciplinarity of the research object, including the consideration of various factors. In particular, according to the authors of the study [1], balanced development is a coordinated economic-socio-ecological development. In the paper [2], balanced development is understood as the achievement by the region of given development parameters taking into account the interests of all stakeholders. Thus, the basic characteristic of balanced development, emphasized by various authors, is the presence of coherence (interests) between the components of development (stakeholders).

In addition, the concept of "balanced development" is often identified with other categories (e.g., "sustainable development"). To more clearly establish the boundaries of

[1] For example, underfunding of the social block in education and health care (according to the authors' calculations on the basis of Rosstat and Eurostat data, in 2021 in Russia compared to EU countries the expenditures on these areas amounted to 7.3% and 12.9% of GDP or 20.9% and 25.1% of all expenditures of the consolidated budget of the territory, respectively), as well as excessive workload of pedagogical and medical workers (including the formation of various reports) in the future leads to the deterioration of financial and economic indicators of the region's development as a result of the fall (or preservation of the same level).

[2] URL: https://tass.ru/ekonomika/7037106 (accessed on 28.05.2024).

[3] URL: http://www.council.gov.ru/events/news/90944/ (accessed on 20.05.2024).

[4] Mishustin named the main areas of work for the new government. URL: https://www.rbc.ru/politics/10/05/2024/663e033f9a794760e4128530 (accessed on 20.05.2024).

[5] Decree of the President of the Russian Federation from 7 May 2024 No. 309 "On national development goals of the Russian Federation for the period up to 2030 and in the perspective up to 2036". URL: https://rg.ru/documents/2024/05/07/prezident-ukaz309-site-dok.html (accessed on 24.05.2024).

[6] Resolution of the Government of the Republic of Bashkortostan from 20 December 2018 No. 624 "On the Strategy of Socio-Economic Development of the Republic of Bashkortostan for the Period until 2030". URL: https://economy.bashkortostan.ru/documents/active/298367/ (accessed on 05.08.2024); Law of the Republic of Tatarstan from 17 June 2015 No. 40 "On Approval of the Strategy of Socio-Economic Development of the Republic of Tatarstan until 2030". URL: https://mert.tatarstan.ru/strategiya-sotsialno-ekonomicheskogo-razvitiya.htm (accessed on 05.08.2024); Resolution of the Government of the Nizhny Novgorod Region from 21 December 2018 No. 889 "On Approval of the Strategy of Socio-Economic Development of the Nizhny Novgorod Region until 2035". URL: https://strategy.nobl.ru/assets/content/main/strategiya-22.09.pdf (accessed on 05.08.2024).

the subject field of this concept, the article [3] conducted a study of publications on the basis of ScR-methodology (scoping review), which allowed us to define the balanced development of the region as a spatial and dynamic characteristic of the process of continuous coherence between economic entities at the sectoral, territorial and systemic levels. In another paper, the authors, separating the concepts of "sustainable development" (constant development achieved despite the influence of negative factors) and "balanced development", formulate a definition of sustainable balanced development as the constant development of economic, socio-ecological subsystems of the region, taking into account their coordinated interaction, giving a synergetic effect to ensure dynamic stability [1].

Consequently, the distinguishing characteristic of sustainable development from balanced development is the ability of the territorial socio-economic system to ensure continuous (stable) development even under the influence of negative factors of the external environment, while balance is characterized by the consistency of interaction between the elements of this system. It is logical that sustainable self-development of the region in the medium term, and even more so in the long term, cannot be ensured without its balance.

Since balance implies the establishment of a certain balance between the various components of the territory's development (in the form of the absence of significant differentiation, distortions in development), to a certain extent it can be quantitatively characterized by economic security indicators and their threshold values [4–6]. Including through the prism of economic security indicators, the works of various authors consider such aspects of social development as individual well-being [7], the priority of taking into account demographic [8], human resources [9], economic and criminogenic [10] indicators in assessing the results of regional policy, as well as the standard of living of the population as a whole [11]. In addition, researchers assess the level of economic security of the territory from the position of its sectoral specifics [12], environmental condition [13], etc. Thus, within the framework of assessing the economic security of the region it is possible not only to analyse various aspects of its balanced socio-economic development, but also to determine their sufficiency to ensure the sustainability of development.

In foreign scientific literature, the balanced development of territory has also been extensively researched [14–16], including in the context of tourism as a driver of development [17, 18], problems of transport accessibility in rural areas [19], the definition of indicators and their threshold values for assessing the imbalance of Inner Peripheries [20], environmental analysis in accordance with sustainable development goals [21]. Foreign authors actively study financial aspects, which are considered from the point of view of the mutual influence of the processes of financialization of rural territories and spatial components of their development [22]. On the example of urban clusters, the possibilities of applying the model of joint optimal allocation of land use (COAL model) between different clusters (production, residential, environmental space) as a basis for ensuring balanced development are studied [23].

The above review of scientific publications of domestic and foreign scientists confirms the relevance of the study of this topic, especially at the regional level. The purpose of the study is to identify and analyse the problems of balancing social, economic, fiscal, credit and other aspects of integrated development of the Russian Federation subjects (on the example of the regions of the Volga Federal District — VFD) in the conditions of sanctions and to develop recommendations for their elimination. In order to achieve the set goal, it is necessary to solve the following tasks:

- to collect and systematize indicators of economic security at the regional level, characterizing various aspects of integrated development of territories;
- to propose a method for assessing the economic security of regions from the point of view of the balance of their development;
- to assess the level of balanced development subjects of the Russian Federation and identify distinctive features (problem areas) that affected its dynamics in different periods in the context of development components;
- to formulate recommendations to improve the balanced development of territories.

MATERIALS AND METHODS OF RESEARCH

In our opinion, it is most appropriate to use the approach based on the dynamics of economic security indicators as an approach to assess the balance of territorial development. Since the assessment of economic security involves the consideration of many factors from various spheres of activity, the use of this approach allows us to consider various aspects of the balance of socio-economic development of the regions in a comprehensive manner, as well as to determine whether their current state is sufficient to ensure long-term sustainable development through the threshold levels of economic security. It is proposed to assess the balanced development subjects of the Russian Federation by 26 indicators in the context of 4 components:

- social development (13 indicators);
- economic (5 indicators);
- innovation (5 indicators);
- environmental (3 indicators).

The thresholds for these components have been suggested by academics and experts in the field (*Table 1*).

It is proposed to use the method of assessing regional economic security proposed by V.K. Senchagov and S.N. Mityakov as a basis [24]. This toolkit allows to bring the indicators, which are different in their impact on socio-economic development, to a single scale from –1 to +1, where the threshold values of economic security indicators pass through the zero level. Formula (1) is used to normalize the indicators whose growth has a positive impact on the region's economy:

$$y = 2^{1-a/x} - 1, \quad (1)$$

where y — normalized value of the indicator; x — initial value of the indicator; a — indicator threshold.

If the increase in the indicator negatively affects the socio-economic dynamics of the territory, then the formula is used (2):

$$y = 2^{1-x/a} - 1. \quad (2)$$

The integral indicator within the development components and the overall integral indicator are calculated as the arithmetic mean of the sums of normalized indicators within a certain component in the first case and indicators for all components in the second case. It is proposed to group regions by the level of balanced development according to the following scale: high level — with positive values of the integral indicator; average level — with values from — 0.2 to 0, below average — from –0.4 to –0.2; low level — from –0.6 to –0.4; critical level — from –0.8 to –0.6; catastrophic level — below –0.8.

The calculations are based on the data of Rosstat,[7] the Bank of Russia[8] and the Ministry of Finance of the Russian Federation[9] on the example of the regions of the Volga Federal District (VFD) for the period 2019–2022, which allows us to compare the change

[7] Regions of Russia. Socio-economic indicators. Rosstat. URL: https://rosstat.gov.ru/folder/210/document/13204 (accessed on 20.06.2024).

[8] Bank of Russia. URL: https://www.cbr.ru/statistics/bank_sector/sors/#a_63140 (accessed on 20.06.2024).

[9] Electronic budget. Ministry of Finance of the Russian Federation.URL: https://budget.gov.ru/Главная-страница (accessed on 20.06.2024).

Table 1

Indicators of Regional Economic Security and their Threshold Values

No.	Indicators	Threshold value
	Social development	
1	Life expectancy (total population), years	>80
2	Life expectancy (men), years	>77
3	Life expectancy (women), years	>85
4	Fertility rate (number of children per 1 woman), un.	>2.15
5	Ratio of people of retirement and working age,%	<40
6	Ratio of the number of deaths to the number of births, un.	<1
7	Share of population with incomes below subsistence minimum,%	<6
8	Ratio of average per capita cash income to subsistence minimum, times	>3.5
9	Gini index, un.	<0.3
10	Funds ratio, times	<7
11	Area of housing per 1 inhabitant, sq. m.	>30
12	Share of expenditures on health care, education and culture,% of GRP	>15
13	Crime rate (number of registered crimes per 100,000 population), un.	<1000
	Economic development	
14	Investments in fixed capital, as% of GRP	>25
15	Depreciation of fixed assets,%	<45
16	Profitability of production,%	>15
17	Share of manufacturing in industry,%	>70
18	Volume of business lending,% of GRP	>40
	Innovative development	
19	Share of shipped innovative products,%	>30
20	Number of persons engaged in R&D per 10,000 employed in the economy, persons	>120
21	Domestic expenditure on R&D,% of GRP	>2.2
22	Number of applications for inventions and utility models filed per 10,000 population, un.	>5
23	Share of innovation-active enterprises,%	>40
	Environmental development	
24	Share of environmental expenditures,% of GRP	>5
25	Discharge of polluted wastewater, thous. cubic metres per sq. km	<0.3
26	Emissions of pollutants into the atmospheric air from stationary sources, tonnes per sq. km	<0.5

Source: Compiled by the authors based on the works of [25–27].

Table 2

Integral Index of Balanced Development of Regions of the Volga Federal District in 2019–2020

Region	2019	2020	2021	2022	Dynamic
Regions with a level of balanced development below average					
Nizhny Novgorod region	–0.40	–0.37	–0.39	–0.38	0.02
Regions with a low level of balanced development					
Ulyanovsk region	–0.40	–0.41	–0.40	–0.40	0.00
Republic of Mordovia	–0.40	–0.39	–0.39	–0.40	0.00
Republic of Tatarstan	–0.44	–0.44	–0.44	–0.41	0.03
Perm region	–0.46	–0.45	–0.44	–0.42	0.03
Penza region	–0.43	–0.43	–0.44	–0.45	–0.02
Kirov region	–0.49	–0.48	–0.51	–0.50	–0.01
Samara region	–0.52	–0.51	–0.51	–0.52	0.00
Republic of Mari El	–0.55	–0.56	–0.54	–0.53	0.02
Republic of Bashkortostan	–0.55	–0.51	–0.51	–0.54	0.01
Saratov region	–0.54	–0.54	–0.52	–0.54	0.00
Udmurt Republic	–0.56	–0.54	–0.56	–0.56	0.00
Chuvash Republic	–0.54	–0.55	–0.56	–0.57	–0.02
Orenburg region	–0.59	–0.59	–0.61	–0.60	–0.01

Source: Calculated by the authors based on data Rosstat, Bank of Russia, Ministry of Finance of the Russian Federation. URL: https://rosstat.gov.ru/folder/210/document/13204; https://www.cbr.ru/statistics/bank_sector/sors/#a_63140; https://budget.gov.ru/Главная-страница (accessed on 20.06.2024).

in the values of indicators formed in the pre-pandemic, pandemic, post-pandemic and sanctions periods (although sanctions restrictions against the Russian economy by Western countries were imposed earlier, but they were not so total as from 2022).

RESEARCH RESULTS

The current state of socio-economic development of Russia's regions is characterized by a generally insufficient level of economic security for sustainable socio-economic development (*Table 2*).

Over the period under review, the integral index of balanced development in the regions had multidirectional weak dynamics, which is associated with both high inertia of the processes characterizing certain components of development and smoothing as a result of summing up the values of indicators that make up the integral index. At the same time, within the development components the level of differentiation in some regions was somewhat higher (except for social development). With the exception of the Nizhny Novgorod region, all the regions of the Volga Federal District can be classified as a group with low development balance (*Table 3*).

As can be seen from *Table 3*, the most balanced (close to the threshold values) indicators of the socio-economic block, where the leaders in the social sphere are

Table 3

Values of the Components of the Integral Index of Balanced Development of Regions of the Volga Federal District in 2022

Region	Development component in 2022 and its dynamics compared to 2019							
	Social		Economic		Innovation		Environmental	
	2022	change	2022	change	2022	change	2022	change
Republic of Bashkortostan	–0.16	0.01	–0.24	0.00	–0.82	–0.01	–0.93	0.04
Republic of Mari El	–0.19	0.00	–0.14	0.13	–0.92	–0.08	–0.86	0.05
Republic of Mordovia	–0.24	–0.02	–0.18	–0.02	–0.66	0.02	–0.52	0.02
Republic of Tatarstan	–0.11	0.01	–0.12	0.03	–0.41	0.09	–1.00	–0.01
Udmurt Republic	–0.19	0.01	–0.22	–0.04	–0.85	0.00	–0.98	0.01
Chuvash Republic	–0.18	–0.01	–0.23	0.00	–0.91	–0.10	–0.94	0.02
Perm region	–0.21	0.02	–0.06	0.06	–0.62	–0.04	–0.82	0.07
Kirov region	–0.21	0.00	–0.27	0.05	–0.87	–0.10	–0.64	–0.01
Nizhny Novgorod region	–0.19	0.00	–0.14	0.09	–0.28	–0.06	–0.91	0.05
Orenburg region	–0.21	0.00	–0.36	–0.07	–0.96	0.03	–0.88	0.00
Penza region	–0.20	–0.01	–0.14	0.05	–0.70	–0.09	–0.75	–0.03
Samara region	–0.22	–0.01	–0.22	0.02	–0.66	–0.02	–0.98	0.01
Saratov region	–0.22	–0.01	–0.27	0.05	–0.86	–0.03	–0.79	0.01
Ulyanovsk region	–0.20	0.00	–0.34	–0.07	–0.33	0.05	–0.73	0.03

Source: Calculated by the authors based on data Rosstat, Bank of Russia, Ministry of Finance of the Russian Federation. URL: https://rosstat.gov.ru/folder/210/document/13204; https://www.cbr.ru/statistics/bank_sector/sors/#a_63140; https://budget.gov.ru/ (accessed on 20.06.2024).

the Republic of Tatarstan, in the economic sphere — Perm region and the Republic of Tatarstan. However, even these leading regions managed to achieve an economically safe level only for some indicators: Tatarstan — for indicators 7, 8, 10, 11, 15–17, Perm region — 10, 16 (*Table 1*). In contrast to the social sphere, which showed insignificant dynamics of the integral index by regions, in the economic sphere the most significant growth was observed in the Republic of Mari El (comprehensive positive change in all parameters) and Nizhny Novgorod region (mainly due to improved values of investment and profitability of production indicators).

In the field of innovation and environmental development of the RF subjects under consideration, there is a significant lag behind the required parameters. Three regions demonstrate a more favourable position in terms of innovation compared to other territories: Nizhny Novgorod region (the leading region in terms of employment and investment in R&D in the Volga Federal District) retained its leadership despite the overall negative dynamics in this component of development, Ulyanovsk region (1st place in the Volga Federal District in terms of patent activity and 2nd place in terms of R&D expenditures relative to GRP), Republic of Tatarstan (1st place in the Volga Federal District

Table 4

Problem Areas for Balanced Development of the Regions of the Volga Federal District in 2019–2022

Period	Distinctive features (problem areas) in development			
	Social	**Economics**	**Innovation**	**Environmental**
Pre-pandemic (2019)	Low level of expenditures on healthcare, education and culture, socio-demographic indicators	Relatively high level of fiscal capacity of subjects of the Russian Federation	Critical level of innovative development in most regions	High level of environmental pollution, low level of environmental expenditures
Pandemic (COVID-19) (2020)	Increase in the share of social expenditures, decrease in the life expectancy of the population	Increase in investment activity, level of lending, decrease in the provision of budgets of the constituent subjects of the Russian Federation	Increase in the share of innovation-active enterprises with negative trends in other aspects	Increase in expenditures on environmental activities
Post-pandemic (2021)	Reduction in social expenditures, return of income inequality to pre-pandemic levels	Reduction in the share of manufacturing in industrial output	Continued multidirectional dynamics of indicators	Slight reduction in emissions, return of expenditures to pre-pandemic levels
Sanction (2022)	Multidirectional dynamics of indicators, but values, as a rule, are below the pre-pandemic level	Active renewal of fixed assets in industry	Deterioration or preservation at the same level of indicator values	Trend persistence, all indicators are below the economic security threshold
Level and dynamics of balanced development of regions	Medium, weak negative dynamics	Medium, weak positive dynamics	Low, weak positive dynamics in 2020, then return to the initial values	Catastrophic, weak positive dynamics

Source: Developed by the authors.

in terms of innovation activity of enterprises). The Perm region, Nizhny Novgorod region and the Republic of Mari El show the most significant growth in the introduction of green technologies.

If we consider the dynamics of balanced development of regions through the prism of the influence of significant factors of socio-economic transformation (COVID-19, sanctions), we can distinguish the pre-pandemic, pandemic, post-pandemic and sanctions periods, the distinctive features (problem areas) of which are summarised in *Table 4*.

Despite the fact that opposite trends could be observed in some regions, in general, the dynamics of the components of balanced development of the regions was as follows:

1. Pre-pandemic period (2019) — a relatively stable state of the socio-economic and budgetary sphere with a generally low level of balanced development of the regions;

2. Pandemic period (2020) — an activation of the investment, financial and budgetary systems, manifested in the form of growth in the share of investment and loans relative to GRP, gratuitous receipts to the consolidated budgets of the regions from the federal budget, increase in social spending. However, this growth was not of a long-term nature and made little use of the "window of opportunity" for import substitution, as well as failed to reverse the negative trends in the social and innovative spheres;

3. Postpandemic period (2021) — an increase in financial and investment activity in the economy, which started in 2020, was not continued (the share of investment to GRP in 2021 fell by 2.6% in Russia and 2.5% in the Volga Federal District), which, against the background of an improved oil price environment, strengthened the positions of the extractive sector in industry and led to a decline in the share of manufacturing in industrial output; in the social sphere, there was a continuation of negative dynamics in socio-demographic indicators with some improvement in the indicators of the economic situation of the population;

4. The sanctions period (from 2022) — is characterised by weak multidirectional dynamics of indicators with values close to the pre-pandemic level. In the social sphere, relatively stable positive dynamics is observed in the income inequality of the population, in the economy — in the degree of depreciation of fixed assets, in innovation — in the growth of the share of innovation-active enterprises, in ecology— in the discharge of polluted wastewater.

CONCLUSION

Thus, according to the results of the conducted research the following problems of balanced development of the regions can be identified:

- the general level of balanced development of the regions of the Volga Federal District does not meet the requirements of economic security and in its current form does not allow to ensure long-term sustainable socio-economic development of the territories;
- significant skewness, heterogeneity in the level of balance by development components, indicating their inconsistency as the most important characteristic of the concept of balance. The most difficult situation is in the innovation and environmental spheres, which, when considering the issue of balancing the development of territories in a comprehensive manner, negatively affects social and economic parameters. The low level of innovation activity restrains the growth of labour productivity, which forms the economic basis for increasing the material well-being of citizens, and environmental problems (the solution of which largely depends on the introduction of innovative developments in the field of green technologies) negatively affect the health of the population;
- the analysis of periodisation of territorial development shows that the COVID-19 pandemic and the sanctions pressure on the Russian economy as a whole did not have a significant impact on the balanced development

of the RF subjects under consideration, which indicates, on the one hand, a high margin of safety of territorial socio-economic systems, and, on the other hand, the need to find effective mechanisms for launching internal sources to ensure their balanced development.

As general recommendations for the subjects of the Volga Federal District to improve the balance of integrated development of the regions, we can suggest:

Firstly, given the interconnectedness of the components, it is necessary to increase labour productivity on the basis of stimulating innovative activity of enterprises by expanding the practice of using investment and other instruments available to development institutions (venture investments, grants to innovative start-ups, etc.) and the state (investment tax deductions for enterprises);

Secondly, a more active monetary policy to provide businesses with credit resources for the implementation of investment projects, including in the innovation and environmental spheres (in 2022, this indicator for the Volga Federal District was on average about half the norm (21.7% vs. 40% of GRP));

Thirdly, the growth of tax revenues from increased business and innovation activity of territories[10] will form the basis for increasing the share of social expenditures on education and health care up to generally accepted standards (15% of gross product), but even at the current level of financing (5.5% in the Volga Federal District in 2022), a relevant area is the development of measures to improve the efficiency of the use of budget funds allocated within the framework of national projects and state programmes for socio-economic development of the regions (primarily in the field of social and economic development of the regions).

Despite the similar general level of balanced development of the regions considered, there are undoubtedly certain peculiarities in one or another region, which implies the need to develop specific recommendations. As an example, let us consider several regions of the Volga Federal District:

The Republic of Bashkortostan — an increase in balanced development can be achieved by:

- expanding bank lending to the region's enterprises (including through the development of guarantee mechanisms in the form of the return of provisions on irrevocable state guarantees of the constituent entities of the Russian Federation to the legislation[11]), the level of which is below the average for the district and demonstrates negative dynamics (if in 2019 the volume of loans to legal entities in the republic was 20.6% of GRP, in 2022–18.1%), as well as attracting investment in the form of issuing digital financial assets;
- formation of incentives for the development of innovation activity in the region (including on the basis of building a flexible system of grant programmes aimed at financial support for innovative start-ups, development of joint programmes for training personnel through the interaction of scientific and educational centers (Eurasian Research and Development Centre), educational organisations of higher and secondary education and industrial enterprises) in order to increase the share of innovative products (5.1% in 2022, with an average of 10.2% in the Volga Federal District and a 30% threshold), which is constrained by a relatively low level of domestic R&D expenditure to GRP (8th in the Volga Federal District in 2022), a decline in patent activity (9th) and the number of persons employed in R&D (8th);
- increased funding for projects aimed at introducing technologies to reduce air pollutant emissions, including under

[10] The analysis of the structure of consolidated budgets of the constituent entities of the Russian Federation shows that in the most balanced and economically strong regions (the Republic of Tatarstan, Nizhny Novgorod region, Perm Krai) the share of non-repayable revenues in 2022 did not exceed 20% (33.0% in the Volga Federal District excluding these regions).

[11] URL: http://komitet-finans.duma.gov.ru/novosti/ce6e53de-0047–46bf-b420–3bfe5160c852 (accessed on 07.08.2024).

the federal Clean Air Project (despite the reduction of emissions from 3.3 tonnes per square kilometre in 2019 to 3.0 tonnes, this level is slightly higher than that of the Volga Federal District (2.2 tonnes)).

2. Republic of Tatarstan — the main constraints are concentrated in the field of ecology. During the period under consideration, there is a decrease in expenditures on environmental measures in relation to GRP, as well as an increase in emissions into the atmospheric air, which indicates the need for increased attention to ESG-agenda, given the more than twofold excess of the level of this type of pollution compared to the average values for the Volga Federal District (4.7 tonnes per square kilometre versus 2.2 tonnes). In this regard, it seems advisable to consider the possibility of participation of the republic's cities in the federal project "Clean Air" or increase (return) the level of Tatarstan's budget expenditures on the environment to the average level in the Volga Federal District (0.8% of GRP in 2022, which would give 10 billion rubles of additional expenditures on the environment), as well as stimulate the issuance of green bonds by enterprises. The implementation of this instrument, including as part of social investment (in the improvement of public space, environmental projects) will have a favourable impact on the quality of life of the population.

3. The Republic of Mordovia is the region with the lowest level of social sphere development, where the main efforts should be directed to the development and implementation of measures in the field:

• reduction of imbalances in socio-demographic indicators (indicators 4–6 of *Table 1*), which, given the high inertia of these indicators, requires the formation of a long-term state programme to support an increase in the birth rate. Currently, a demographic programme,[12] is being implemented in the republic, but it is designed only until 2025 and does not have its own resource support. The regional project "Financial support for families at the birth of children" is also operating in the region within the framework of the national project "Demography". At the same time, in our opinion, the shortcomings of the project include weak interconnection with the final indicators of the development of this sphere (for example, among the target indicators of the project there are no indicators directly characterizing the birth rate), as well as discrete dynamics of the forecast values of some indicators. In addition, one of the constraints to increasing the birth rate, which is not considered by the project, is the low level of income of families with children, and in this regard, the creation of high-paying jobs in the territory of the constituent entity of the Russian Federation is important;

• increase in the level of average per capita income of the population. According to this indicator in 2022 the republic was in last place in the Volga Federal District, which at the level of subsistence minimum as in the Republic of Tatarstan provided one of the lowest values of the ratio of these indicators (2.2 rubles against 3.8 rubles in Tatarstan and the norm of 3.5 rubles). Also, the region is the most subsidized in the Volga Federal District and its budgetary capacity is very limited (the share of non-repayable payments in total consolidated budget revenues in 2022 was 51.0%). In this regard, in 2021 the Government of the Russian Federation adopted a programme for the development of the region until 2026[13] in order to increase investment activity, create new highly skilled and highly paid

[12] Resolution of the Government of the Republic of Mordovia of 29 June 2023 No. 303 "On Approval of the Regional Programme to Increase the Birth Rate and Support Families with Children in the Republic of Mordovia for the Period 2023–2025". URL: http://publication.pravo.gov.ru/document/1300202307030001?index=1 (accessed on 07.08.2024)

[13] Order of the Government of the Russian Federation No. 3955 from 29 December 2021 "On approval of the programme of socio-economic development of the Republic of Mordovia for 2022–2026".URL: https://docs.cntd.ru/document/727709769 (accessed on 07.08.2024).

jobs, and increase the population's income as a basis for the formation of material well-being of families with children. In our opinion, it would be advisable to expand the sections of the programme devoted to the development of small and medium-sized enterprises (3 measures) and the social sphere (1 measure) by linking them through measures to support innovative and socially oriented entrepreneurship (including the development of medical equipment and drugs for the rehabilitation of SWO participants and the provision of social services in this area).

Theoretical significance lies in the proposal of an approach to assess the balance of development at the regional level on the basis of the formed system of indicators of economic security, allowing to take into account the level of sufficiency of ensuring sustainable development of the territory in a multidimensional section.

The practical significance of the conducted research is the identification of problem areas in the balanced development of the subjects of the Russian Federation in the Volga Federal District, specified by components and time periods, as well as the development of recommendations for the harmonization of integrated socio-economic development of the regions.

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P.A. Ivanov — selection of indicators to be analysed, description of methods and calculations used, participation in calculations and analysis of obtained results, formation of research conclusions.

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Investments in Economic Growth and Structural Transformation of Russia

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ABSTRACT

The paper considers investments in fixed capital of the Russian economy and their impact on economic growth and structural transformation, which is understood as a change in the proportions between the basic sectors — processing, raw materials and transaction. In orthodox economic theories, gross fixed capital formation is given a central place in ensuring economic growth in the long term, although in practice there are many conditions that weaken such an impact. **The purpose of the study** is to identify the modes of the investment process in the coordinates of "investment — risk", determining the impact on the growth rate and assessing the distribution of investments by economic sectors that form the economic structure. This will allow specifying the tasks of development of the Russian economy, highlighting the directions of structural policy and measures to stimulate economic growth that go beyond the stereotypical orthodox approach, which reduces recommendations to an increase in the accumulation rate and investments. **The methodology of the study** is the theory of economic growth and structural dynamics, empirical and regression analysis of data, ideas about the investment process and measures to stimulate it, a method for assessing the risk by the standard deviation of gross profit. **The result is** that the article theoretically identifies several investment dynamics regimes, defining two basic investment types (according to the dynamics of investment and risk) — "risky" and "hedge". The current growth structure in Russia is assessed as based on risky investments, fixing the relationship between the main sectors and their contribution to the overall GDP growth rate. An empirical analysis of economic growth in Russia in the period 2000–2023 confirms that the dynamics of investments determined the growth rate, which in turn depended on changes in the risk generated by the institutional conditions of development. The risky type of investment also limited growth, and structurally, investments in fixed capital were mainly directed to transaction activities, then to the raw materials sectors and only then to processing. This circumstance actualizes the task of structural changes, which should be reduced to a change in the investment regime and institutional conditions that encourage capital renewal in the manufacturing sectors.

Keywords: economic growth; investment; risk; structure; economic sectors; investment policy; fixed capital; model

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INTRODUCTION

Many tasks of economic development in Russia [1], set 30 years ago, remain relevant even after such a significant period, determining proposals for the growth trajectory of the Russian economic system today [2]. The task of accelerating the pace of economic growth and its structural transformation arises again. However, despite the large number of scientific works on industrial revolutions and technological changes [3–6], the paradox of "rapid industrialization" [7] is once again overlooked. This phenomenon occurs when the pace of industrial development — relatively fast — does not make a significant (in the sense of determining) contribution to GDP growth. In terms of contribution to growth rates, manufacturing and industry made the second largest contribution after transactional sectors throughout the entire period from 2000 to 2022.

Structural changes can be such that they can either slow down the growth rate, lead the economy to a crisis, or, conversely, ensure relatively high dynamics. The financial sector [8], the fiscal policy being implemented [9], the sanctions imposed against the country [10], as well as the structure of investments — public and private [11] — have a strong influence on growth, since it is investments that significantly affect the renewal of fixed capital.

The industrial system serves as the foundation for the development of the modern economy, despite the dominance of the service sector — comprising services and transactions — and the significant contribution of this part of the economy to its growth rate (in many developed countries, except for China [12]). It determines not only the growth of individual sectors, including services, but also shapes the trajectory of technological renewal. On one hand, the established structure of the economy predetermines the scale of investment and capital creation in the sectors. On the other hand, the pace of investments and their efficiency, as well as the structure of resource distribution, influence the future growth parameters of the economy.

What has been said allows us to formulate the goal of this study — to identify the established investment model of the Russian economy's development in the coordinates of "investment — risk" while identifying new tasks for forming an investment model of economic growth. The methodology consists of the theory of economic growth and the investment process, empirical and regression data analysis. The information base of the study is Rosstat data for the period 2000–2023.

Under the term "investments", the article discusses investments in fixed capital (gross fixed capital formation).

To achieve the research goal, it will be necessary to sequentially solve two relevant tasks.

Firstly, to build a theoretical model of the relationship between investments and risk, identifying the modes of the investment process of economic growth, and to identify the nature of this relationship for the Russian economy.

Secondly, to identify the structural characteristics of the investment process in Russia, their correspondence with the established sectoral economic structure in order to provide an overall assessment of the impact on economic growth. Let's examine each task in more detail.

RESEARCH METHODOLOGY: THE "INVESTMENTS-RISK" MODEL

For economic growth, it is necessary to update the capital base of the economy, to increase it, that is, it is required to invest in fixed capital, to increase the accumulation rate [13–16]. In China, this indicator reaches 35–40% of GDP [12], which creates the foundation for the investment model of economic growth.

It should be noted that such a model has not been observed in Russia over the past

30 years [17–18], which could not fail to affect the GDP growth rate. However, it is important to note that the magnitude of the accumulation rate, although necessary, is not sufficient for economic growth [18]. It is also important how investments in fixed capital are distributed across the structure of the economy, what the dynamics of the accumulation rate are, and what drives its growth. If the increase in the accumulation rate occurs at the expense of a reduction in gross consumption and the rate of consumer spending, it may have a stronger impact on growth, including the renewal of the capital base at the next stages of economic development, than the increase in the accumulation rate. The structure of investments, the risk of their implementation, the readiness of facilities to accept and utilize investments, as well as interest rates (but not only them) have a strong influence. The relationship between investments in fixed capital and risk can vary and shape the trajectory of economic development and the investment process itself, with institutional conditions and constraints also potentially having a significant impact on this process. Let us examine this relationship in more detail, using a modeling framework in the analysis, and then present empirical results for the Russian economy. The econometric model is constructed under the assumption of a relationship between investments and risk. Risk is assessed as the standard deviation of returns.[1]

In the paper [19, p. 155–157], a model of the relationship between investments and the risk of conducting economic activities of the following kind was proposed:

$$I = r^b e^{1-r}, \quad (1)$$

where I — the amount of investments, in particular, investments in fixed capital ($I > 0$);

r — the amount of risk, assessed by the standard deviation of total (gross) profit ($r > 0$)[2];

b — the model coefficient, which essentially characterizes the relationship between investments and risk ($b > 0$). This is a numerical coefficient of the model, which is determined empirically.

The study of the possible relationship with the risk of this coefficient constitutes a separate task that was not included in this work. The existing literature includes various studies on the impact of investments, or risk and institutional changes on investments, finance, and banking on growth [20–26]. However, the different nature of the relationship between risk and investments, their joint changes, and mutual influence is usually not taken into account. The model presented above provides a general framework for researching various options for changing these parameters.

The constructed model links investments and risk. In any country, many factors influence investments. Here, investments in the Russian economy and risk, assessed as the standard deviation of profit, which characterizes the investment process itself, are examined. Other risk assessment methods are cumbersome, have similar drawbacks, and, in general, do not work. Variance provides a range of values, and where the risk is higher, the range will be more significant.

Following formula (1), let's present the graph of the relationship between investments and risk for different coefficients b (see *Fig. 1*).

Model (1) is a theoretical model, the construction of which, from our point of view, should take into account various scenarios of investment and risk dynamics, including the scenario with low risk, where a decrease

[1] This is a standard, well-known method of risk assessment. It was used by the founding fathers of portfolio investment theory, J. Tobin and H. Markowitz.

[2] We assume that risk cannot be zero, meaning it is always present. For a quantitative assessment of risk, the standard deviation of the total (gross) profit is taken. It is evaluated using the standard formula for such calculations: $\delta = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \mu)^2}{n}}$, where δ — standard deviation; x_i — value of an individual sample; μ — average arithmetic sample; n — sample size.

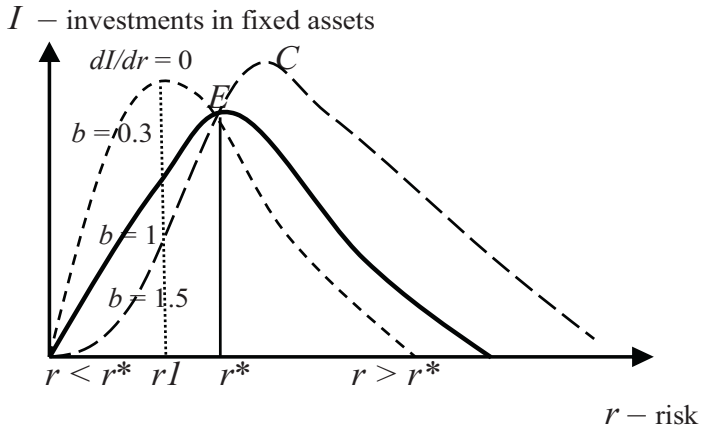


Fig. 1. **Investment and Risk According to the Model (1) [27]**

Source: Author calculation.

in risk may be accompanied by a decrease in investments. There are areas where an increase in investments is accompanied by an increase in risk, and a decrease in risk leads to an increase in investments (see *Fig. 1*). During the structural transformation of the economy, the risk may increase, but there are two possible scenarios: investments may rise (usually in the initial period) or decrease with the increase in risk when the structural transformation exhausts its potential. Structural transformation should be understood as targeted actions with necessary investments to change the proportions of the economic system, creating long-term conditions for its growth. A decrease in risk may lead to an increase in investments, but it may also be accompanied by a decrease if it reduces the need for investments in structural changes, which is reflected in the model in *Fig. 1* [19, 27].

The proposed and tested model (1) in several studies is interesting because it allows for the consideration of several modes of investment in the fixed capital of the economic system, identifying the state according to these modes for a specific economic system, after which changes can be introduced into the investment policy. From *Fig. 1*, constructed according to model (1), it can be seen that the situation differs for different risk levels concerning some risk r^*, corresponding to the curve with point E and a coefficient value of $b = 1$ (see *Fig. 1*). If the current risk is less than this value r^*, then with the increase of the coefficient b, provided that the coefficient is initially less than one and reflects the institutional organization of the process of investing in fixed capital, with its increase, investments will decrease, and with its decrease, they will increase, as seen in model (1) and *Fig. 1*. Thus, to increase investments under the existing business risk, the coefficient b should be reduced. In this case, and given the adequacy of this model, additional research is required regarding the dependence of this coefficient on various institutional conditions. If the conditions are fixed, then for $b < 1$, the increase in investments occurs according to this model with an increase in risk. Therefore, when the risk $r < r^*$, its increase is permissible simultaneously with the growth of investments. It will not oppose the increase in investments up to the level $r1$, after which, with further increase in risk, investments will decrease (when $b < 1$).

With a risk of $r > r^*$ and $b \leqslant 1$, an increase in risk is observed to lead to a decrease in investments, according to model (1) and *Fig. 1*. This is already a different model of the "investment — risk" dynamics. If $b > 1$, then this decrease does not happen immediately; there is a section of increasing investments

Table

Investment Types and Modes (by Risk and Parameter b) for Investment Growth

Investments	For b > 1, b < 1
Risky (r < r*)	Decrease
Hedge (r > r*)	Increase

Source: Compiled by the author based on *Fig. 1*.

up to point C (section EC in *Fig. 1*). With a decrease in the coefficient *b* at relatively high risk, a decrease in investments will also be observed under otherwise equal conditions (see *Fig.* 1). Therefore, to increase investments at the same risk, it is necessary to increase the coefficient *b*, rather than decrease it, as is the case with relatively low risk $r < r^*$.

Certainly, the model is constructed under the assumption of no relationship between the coefficient *b* and risk, but this relationship may arise because if the coefficient reflects institutional conditions, then their change and the introduction of certain rules can increase or decrease the risk of conducting economic activities and separately the risk of investing. As described above, various modes of the investment process emerge within the framework of the relationship between investments, risk, and institutional conditions. From this, economic policy measures arise (substantive assessment). Firstly, if the risk is relatively high $r > r^*$, the parameter *b* should be increased and the risk lowered, which will contribute to the accumulation of investments up to point C. Secondly, with relatively low risk, it is beneficial to lower the parameter *b* and allow the risk to increase to the value $r1$ or r^*.

Guided by model (1) and the description of *Fig. 1*, we will identify four basic modes of the investment process that determine the nature of the renewal of fixed capital (economic funds) and thereby influence both the GDP growth rate and structural transformation. Two modes are distinguished when $b < 1$, and two when $b > 1$. And one mode each when $b = 1$, with risk being greater or less than the value r^*, corresponding to the highest level of investment according to model (1) (see *Fig. 1*).

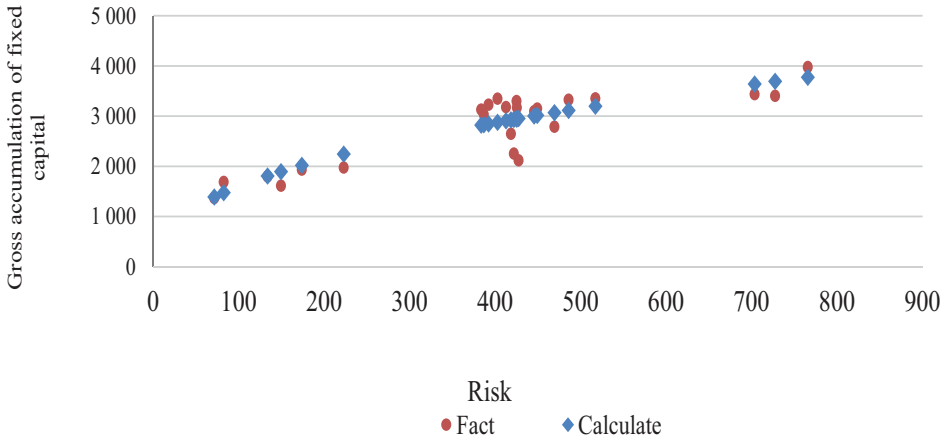
Based on the change in investments due to changes in risk, two basic types of investments can be distinguished: 1) "risky investments", which grow with an increase in risk (as confirmed by *Fig. 5–7*); 2) "hedging investments", which require a decrease in risk for growth. Since the coefficient *b* reflects the institutional support of the investment process, its decrease can be considered as a reduction in institutional dependence, while its increase can be seen as an enhancement of institutional regulation of this process.

For each type, two modes are allocated, depending on the required change in the coefficient *b* for increasing investments (see *Table*).

Thus, the type of investment process by risk will, in a certain sense, be determined by institutional changes. For risky investments, it should be reduced in the form of lowering the coefficient *b*. For hedge investments — increase it, in the form of raising *b*. It was mentioned above that *b* is the model coefficient, which may depend on a number of conditions of the investment process. Its study and dependence on various conditions $b = f(x1 \ldots xn)$ constitutes a separate task — both econometric, statistical, and empirical — that was not included in the scope of this article within the framework of the theoretical model. Therefore, the practical tools and scenarios determining this coefficient could constitute a separate research task.

With relatively low risk, it is necessary not to consider its increase for the purpose of increasing investments, but to change institutional conditions in such a way[3] that the coefficient *b* is reduced (assuming the adequacy of the model under consideration). With relatively high risk, both the risk itself

[3] How exactly — this constitutes the direction for further research on the proposed model.



$I=229*r^{0.42}$

$R^2= 0.79$

$R\_adj^2=0.78$

Fig 2. **Relationship Between Investments in Fixed Capital (Gross Accumulation) and Risk in the Russian Economy, Billion Rubles, in 2000 Prices, 2000–2023**

Source: calculated by the author based on Rosstat data. URL: https://rosstat.gov.ru/statistics/accounts; https://rosstat.gov.ru/statistics/finance; https://rosstat.gov.ru/statistics/accounts; https://rosstat.gov.ru/statistics/finance (accessed on 20.01.2025).

Note: Model statistics: F-criterion = 81.84; D-W calc. = 1.56 ∈ [1.45; 2.55]; White test: $\chi 2$ calc. = 2.35; $\chi 2$ crit. = 3.84.

should be reduced and the coefficient b increased to boost investments.

Let's outline the algorithm for further research in the form of the following three main steps.

Firstly, let's determine the relationship between gross accumulation (investment in fixed capital) and risk over the period from 2000 to 2023, as well as the growth rates of GDP and gross accumulation.

Secondly, we will determine the nature of investment in Russia (risky and hedging investment processes), and analyze the structure of investments in fixed capital by economic sectors (manufacturing, raw materials, and transactional).

Thirdly, we will formulate the tasks of structural transformation in light of the economic growth policy implemented within the framework of the investment development model.

Let's apply the above-described methodology to the study of investments in the Russian economy, for which a truncated model (1) in the form of an exponential function will be valid (selected using the model selection method). We will implement the introduced research algorithm.

INVESTMENTS, RISK, AND ECONOMIC GROWTH IN RUSSIA

For the Russian economy, a variant of model (1) in the form of an exponential function of investments dependent on risk is possible, then $I = r^b$, where the coefficient b can be greater or less than zero. Analyzing such a model, it is not difficult to show that the boundary point will be the equality of the amount of investments and risk (for any value of b). If the risk is above this value for both $b < 0$ and $b > 0$, increasing the coefficient for the given risk will correspond to a larger amount of investments. If the risk is less than the amount of investment, then lowering b will correspond to a greater amount of investment for the same risk, both for $b < 0$ and for $b > 0$.

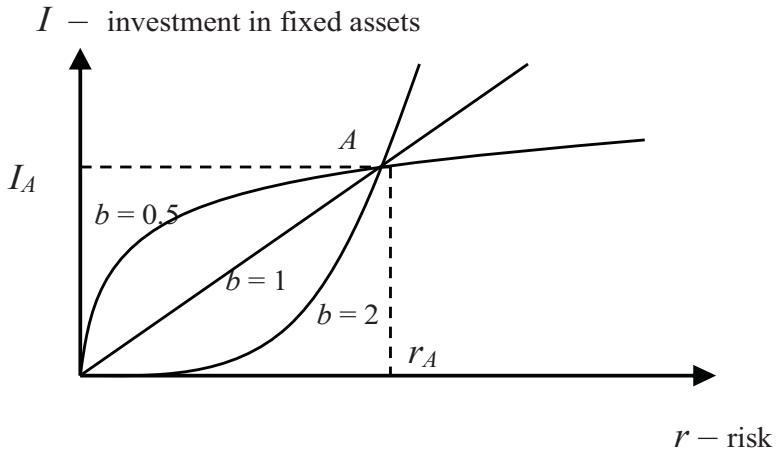


Fig 3. **Diagram of the Relationship Between Investment and Risk for Different Values of the Coefficient *b***
Source: Author calculation.

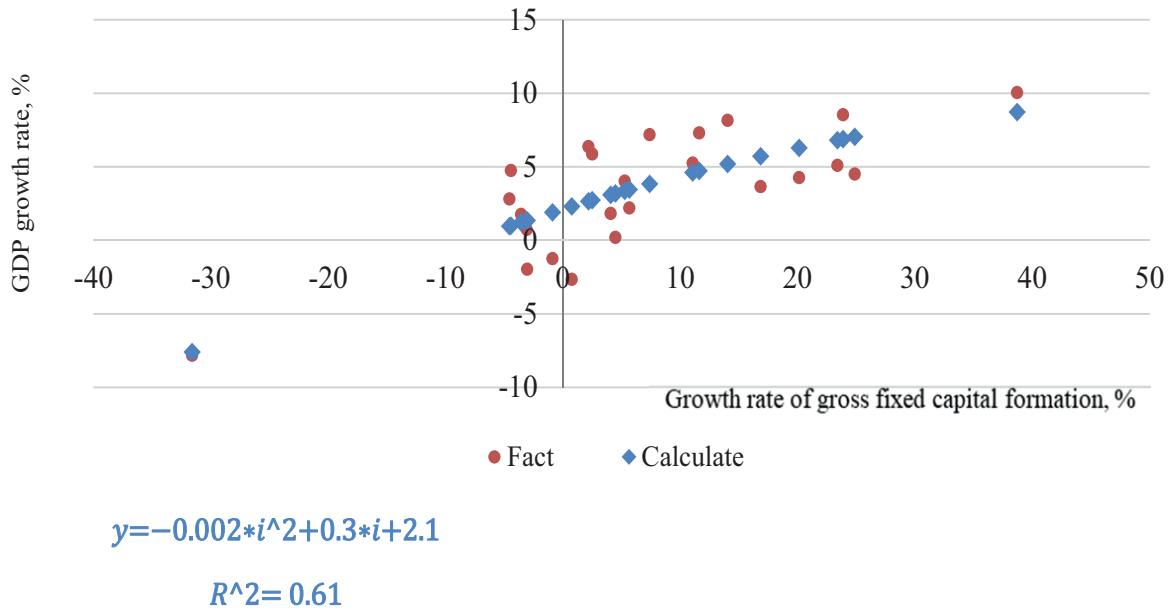


Fig. 4. **Russia's GDP Growth Rate and Gross Capital Formation Growth Rate, 2000–2023**
Source: calculated by the author based on Rosstat data. URL: https://rosstat.gov.ru/statistics/accounts https://rosstat.gov.ru/statistics/accounts (accessed on 20.01.2025).

Fig. 2 shows the relationship between investments and risk for Russia over the period 2000–2023. As we can see, the regression model is an exponential function with a coefficient $b = 0.42 > 0$. With increasing risk, investments also rise. This corresponds to the situation to the left of point r^* in *Fig. 1*, that is, the regime of risky investments, although the model in *Fig. 2* differs from the model in *Fig. 1*. However, the range of change in coefficient b that contributes to increasing investments for a certain level of risk is limited, as if the risk exceeds a certain value, a decrease in the positive coefficient b will lead not to an

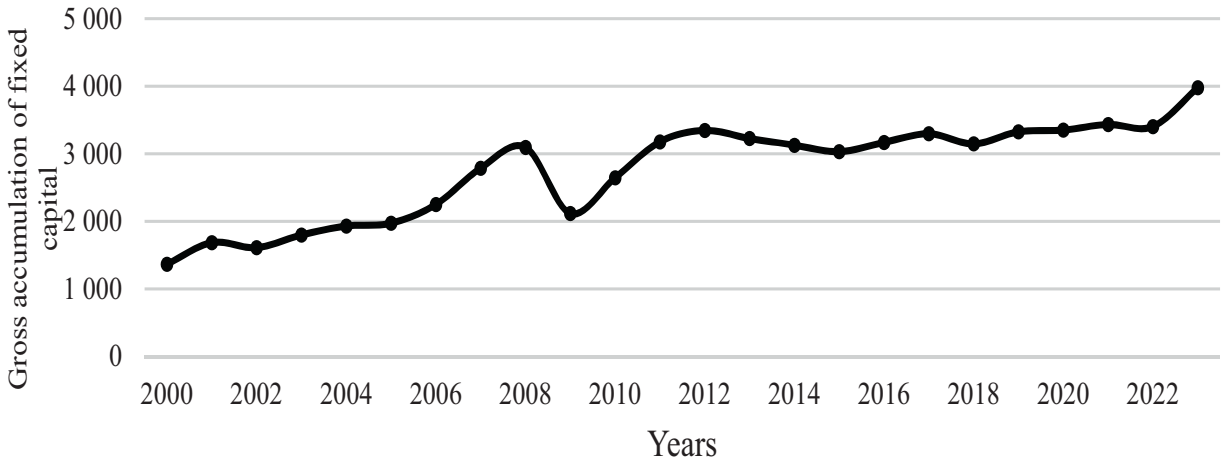


Fig 5. **Gross Fixed Capital Formation in Russia, 2000–2023 in 2000 Prices, Billion Rubles**

Source: Built built by the author on the basis of Rosstat data. URL: https://rosstat.gov.ru/statistics/accounts; https://rosstat.gov.ru/statistics/accounts (accessed on 20.01.2025).

increase, but to a decrease in investments. This situation is schematically shown in *Fig. 3*. To the right of point A, there will be a reduction in investments for this level of risk, in contrast to what will be observed to the left of point A (see *Fig. 3*).

The empirical analysis of *Fig. 2* does not provide an understanding of how to adjust the value of coefficient *b* and by what methods. This requires additional research, and quite extensive, which constitutes the content of the analytical development task — its formulation is proposed here, but its solution goes beyond the scope of this article.

Fig. 2 provides an overview of the established elasticity of investments in fixed capital with respect to risk in the Russian economy.

The task of determining the impact of investments on the growth rate and structural transformation should be reduced to identifying the conditions and methods of their changes that specifically affect this indicator. This determination will undoubtedly influence the rate of increase in investments in fixed capital. And the rate of increase in investments, in turn, cannot fail to affect the overall dynamics of Russia's GDP. The relationship between the GDP growth rate and the gross accumulation growth rate is illustrated in *Fig. 4*.

The spread of empirical points in *Fig. 4* and the fitted regression indicate that a higher growth rate of investments ensures an increase in the growth rate of the economy, while a lower growth rate of investments corresponds to a lower growth rate of the economy. The approximate ratio is as follows: a 10% increase in gross accumulation corresponded to a GDP growth rate of about 5% (slightly lower), and a 20% increase corresponded to a GDP growth rate of 7–8%.

It is important to note that with a zero growth rate of investments and even with a slight decline of up to 2%, a positive growth rate of the Russian economy was ensured. These speed ratios indicate that the established structure determines the sensitivity of GDP to gross accumulation, the distribution of investments across the economy, and the resulting rate of GDP growth, which is also influenced by other factors (sources) of growth. In this regard, increasing the accumulation rate cannot guarantee economic growth; rather, the assessment of the structure of investment

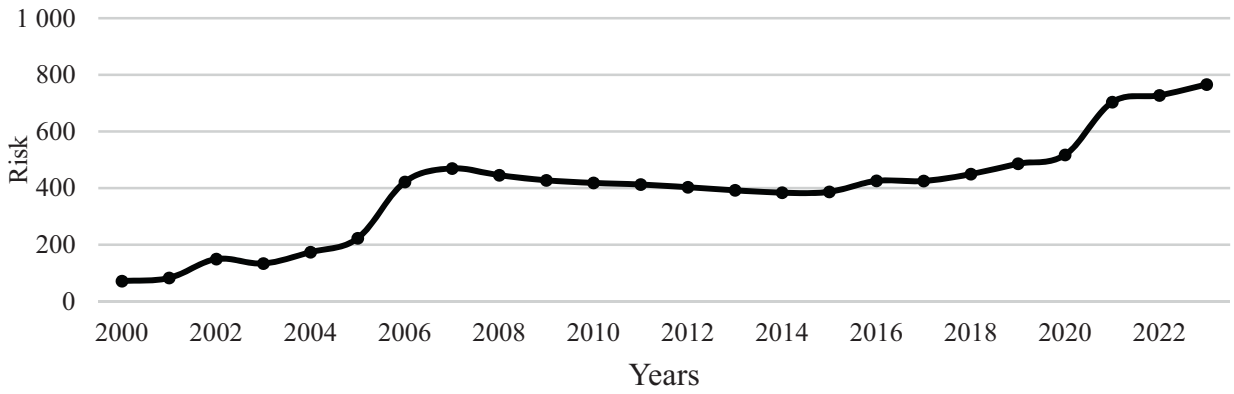


Fig. 6. **Risk Dynamics in Russia, 2000–2023, in 2000 Prices, Billion Rubles**

Source: calculated by the author based on Rosstat data. URL: https://rosstat.gov.ru/statistics/finance; https://rosstat.gov.ru/statistics/finance (accessed on 20.01.2025).

distribution across sectors, measuring their contribution to the overall economic growth rate, is more valuable. Such an analysis indeed represents the consideration of structural transformation in terms of investments and growth. Of course, the regression in *Fig. 4* is valid within the real range of the parameters involved and shown in the figure. When there is a significant deviation beyond these boundaries, it is necessary to select a different model (this regression is demonstrative, by the way, with a rather low determination $R2 = 0.61$).

Economic growth, in its style, can be based on risky or hedge investments. However, both the dynamics and the magnitude of investments will determine overall growth, taking into account the nature of the investments in fixed capital (how the renewal process is going) and their distribution structure. Let's move on to examining how investments are distributed across the three basic economic sectors — processing, raw materials, and transactional.[4]

INVESTMENTS IN STRUCTURE (RAW MATERIALS, PROCESSING, AND TRANSACTIONAL SECTOR) OF THE RUSSIAN ECONOMY

In classical theories of economic growth, investments and the creation of capital funds are considered fundamental conditions for the long-term growth and development of the economic system [7]. Models with variations of growth factors still rely on this foundation, regardless of the dominance of sectors of material production or service activities, which has long been observed in the modern economies of developed countries. Capital shapes the structure of the economy, alters it, but also becomes a derivative of this structure, as investments are distributed according to the already established proportions between types of activities, their profitability (efficiency), and the set development goals and methods of regulating this development. *Fig.5* shows the dynamics of investments in

[4] In total, three sectors contribute to the GDP of the Russian economy. The composition of the sectors is determined in accordance with Rosstat data on the following types of activities. The raw materials sector includes agriculture, forestry, hunting; fishing and aquaculture; mining; electricity, gas, steam supply and air conditioning; water supply; wastewater management, waste collection and disposal, pollution remediation activities. The manufacturing sector includes manufacturing industries; construction. The transactional sector includes wholesale and retail trade; repair of motor vehicles and motorcycles; transportation and storage; accommodation and food service activities; information and communication activities; financial and insurance activities; real estate activities; professional, scientific and technical activities; administrative and support service activities; public administration and defense; social security; education; human health and social work activities; arts, entertainment and recreation activities; other service activities. Source for Russia: Rosstat data. URL: https://www.gks.ru/accounts (accessed on 20.01.2025).

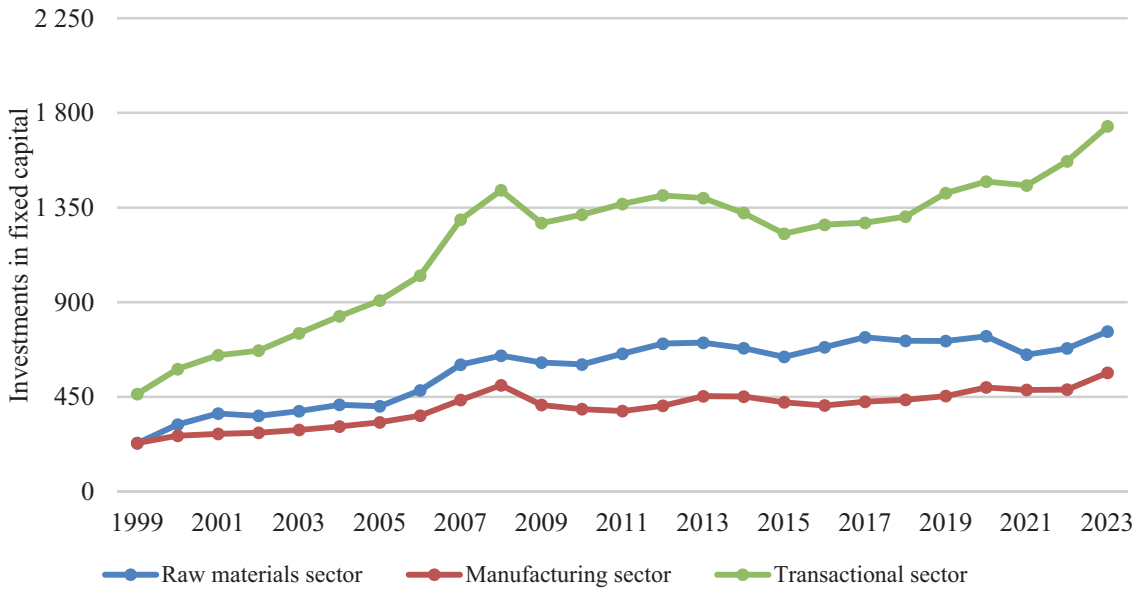


Fig. 7. **Distribution of Investments in Fixed Capital Between Three Basic Sectors of the Russian Economy, 1999–2023 Billion Rubles in 2000 Prices**

Source: Calculated by the author based on Rosstat. URL: https://rosstat.gov.ru/statistics/accounts; https://rosstat.gov.ru/storage/mediabank/Tab-inv-okved.htm; https://rosstat.gov.ru/statistics/accounts; https://rosstat.gov.ru/storage/mediabank/Tab-inv-okved.htm (accessed on 20.01.2025).

fixed capital (gross accumulation) in Russia during the period 2000–2023 at 2000 prices. *Fig. 6* shows the dynamics of risk.

Let's note that from 2011 to 2022, there was no significant growth in investments in 2000 prices. There was a slowdown in the investment process, which was quite prolonged, and its stabilization at approximately the 2008 level (see *Fig. 5*). In the period from 2000 to 2008, investments in fixed capital more than doubled. Significant growth in investments only occurred in 2023 due to the activation of the budgetary mechanism, the implementation of national projects, and the resolution of development tasks in the manufacturing sector (including defense tasks).

Risk also increased during the period 2000–2007, and at a faster rate than investments in fixed capital, almost 5 times (*Fig. 6*). Then there was a slight decrease until 2015, after which it rose almost 2 times by 2023. Thus, from 2010 to 2012, investments increased with a slight decrease in risk. Subsequently, risk did not increase, but investments did not significantly increase either. From 2020, there was an increase in risk with a slight increase in investments, then the increase in risk was accompanied by an increase in investments. Thus, there are segments in the evolution of the investment process where a decrease in risk is accompanied by an increase in investments, as well as an increase in risk observed with an increase in investments, but the increase in risk outpaces the increase in investments (2000–2007). A similar scenario is observed in 2021–2023, where the increase in risk outpaces the increase in investments (*Fig. 5, 6*).

The renewal of fixed capital, on the one hand, reflects changes in the growth potential of specific types of activities and economic sectors. On the other hand, the scale of investment in fixed capital is determined by the scale of the sector, industry, the development tasks of specific types of activities, and the emerging need for capital and its renewal.

From *Fig. 7*, it can be seen that the largest volume of investments in fixed capital was

allocated to the transactional sector of the economy, followed by the raw materials sector, and then processing. It should be noted that in terms of GDP share, processing even outpaced the raw materials sector, and the scales of the sectors equalized around 2018, each accounting for about 20% of Russia's GDP.

However, the fixed capital of the raw materials sector required significant investments for maintenance and renewal. Moreover, for a considerable period during the examined timeframe, this sector was more dependent on equipment supplies than processing. The distribution of investments generally mirrors the structure of the sectors, but with a slight difference in the shares of the raw materials sector and processing in terms of investments, there is a clear mismatch with the scale of the sector in terms of GDP. *Fig. 5–7* illustrate this. From *Fig. 7*, it is evident that the share of the transactional sector is higher, followed by the share of the raw materials sector, and then processing.

It should be noted that while the scale is more or less clear, the dynamics of investments in fixed capital clearly surpassed those in the transactional sector compared to the processing and raw materials sectors, where it was quite sluggish (*Fig. 7*), especially after 2009 and up until 2022. In the transactional sector, the revival of investment dynamics occurred in 2017–2018. This is indicative, as it was precisely the service economy that was actively forming and developing, due to the narrowing of material production opportunities and the deindustrialization taking place over several years [19]. Thus, the distribution of investments reflected the emerging structure and solidified it, forming the proportions between the basic sectors of activity in the economy. This also affected the credit activity of the banking system in its influence on economic growth [28].

Usually, all else being equal, a lower level of risk corresponds to a higher growth rate of gross accumulation (investments in fixed capital), and a higher growth rate of investments positively affects the growth rate of GDP. Therefore, measures that reduce the risk of investing and creating fixed capital become the defining growth policy for Russia. Along with the task of distributing these investments across economic sectors, they constitute the true content of structural-institutional growth policy. Ignoring the modes of investing in fixed capital depending on the dynamics of risk means neutralizing the contribution of investments and neglecting the established structural conditions of growth, which need to be changed through targeted actions by the state.

CONCLUSION

Summarizing the conducted research, we highlight the most valuable conclusions.

Firstly, the Russian economy demonstrated a risky type of growth in terms of the main capital investment regime. Moreover, economic growth did not correspond to the investment model, as gross consumption continued to make the main contribution to economic dynamics, while the rate of main capital accumulation remained relatively low [18]. Furthermore, the increase in this rate under the conditions of an established risky type of investment, where investment growth is accompanied by a noticeable increase in risk, will increasingly less determine the current GDP dynamics due to the saturation of the investment growth rate, with not such a high determination of growth and investment rates.

Secondly, the established economic structure shapes the distribution of investment flows among the three basic sectors of the Russian economy. On the one hand, this reinforces the existing proportions, and on the other hand, it determines the contribution of these sectors to the overall GDP growth rate.

Thus, the investment model of economic growth requires construction taking into account the structural features and other qualitative characteristics of the investment

process. This implies an economic policy that creates not only general macroeconomic conditions for the renewal of fixed capital (relatively inexpensive credit, advance capital, currency stability, low price dynamics) but also a diversified sectoral policy that influences the dynamics of investments and the scale of fixed capital investment in the considered sectors of the Russian economy. Without such an approach, discussions about structural policy or some spontaneous shifts that stimulate economic growth in Russia seem meaningless. It is necessary to institutionally structure the economy so that growth zones imply a reduction in the risk of investing fixed capital, while bloated activities that are not development priorities ensure a relatively higher risk, which would be inversely related to the investment process (when risks would lead to a distortion in the level of fixed capital renewal). This approach, in our opinion, constitutes a distant yet promising prospect for the theory and practice of economic policy, shaping the contours of new development tasks and methods of state development management.

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The Study of Specific Empirical Patterns of the Influence of State Macrofinancial Policy on Stimulating Innovation Activity Within the Framework of Endogenous Growth Theory

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ABSTRACT

The **subject** of the study is the empirical patterns of the influence of the state macrofinancial policy on stimulating innovation activity within the framework of the endogenous theory of growth. The **purpose** of the paper is to propose an approach aimed at ensuring direct market competition between several firms in each industry, which combines the concept of endogenous growth with a dynamic industry model of ideal Kurnout — Nash equilibrium. The scientific contribution and **novelty** of the research lies in the development of new and improvement of key methodological approaches already used to assess the impact of R&D subsidies on endogenous productivity growth. In particular, new key characteristics of competition through R&D are introduced, which are usually absent in most endogenous growth models, including: 1) deterministic entry and exit from the market; 2) the distribution of firm sizes; and 3) more complex market structures that vary by industry and over time. The main **conclusion** is the fact that the results obtained by the author confirm the correctness of using the proposed methodological approach. The summary results confirm the existence of partial equilibrium conditions for a particular industry, demonstrating how growth-stimulating subsidies for R&D change the endogenously determined structure of the market. R&D subsidies "stretch" the distribution of market shares by increasing the number of firms in the market, but at the same time increase the differences in market shares between firms. The new methodological approach proposed by the author provides an important step towards the study of a more formalized apparatus for studying the dynamic industry model of ideal equilibrium.

Keywords: empirical patterns; macrofinancial policy; theory of endogenous growth; innovations; R&D

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INTRODUCTION

What is the relationship between market structure and economic growth? This broad yet fundamental macroeconomic question has been addressed in many studies dedicated to endogenous growth [1–3]. However, the authors of these studies attempted to base their work on strict assumptions regarding market structure in order to maintain analytical modelability. These assumptions include two main types: 1) either a single monopolist dominates all industries, exiting the game only through "creative destruction"; 2) or firms compete in some form of monopolistic competition, where each firm still holds a monopoly but competes with all other firms in the economy as an infinitely small player. In particular, firms in these models do not compete directly in the same product markets, and therefore, the consequences of competition are explained by theoretical market structures that possess only a few characteristics that one would typically expect when describing a market with imperfect competition. In this paper, the author proposes to expand the scope of existing research on endogenous growth by incorporating models within the framework of the endogenous growth concept with a dynamic industry model of perfect equilibrium, which will allow for the modeling of direct competition in the goods market, assuming Cournot competition, as opposed to the standard assumption of Bertrand competition. This assumption allows heterogeneous firms to compete in the same market and maintain a stable market share. Firm-level heterogeneity creates dynamic competitive pressure on firms, forcing them to actively invest in R&D. In the author's hypothetical model, firms implement technological innovations that lead to a reduction in production costs. As a result, economic growth is driven by the incentives that arise for firms to lower production costs. At the same time, these incentives are influenced by the market structure, which is determined by both the number of firms and the distribution of production costs among firms. Two more key assumptions should be noted.

Firstly, innovations initially have a temporary private character and then gradually spread throughout the economy, becoming available to other market participants. In most endogenous growth models, innovations immediately spread to the rest of the economy, but competing firms do not enter the market due to the Bertrand competition assumption. However, the slow diffusion of technological processes encourages firms to acquire and enhance technological advantages while simultaneously preventing the permanent monopolization of industries, as would be the case with zero knowledge diffusion.

Secondly, new firms enter the market with below–average productivity. This assumption is made to ensure that the exit hazard rate is negatively related to the age of the firm, which is a significant empirical observation found in individual studies. It sharply contrasts with studies dedicated to endogenous growth, according to which the exit hazard rate is constant and does not depend on the age of the firm.

The method used by the author for solving is based on the Markov perfect dynamic industry model by R. Ericson and A. Pakes [4], as well as A. Pakes and P. McGuire [5]. In the author's model, in each production period, its prices and volumes are determined according to the Cournot–Nash equilibrium, while firms maximize their current discounted value by choosing the level of R&D expenditures in addition to decisions about entering and exiting the market. The dynamic equilibrium is the perfect Markov — Nash equilibrium with an ergodic distribution over the market structure. Thus, the method used by the author involves the distribution of market structures, implying that the industry develops and changes over time, simulating a turbulent, evolving industry environment.

The advantage of this approach is that it allows for the explicit calculation of the ergodic distribution in a steady state and its comparison with the steady states arising under certain macroeconomic conditions. Moreover, the model enables us to consider more important moments of the distribution of firms by size (variance, skewness, etc.) and how they respond to certain changes in macrofinancial policy. This paper presents a partial equilibrium model that allows for a focus on the joint determination of economic growth mechanisms and market structure. At the same time, potentially important feedback effects are not considered. Nevertheless, the results presented

here are interesting in their own right. Firstly, the paper demonstrates that this class of models can explain a sufficient number of "standard examples" encountered in empirical studies of industry market dynamics. Secondly, the empirical analysis presented in the paper shows that R&D taxes hinder companies' involvement in R&D and lead to a more competitive market structure, while subsidies have the opposite effect. This result sharply contrasts with the analysis within the framework of creative destruction models, where taxes are used to reduce the rate of monopoly replacement, while subsidies stimulate firms.

Based on the objectives and tasks of the research, the paper has the following logical structure. First of all, we need to conduct a deep theoretical and methodological analysis of the existing studies on endogenous economic growth, as well as in the field of macroeconomic aspects of assessing the impact of subsidies on R&D on endogenous productivity growth. Next, we will present a theoretical description of the modeling approach used in our research. Then we will proceed to discuss the empirical results of our model's behavior based on the analysis of the partial equilibrium model for a specific industry and discuss the impact of taxes and subsidies on R&D. In conclusion, we will summarize our findings and outline the prospects for further research.

SEPARATE KEY EMPIRICAL REGULARITIES OF THE ENDOGENOUS GROWTH CONCEPT WITHIN THE FRAMEWORK OF A DYNAMIC INDUSTRY MODEL

Before proceeding to a detailed review and critical analysis of the main theoretical and methodological approaches, it will be useful to briefly familiarize ourselves with some key empirical regularities or "standard examples" encountered in empirical studies on the dynamics of industry markets. The purpose of such an introduction follows from one of the main hypotheses of this paper, which is that the proposed market structure matters, and therefore, a model that reflects at least some of the key empirical regularities would be more useful for understanding how macrofinancial policy can influence long-term economic growth and welfare through feedback due to changes in the equilibrium market structure.

There are numerous empirical studies in this field; however, the author will rely only on select works that directly link these "standard examples" with empirical research on endogenous growth. The most noteworthy are the studies by J. Klett and S. Kortum [6], J. Klett and Z. Griliches [7], W. Cohen and R. Levin [8], R. Shmalenzi [9]. Below is an incomplete list of many "standard examples" that are recognized in the scientific community; the others (not listed here) are quite controversial in scientific circles. The purpose of presenting them here is to demonstrate the strengths (and weaknesses) of the subsequent model, which exhibits these features that are not properties of many endogenous growth models.

1. The essence of the first "standard example" is that large firms are inclined towards innovation and invest more in R&D. In individual studies [10–13], the authors note that "quality ladder" models suggest that new innovations are implemented exclusively by new firms, which contradicts the fact that dominant firms are more inclined to adopt innovations. Authors of other studies [14–16] argue that firms with a larger market share are more likely to implement innovations, but the increase in market concentration due to innovations by large firms reduces the overall level of innovations. However, authors of the third line of research [17–19] provide evidence that small firms in certain industries contribute a larger share of "significant innovations", while overall, large firms account for a larger share across all industries.

A bit ahead of ourselves, based on calculated data in OECD countries,* in *Figure 1* we will show the ratio of R&D investments of the largest firm in the market at a given point in time and four small firms depending on their market presence. The diagram clearly shows that large firms spend more on R&D than small ones. Since they all use the same R&D technologies, it follows that larger firms will implement more innovations. This outcome stems from the policy that larger firms, on average, gain more from innovations or lose from their inability to innovate. Established firms with technological leadership protect their market share by investing

* URL: https://www.oecd.org/en/data/indicators/investment-by asset.html?oecdcontrol-c0d5ac5e97-var6=FIXASSET (accessed on 20.07.2024).

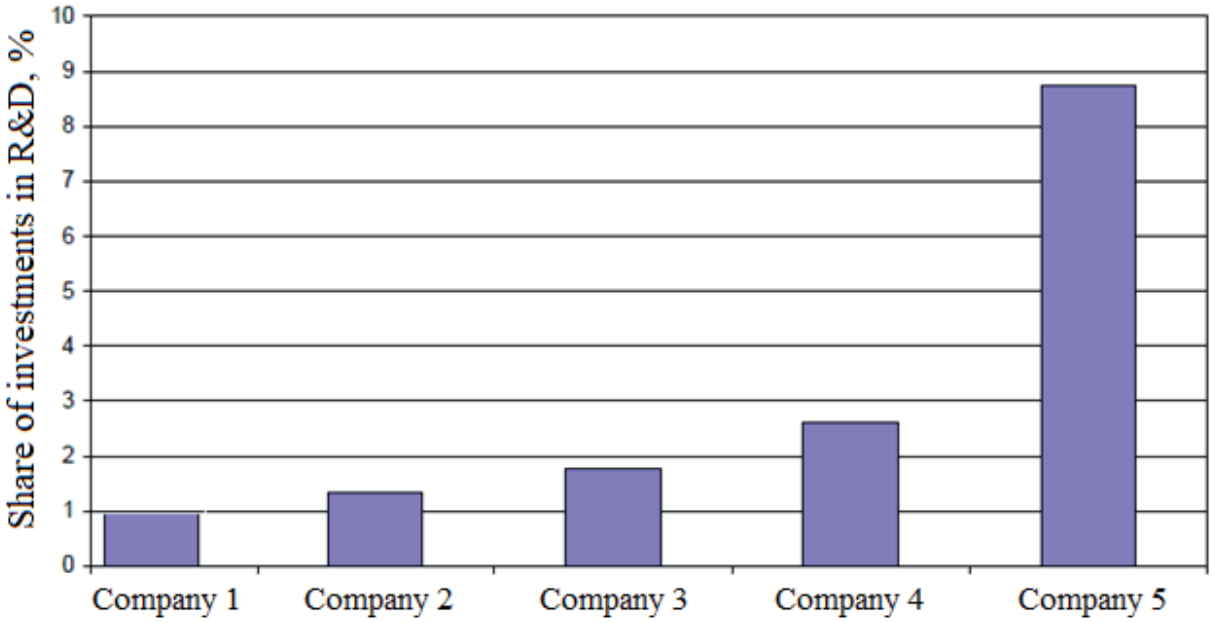

Fig. 1. **The Ratio of R&D Investments Between Companies in OECD Countries Within a Specific Industry, %**

Source: The author' calculations based on OECD statistical data.

more significant resources in R&D than smaller firms.

2. The second "standard example" indicates that R&D expenditures increase the size of profits. It is related to the first but is not necessarily implied by it, and P. Thompson [20] points out that the evidence for the relationship between profits and size is ambiguous. The causal relationship between R&D and profit can be two-way. On one hand, an increase in research and development expenditures may reflect higher expected profits. On the other hand, higher profits may reflect a firm's desire to increase and/or maintain its profitable market share in a competitive environment. Although the first of these two effects is examined in separate empirical studies [21, 22] dedicated to endogenous growth, the reverse direction of the causal relationship from R&D to profitability, emphasized by P. Thompson [20], which he made based on corroborating arguments by P. Geroski [23], is not a feature of these models.

The simple correlation between current profits and R&D expenditures, calculated based on data from OECD countries, is 0.86 when using average levels of profits and investments ranked by firms. This positive correlation largely aligns with the assumptions presented above. Larger and more profitable firms protect their income and profitability by allocating more funds to R&D investments, which subsequently lead to increased profits by maintaining or expanding their competitive advantage. Higher current profits indicate that the firm could lose more by not keeping up with its competitors, thus stimulating more active R&D efforts.

3. The feature of the third "standard example" is that the volumes of R&D investments are proportional to the firm's market share, i.e., the intensity of R&D (usually measured as the ratio of R&D to sales) does not depend on the size of the firm. This case has been the subject of thorough research by various authors, and different econometric estimates have led to different conclusions. For example, in his studies, F. Scherer [24] found that this relationship is close to linear, but for the largest firms, it has some convexity. Furthermore, in their studies, W. Cohen and R. Levin [8] found that most recent studies did not reveal systematic differences in the behaviors of firms of different sizes. In those studies where this was identified, disproportionately high R&D intensity was found in either very small or very large companies [25].

Figure 2 shows the results of calculations and curve fitting using a standard regression equation by the least squares method (LSM) to study the levels of R&D investment based on market share.

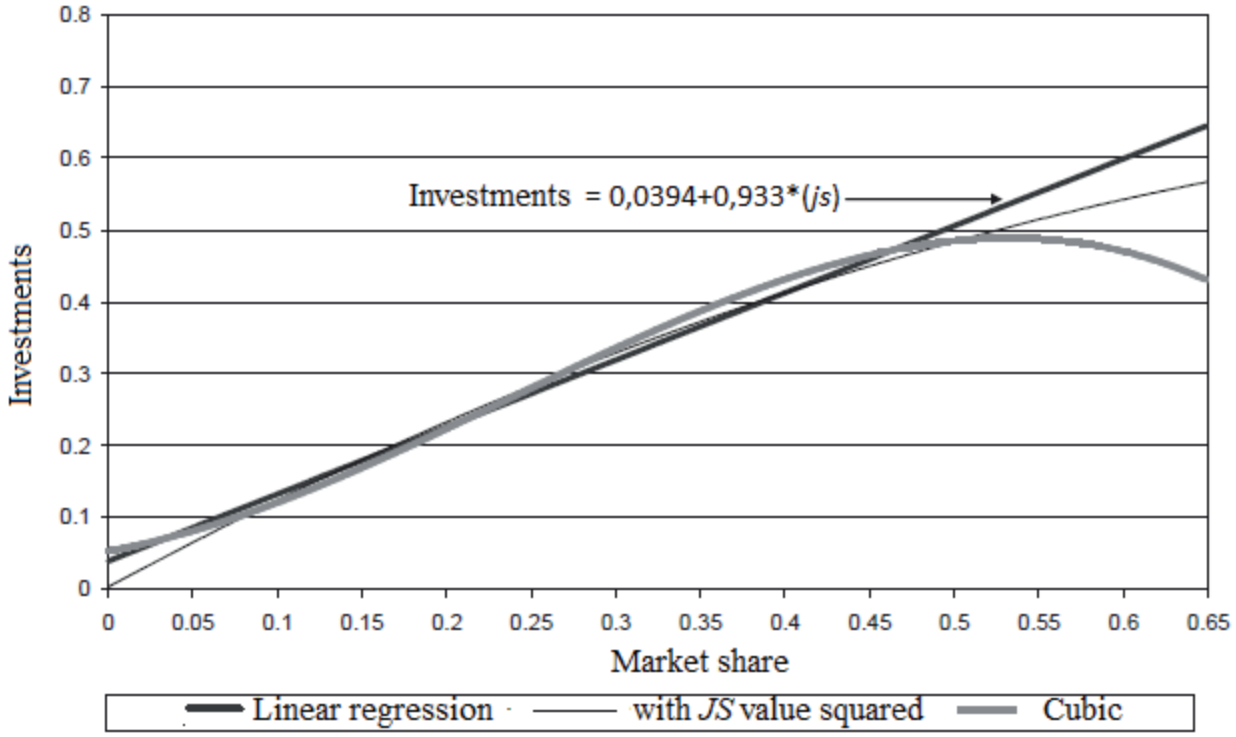

Fig. 2. **Results of the Correlation Calculation Between Current Profit and R&D Expenses of Companies, Calculated Based on Data from OECD Countries**

Source: The author' calculations based on OECD statistical data.

The relationship is almost linear, while the cubic function of market share shows a slight increase for the smallest firms and a concave part for the largest firms. Higher values for the smallest firms indicate that small firms demonstrate a higher level of private innovation. That is, the implicit technological costs for new firms to enter the market, as opposed to the explicit costs associated with exiting the market, are quite high. In cases where exit from the market is not perceived as a threat, small firms invest more than proportionally to their relative production volume. Moreover, the slope of the line of the linear equation (see *Figure 2*) is close to one, indicating that the intensity of R&D is almost, but not quite, independent of the firm's size.

4. The fourth "standard example" indicates that the distribution of R&D intensity is highly uneven. The fact is that existing examples of the ratio of R&D volumes to sales volumes across various industries demonstrate a very stable and highly contradictory dynamic: most firms conduct a small amount of R&D relative to their sales volume or do not conduct any at all, and only a few firms conduct it in large volumes. In particular, in their research, W. Cohen and S. Klepper [26] argue that this asymmetry can be explained by the underlying probabilistic structure of R&D. Moreover, it can be explained even without assumptions that firms of different sizes have different capabilities in conducting R&D. Thus, despite large firms demonstrating lower R&D profitability, W. Cohen and S. Klepper [26] argue that this is consistent with large firms spreading their fixed costs over a broader sales base.

Figure 3 shows the distribution of R&D intensity among companies in OECD countries. The noticeable decline at the lowest levels, but still above zero, is due to the fact that firms with a small market share rarely prefer to invest in R&D at all. Considering that fixed costs in the next period are inevitable, if the firm decides to continue its market presence, the marginal profitability from investments in R&D must exceed a certain lower threshold; otherwise, it will be an inefficient decision. It should also be noted that the model presented by the author assumes some very high values for the ratio of R&D expenditures to sales volume. Nevertheless, the qualitative

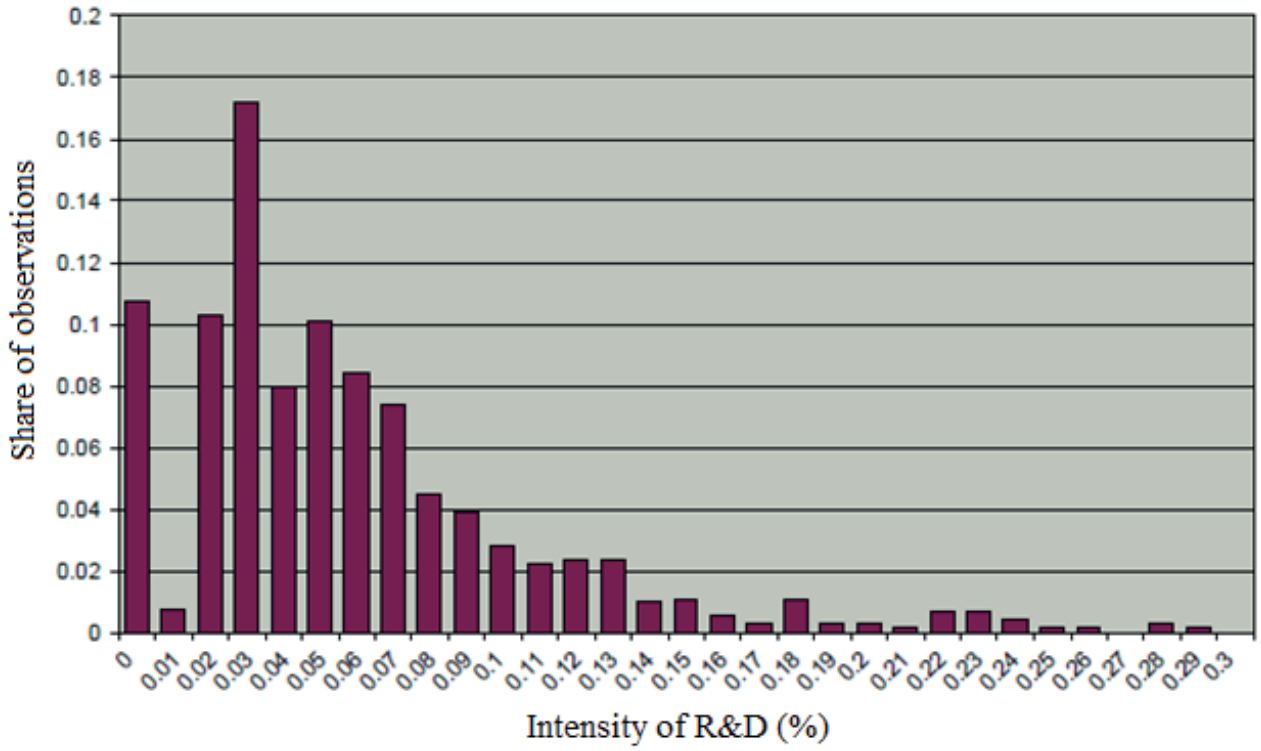

Fig. 3. **Distribution of R&D Intensity Among Companies in OECD Countries (Ratio of R&D Expenditures to Sales Volume)**

Source: The author' calculations based on OECD statistical data.

assessment and quantitative results confirm that the model accurately reflects the key features of the distribution of R&D intensity.

5. The essence of the fifth "standard example" is that the distribution of firms by size is highly varied, and the differences in firm sizes persist. The distribution of firms by size is similar to the distribution of R&D intensity, but, notably, as D. Autretch points out in his research [27], "...practically no other economic phenomenon has remained as stable as the asymmetric distribution of firms by size. It is not only practically identical across all manufacturing industries, but it also remains remarkably constant over time even in developed industrial countries".

6. The sixth "standard example" indicates that the level of risk is negatively related to the age and size of the firm. In particular, in his studies based on the analysis of the U.S. manufacturing industry, T. Dunn [28] found that 61.5% of all new firms exit the market within the first 5 years, and 79.6% of firms exit within 10 years. This fact appears to be quite important when studying the relationship between market structure and economic growth and sharply differs from models within the framework of the "creative destruction" concept, where the risk of market exit is constant and does not depend on the age of the firm. It follows that most new firms "die" relatively quickly, but those that survive endure for a long period of time. It would be natural to assume that this is primarily the result of innovative activity.

7. And finally, the seventh "standard example" states that the turnover rate is inversely proportional to market share concentration. Specifically, in their research, D. Baldwin and R. Caves [29] assert that "an inverse relationship has been established between industry concentration and its average turnover rate, driven by entry into and exit from the market". Although the actual data confirm the assumption of a negative impact of employee turnover on market concentration, the reverse direction of the causal relationship, often used in regression models that also include other indicators of market entry barriers, demonstrates a high degree of multicollinearity, and these results are difficult to interpret as unambiguous. For example, D. Baldwin and R. Caves [29], who use

import volumes as an indicator of competition in their studies, indeed found an increase in turnover in the manufacturing sectors of Canada with higher import volumes, which supports the idea that the causal relationship may be bidirectional.

REVIEW AND CRITICAL ANALYSIS OF MAIN THEORETICAL AND METHODOLOGICAL APPROACHES

If we rephrase the main idea of P. Dasgupta and J. Stiglitz [30], we arrive at the assertion that market concentration and R&D intensity are jointly determined, these are endogenous variables, and causal conclusions in one direction or another, which are made in many econometric studies in this context, can sometimes be misleading. P. Dasgupta and J. Stiglitz [30] convincingly argue that industry concentration measures are not an exogenous explanatory variable for R&D, but other factors jointly determine the equilibrium. However, this does not mean that market structure does not influence R&D. On the contrary, both variables (market structure and R&D intensity) exert reciprocal influence on each other. In a broader sense, the growth rates of the industry or the economy as a whole can be classified in the same category of endogenous variables and provide feedback effects.

In the Dasgupta — Stiglitz model, the central form of competition is scientific activity. To relate this type of competition to market structure, it is necessary to go beyond both perfect and monopolistic competition. In the first case, research is not conducted because it is based on the assumption that all firms have access to the same technology. In the second case, market power is sharply limited by the presence of an infinitely large number of imperfect substitutes, resulting in firms maintaining symmetric investment strategies. However, the question arises whether we can say anything about the intensity of research and, ultimately, the growth of the industry if R&D does not lead to degeneration, i.e., the market structure can change directly as a result of participating in R&D, and firms absorb this effect?

The Dasgupta — Stiglitz model was significantly influenced by the simplifying assumption that all firms in the goods market are homogeneous. Following the Dasgupta–Stiglitz model, a study characterizing industry dynamics with heterogeneous firms emerged. One of the first was B. Jovanovic's study [31], in which the author reveals his approach: introducing heterogeneity at the firm level, allowing new firms to determine efficiency levels based on the overall distribution. However, efficiency remains unchanged, and therefore, R&D is not conducted. Moreover, in their studies, R. Ericson and A. Pakes [4] provide empirical evidence that for the manufacturing sector, the initial size effect disappears over time, which is consistent with Gibrat's law [32] and active search models such as Ericson — Pakes [4], but not with passive learning models such as B. Jovanovic [31] or H. Hopenhayn [33]. The opposite statement may be true for the retail industry. Thus, in this context, in addition to the arguments of Dasgupta and Stiglitz, the key area of competition should be R&D.

Thus, in the Ericson — Pakes model, firms compete with each other through investments in R&D. The model accurately reflects entry/exit indicators in the industry, the age distribution of firms, the ratio of investments to market share [4]. Due to these features and following the logic of the Dasgupta — Stiglitz approach, according to which the R&D sector is the key area of competition, this type of active learning model is best suited for solving the set tasks. However, the initial model cannot account for productivity growth within the industry, and changes are necessary to take this basic model and adapt it to address growth issues within the industry.

But for this, we first need to reveal the essence of the relationship between market structure and endogenous growth theory. Thus, F. Aghion's study [14] is most similar here in that it examines the impact of "aligned" and "unaligned" degrees of competition in the goods market, which essentially serves as an indicator of differences between two firms. In this model, there is a duopoly in each sector with fixed product differentiation, and the level of R&D carried out by firms corresponds to an inverted U-shaped curve, where the intensity of R&D increases as firms converges in quality. The approach presented by the author makes it possible to analyze several steps further, allowing for the presence of more than two firms in each industry and introducing endogenous entry and exit. The approach considered

by the author includes P. Peretto's "creative accumulation" model [34] with an oligopolistic competition economy, which implies that the number of firms determines market concentration, firm size, and the intensity of R&D. An increase in the number of firms accelerates economic growth by expanding the market size. However, since profit increase is an internal factor of the firm, an increasing number of firms are slowing down their growth rates, as innovations depend on the average level of R&D rather than on total R&D, as indicated in most other models. The model here also assumes an increase in profit at the firm level, but allows for heterogeneity in firm sizes and, consequently, higher degrees of market structure that must be determined endogenously.

In his study, P. Thompson [21], using an approach analogous to that of P. Peretto [34], but with stochastic elements, allows for the replacement of existing monopolies with firms of arbitrary productivity levels, but the degree of competition within the industry remains limited by "creative destruction". As P. Thompson [20] notes, in an attempt to align the basic model with observed empirical patterns, he assumes that the intensity of R&D does not depend on the size of the firm, and this may lead to a change in the size of the firm that corresponds to empirical data. However, entry and exit from the market are essentially random, and the degree of exit risk does not depend on the age and size of the firm, which contradicts key empirical data obtained in industry studies.

The studies by J. Klette and Z. Griliches [7], J. Klette and S. Kortum [6] are also based on market structure characteristics related to incentives for conducting R&D. The first study uses the concept of differentiated goods. However, the authors abstract from cases of market entry/exit, assuming a random process of "creative destruction" in each product line, which is negatively correlated with the amount of R&D conducted by the firm. Consequently, the incumbent monopolist chooses expenditures sufficient to just prevent R&D competition from entering, thereby eliminating the entry/exit process from it. Thus, the model boils down to competition in R&D and goods, unlike direct competition in R&D between firms in the same industry, as emphasized in the Dasgupta — Stiglitz approach. The second study, however, allows for entry/exit from the market through a stochastic process of "creative destruction", but firms represent a set of goods and thus operate in multiple directions simultaneously. Success in R&D gives the firm an advantage in the market where it currently dominates. This assumption leads to firms not improving their own performance. This reiterates, albeit in a different context, the unattractive feature of models of the "creative destruction" concept, where firms do not conduct R&D or do so to a lesser extent than outsiders, to improve their own performance.

The approach described below consistently complements the examples mentioned above and can explain the behavior of a firm in a dynamic, turbulent environment characterized by the heterogeneity of firms and decisions about entering/exiting the market. Technological innovations are gradual rather than radical, as in the case of F. Aghion's research [14], and thus there is no "creative destruction" as in most endogenous growth models. Dominant firms can be replaced by competitors, but only because they fail to keep up with competitors in R&D, which is a gradual process.

Here we return to the aforementioned Dasgupta–Stiglitz approach and the issue of productivity growth in a dynamic market structure. Unlike the studies we reviewed above, the approach discussed in the paper takes into account the evolution of market structure and defines the market structure and economic growth in aggregate, just as in the Dasgupta–Stiglitz approach. The methodological basis for this study is the dynamic industry model of perfect equilibrium by Nash, developed within the framework of the research by R. Ericson and A. Pakes [4], A. Pakes and P. McGuire [5]. The basic structure of the Ericson — Pakes model is used and extended to ensure endogenous productivity growth. In the Ericson–Pakes model, the marginal production costs for all firms can only take on a finite set of values. In our model, however, the marginal costs can take on an infinite set of values, but the state space remains small and finite because a key property of the profit function is its homogeneity of degree zero in the vector of marginal costs among firms. Thus, the firms' decisions will depend on the relative levels of

marginal costs in different firms, rather than on the absolute levels of marginal costs.

The intermediate goods sector is a sector of the economy that includes R&D. Companies choose the level of production, investments in R&D, and decide whether to enter the market if they are currently active, or exit it if they are currently inactive. A dynamic equilibrium is an ideal Markov and Nash equilibrium, which assumes that decisions depend only on the current state, which is the current market structure [35, 36]. The current market structure, more formally defined below, is the total number of firms and the indicator of the relative levels of their marginal costs. Thus, the quantity of goods produced in any period does not have an intertemporal effect that could arise from learning by doing, as, for example, is the case in K. Arrow's research [15]. Dynamic decisions regarding R&D investments, market entry/exit, affect the future marginal costs of each firm and, consequently, alter the market structure in the subsequent period. Since we are directly dealing with market structure here, it was necessary to designate this topic. However, considering the formal constraints imposed on the volume of publications, we tried to limit ourselves to a few theses on the factors influencing the Cournot — Nash equilibrium and R&D investments, as well as the characterization of dynamic problems in the evolution of market structure.

EMPIRICAL ANALYSIS OF THE RESULTS OF EVALUATING THE IMPACT OF R&D SUBSIDIES ON ENDOGENOUS PRODUCTIVITY GROWTH

Since the necessity of the aforementioned evolution of market structure was limited to its role in achieving partial equilibrium for a single industry, demonstrating how growth-stimulating R&D subsidies alter an endogenously determined market structure, we can now proceed directly to answering the main question: "How do R&D subsidies and taxes, typically used in endogenous growth models, affect market structure when the market structure itself is endogenous?". To answer this question, we will proceed with an empirical evaluation of the model at various levels of subsidies and R&D taxes. *Table 1* presents the summary calculation data on the results of the empirical evaluation. As can be seen from *Table 1*, the growth rates of production and market concentration levels increase with subsidies and decrease with taxes. The results of the empirical analysis indicate that changes in production growth rates are directly dependent on corresponding changes in R&D investment volumes. *Table 2* shows the change in the Herfindahl–Hirschman Index (*HHI*), presented as a variance. The *HHI*, the sum of market shares squared, can be transformed into the following equation:

$$HHI = \sum_{k=1}^{K} js_k^2 = \frac{1}{K} + KVar\left(js\right), \qquad (1)$$

which demonstrates how the first two moments of the market share distribution among firms contribute to concentration. The *HHI* values presented in *Table 2* are derived from the average market shares of firms ranked from one to six. The values $1/K$ indicate the average number of active firms in the market, while the remainder represents the difference in market shares.

Overall, from *Table 2*, we see those subsidies conditionally "stretch" the distribution of market shares, while taxes "compress" them. The increase in market concentration associated with R&D subsidies (and the decrease with taxes) follows from the dominant effect of the dispersion component. When subsidized, the average value increases (column (4)). It is clear that with subsidies, less efficient firms are willing to stay in the market longer, as the associated costs are lower. Accordingly, from *Table 1,* it can be seen that with increased subsidies, the turnover rate decreases. The increase in the number of active firms itself reduces the market concentration indicator. However, this is sufficiently compensated by the increase in the market share difference. *Table 1* also shows the average number of private innovations implemented by the leading firm. The baseline figure increases from 6.77 to 7.43 with a small subsidy of 10% and sharply rises to 8.81 with a 50% subsidy. With taxes that reduce the incentives of the leading firm to expand its technological leadership, the opposite occurs. As a result, thanks to subsidies, leading efficient firms capture a larger market share, as shown in column (5) of *Table 2*. The last column

Table 1

Results of Calculations on the Impact of Subsidies and Taxes on R&D on Market Structure Changes

Scenarios of state macrofinancial policy	Rate, %	Average value of the HHI index	Turnover rate, %	The level of investment in R&D	The leader's share in total investments	Average number of private innovations introduced by the market leader
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Subsidies	50	0.390	35.8	1.837	0.326	8.81
	25	0.387	50.5	1.503	0.368	7.95
	10	0.386	60.6	1.235	0.398	7.43
Taxes	10	0.412	72.3	0.905	0.434	6.12
	25	0.396	79.5	0.776	0.462	5.75
	50	0.389	86.7	0.582	0.491	4.67
Basic	0	0.382	67.2	1.148	0.412	6.77

Source: The author' calculations based on OECD statistical data.

shows the percentage contribution of the variance component to the *HHI*.

Table 3 shows the impact on the number of firms in more detail. In the baseline case, about 16% of observations involve two or three firms, but when subsidies are 50%, this figure drops to 2%. The introduction of high taxes has the opposite effect, as periods with two or three firms account for 33% of all cases. This effect alone increases the *HHI*, but the compressed distribution of market shares leads to a reduction in variance, which more than compensates for the change in quantity.

Returning to *Table 1*, we note that it also illustrates the dynamic effects caused by macrofinancial policy using one of the turbulence indicators. The last column indicates how many times the position of the firm with technological leadership, i.e., the highest number of private innovations, changed. Taking the baseline figure as an example, the leading firm has a 9.85% chance of losing the top spot in the ranking at any given moment. This indicator is declining due to subsidies, as leading firms begin to expand their technological leadership. Taxes increase the degree of instability, as the leading firm is not inclined to invest in R&D. It can also be noted that as market concentration increases (decreases) due to subsidies (taxes), the level of turnover changes in the opposite direction in accordance with "standard example" 7 provided at the beginning of the paper. It is important to note that the increase in cost for small firms receiving subsidies occurs despite the fact that they are relatively less efficient compared to the leading firm due to the "spread" of distribution.

The conclusions from these results are as follows: R&D subsidies lead to an increase in the number of firms, as well as a rise in the level of concentration as the distribution sphere expands. This effect results in an increase in the price/cost ratio for the leading firm(s). The weighted average difference between price and cost increases under some strategies but decreases under others. In particular, small subsidies can increase the average difference between price and costs, while larger subsidies will reduce it, but at the expense of subsidizing a greater number of firms. At the same time, higher levels of concentration partially offset the positive impact of subsidies on total R&D by reducing the cost of continuing operations for all lagging firms. Finally, subsidies encourage relatively inefficient firms to remain in the market, which is a side effect of subsidies and leads to the hindrance of new firms entering the market, as they face a larger number of competitors and leading firms with greater technological advantages.

Thus, from an industry perspective, the main benefits of R&D subsidies are received by leading

Table 2

Numerical Dispersion Decomposition of the HHI Index

Scenarios of state macrofinancial policy	Rate, %	Average value of the HHI index	Value $1/K$	$KVar(js)$	(5) / (3), %
(1)	(2)	(3)	(4)	(5)	(6)
Subsidies	50	0.390	0.245	0.174	44.6
	25	0.387	0.251	0.168	43.4
	10	0.386	0.256	0.163	42.2
Taxes	10	0.412	0.292	0.142	34.4
	25	0.396	0.299	0.120	30.3
	50	0.389	0.303	0.097	24.9
Basic	0	0.382	0.259	0.153	40.05

Source: The author' calculations based on OECD statistical data.

Table 3

The Impact of Taxes and Subsidies on R&D on the Distribution of Companies

Scenarios of state macrofinancial policy	Rate, %	One company, %	Two companies, %	Three companies, %	Four companies, %	Five companies, %	Six companies, %
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Subsidies	50	0.00	0.37	1.62	40.02	59.75	1.78
	25	0.00	2.01	5.13	36.79	59.42	0.31
	10	0.012	3.72	7.96	31.15	59.94	0.00
Taxes	10	0.03	7.02	11.37	23.89	56.10	0.01
	25	0.03	10.15	14.62	17.61	53.55	0.015
	50	0.03	11.78	18.99	16.87	50.17	0.15
Basic	0	0.032	4.94	11.02	26.57	55.08	0.00

Source: The author' calculations based on OECD statistical data.

firms. This result sharply contrasts with most entrenched growth models, particularly those based on the concept of "creative destruction". In these models, an increase in R&D subsidies leads to a rise in R&D activities from potential entrants, accelerates the pace of "creative destruction", and reduces the expected lifespan of existing monopolists. In this case, subsidies extend the dominance of leading firms, which take advantage of the subsidies to expand their technological leadership, increasing their profitability, profits, and significance in the market.

CONCLUSION

The approach presented in this paper demonstrates ways to achieve endogenous productivity growth within the context of the R. Ericson and A. Pakes model [4]. Moreover, the paper shows that the basic partial equilibrium model is consistent with a number of key empirical regularities found in industry studies

[28], [29, 30], which the authors have identified as desirable properties of the endogenous growth model.

The main objective of this paper was to investigate the macrostructural aspects of evaluating the impact of taxes and subsidies on R&D on endogenous productivity growth. The main findings indicate that subsidies and taxes have a dual effect. As investment goods prices decrease at a certain point in time, more firms are willing to stay in the market even with negative profits. Such expansion of firms reduces market concentration, but, compensating for this effect, leading firms leverage advantages and increase their technological superiority over competitors, which leads to the growth of leading companies' profits. The net effect of concentration is an increase in the volume of subsidies. Nevertheless, subsidies enhance welfare by accelerating long-term economic growth. The obtained results sharply differ from other existing studies on endogenous growth, where R&D subsidies benefit firms exiting the market and increase the speed of "creative destruction". However, in our case, R&D subsidies primarily benefit firms entering the market and reduce the exit rate of leading firms. Although the analysis presented in the paper describes the equilibrium distribution of market structures and the associated industry growth rates, determining the aggregate economic growth rates and how they interact with the market structure requires establishing a complete general equilibrium model, which may be the subject of further research.

The results of this study, based on OECD countries, show that the long-term and short-term impact of state macrofinancial policy on stimulating innovative activity within the framework of endogenous growth theory is evident. They contribute to long-term economic growth, despite the heterogeneity of short-term results. Although even in the short-term dynamics, there are strong endogenous links between innovation, business activity, and economic growth, and all three variables are closely interconnected. Thus, as primary macroeconomic measures that the government of the Russian Federation should undertake, the stimulation of R&D, innovation, and business activity can be highlighted in order to take advantage of the obvious causal relationships between these variables in the short term.

Moreover, stimulating innovation through macrofinancial policy tools is a viable long-term doctrine, regardless of how we define these variables. Thus, the empirical results obtained from studying the experience of OECD countries confirm the idea that long-term economic growth in the Russian Federation will depend on the effectiveness of the interrelationship between macrofinancial policy and the national innovation system, which promotes both a dynamic business culture and an innovative climate in all regions. Strong support for innovation and business activity will strengthen the competitiveness of existing sectors of the economy, and the interaction between these two variables will lead to the emergence of new points of economic growth.

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Assessment of the Impact of Republic of Armenia State Budget Expenditures on Economic Growth

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ABSTRACT

The current article is devoted to analysing the state budget expenditures of the Republic of Armenia regarding its impact on economic growth rates. The object of the study is the expenditures of the state budget of the Republic of Armenia. The study **aims** to analyze and assess the impact of the state budget expenditures on the economic growth rate in the country. The main **hypothesis** of the study is that inefficient spending of budgetary funds not only does not stimulate but, in many ways, is a significant factor of the slowdown in economic growth in Armenia. The methodological bases of the study are the provisions of modern economic theory regarding the impact of government spending on economic growth rates. The study used **methods** of qualitative, statistical and econometric analysis of indicators, followed by the identification of cause-and-effect relationships and impact assessment. Data on the expenditures of the state budget of Armenia was taken as the informative basis of the study. The study of the scientific literature allowed to identify key theoretical approaches regarding the impact of the state budget expenditures on the economic growth rates in the country. The study examined in detail the expenditure articles of the state budget of Armenia, highlighting positive and negative factors influencing economic growth. In this regard, a vector autoregression model was built to identify the impact of spending on economic growth in the country. The **result** of the study was the conclusion that the impact of the state budget expenditures on the economic growth rates has a long-term negative nature in Armenia. The analysis of both the structure of state budget expenditures and the constructed vector autoregression model proves that the lack of an expenditure policy regarding the development of human capital, infrastructure and other components of public spending is one of the significant factors of the slowdown in economic growth in Armenia.

Keywords: public spending; economic growth; economic development; fiscal policy; economy of the Republic of Armenia

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INTRODUCTION

The expansion of government spending in times of crisis leads to an increase in aggregate demand, and this tool is used by most countries. However, in the scientific literature considering the specific experience of countries, one can find quite contradictory conclusions [1–5].

Since the problem of ensuring sustainable and long-term economic growth in developing countries is very acute, the relevance of using fiscal methods in solving this problem comes to the fore. At the same time, the spending policies of developing countries are aimed at ensuring primary objectives and often ignore strategic and long-term goals to achieve a high level of well-being of the population. In this regard, it is relevant to consider Armenia's experience in the field of the expenditure policy of the country's state budget in order to analyze and assess its impact on economic growth.

The key objective of the study was to determine the impact of the expenditure side of the state budget on the pace of economic growth in the country.

LITERATURE REVIEW

Considering the impact of spending policy on the economy, it is impossible to single out unambiguous conclusions that certain authors come to [6]. Some studies have shown positive effects [7–9], while others have shown negative effects [10–12]. There are also some studies that conclude that government spending does not have a significant impact on economic growth [13–15]. Slemrod et al. Using data from advanced economies as an example [16], they concluded that there is no convincing evidence that government spending has either a positive or negative impact on growth due to the

shortcomings of the assessment models used in these studies.

Berg and Hankerson [17] explain the contradictory results of their research by the difference in the structures of the state budget in different countries, as well as the structures of the economies themselves. On the other hand, Wu, Tang, and Lin [18] found that government spending contributed to economic growth even with varying degrees of economic development in the countries studied. The exception is low-income countries, which, according to the authors, is most likely due to poor institutions and high levels of corruption.

Boz et al. [19] found in their work that the size of government capital expenditures in relation to GDP has a significant positive correlation with economic growth, but this does not apply to current government budget expenditures. The authors also found a strong positive relationship between investment and spending on education and economic growth. Islam and Nazemzade [20] in their work examined the US state budget and its impact on economic growth and came to the conclusion that the volume of the state budget is of great importance.

The same relationship was discovered by Alam et al. [21], who proved in their work that an increase in social spending on education, healthcare, and social security increases productivity, thereby contributing to economic growth.

Devarajan et al. [22], on the contrary, found a positive relationship between the share of current expenditures and per capita income growth in developing countries and a negative relationship between capital government spending and growth. According to this work, there are certain conditions under which changes in the cost structure lead to higher sustainable growth. This includes the productivity of the various expenditure components and the level of initial shares in the total revenue structure of the State budget.

On the other hand, Hakro [23] found that for a group of Asian countries, investments in physical capital positively correlate with GDP growth per capita. The results of the Landau study [24] also revealed a negative relationship between the growth rate of real GDP per capita and the share of government spending on consumption in GDP.

In addition to the direct impact of various government budget expenditures on economic growth, research can be found in the scientific literature that focuses more on the impact of changes in the structure of government spending or the redistribution of spending on long-term economic growth and on determining which elements of government spending have the most significant impact on economic growth and development [25–28]. Many authors point out the importance of redistributing funds to education [29–31] and infrastructure [32–34] for long-term growth. Taiwo [35] also identified a positive relationship between GDP and current and capital expenditures by analyzing data on Nigeria. Saes et al. [36] have identified a positive relationship between government spending and economic growth by analyzing the experience of 15 Euro area countries. On the other hand, Romero-Avila and Strauch [37], studying the same region, came to the conclusion that the size of the budget in terms of its expenditure side has a negative impact on the growth rate of per capita income in 15 European countries. These conclusions are consistent with the theory of endogenous growth, according to which the main factors of cross-country differences in the level of development and growth are investments in human capital, physical capital and infrastructure, as well as the development of the education and science system [38–40].

Thus, the effect of increased government spending can only be estimated in the long term. Even the direct expansion of government budget expenditures in times of crisis only serves as an anticyclical measure, but it cannot ensure sustainable economic growth in the long term. In other words, expanding demand through expanding spending on social needs cannot ensure sustainable economic growth, while spending on education, science, human capital, and infrastructure will ensure growth only in the long term.

RESEARCH METHODOLOGY

The theoretical and methodological basis of the research was classical and modern approaches

in the field of studying government budget expenditures and their impact on economic growth rates.

The information base of the study was the databases of the Ministry of Finance of the Republic of Armenia and the World Bank, materials from periodicals and news agencies, including those distributed via the global Internet, as well as calculations obtained by the authors themselves during the research.

Methods of comparative and systematic analysis, deduction and induction, graphical method, mechanisms of econometric and statistical analysis and other methods of information collection and processing were used in the work. The ToolPak Ms Excel 2016 application package and the EViews 10 econometric package were used as modern information technologies.

The key objective of the study was to assess the impact of the expenditure side of the Armenian state budget on the country's economic growth in the medium and long term. In this regard, the article examines the structure and direction of government spending in Armenia, through the analysis and evaluation of key items of the expenditure side of the state budget, and the impact of the expenditure side of the state budget on the pace of economic growth in the country.

STATE BUDGET EXPENDITURES IN ARMENIA

The economic classification divides the state budget into current and other expenditures, which are shown in *Fig. 1*. As we can see, government budget expenditures have been steadily increasing over the past fourteen years. At the same time, current expenditures occupy a dominant position in the total budget expenditures. The actual execution of both current and other expenses differs slightly from the annual plan. On the other hand, during periods of recession and stagnation of the country's GDP, there is no stimulation of economic activity through spending policies. The exception is the period 2020–2021, which can be explained by a sharp increase in health and defense spending.

From the point of view of the impact on economic growth rates, it is not the dynamics of government budget expenditures themselves that is of greater interest, but its structure. As it was shown in the theoretical review of scientific literature, stimulating economic growth through government spending is possible both in terms of demand and supply.

The current expenditures of the RA state budget by their structure indicate the dominant role of the state budget in stimulating consumer demand (*Fig. 2*). The largest share in the cost structure is formed by social benefits and pensions, as well as by wages. At the same time, the largest growth is observed in both items compared to other items of current expenses. On average, current social spending has increased 3–4 times since 2008, and labor costs have increased 4–5 times. The latter is reflected in the dynamics of final consumption expenditures, especially in times of crisis. Interest expenses are also showing a large increase, and the share of these expenses is also showing a significant increase, which is due to both the build-up of government debt and the increasing debt payments over time.

While the share of social spending in current expenses has increased by about 10% over 13 years, the share of labor costs has increased by only about five percent (*Fig. 3*). The share of interest payments has increased by about 7–8 times over the past five to six years.

It is interesting to note a noticeable reduction in the cost of purchasing goods and services since 2015, which indicates a significant reduction in public procurement, which, as a rule, is a good incentive for expanding supply and developing the real sector in certain sectors of the economy. Along with this, there is an increase in subsidies both in absolute terms and as a share of current expenses. The analysis of the structure of current expenditures makes it possible to characterize the spending policy of the state budget as stimulating economic growth along the demand line.

However, against the background of a restrictive tax policy that reduces consumption, the effect of expanding demand for current spending offsets the positive impact on economic growth. At the same time, there is no incentive in terms of supply expansion either in the tax or in the spending

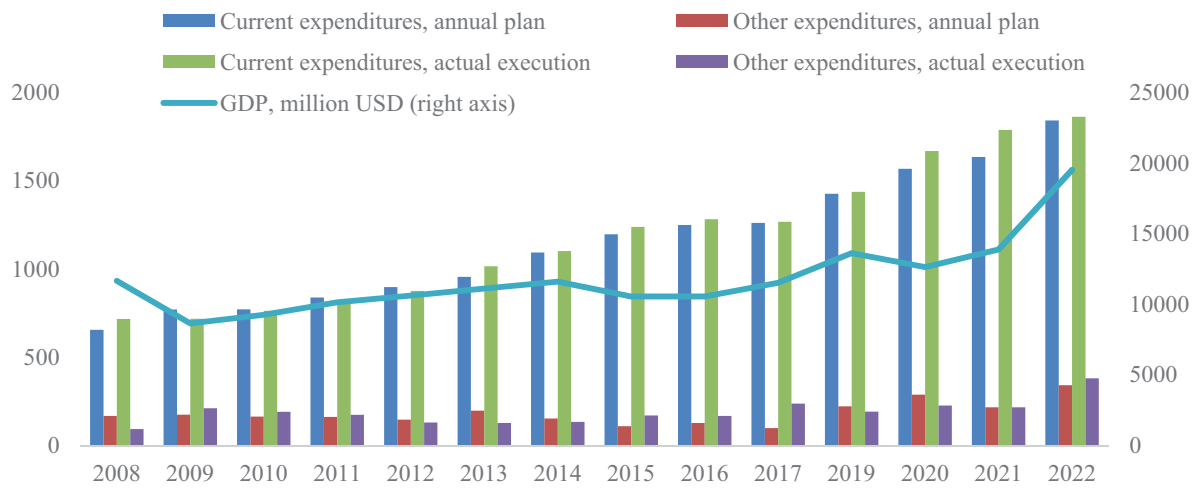

Fig. 1. **Расходы государственного бюджета РА, млрд драмов РА / RA State Budget Expenditures, Billion AMD**

Source: Database of the Ministry of Finance of RA. URL: https://minfin.am (accessed on 15.01.2024).

policy of the state budget. The latter is reflected in the dynamics of the country's GDP (*Fig. 1*). After the global financial crisis, the Armenian economy stagnated for 10 years and regained its pre-crisis GDP level only in 2019.

The functional classification of state budget expenditures is of greater interest in terms of its impact on economic growth (*Fig. 4)*. Social protection, general public services and defense account for the largest share of expenditures, which are also leading in terms of growth rates. The rest of the expenditure items of the state budget as a whole show a fairly stable picture, with the exception of healthcare in 2020–2021, due to the costs associated with the COVID-19 pandemic. Considering the structure of expenditures in shares, it can be noted that most of the budget items retained their shares in the total expenditures of the state budget (*Fig. 5)*.

From the point of view of the impact of the expenditure side of the state budget on the formation of economic growth, the share of expenditures in GDP, as well as the growth rate of expenditures, is of great importance (*Fig. 6*). The share of state budget expenditures in GDP shows a slight increase. As of 2022, this figure was 26.4% of GDP, and in 2007 it was 20.2%. It should be noted that a moderate increase in spending was observed during the global financial crisis, when the Armenian economy experienced a recession of 14.4%, which required drastic injections into the economy from the state.

The first place in the overall structure of expenditures of the state budget of Armenia is occupied by expenditures on social needs (see *Fig. 7*). About 75% of these expenses are related to pension provision. Over the past two years, there has been an increase in expenses that are not related to social protection. This is primarily due to various social programs of the Government of the Republic of Armenia related to the COVID-19 pandemic and the Second Artsakh War in 2020.

It should also be noted that government spending on social needs has increased over the past 15 years. However, a key share of this growth is accounted for by pension provision, which, in particular, is due to the aging process of the population in Armenia, which has been observed in recent years. As for the impact on economic growth, in the case of social expenditures of the state budget, such an impact occurs through increased consumption, which in this case is expressed in pension costs. Given that social spending has only tripled over the past 15 years, and taking into account the average rate of inflation, the impact on

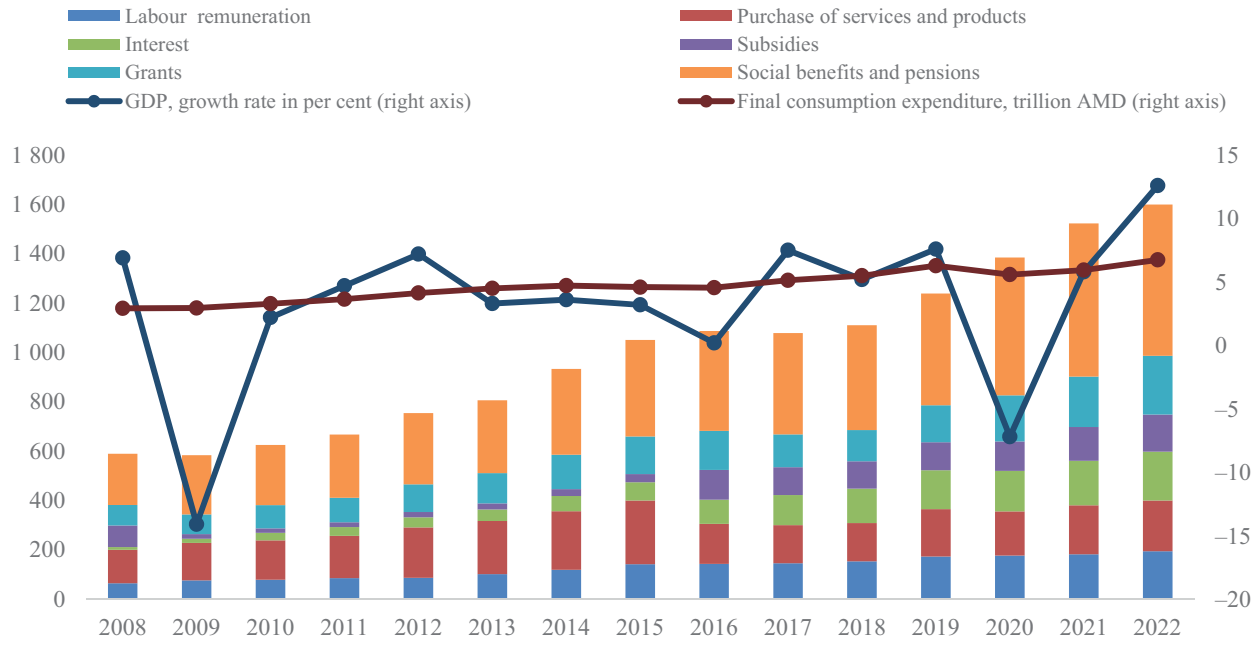

Fig. 2. **Current Expenditures, Structure, Billion AMD**

Source: Database of the Ministry of Finance of RA. URL: https://minfin.am (accessed on 15.01.2024).

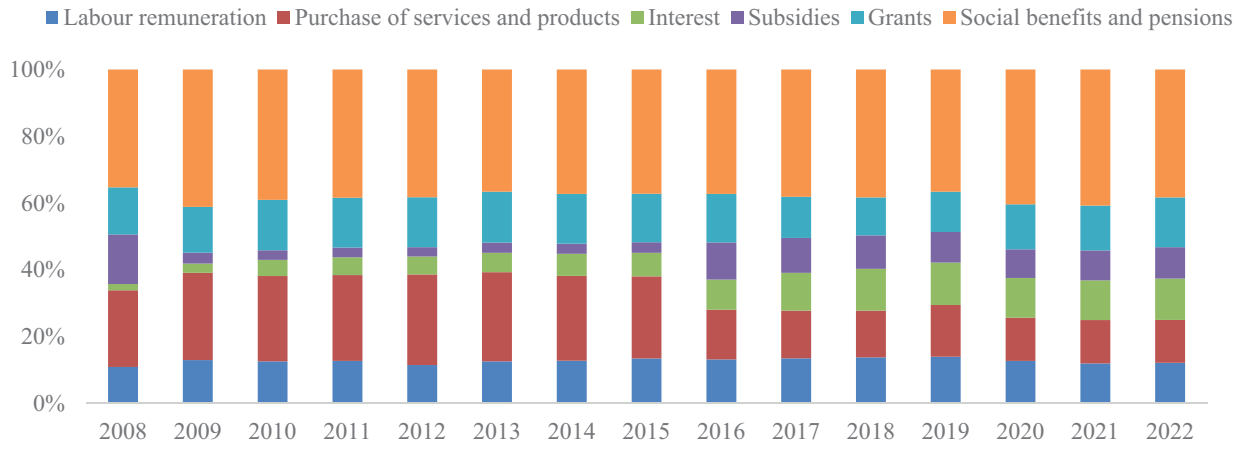

Fig. 3. **Current Expenditures, Structure, %**

Source: Database of the Ministry of Finance of RA. URL: https://minfin.am (accessed on 15.01.2024).

economic growth under this expenditure item may be significant.

This thesis is also confirmed by the share of social expenditures in GDP, which as of 2022 amounted to 7.2% and remained almost unchanged on average over the period under review (*Fig. 8*). The share of social expenditures in total government budget expenditures has also not changed. If in 2007 it was 9.9%, and during the crisis of 2008–2009 it increased to 26.2%, then in 2022 it amounted to 27.4%. The average growth rate of social spending is about 7.5%.

The second place in state budget expenditures is for general public services (*Fig. 9*). As we can see, the dynamics of expenditures on public services shows a significant increase. At the same time, the key expenditure item in this block is operations on government debt, the costs of which have increased more than twenty times since 2007. This fact is due to a significant increase in Armenia's

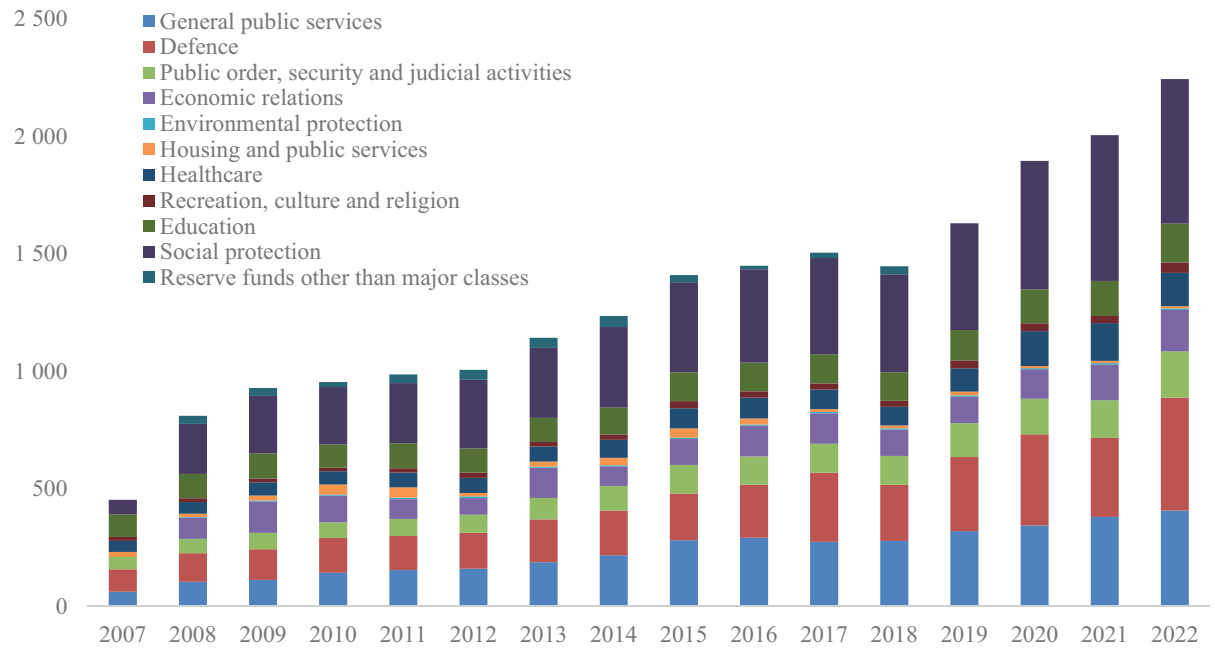

Fig. 4. **RA State Budget Expenditures, Structure, Billion AMD**

Source: Database of the Ministry of Finance of RA. URL: https://minfin.am (accessed on 15.01.2024).

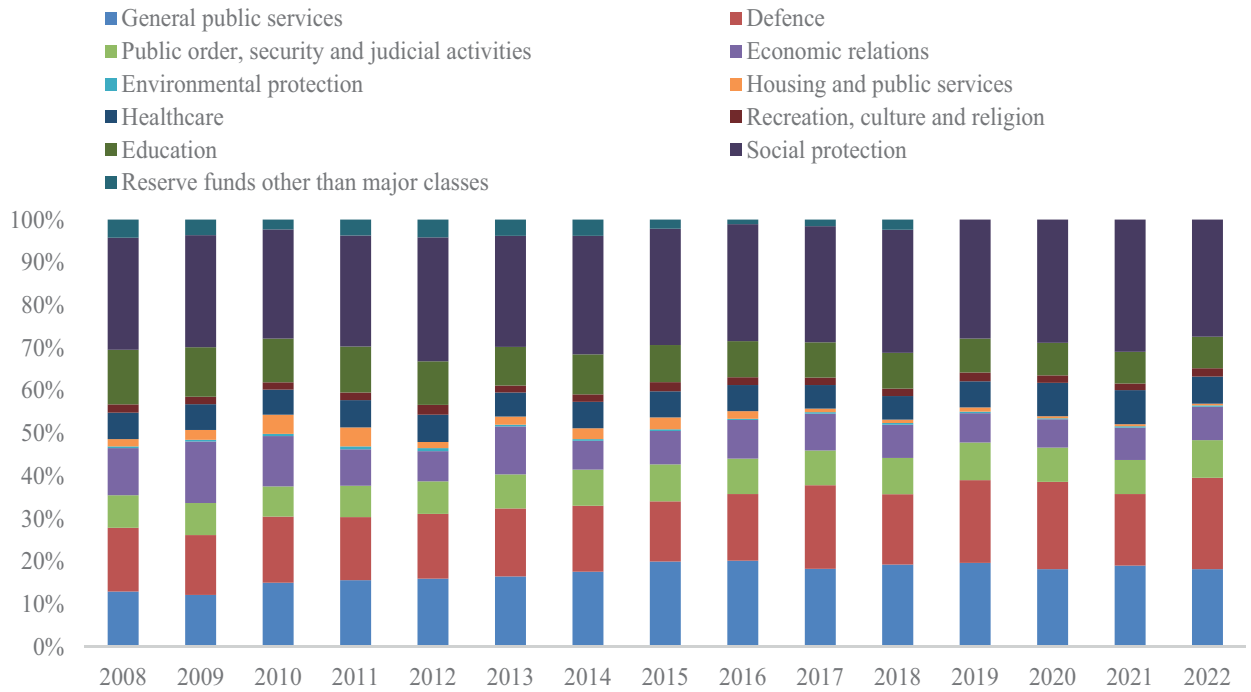

Fig. 5. **RA State Budget Expenditures, Structure, %**

Source: Database of the Ministry of Finance of RA. URL: https://minfin.am (accessed on 17.01.2024).

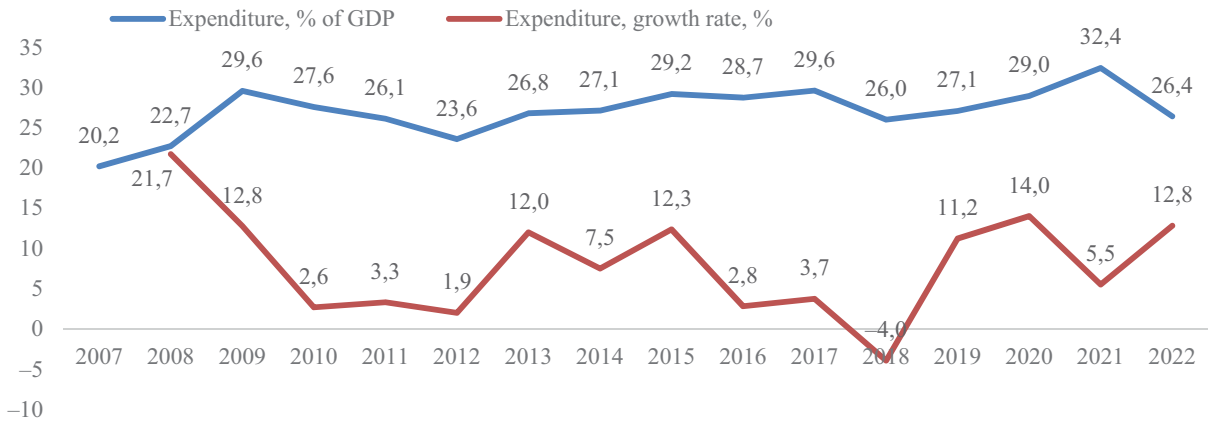

Fig. 6. **RA State Budget Expenditures, GDP % and Growth Rates**

Source: Database of the Ministry of Finance of RA. URL: https://minfin.am (accessed on 17.01.2024).

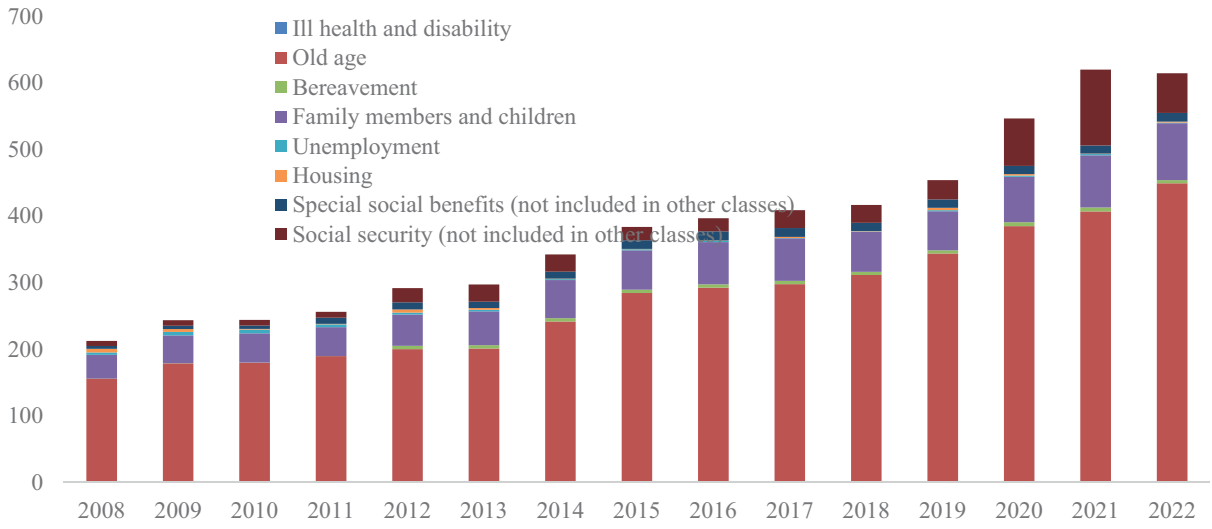

Fig. 7. **Social Protection, Structure, Billion AMD**

Source: Database of the Ministry of Finance of RA. URL: https://minfin.am (accessed on 17.01.2024).

public debt on both external borrowings and domestic debts.

It can be noted that, starting in 2015, expenditures on legislative bodies, etc., which occupy the first place in the structure of expenditures on public services, are decreasing every year and are replaced by expenditures on public debt. The burden of public debt actually changes the spending policy for this item.

On the other hand, from the point of view of economic growth, expenditures on various scientific and research developments are of greater interest, which are also represented to a certain extent in the structure of expenditures on public services. However, it should be noted here that the extremely small amounts allocated through research and development cannot positively affect the pace of economic growth in the long term.

Nevertheless, considering the share of expenditures on public services in the total structure of state budget expenditures, one can see a significant increase, which is due to the costs of servicing Armenia's public debt (*Fig. 10*). If in 2007 this figure was 9.8%, then in 2022 it will be 18.2%. The share of these expenditures in the

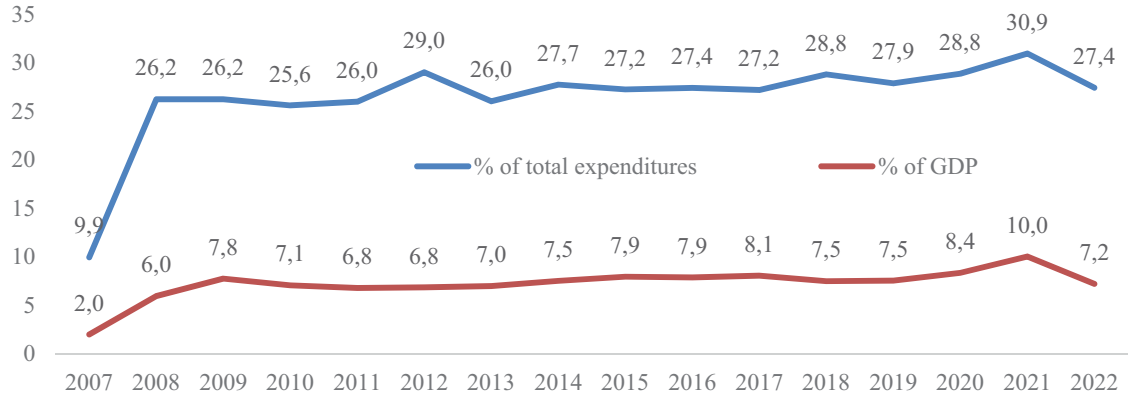

Fig. 8. **Social Protection, % of GDP, and % of Total Expenditures**

Source: Database of the Ministry of Finance of RA. URL: https://minfin.am (accessed on 17.01.2024).

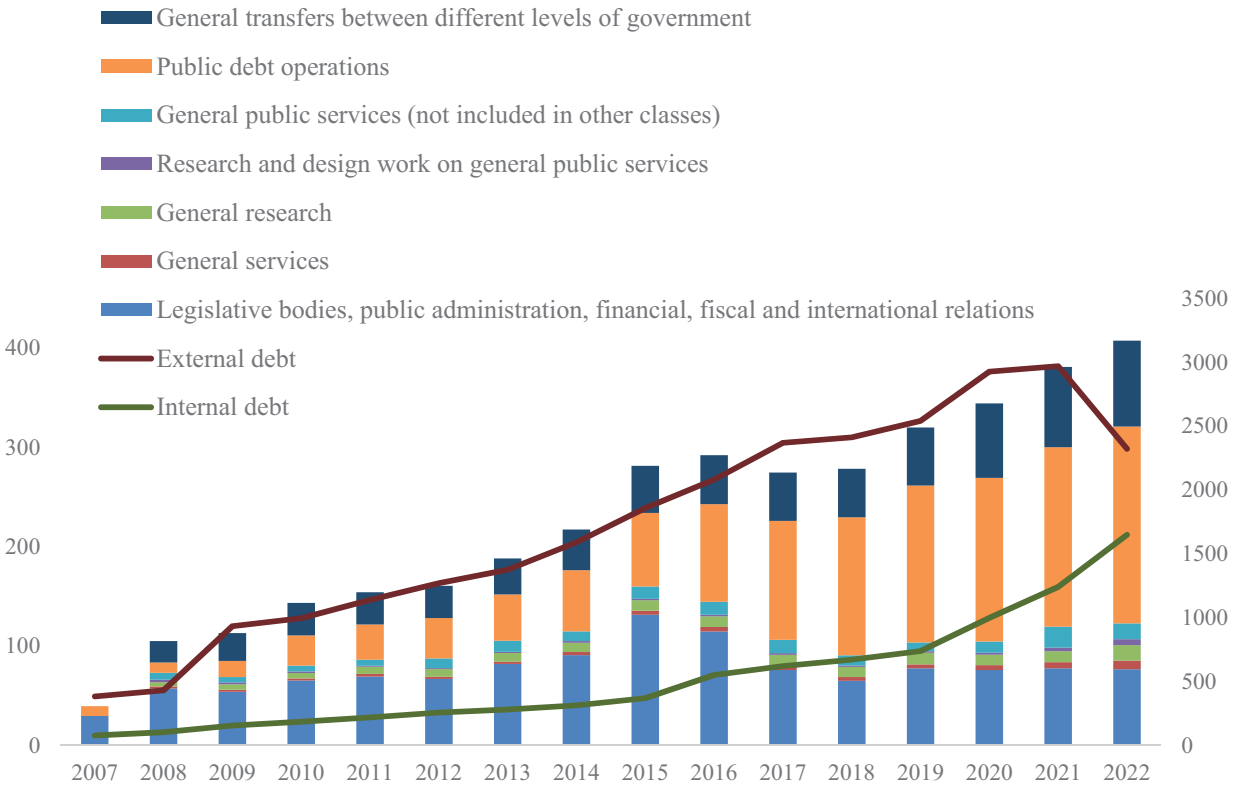

Fig. 9. **General State Services, Structure and Government Debt (Right Axis), Billion AMD**

Source: Database of the Ministry of Finance of RA. URL: https://minfin.am (accessed on 17.01.2024).

country's GDP is also growing. In 2007, the share of expenditures on general public services in GDP was 2%, compared with 4.8% in 2022. The growth rate of spending on public services is upward.

Defense expenditures occupy the third place in the structure of expenditures of the Armenian state budget (*Fig. 11*). Spending on the military-industrial sector can affect the expansion of GDP if this block is focused on the production of weapons and various types of military goods, including research and development. However, in the case of Armenia, defense spending is not of this nature,

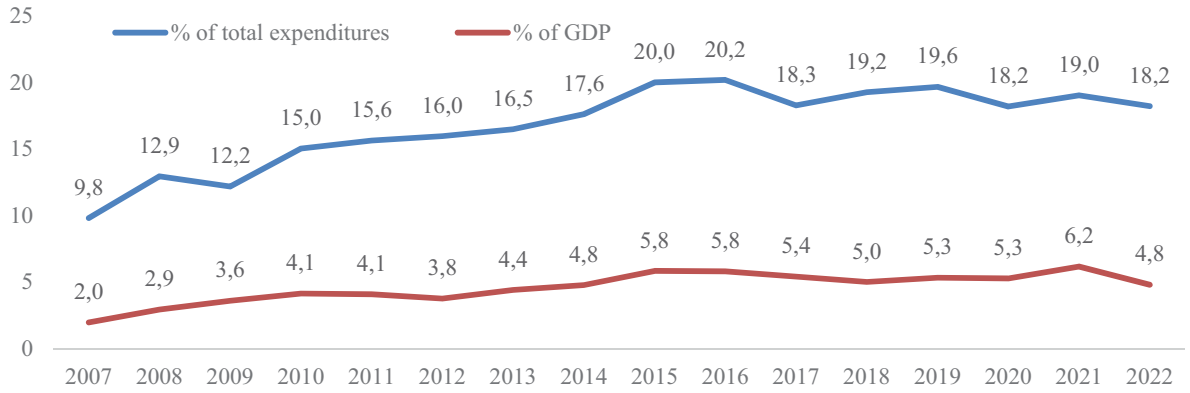

Fig. 10. **General State Services, % of GDP, and % of Total Expenditures**

Source: Database of the Ministry of Finance of RA. URL: https://minfin.am (accessed on 17.01.2024).

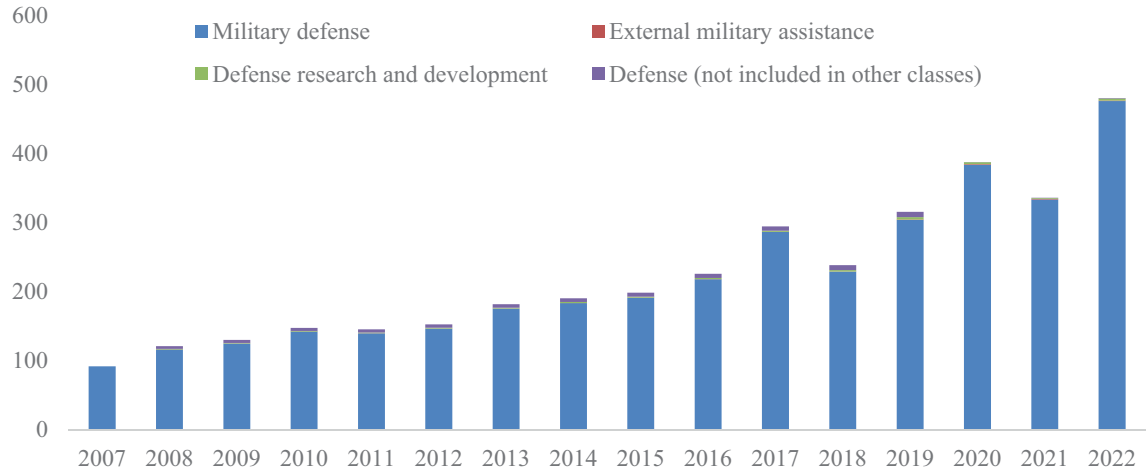

Fig. 11. **Defence, Structure, Billion AMD**

Source: Database of the Ministry of Finance of RA. URL: https://minfin.am (accessed on 17.01.2024).

which means that it cannot be significant in terms of economic growth.

The increase in expenses can be observed during the periods of escalation of the military conflict with Azerbaijan in 2016 and 2020. At the same time, 99% of defense spending is on military defense, while spending on research and development in this area accounts for a negligible share. As for the share of defense expenditures in total government budget expenditures, it ranges from 15–17% and has shown a slight increase since 2016 (*Fig. 12*). The share of defense spending in the country's GDP in 2022 was 5.7% and has almost doubled over the past fifteen years.

From the point of view of human capital development, spending on healthcare and education is of strategic importance. At the same time, considering the dynamics and structure of healthcare costs in Armenia, we can see only a slight increase in the period 2008–2019 (*Fig. 13*). A sharp increase in spending on public health services can be observed in 2020–2021, which was caused by the COVID-19 pandemic, as well as the Second Artsakh War. Already in 2022, there is a decrease in the level of expenses for this item.

It should be noted that there is an insignificant share of expenses on medical products, devices and equipment, which could improve the quality of medical services provided and, as a result,

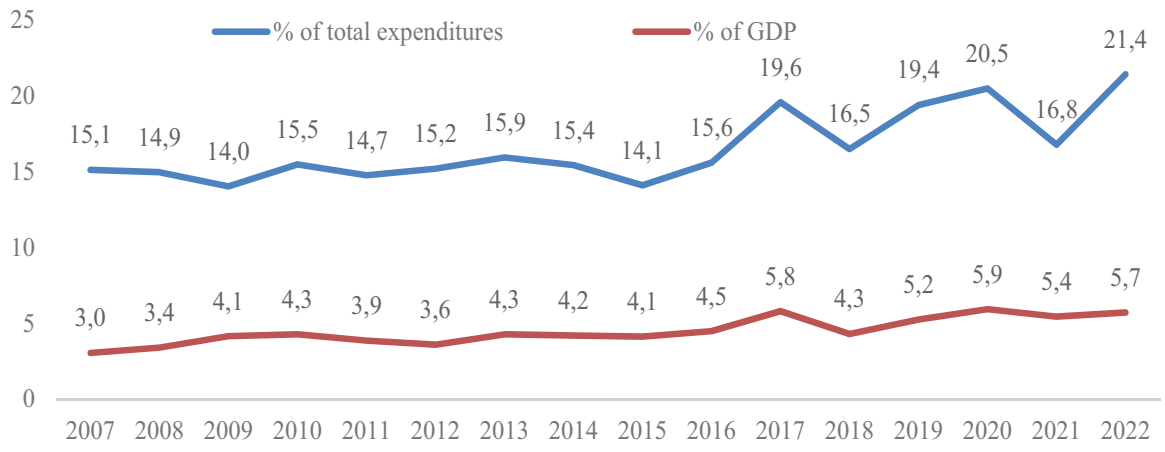

Fig. 12. **Defence, % of GDP, and % of Total Expenditures**

Source: Database of the Ministry of Finance of RA. URL: https://minfin.am (accessed on 17.01.2024).

improve the quality of human capital. Thus, in the long term, one cannot expect a positive impact of healthcare spending on economic growth. This is also evidenced by the share of healthcare expenditures in the country's GDP (*Fig. 14*). With the exception of 2020–2021, this indicator has hardly increased. In 2007 the share of state budget expenditures on healthcare in GDP was 1.5%, and in 2022–1.7%. On average, healthcare expenditures in the total expenditures of the RA state budget range from about 6%.

A fairly large item in the structure of state budget expenditures is the expenditure item on public order, security and judicial activities (*Fig. 15*). The largest share (about 70% on average) is spent on public order and security, that is, on the police and internal troops. A noticeably smaller share is spent on judicial activities, which are of strategic importance from the point of view of the formation of the institutional environment. This, in turn, is one of the most necessary components for the formation of sustainable economic growth rates.

As for the share of these expenditures in total expenditures and in the country's GDP, it should be noted that it maintains its position throughout the period under review (*Fig. 16*). As of 2022, the share of these expenditures amounted to 8.8% of the total expenditures of the state budget, and the share in Armenia's GDP was 2.3%.

One of the unstable items of expenditure of the state budget from the point of view of dynamics is expenditure on economic relations (*Fig. 17*). In their structure, the key places are occupied by expenditures on agriculture and transport. It is important to note that the dynamics of spending on economic relations is very volatile. There is a feeling that this article is formed more according to the residual principle, which indicates the lack of a strategy in this area.

From the point of view of the share in total budget expenditures, we can observe a noticeable decline, while the share in GDP fluctuates on average within 2% (*Fig. 18*).

One of the most significant budget items, which have a direct impact on the economic development of the country in the long term, is the item of expenditure on education (*Fig. 19*).

The first thing to note is the lack of significant growth in absolute indicators in this block throughout the period under review. In total, over the past 13 years, the volume of education expenditures in the state budget has increased by about 20%. General secondary education occupies a dominant position in the structure of education costs, with preschool and primary education taking the second place. Higher education accounts for about 7%. It should be noted that there is a slight increase in expenditures on primary vocational (craft) and secondary vocational education, which generates human capital with secondary specialized education. However, most of these educational institutions

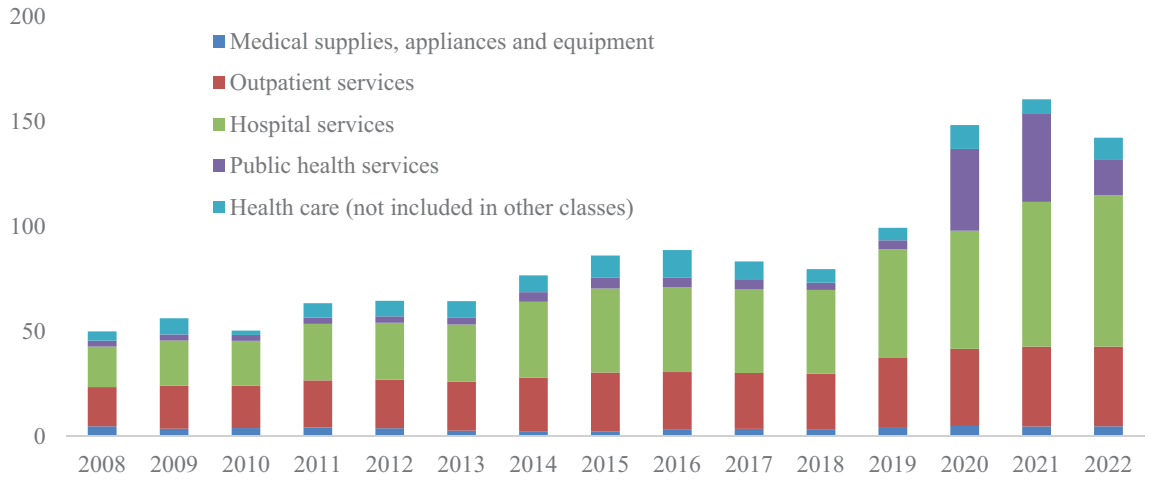

Fig. 13. **Healthcare, Structure, Billion AMD**

Source: Database of the Ministry of Finance of RA. (accessed on 17.01.2024).

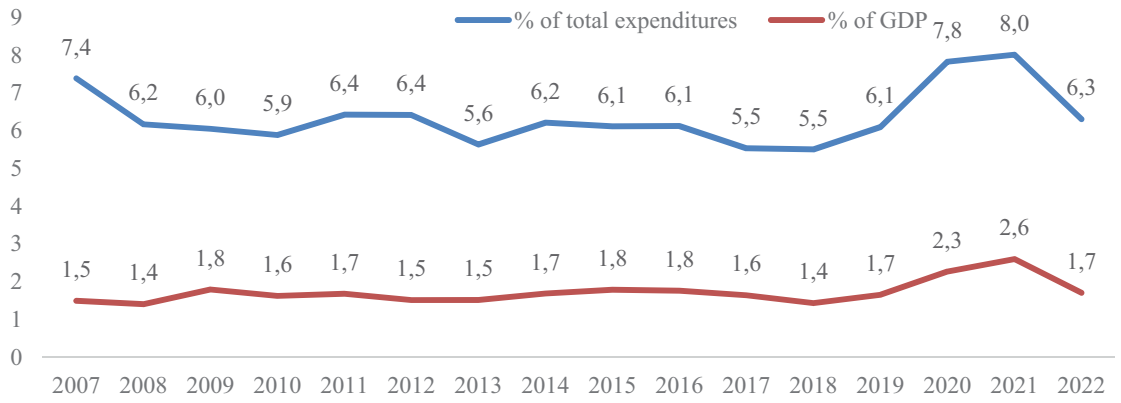

Fig. 14. **Healthcare, % of GDP, and % of Total Expenditures**

Source: Database of the Ministry of Finance of RA. URL: https://minfin.am (accessed on 17.01.2024).

focus on the same specialties as higher education, and functionally the task of building up a workforce with a highly focused education is not fulfilled.

In the period 2007–2022, the share of education expenditures in the State budget decreased by almost half and amounted to 7.4%. The share of education expenditures in GDP also decreased and amounted to 1.9%.

Thus, summarizing the above analysis of the structure of state budget expenditures, it can be concluded that among the priority areas of expenditures, there were no significant government investments in industries that affect economic growth in the long term (education, science, infrastructure, institutional environment). In this sense, the analysis of statistics did not reveal any significant impact of government budget expenditures on maintaining or ensuring aggregate demand. However, this thesis can be shown more reasonably on the basis of an econometric analysis.

GOVERNMENT BUDGET EXPENDITURES IN ARMENIA AND ECONOMIC GROWTH (MODEL)

One of the most popular methods for analyzing the impact of spending policies on economic growth is the estimation of impact coefficients using a vector autoregressive model (VAR). In

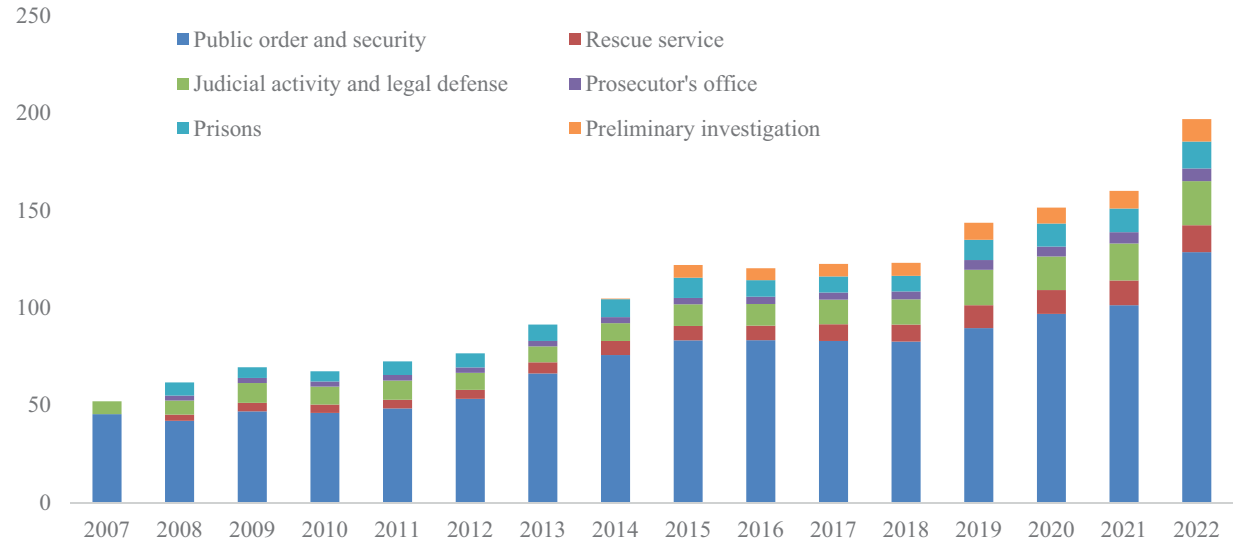

Fig. 15. **Public Order and Safety, Structure, Billion AMD**

Source: Database of the Ministry of Finance of RA. URL: https://minfin.am (accessed on 17.01.2024).

this regard, a vector autoregression model was developed to identify the impact of spending policy on Armenia's economic growth. The study used quarterly data on Armenia's GDP and data on all types of expenditures from 2008 to 2018. The source of expenditure data is the Database of the Ministry of Finance of the Republic of Armenia and the National Statistical Service of the Republic of Armenia. Starting in 2019, the Ministry of Finance does not publish quarterly expenditure statistics on functional classification.

The following variables were used as endogenous factors influencing economic growth:

- Education expenses (EDU), million drams, 2008Q1–2018Q4;
- Expenses on economic relations (ER), million drams, 2008Q1–2018Q4;
- Healthcare costs (HC), million drams, 2008Q1–2018Q4;
- Expenses for public order, security and judicial activities (SEC), million drams, 2008Q1–2018Q4;
- Defense expenditures (DEF), million drams, 2008Q1–2018Q4;
- Expenses for general public services (PS), million drams, 2008Q1–2018Q4.

As an exogenous variable, it is customary to include the largest trading partner in the GDP model, which makes it possible to display external shocks to the country's economy. According to statistics, Russia is Armenia's largest trading partner (*Fig. 21*). In this regard, we have selected the GDP of the Russian Federation (GDP_RF) as an exogenous factor. We also included the inflow of cash transfers (REM) in the model as a factor reflecting external shocks.

All time series were adjusted for seasonality using the Census X-13 procedure, which allowed the time series to be cleared of seasonality while maintaining the dynamics structure. To obtain stationary time series, the following standard procedure was applied: logarithmization of time series using the natural logarithm (e), calculation of the first differences relative to the corresponding quarter of the previous year. The final time series were tested for stationarity (ADF unit root test) and distribution normality (Histogram and Jarque-Bera test). Descriptive statistics of variables are presented in *Table 1*.

As a result of the initial statistical data processing, stationary time series with a normal distribution from 2009Q1 to 2018Q4 were obtained. As a result of the analysis, it turned out that defense spending and general public services are not significant variables for Armenia's GDP and were excluded from the model. *Table 2* shows the results of the vector autoregression model. We selected a model with 4 lags based on an analysis

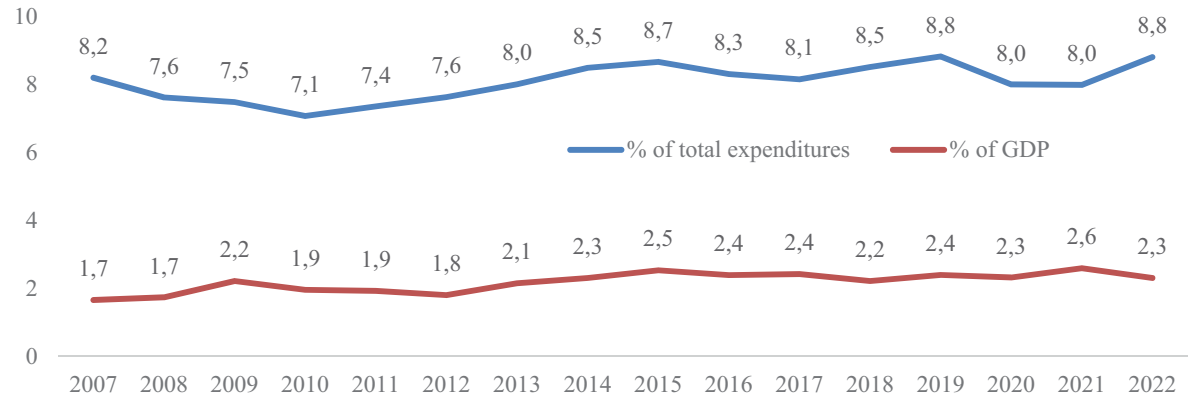

Fig. 16. **Public Order and Safety, % of GDP, and % of Total Expenditures**

Source: Database of the Ministry of Finance of RA. URL: https://minfin.am (accessed on 17.01.2024).

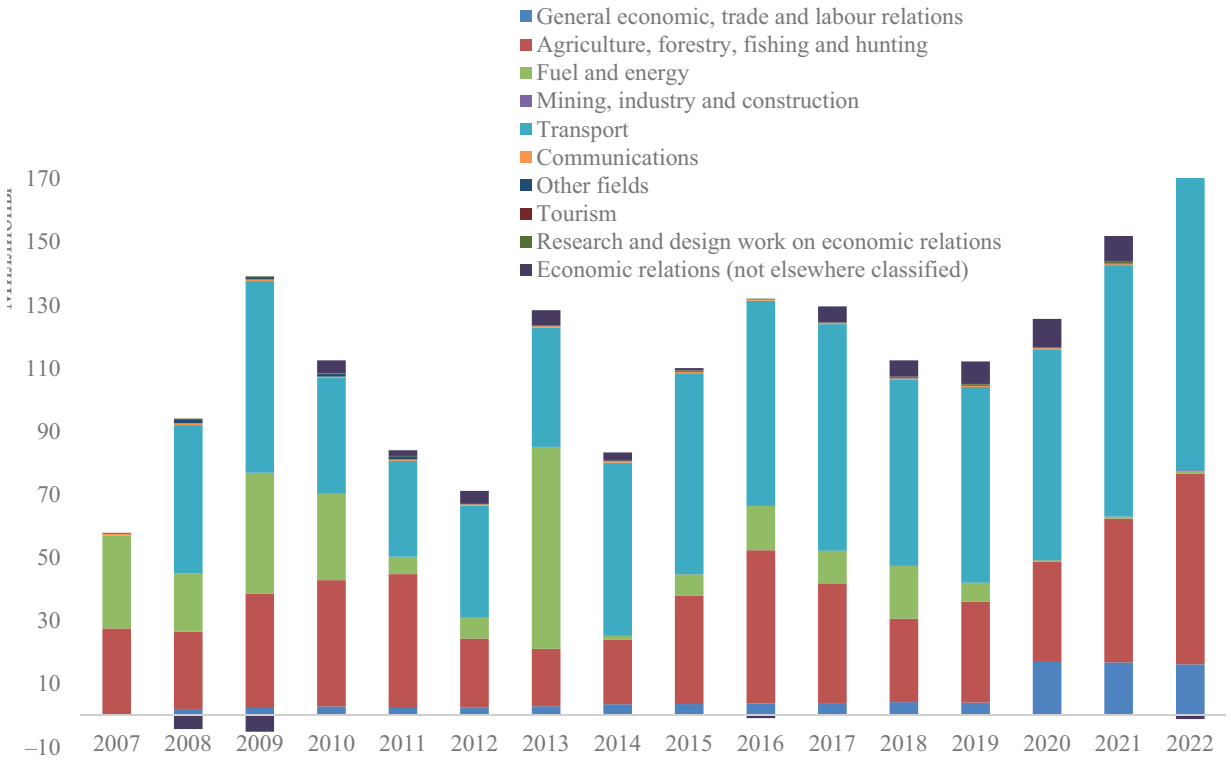

Fig. 17. **Economic Affairs, Billion AMD**

Source: Database of the Ministry of Finance of RA. URL: https://minfin.am (accessed on 17.01.2024).

of the quality of the model according to the criteria of Akaike and Schwartz.

We have performed all the necessary tests to verify the reliability of the coefficient estimation results using the VAR(4) model. *Table 2* demonstrates that, according to Darbin-Watson statistics, there is no problem with the autocorrelation of the residuals of the regression model in the model. We also conducted a test for the heteroscedasticity and normality of the residue distribution (*Table 3*). The results show that the random errors of the model are homoscedastic and the residue distribution is normal.

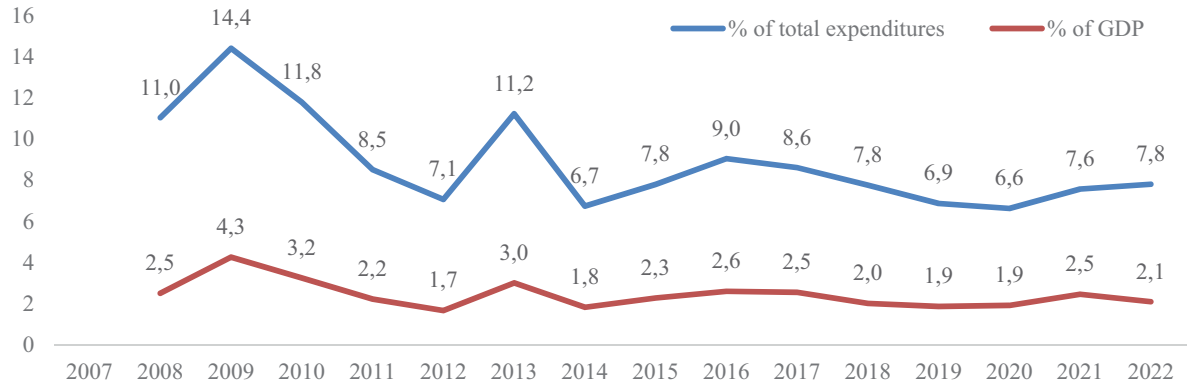

Fig. 18. **Economic Affairs, % of GDP, and % of Total Expenditures**

Source: Database of the Ministry of Finance of RA. URL: https://minfin.am (accessed on 17.01.2024).

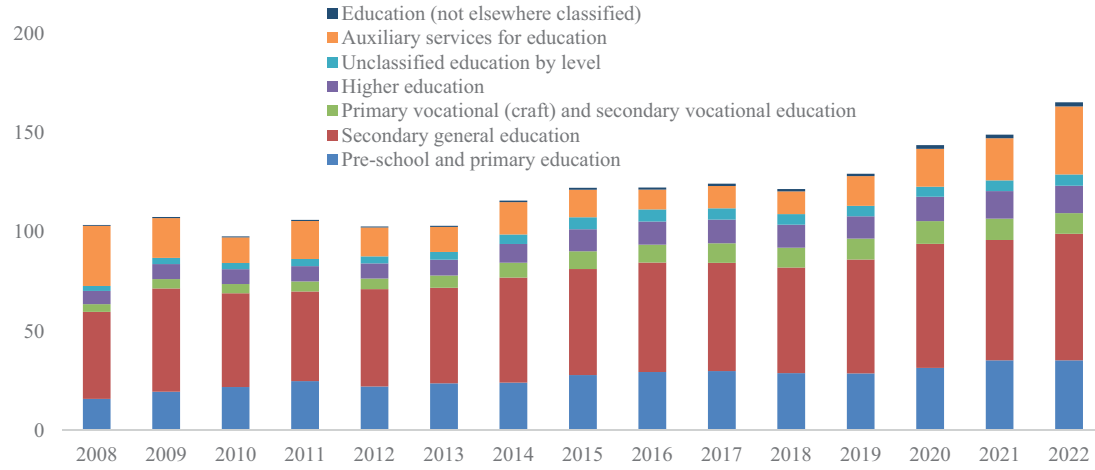

Рис. 19 / Fig. 19. **Образование, структура, млрд драмов РА / Education, Structure, Billion AMD**

Source: Database of the Ministry of Finance of RA. URL: https://minfin.am (accessed on 17.01.2024).

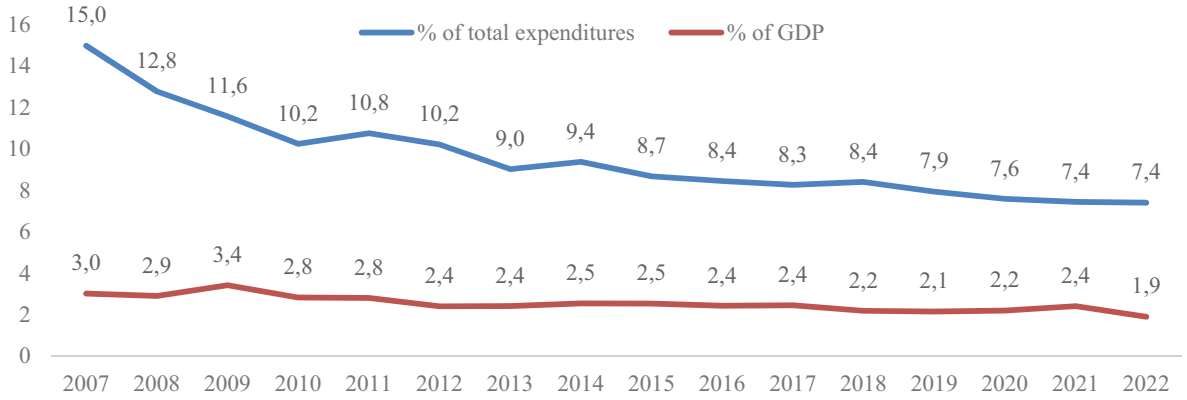

Fig. 20. **Education, % of GDP, and % of Total Expenditures**

Source: Database of the Ministry of Finance of RA. URL: https://minfin.am (accessed on 17.01.2024).

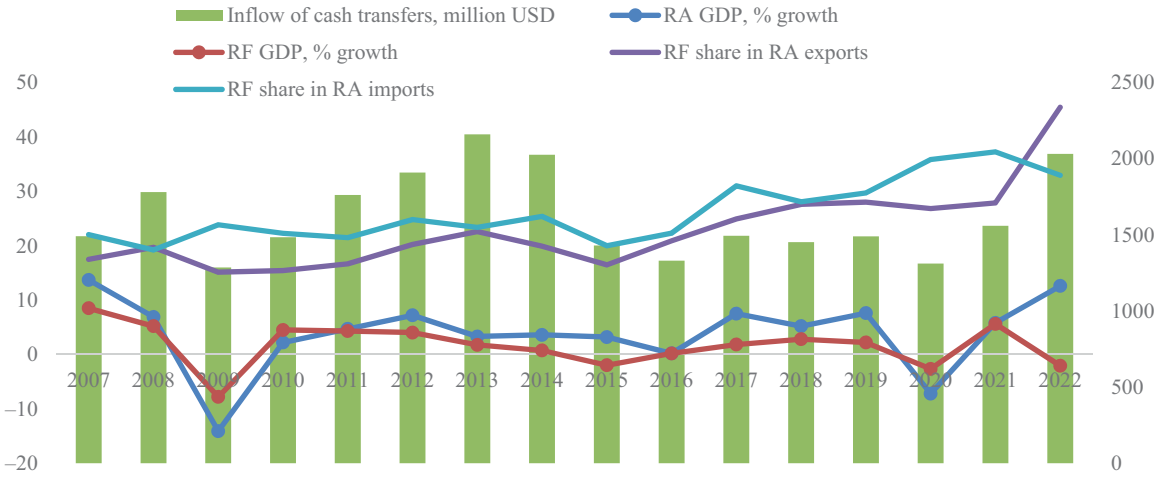

Fig. 21. **GDP of RA, GDP of RF, Inflow of Money Transfers to RA, Share of RF in the Trade Flows of RA**

Source: Database of the Statistical committee of RA and the World Bank. URL: https://armstat.am; https://data.worldbank.org/ (accessed on 12.04.2024).

The VAR(4) model with estimated coefficients is presented below:

$$
\begin{aligned}
GDP = {} & GDP(-)+ \quad GDP(-)- \quad GDP(-)- \\
& -0,2614 * GDP(-4) - 0,0564 * EDU(-1) - 0,3986 * EDU(-2) + \\
& + 0,2161 * EDU(-3) - 0,0459 * EDU(-4) - 0,0223 * ER(-1) - \\
& - 0,0917 * ER(-2) + 0,0164 * ER(-3) - 0,0713 * ER(-4) + \\
& + 0,1705 * HC(-1) - 0,2665 * HC(-2) - 0,1852 * HC(-3) - \\
& - 0,2426 * HC(-4) + 0,1037 * SEC(-1) - 0,0598 * SEC(-2) + \\
& + 0,2938 * SEC(-3) + 0,0604 * SEC(-4) + 0,1538 * \\
& * GDP\_RF - 0,044 * REM + 0,114
\end{aligned}
$$

The results of the econometric analysis show a negative impact on GDP for almost all expenditures, except for expenditures on public order, security and judicial activities. The results also show that education spending affects economic growth with a time lag of 2 quarters. On the other hand, spending on economic relations affects the country's economic growth after the 2nd and 4th quarters. Healthcare costs have the longest impact, starting in the second quarter after the changes.

The negative impact of spending on economic growth contradicts theory, while a review of empirical research shows that many authors find a negative relationship between government spending and economic growth. The reasons for these results are underdeveloped institutions, corruption, and inefficient cost allocation, as spending on education, science, human capital, and infrastructure, which can ensure sustained economic growth, has too small a share.

CONCLUSIONS

The effectiveness of the impact of the expenditure side of the state budget depends both on the capabilities of the budget itself and on the cost structure of the state, not to mention the economy itself, the degree of its development and many other factors.

Table 1

Descriptive Statistics of Variables

Variables	GDP	EDU	ER	HC	SEC	DEF	PS	REM	GDP_RF
Mean	0.0594	0.0176	0.0335	0.0469	0.0694	0.062	0.09745	−0.0051	0.0923
Median	0.0636	0.0123	0.0374	0.0597	0.0685	0.0617	0.06796	0.0665	0.0775
Maximum	0.1689	0.2311	1,1167	0.3317	0.2436	0.4825	0.4133	0.2088	0.2755
Minimum	−0.097	−0.154	−0.858	−0.1629	−0.075	−0.3257	−0.1705	−0.335	−0.1022
Std. Dev.	0.0583	0.0856	0.3665	0.0981	0.084	0.1481	0.1479	0.1699	0.0862
Skewness	−0.686	0.2636	0.3323	0.1242	0.223	0.0542	0.42253	−0.7068	0.1007
Kurtosis	3.6381	3.3746	3.9846	3.5957	2.1814	3.9843	2.5565	2.0694	3.4324
Jarque–Bera	3.8199	0.6973	2.352	0.6943	1.4484	1.6344	1.5179	4.7743	0.3792
Probability	0.1481	0.7057	0.3085	0.7067	0.4847	0.4417	0.4681	0.0919	0.8273
Observations	40	40	40	40	40	40	40	40	40

Source: Calculated by the authors using the EViews 10 econometric package.

Table 2

Результаты модели VAR (4) / The Results of VAR (4) Model

Variables		Coeff.	Standard error	P-value	t-statistics
GDP	GDP(−1)	−0.175710	0.18339	0.3416	−0.95810
	GDP(−2)	0.001943	0.23538	0.9934	0.00825
	GDP(−3)	−0.334346	0.25348	0.1918	−1,31902
	GDP(−4)	−0.261385	0.18558	0.1638	−1,40849
Education	EDU(−1)	−0.056390	0.11834	0.6353	−0.47649
	EDU(−2)	−0.398578	0.17430	0.0255	−2,28675
	EDU(−3)	0.216098	0.14058	0.1291	1,53720
	EDU(−4)	−0.045892	0.14457	0.7519	−0.31744
Econonic relations	ER(−1)	−0.022273	0.02479	0.3723	−0.89847
	ER(−2)	−0.091686	0.02454	0.0004	−3,73647
	ER(−3)	0.016396	0.02847	0.5666	0.57598
	ER(−4)	−0.071313	0.03533	0.0477	−2,01842
Healthcare	HC(−1)	0.170536	0.15212	0.2664	1,12110
	HC(−2)	−0.266455	0.13119	0.0464	−2,03099
	HC(−3)	−0.185198	0.10441	0.0808	−1,77376
	HC(−4)	−0.242577	0.12945	0.0654	−1,87389
Public order, security and judicial activities	SEC(−1)	0.103698	0.13244	0.4365	0.78300
	SEC(−2)	−0.059806	0.12826	0.6426	−0.46627
	SEC(−3)	0.293819	0.15551	0.0633	1,88937
	SEC(−4)	0.060391	0.13517	0.6565	0.44679

Table 2 (continued)

Variables	Coeff.	Standard error	P-value	t-statistics
GDP_RF	0.153802	0.15035	0.3101	1,02295
REM	–0.044286	0.07079	0.5338	–0.62557
C	0.113965	0.02815	0.0001	4,04841
R-square	0.82964			
R-square adj,	0.541338			
F-statistic	2.87768			
Akaike AIC	–3.975593			
Schwarz SC	–2.9639			
Durbin-Watson stat	1.901465			

Source: Calculated by the authors using the EViews 10 econometric package.

Table 3

Heteroskedasticity and Normal Distribution Tests

Test	Chi-sq / Jarque-Bera	df	Prob.
Heteroskedasticity	521.6169	510	0.3513
Normal Distribution (Cholesky of covariance)	16.52684	10	0.0855

Source: Calculated by the authors using the EViews 10 econometric package.

The developed vector autoregression model to identify the impact of spending on economic growth showed a negative relationship in the case of Armenia. The reason for this result is undeveloped institutions, the presence of corruption, as well as inefficient cost allocation, since expenditures on education, science, human capital and infrastructure, which can ensure sustainable economic growth, have too small a share.

At the same time, considering the spending policy of Armenia, it should be noted the obviously social nature of the structure of state budget expenditures. Most of the spending solves various social problems, whether it is spending on social needs or increasing spending on the state apparatus. All this combined makes it possible to maintain, but not increase, consumption in the GDP structure, and at the same time does not have a positive impact on economic growth rates. At the same time, in terms of long-term positive effects for the economy, it is necessary to increase spending on infrastructure, the institutional environment, as well as on all areas that affect the development of technology and innovation in the economy. Optimizing the expenditure side of the state budget would free up additional financing for more important budget items in terms of ensuring sustainable economic growth.

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E.M. Sandoyan — statement of the problem and scientific supervision, development of conclusions.
M.A. Voskanyan — critical analysis of literature, interpretation of research results.
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Comparison of Fiscal Policy Cyclicality Models in Foreign Countries

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ABSTRACT

The article **is devoted to** the issues of fiscal policy cyclicality in foreign countries. The **purpose** of the article is to explore the features of the fiscal policy cyclicality of some federal countries — representatives of the "group of twenty" for the period from 1971 to 2022. The objective predetermined the setting of the following **tasks**: to analyze the cyclicality of fiscal policy by expenditures, to analyze the cyclicality of tax policy, as well as to compare the obtained results to identify common patterns of cyclicality for countries with a similar level of economic development. The study of fiscal policy cyclicality is **relevant** because it allows governments to adjust their fiscal policies according to the current state of the economy. This helps to smooth out fluctuations in economic activity and reduce the risk of recessions. Research **methods** — econometric modeling (building a linear regression model and using pooled binary least squares estimation), comparison, analysis. Main **results** of the study: the procyclicality of the public expenditure policy is confirmed in all the countries studied over the period considered, and it has an inverse dependence on the level of economic development of the country (the higher the level of development of the country in the period considered, the less procyclical its expenditure policy). The fiscal policy of all countries under consideration is countercyclical in terms of VAT, corporate and individual income taxes, but the degree of countercyclicality is different everywhere. The **novelty** of the study is the construction of a dynamic model without a free term, as well as the inclusion in the analysis of periods of global financial crisis, pandemic, the current stage of technological mode change and geopolitical bifurcation. The **practical significance** of the study lies in the possibility of balanced development of territories: in federal countries, where there are different levels of economic activity and income in different regions, the establishment of the type of cyclicality of fiscal policy allows a more even distribution of tax and budgetary resources to support the sustainable development of all regions.
Keywords: fiscal policy; budget expenditures; tax rates; countercyclicality; procyclicality; financial crisis

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INTRODUCTION

Global challenges at the present stage are associated with four elements of the world landscape: climate change; demographic bifurcation; technological acceleration; geostrategic shifts.[1] Each of these areas is characterized by a high degree of uncertainty, affecting changes in the structure of financial flows to achieve development priorities both at the level of the global economy and for individual sovereign states.

The role of fiscal policy has significantly strengthened as a result of large-scale budgetary expansion measures during the global financial crisis [1]. Most developed countries made unprecedented decisions regarding financial aid during the pandemic, rapidly increasing expenditures, providing tax benefits, exemptions, deferrals, and budgetary rule exceptions, which further enhanced the significance of budgetary and tax instruments[2] [2–4]. Despite the fact that budget rules were more flexible during crises, they failed to prevent the growth of public debt, which negatively affected the debt burden and the servicing of debt obligations [5].

Procyclical fiscal policy is suboptimal and is characterized by the absence of smoothing effects on cyclical fluctuations from the applied tools. Identifying the sources of procyclicality is

[1] The Global Risks Report 2024. 19th Edition. World Economic Forum. URL: https://www3.weforum.org/docs/WEF_The_Global_Risks_Report_2024.pdf (accessed on 10.04.2024).

[2] Fiscal Monitor: Helping People Bounce Back. International Monetary Fund (IMF). 2022. Washington, DC: IMF, October. 100 p.

crucial for making informed decisions in public finance management, budget parameters, and the establishment of budget rules.

Studies on the nature of fiscal policy by the criterion of cyclicality show a number of common conclusions, with most research assessments based on the classification of countries by income level. In developing countries, government spending usually exhibited a procyclical nature, while in developed countries, it was acyclical or countercyclical [6, 7]. The procyclical nature of fiscal policy in many developing countries has also been confirmed by most authors [8, 9]. The acyclicality of tax policy in developed countries and procyclicality in developing countries was demonstrated in the work [6]. After the global financial crisis, fiscal procyclicality showed a decline in low — and middle-income countries, while high-income countries returned to procyclical behavior [10].

The role of budget rules in reducing the procyclicality of fiscal policy has both positive effects [11, 12] and negative effects [13]. Results have shown that expenditure rules cause procyclical effects; the balance rule increases the degree of countercyclicality of value-added tax (VAT), corporate tax, and income tax rates, while the revenue rule increases the degree of countercyclicality of the income tax rate [14].

Thus, previous studies do not reflect absolute consensus in assessing the impact of fiscal policy on cyclicality, although general conclusions have been reached in some cases. Using the approach [6], we evaluated the cyclicality of fiscal policy and tax rates for individual taxes, with the advantage of our study being the inclusion of 2022 data, which had not been done before.

For the analysis of budgetary and tax policy, countries with developed fiscal institutions were selected: Australia, Germany, India, the USA, and South Africa. Observations were made over the period from January 1971 to December 2022. It should be noted that in the USA and Australia, VAT is not levied at the federal level, so the analysis of the cyclicality of the VAT rate in these countries was not conducted. The period for assessing cyclicality in India was conducted from the year VAT was introduced — from 2005. In South Africa, VAT was introduced in 1991; before that, a goods and services tax (GST) was used, which was taken into account when collecting and processing data.

The sources of data were the national accounts of the World Bank, the official websites of the Tax Policy Center, Tax Foundation, Trading Economics, the Australian Department of Finance, the Parliament of the Commonwealth of Australia, and the South African Reserve Bank.

The purpose of the paper is to assess the cyclicality of the fiscal policy of federal states over a fifty-year retrospective through the modeling of real final consumption and tax rates.

METHODOLOGY

At the preprocessing stage, procedures were carried out to transform the dataset, which consists of numerous records: deflating nominal government expenditures and gross domestic product (GDP) using the GDP deflator; calculating growth rates for all indicators.

To measure the cyclicality of fiscal policy (government spending, tax rates) across countries, a regression model was used:

$$FISCAL_t = \beta RGDP_t + \varepsilon_t,$$

where t — year; ε_t — random measurement error, *FISCAL* is measured either by the growth rate of real government final consumption or the tax rate, and *RGDP* — is real GDP.

Such a model has already been used by some researchers [15] to analyze the cyclicality of fiscal policy in countries of the Organization for Economic Co-operation and Development (OECD) and non-OECD countries. The feature of this work is the construction of a model without a constant term, which ensures its greater robustness, as confirmed by passing all statistical tests. The model is dynamic, as growth rates of indicators were used instead of absolute values.

In the linear regression model, the combined estimate of binary least squares is unbiased and efficient under usual assumptions. The variance decreases since there is no other linear unbiased estimator of the regression coefficients.

For government expenditures, the calculated indicator β is a measure of the cyclicality of expenditure policy: a positive and statistically significant coefficient indicates procyclicality of the budget; a negative and statistically significant coefficient indicates countercyclicality of the budget, while a statistically insignificant coefficient indicates acyclicality of the budget.

The study also employs the approach [6], where the dependent variable reflects VAT, personal income tax (PIT), or corporate income tax (profit tax). However, the interpretations of the signs of the cyclicality coefficients of tax rates are opposite to those of the expenditure policy estimates. We acknowledge the potential error in the panel estimates, which is likely due to endogeneity and omitted variables.

RESULTS

The fiscal behavior of government expenditures across five countries during the analyzed period is presented in *Tables 1–3*.

Analyzing the regression statistics (*Table 1*), we see that real GDP explains 21.3% of the variation in real government final consumption expenditure in the USA, 29.4% in Germany, 62.2% in India, 66.2% in Australia, and 41% in South Africa.

The data in *Table 2* show that, since the F-significance values are less than 0.01 for all countries, the results are significant.

The results of the *t*-test (*Table 3*) show that the values of coefficient β are statistically significant for the ordinary least squares models constructed for all countries.

A positive and statistically significant *beta* coefficient indicates the procyclicality of fiscal policy in all five countries from 1971 to 2022.

However, the fiscal policy of some countries is more procyclical. For example, the fiscal policy of Australia, India, and South Africa was more procyclical than the policy of Germany and the US. That is, the higher the level of development of a country during the evaluation period, the less procyclical its policy was. This is generally consistent with the results obtained in [15], which concluded that the fiscal policy of non-OECD countries is more procyclical than that of OECD countries, and found that high-income countries are the least procyclical in fiscal terms, followed by upper-middle-income countries, lower-middle-income countries, and low-income countries. This also aligns with the results of the study [14], which proves that on average, large OECD countries (the USA, the UK, Japan, Germany, France, Italy, and Spain) conduct procyclical fiscal policy slightly less often than other OECD countries.

The fiscal behavior of tax rates across five countries during the analyzed period is presented in *Tables 4–6*.

According to the data presented in *Table 4*, real GDP explains 40% to 80% of the variations in tax rates.

Based on the obtained data (*Table 5*), the hypothesis of equality of means is not accepted (F-significance < 0.05), thus the results are significant for all models.

Despite the results of individual studies noting the acyclic nature of tax rates, the application of a model without a constant term allowed us to achieve significance for coefficient β in the models constructed for the selected taxes in the countries under consideration. In all countries (*Table 6*), fiscal countercyclicality is observed.

CONCLUSIONS AND DISCUSSIONS

Interpreting the obtained results, we saw that they almost completely coincide with the conclusions of the work [15], with the only difference being that the models constructed by the authors of this study indicate procyclicality of tax policy regarding VAT in OECD countries. However, considering the very low values of coefficient β in our models for all three VAT-collecting countries (0.02–0.03), one can

Table 1

Regression Analysis of the Impact of real GDP on the Percentage Change in Real Government Spending by Country (Australia, Germany, India, USA, South Africa) for the Period 1971–2022

Country	Values of the indicators	
Australia	Multiple R	0.81388449
	R-squared	0.66240796
	Normalized R-squared	0.64280012
	Standard error	2.44023152
	Observations	52
Germany	Multiple R	0.54258807
	R-squared	0.29440181
	Normalized R-squared	0.27479397
	Standard error	2.43156644
	Observations	52
India	Multiple R	0.78862213
	R-squared	0.62192486
	Normalized R-squared	0.60231702
	Standard error	4.27653813
	Observations	52
USA	Multiple R	0.46178387
	R-squared	0.21324434
	Normalized R-squared	0.1936365
	Standard error	1.89742589
	Observations	52
South Africa	Multiple R	0.640029661
	R-squared	0.409637966
	Normalized R-squared	0.390030123
	Standard error	3.297287836
	Observations	52

Source: Author's calculations.

conclude that there is very weak (or implicit) countercyclicality. One of the reasons for this phenomenon may be the nature and characteristics of fiscal regulation. Similar results were obtained [14] with an explanation of the countercyclicality of VAT through the action of the budget balance rule, which increases the degree of countercyclicality of the tax.

Recent studies using dynamic general equilibrium models have shown that fiscal policy is particularly effective during periods of recession [16]. Empirical data is also accumulating on the increased effectiveness of fiscal tools during adverse periods [17, 18].

Budget consolidation aimed at reducing expenditures and budget deficits, tightening tax

Table 2

Analysis of Deviations in Assessing the Impact of Real GDP on the Percentage Change in Real Government Spending by Country (Australia, Germany, India, USA, South Africa) for the Period 1971–2022

Country	Indicator	df	SS	MS	F	Significance F
Australia	Regression	1	595.8893	595.8893	100.0699	0.0000
	Balance	51	303.6912	5.9547		
	Total	52	899.5805			
Germany	Regression	1	125.8130	125.8130	21.2791	0.0000
	Balance	51	301.5383	5.9125		
	Total	52	427.3513			
India	Regression	1	1 534.3155	1534.3155	83.8938	0.0000
	Balance	51	932.7277	18.2888		
	Total	52	2467.0432			
USA	Regression	1	49.7665	49.7665	13.8232	0.0005
	Balance	51	183.6115	3.6002		
	Total	52	233.3780			
South Africa	Regression	1	384.7385	384.7385	35.3877	0.0000
	Balance	51	554.4775	10.8721		
	Total	52	939.2160			

Source: Author's calculations.

Table 3

The Values of the Coefficient β When Assessing the Impact of Real GDP on the Percentage Change in Real Government Spending by Country (Australia, Germany, India, USA, South Africa) for the Period 1971–2022

Country	Coefficient b	Standard error	t-statistic	Value P
USA	0.2846	0.0765	3.7180	0.0005
Germany	0.5608	0.1216	4.6129	0.0000
India	0.8739	0.0954	9.1594	0.0000
Australia	1.0035	0.1003	10.0035	0.0000
South Africa	0.8219	0.1382	5.9488	0.0000

Source: Author's calculations.

Table 4

Regression Analysis of the Impact of Real GDP on the Tax Rates by Country (Australia, Germany, India, USA, South Africa) for the Period 1971–2022

Country	Values of the indicators			
	Descriptive statistics	VAT (GST)	Income tax	Corporate income tax
Australia	Multiple R	-	0.89287404	0.88939524
	R-squared	-	0.79722405	0.79102389
	Normalized R-squared	-	0.77761621	0.77141604
	Standard error	-	0.23550847	0.17391146
	Observations	-	52	52
Germany	Multiple R	0.63348667	0.68912649	0.70269714
	R-squared	0.40130536	0.47489532	0.49378327
	Normalized R-squared	0.38169752	0.45528748	0.47417543
	Standard error	0.12223079	0.37140913	0.34182669
	Observations	52	52	52
India	Multiple R	0.83905552	0.73746282	0.80273366
	R-squared	0.70401417	0.54385141	0.64438133
	Normalized R-squared	0.64151417	0.52424357	0.62477349
	Standard error	0.08356748	0.33862127	0.27112467
	Observations	17	52	52
USA	Multiple R	-	0.78757497	0.80377563
	R-squared	-	0.62027433	0.64605526
	Normalized R-squared	-	0.60066649	0.62644742
	Standard error	-	0.29217865	0.22901153
	Observations	-	52	52
South Africa	Multiple R	0.62219026	0.68121186	0.66852275
	R-squared	0.38712072	0.46404959	0.44692267
	Normalized R-squared	0.36439345	0.44444175	0.42731483
	Standard error	0.10127868	0.34769908	0.29639579
	Observations	45	52	52

Source: Author's calculations.

Table 5

Analysis of Deviations in Assessing the Impact of Real GDP on the Tax Rates by Country (Australia, Germany, India, USA, South Africa) for the Period 1971–2022

Country	Tax	Indicator	df	SS	MS	F	Significance F
Australia	Income tax	Regression	1	11.1211	11.1211	200.5091	0.0000
		Balance	51	2.8287	0.0555		
		Total	52	13.9498			
	Corporate income tax	Regression	1	5.8387	5.8387	193.0470	0.0000
		Balance	51	1.5425	0.0302		
		Total	52	7.3813			
Germany	VAT	Regression	1	0.5107	0.5107	34.1853	0.0000
		Balance	51	0.7620	0.0149		
		Total	52	1.2727			
	Income tax	Regression	1	6.3625	6.3625	46.1235	0.0000
		Balance	51	7.0352	0.1379		
		Total	52	13.3977			
	Corporate income tax	Regression	1	5.8128	5.8128	49.7474	0.0000
		Balance	51	5.9591	0.1168		
		Total	52	11.7719			
India	VAT	Regression	1	0.2658	0.2658	38.0566	0.0000
		Balance	16	0.1117	0.0070		
		Total	17	0.3775			
	Income tax	Regression	1	6.9722	6.9722	60.8057	0.0000
		Balance	51	5.8479	0.1147		
		Total	52	12.8201			
	Corporate income tax	Regression	1	6.7931	6.7931	92.4120	0.0000
		Balance	51	3.7489	0.0735		
		Total	52	10.5420			
USA	Income tax	Regression	1	7.1118	7.1118	83.3075	0.0000
		Balance	51	4.3538	0.0854		
		Total	52	11.4656			
	Corporate income tax	Regression	1	4.8822	4.8822	93.0903	0.0000
		Balance	51	2.6748	0.0524		
		Total	52	7.5570			
South Africa	VAT or GST	Regression	1	0.2851	0.2851	27.7923	0.0000
		Balance	44	0.4513	0.0103		
		Total	45	0.7364			
	Income tax	Regression	1	5.3385	5.3385	44.1581	0.0000
		Balance	51	6.1656	0.1209		
		Total	52	11.5041			
	Corporate income tax	Regression	1	3.6204	3.6204	41.2113	0.0000
		Balance	51	4.4804	0.0879		
		Total	52	8.1008			

Source: Author's calculations.

Table 6

The Values of the Coefficient β When Assessing the Impact of Real GDP on the Tax Rates by Country (Australia, Germany, India, USA, South Africa) for the Period 1971–2022

Country	Tax	Coefficient b	Standard error	t-statistic	Value P
Australia	PIT	0.1371	0.0097	14.1601	0.0000
	Profit tax	0.0993	0.0071	13.8941	0.0000
Germany	VAT	0.0357	0.0061	5.8468	0.0000
	PIT	0.1261	0.0186	6.7914	0.0000
	Profit tax	0.1205	0.0171	7.0532	0.0000
India	VAT	0.0180	0.0029	6.1690	0.0000
	PIT	0.0589	0.0076	7.7978	0.0000
	Profit tax	0.0581	0.0060	9.6131	0.0000
USA	PIT	0.1076	0.0118	9.1273	0.0000
	Profit tax	0.0891	0.0092	9.6483	0.0000
South Africa	VAT or GST	0.0243	0.0046	5.2718	0.0000
	PIT	0.0968	0.0146	6.6452	0.0000
	Profit tax	0.0797	0.0124	6.4196	0.0000

Source: Author's calculations.

policies, is focused on restoring fiscal stability. At the same time, implementing austerity plans through budget cuts is less costly and has a quicker effect. Meanwhile, economic decisions based on tax increases lead to a deepening recession in the short-term [19, 20]. In the long-term, tax instruments and responsible fiscal policy are a priority. At the same time, non-compliance with budget rules is not necessarily a sign of inefficiency and should be considered in conjunction with the decisions made by the government [14, 21].

The impact on cyclicality occurs through the limitation of budget parameters during economic downturns, when the cost of financing additional expenses can significantly increase in the absence of a formed reserve. After budgetary expansion, if the borrowing country faces rising borrowing costs, its ability to service the debt will be in a high-risk zone.

The imbalance in the current period is characteristic of Russia, despite the extremely low level of public debt by international standards (about 15% of GDP), the cost of borrowing is quite high. The share of debt servicing costs in the total revenue of the federal budget will be 6.5% in 2024, with a projected increase to 9.7% in 2026. Due to the exit of foreign investors, a decrease in market liquidity and predictability of borrowing costs is noted.

We consider that an abundance of fiscal space, determined by the budget balance, the level of budget expenditures, and tax policy, minimizes the possibilities of conducting counter-cyclical fiscal policy; the combination of several fiscal rules appears to be more effective.

The conducted analysis allows for the formulation of a number of important recommendations for future research. The grouping of countries, time periods, and the selection of regressors influence the obtained results. It seems interesting to continue research on federal states in terms of the

freedom to make decisions at the sub-federal level regarding the management of budget expenditures, tax rates, and incentives, as well as the impact on the cyclical behavior of fiscal policy of such institutional categories as budget rules, which should help in justifying decision-making during periods of economic growth and decline.

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The Role of Gold in the Modern Economy

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ABSTRACT

The **subject** of the study is the role of gold in the economy and its prospects as a financial instrument. Gold has been a valuable asset for several millennia, capable of performing the functions of money, and even after demonetization remained an important financial asset and resource for industry, which is largely due to its unique natural characteristics. Gold is capable of yielding an average annual yield of about 15%, which makes it profitable for both private investors and governments to invest in this asset. The **purpose** of the study is to determine the modern role of gold and its prospects as a financial instrument. The study should help to understand how the role of gold in the economy has changed and what it is today. In addition, the study can help identify the potential of gold as an asset in the financial market, based on a serious theoretical and historical basis. The paper analyzes the gold market and identifies factors affecting the price of gold; based on the analysis of the dynamics of gold prices, their correlation with the consumer price index was revealed. The financial instruments of the gold market are considered and the differences between them are formulated. The presented index "Index of gold bonds" allows you to track the dynamics of the market and create a diversified investment portfolio of this type of securities. A theoretical analysis of the scientific and methodological literature was carried out; generalization and systematization of the theoretical aspects of the research topic. The historical method, the economic and statistical method, the mathematical method, the practical synthesis and processing of information were also used, which made it possible to process and describe the results of the study. Based on the results of the work carried out, it can be **concluded** that gold, having unique natural properties that determine its rarity and usefulness in the economy, allows its owners to receive sufficient average annual returns to beat inflation. Secured and physical gold was, and still is, a hedge asset against infrastructural instability, and therefore is necessary for the structure of the population's "safety cushion" and the state's international reserves.

Keywords: gold market; financial instruments of the gold market; gold bond index; price forecast; gold reserve

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INTRODUCTION

If we evaluate the role of gold from a historical perspective, until the beginning of the 20th century, it maintained its position in the economy and monetization, but as the gold deficit increased, the process of its demonetization began, culminating in 1976. However, it is precisely this scarcity, which is exacerbated by the consumption of this precious metal by industry, that has made it an effective means of accumulating savings. Gold has shown a high average annual return and is currently an almost ideal financial instrument for protecting savings from inflation, which defines its role in the modern economy.

During serious political and economic upheavals, geopolitical instability, financial markets are in a state of panic, which significantly increases the demand for gold, as this asset has been preserving the savings of economic entities for over a millennium.

The subject of this study is the gold market. The degree of understanding of the role of gold in the modern economy is relatively high, as it is one of the most well-known assets in history. Many economic studies and analytical reports are dedicated to this topic; however, some important subsections and prospects of this financial instrument are still insufficiently covered [1, 2].

Researchers have focused on various aspects of this issue, such as pricing and identifying the best instruments in this market. However, individual studies do not cover the entire topic comprehensively and are rather specialized. This situation defines the purpose of our paper is to determine the modern role of gold and its prospects as a financial instrument.

The theoretical and methodological foundation and information base include: works by leading domestic and foreign authors in the fields of history and economics, as well as internet resources. The information base includes materials from Rosstat, the Central Bank of the Russian Federation, news websites, and papers.

ANALYSIS OF THE MODERN GOLD MARKET

As of today, gold is not considered money; however, it remains one of the most important resources in the economy. This is due to its unique natural properties (*Table 1*).

The list of applications for gold is endless, and in the future, it is likely that new ways to use it will emerge.

Such applicability across various industries and high rarity contribute to the high value and decent profitability of this metal.

By referring to the archive of gold quotes from the Central Bank's website, it can be analytically deduced that over a period of 23 years, gold has brought its owners, since 2000, about 2 500% profit with an average annual return of approximately 15% (*Fig. 1*).

All this makes gold not only a fairly universal resource for the real sector of the economy but also an attractive object for investment. Especially during periods of instability, individuals actively engage in gold transactions for these purposes, which ensures high liquidity in its market.

States also include gold in their international reserves. They store their gold reserves in central banks to ensure the stability and reliability of the national currency. In times of crisis, states use it to protect their assets from inflation and as a guarantee of the country's solvency. In addition to gold, international reserves also include currency, debt securities, and IMF quasi-currency instruments. Considering that these assets are also backed by gold, but by the central banks of other countries, there is no point in holding these assets, except as a minimally necessary reserve for foreign trade operations, and they introduce additional risks from globalization for the national financial system.

ANALYSIS OF FACTORS INFLUENCING THE PRICE OF GOLD

Revealing the role of gold in the modern economy, it is necessary to understand which

Table 1

Gold Consumption in the Economy

Alternative energy	Jewelry industry	Mechanical engineering	Microelectronics	Central banks
Medicine	Private investors	Nuclear power industry	Space industry	Glass industry

Source: Compiled by the authors.

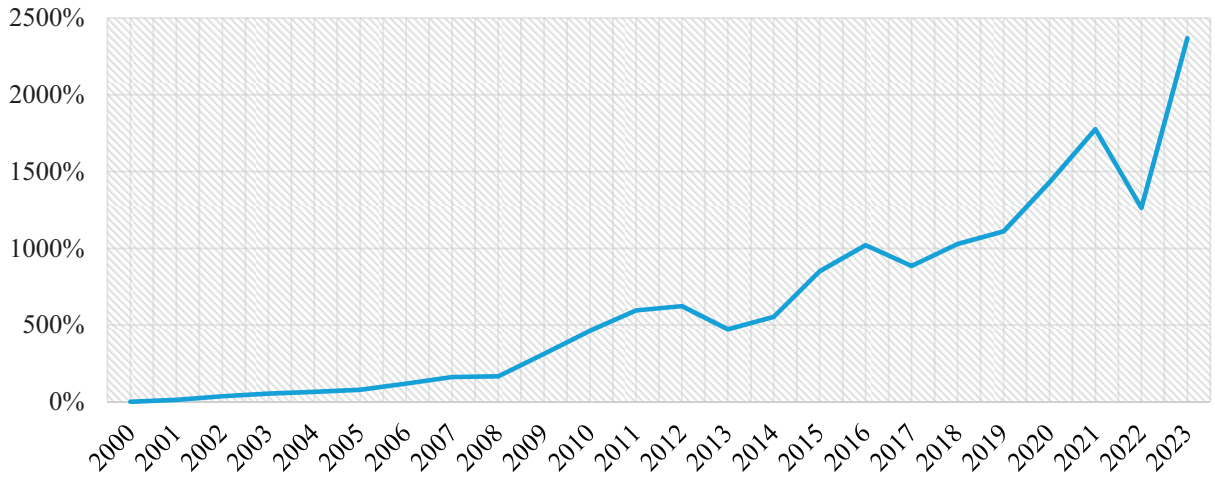

Fig. 1. **Yield Chart of 1 g of Gold to the Base Year 2000**

Source: Compiled by the authors according to data from the website of the Bank of Russia. URL: https://cbr.ru/hd_base/metall/metall_base_new/ (accessed on 04.02.2024).

factors influence its price (they are closely related to the role of gold):

- the economic and political instability in the world or in a specific country increases the demand for gold, which, with unchanged supply, leads to a rise in its price;
- the negative dynamics of global financial markets lead to capital outflows, which create a demand for safe assets, resulting in an increase in demand and prices for gold. However, in some crises, this dependence was disrupted — thus, in 2008, the price of gold fell by 17% while the Dow Jones Industrial Average index decreased by 14% over the same period [3];
- purchases of gold by central banks, how demand for gold in large volumes leads to an increase in gold prices;
- the average market cost of gold mining, determined by technological innovations in its production. The higher it is, the higher the prices for gold. The very amount of gold reserves in the Earth's crust is the limit of its supply, which leads to increased mining costs throughout history;
- the rise in inflation positively affects the price of gold, which is largely due to the increase in production costs because of the general rise in prices and wages;
- the depreciation of the national currency usually leads to inflation. However, an important factor here is that gold prices are primarily determined by supply and demand on the London Metal Exchange (LME), where prices are expressed in dollars. This means that a decline in the national currency's exchange rate against the dollar simultaneously leads to an increase in gold prices in that currency;

Table 2

The General Structure of Gold Consumption in the World

Indicators	1970	1975	1980	1984	1994	1996	2005	2012	2016
Mining	1257.7	910.2	895.7	1058.5	2209.0	2284.0	2450.0	2613	3236
Scope of application									
Jewelry	1066	516	127	819	2604	2807	2709	2129	2042
Dentistry	58	63	64	51	52	55	62	12	18
Coins, medals	91	272	201	174	75	60	37	294	265
Electronics	89	66	89	122	192	207	273	267	255
Other consumption	62	57	66	53	200	348	646	1985	1729
Total consumption	1366	974	547	1219	3123	3477	3727	4687	4309
Average gold price, USD per 1 g	1.0	4.2	19.7	13.0	11.9	12.5	14.2	54.1	4.21

Source: Pleshivtseva A.A. [4].

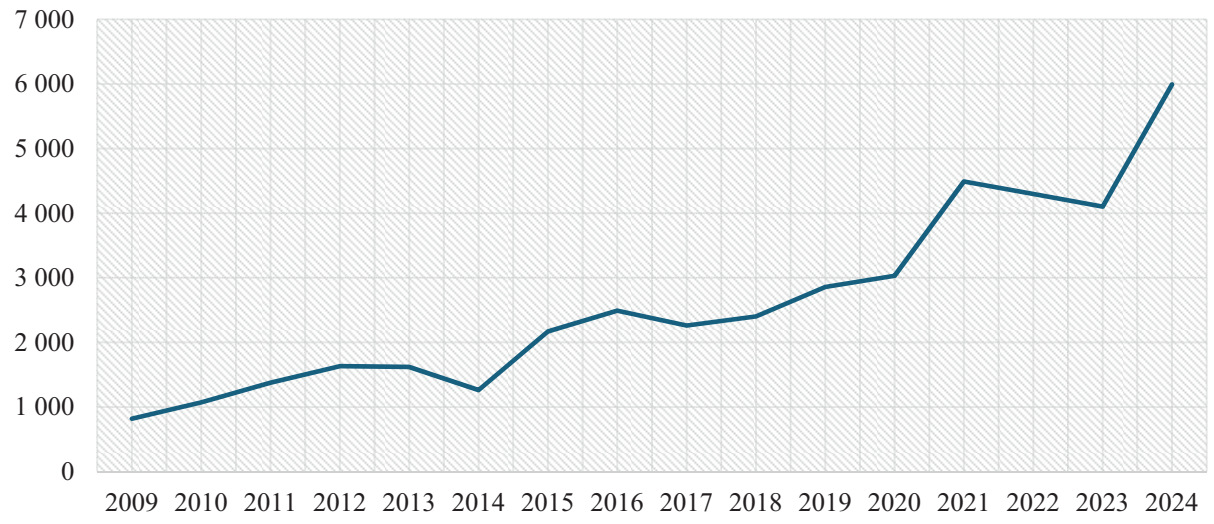

Fig. 2. **Chart of the Price Dynamics of 1 g of Gold**

Source: Compiled by the authors according to data from the website of the Bank of Russia. URL: https://cbr.ru/hd_base/metall/metall_base_new/ (accessed on 04.02.2024).

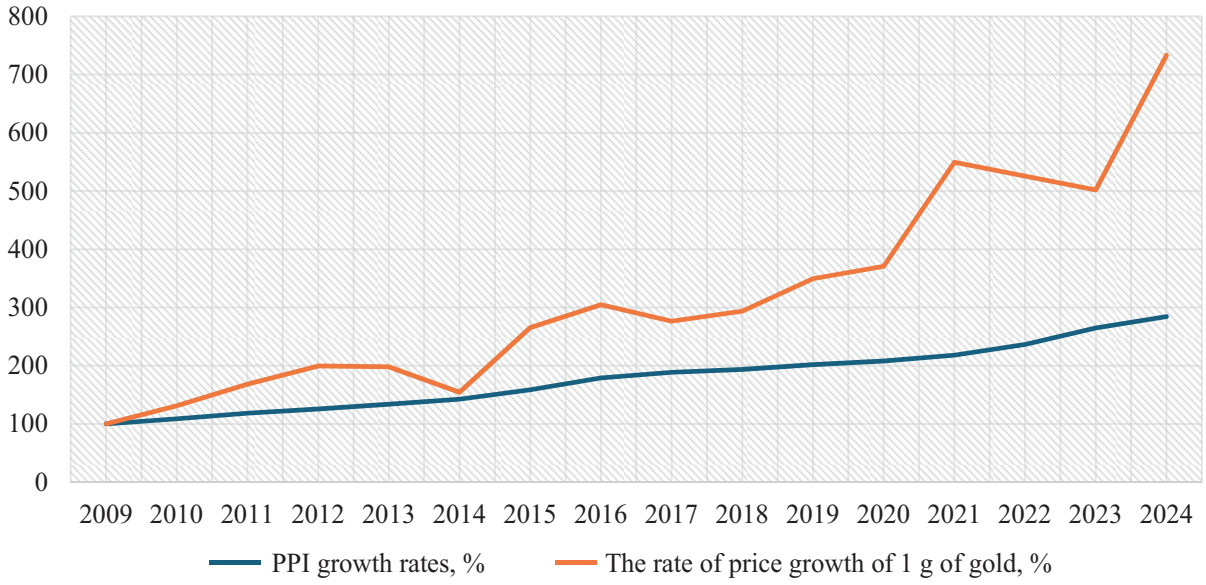

Fig. 3. **Chart of the Growth Rates of Prices of 1 g of Gold and CPI**

Source: Compiled by the authors according to data from the website of the Bank of Russia. URL: https://cbr.ru/hd_base/metall/metall_base_new/ (accessed on 04.02.2024).

- the demand for gold from the industrial and jewelry sectors directly affects the price of gold;
- especially strong influence is exerted by the discovery of new ways to use gold;
- speculative demand from traders also affects prices, but this is mostly short-term price fluctuations.

According to *Table 2*, the structure of gold consumption over the past half-century has been constantly changing, while mining volumes have been increasing. However, the overall volumes of gold consumption have been growing more strongly, which has led to a steady rise in gold prices.

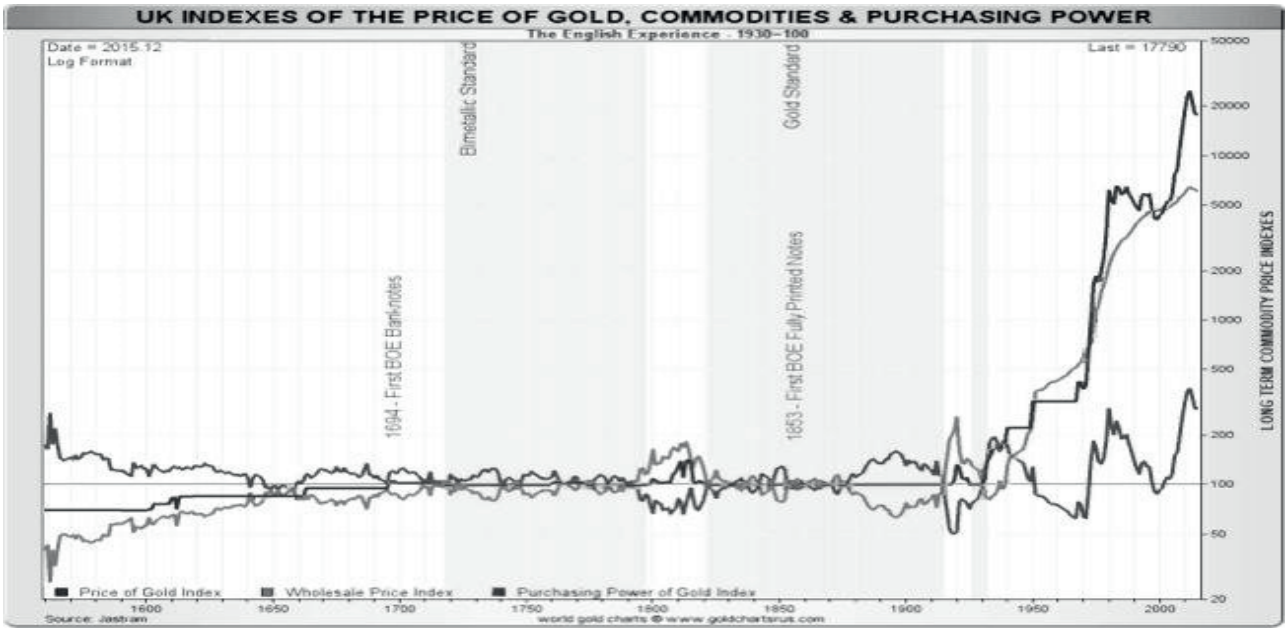

Fig. 4. **The "Golden Constant" Chart**

Source: Koos Ya. [9].

All the aforementioned factors influence gold prices, which explains its current value. The instability in financial markets, manifested in the mass bankruptcies of Western banks and high inflation, as well as geopolitical crises, lead to a surge in demand for a safe asset like gold. With its limited supply, this results in rising prices.

DYNAMICS OF GOLD PRICES IN COMPARISON WITH INFLATION

Inflation nowadays is one of the most important factors, if not the most important, affecting the price of gold. This is due to the high volumes of national currency issuance, which leads to an imbalance in the Fisher equation. However, in our opinion, there is another factor in this equation that often does not receive enough attention — the size of the central bank's assets. Since its assets are backing the national currency, without significant increases in international reserves, the issuance leads to the devaluation of money with each subsequent new monetary unit released. This is especially noticeable with an unchanged velocity of money circulation and commodity mass, which is often characteristic of the short-term period [5, 6].

For an analysis of this effect, let's examine the dynamics of gold prices and compare them with inflation (*Fig. 2*). We will refer to a source we have previously used — the archive of gold prices from the Bank of Russia's website from 01.01.2009 to 01.01.2024 over a period of 15 years, which is sufficient for identifying dependencies and patterns in the market [7].

The chart shows a positive price trend for this asset over a 15-year period. There is also a noticeable sharp increase in periods following significant geopolitical events: after 2014, 2020, and 2022.

To determine the size of inflation, let's refer to the consumer price index (CPI) from the Rosstat website[1] (*Fig. 3*).

For the convenience of comparison and identifying correlation, we will take the price of 1 g of gold and the CPI on 01.01.2009 as 100%. This will allow us to compare the growth rates between these two indicators.

[1] Website of the Federal State Statistics Service. URL: https://rosstat.gov.ru/ (accessed on 04.02.2024).

From this chart, we can determine that the rise in gold prices outpaced inflation. This is related to other factors that were described earlier.

Let's determine the paired (linear) correlation coefficient using the formula provided below:

$$r = \frac{\overline{xy} - \overline{x} * \overline{y}}{\sigma_x * \sigma_y}.$$

The coefficient was 0.947, which indicates a very strong direct relationship between the level of inflation and the change in the price of gold. Thus, gold is an extremely effective tool against inflation and justifies its title as a "safe haven".

Another interesting effect in the gold market is the "Golden Constant" discovered by Roy Jastram — a purchasing power that has remained unchanged over the past 500 years and fluctuates around a horizontal line [8] (*Fig. 4*).

Before the era of great geographical discoveries, gold prices were rising, and only the massive influx of gold from the New World led to a price revolution —huge inflation associated with the fact that money was made of gold. However, after these events, gold gradually restored its value, and by the 20th century, the purchasing power of gold even increased.

This implies that, on average, the price of gold is strongly correlated not only with the Russian consumer price index but also historically maintains its purchasing power, correlating with the UK CPI.

FINANCIAL INSTRUMENTS OF THE GOLD MARKET

To better understand the role of gold in the modern economy, it is important to determine which financial instruments are used by participants in this market. We will examine the most well-known instruments [10].

The first of these is physical gold in the form of bars and coins (bullions and coins). This instrument is the most well-known, as it has been used for more than a millennium. It is in this form that it is consumed by the industry and the jewelry sector [11]. From the perspective of financial risks, gold coins and bars are one of the safest assets, as they cannot simultaneously lose all their value, and a loss of at least 50% of their value is only possible in an extremely unlikely scenario. This is precisely why there is significant demand for them during moments of geopolitical and economic tension.

Investments in this instrument are also commonly referred to as "thesaurization", as gold coins have been serving as cash since the first millennium BC. The downside of this process is that, when it becomes widespread, it leads to a drain of funds from the private sector, and businesses have fewer sources of financing.

Also, physical gold, in all forms, is traded with significant spreads, and in the event of the slightest damage, banks only accept it at a considerable discount.

The next instruments are allocated metal accounts and unallocated metal accounts. The first involves the accounting and storage of the client's bars and coins on the principle of a safe deposit box, with a fee charged for this, provided that the bank does not have the right to use the metal for its own purposes. In the second case, it involves accounting for and storing gold in non-cash form by transferring the monetary equivalent of its market value to the bank, on the condition that the bank can use the metal in its transactions and accrue interest on this account.

This instrument has its advantages due to the possibility of earning additional income in the form of interest, significantly lower buy and sell spreads, as well as the absence of risks of damaging or losing the asset. A clear example: at Sberbank on 03.02.2024, you can purchase 1 g of gold in the form of a bar for 7 016 rubles and sell it for 5 562 rubles, which means a spread of 20.72%. On an unallocated metal account (UMA), you can purchase 1 g of

gold for 6 140 rubles and sell it for 5 621 rubles, which means a spread of 8.45%.[2]

On the other hand, it is important to choose reliable banks and especially critically consider risks, including infrastructural ones, if these are foreign banks.

A similar instrument to the previous one is gold certificates. These are documents confirming ownership of gold stored in a bank or another specialized organization. Unlike the previous instrument, they are more liquid.

Gold funds are also a common investment tool for gold. Shares of these funds are often freely traded on the exchange, and they consist of physical gold and have a management company. They charge an annual fee on the fund's assets regardless of their financial performance. They are popular among exchange investors.

The next two risky instruments are also exchange-traded: shares of gold mining companies and gold futures. The prices of shares are directly dependent on gold prices, as the revenue of these companies comes from the sale of gold, but there are risks associated with the efficiency of this business. The second instrument is a contract for the purchase or sale of gold in the future at a pre-agreed price. This is a derivative instrument used, especially by gold mining companies and hedge funds, to hedge against risks associated with fluctuations in the price of this metal. It is also a common object of speculation due to the high volatility and trading volumes of this asset.

A relatively new type of financial asset in the gold market is "gold bonds", whose nominal value is tied to the price of a certain amount of gold in grams. They are largely similar to federal loan bonds with indexed nominal values tied to inflation. Such bonds are considered conservative instruments used by households to protect their savings when the purchasing power of the ruble declines. Gold government bonds are particularly widespread in India and Turkey.

As of today, there are two Russian issuers of gold bonds: the pioneer gold miner in this market, PJSC "Seligdar", which issued its papers back in the spring of 2023, and the largest Russian gold mining company, PJSC "Polyus", which placed its papers in January 2024.[3]

A reasonable response from banks could be the creation of "gold deposits", which operate on the principle of gold bonds but are a more conservative instrument. This type of deposit is likely to become a significantly more sought-after financial instrument than an unallocated bullion account [12, 13].

Another financial asset based on gold is gold-backed stablecoins. There are many private such assets. However, Russia and Iran are considering the introduction of a gold stablecoin to establish mutual payment relations, which may later be recognized in BRICS.[4] An extremely important task for Russia and its depository market is to ensure that the physical gold, which will back these internationally recognized stablecoins, is stored predominantly within our country's territory in Russian depositories. A future scenario similar to the freezing of Russian assets in 2022 is unacceptable.

GOLDEN BONDS INDEX

Gold bonds are excellent for addressing the issue of long-term financing sources, as investors are confident that their money will not depreciate — they will benefit from the rise in gold prices, as well as receive several percent annually on top of that income.

Therefore, the gold bond index becomes relevant — it will allow tracking market

[2] Sberbank. Precious metal bars — buy at Sberbank. URL: https://www.sberbank.com/ru/person/metall (accessed on 04.02.2024).

[3] "Polyus" issued gold bonds worth 15 billion rubles. URL: https://www.interfax.ru/business/942127 (accessed on 18.03.2024).

[4] Russia and Iran have begun discussing the creation of a gold-backed joint stablecoin. Forbes.ru. URL: https://www.forbes.ru/finansy/483765-rossia-i-iran-nacali-obsuzdat-sozdanie-privazannogo-k-zolotu-sovmestnogo-stejblkoina (accessed on 18.03.2024).

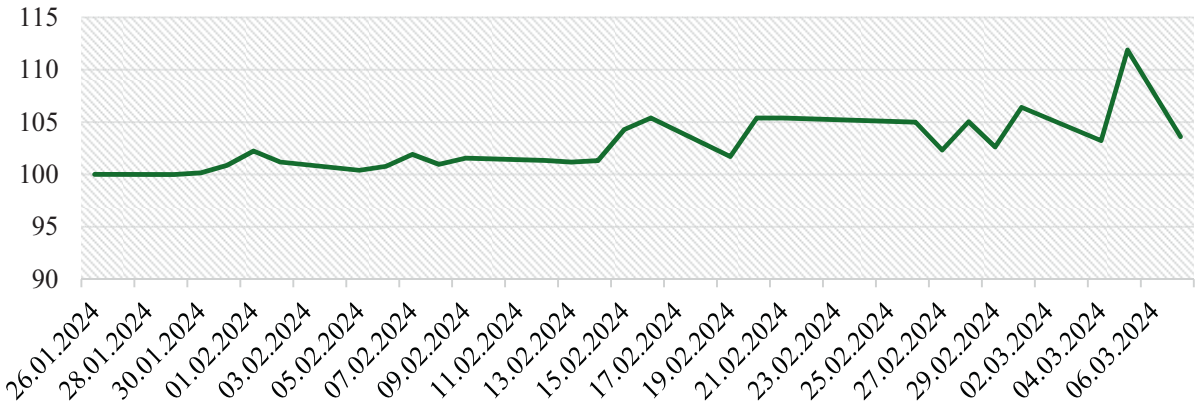

Fig. 5. **Index of Gold Bonds of the Moscow Exchange**

Source: Compiled by the authors according to data from the Moscow Stock Exchange website. URL: https://www.moex.com/ (accessed on 04.02.2024).

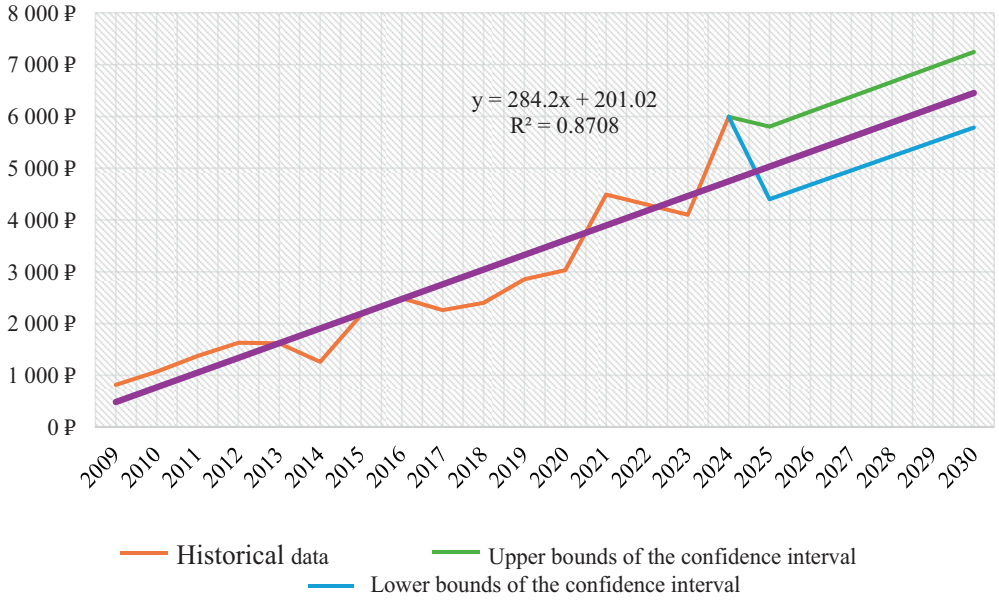

Fig. 6. **Price Forecast of 1 g of Gold in 2030**

Source: Compiled by the authors according to data from the website of the Bank of Russia. URL: https://cbr.ru/hd_base/metall/metall_base_new/ (accessed on 04.02.2024).

dynamics and creating a diversified investment portfolio from this type of security.

Based on the quotes of Polyus bonds (001PLZL-01) and Seligdar (SELGOLD 001 and SELGOLD 002), obtained from the Moscow Exchange website, we created the first "Moscow Exchange Gold Bond Index" in Russia.[5]

It is calculated using the formula:

$$I = \frac{\sum_{i=1}^{n} p_{i,t} * w_{i,t} * k_{trans} * 100}{\sum_{j=1}^{m} p_{j,b} * w_{j,b}},$$

where n — the number of gold bonds on the Moscow Exchange in the current period (there are 3 of them as of today);

[5] Moscow Exchange. Markets. URL: https://www.moex.com/s3079 (accessed on 18.03.2024).

m — the number of gold bonds on the Moscow Exchange in the base period (specifically on January 26, 2024, when there were only 3 gold bonds);

$p_{i,\,t}$ — the price of the i-th bond as a percentage of its value in the current period;

$w_{i,\,t}$ — the share of the i-th bond in the index in the current period;

$p_{j,\,b}$ — the price of the i-th bond as a percentage of the nominal value in the base period;

$w_{j,\,b}$ — the share of the i-th bond in the index in the base period;

K_{trans} — transition coefficient.

The share of a bond in the index is determined by its share of the issuance volumes of the entire market of gold bonds on the Moscow Exchange. Currently, the total issuance volume of all gold bonds is 32 831 719 312.00 ₽. For example, the issuance volume of 001PLZL-01 is 15 000 005 250.00 rubles, which constitutes 45.69% of the total issuance volume of gold bonds on the Moscow Exchange.[6] Therefore, the share of this bond in our index is 45.69%.

It is also necessary to introduce the "Transition coefficient (from the old index composition to the new one)" — it will be used when new securities are added to the index. Its importance is due to the fact that adding securities whose prices are higher or lower than the average price of the securities in the index will lead to unjustified spikes or drops in the index, while in the index, the securities will simply be equivalently replaced. This means that it is necessary to equalize the value of the index on date X without changing the composition and the updated index.

The transition coefficient is equal to the value of the old index divided by the value of the new index:

$$K_{trans} = I_{old} / I_{new},$$

where I_{old} — the value of the index with the old set of security; I_{new} — the value of the index with the new set of security.

For example, if Polymetal also decides to issue gold bonds and after calculations its share of the total issuance volume will be 13.04%, then the index with the new security will be 108.7251970852840, while the index with the old set of securities will be 108.532004439080. Consequently, K_{trans} = 0.9982231106368780.

By multiplying the index with the new composition by this coefficient, we will obtain the correct value of I_{ub} relative to the base value. When new securities are introduced into the index composition, the transition coefficient will be calculated in a similar manner.

Moreover, it is important to note that if, during the recalculation of the index for the new composition, at least one security or many securities were added, this coefficient is calculated quickly using the aforementioned formula, regardless of the number of new securities introduced, just like for a single security (*Fig. 5*).

In this chart, we can identify the positive dynamics of the Moscow Exchange Gold Bond Index. However, it is still relatively young, and it will be important to continue studying it over longer periods [14].

We have been calculating this index since 26 January 2024, as it was on this day that the first gold bond from PJSC "Polyus" was issued, making the gold bond market consist of at least two issuers.

To date, this index can be useful for financial organization analytics.

GOLD PRICE FORECAST FOR 2030

Using historical gold price data from the Bank of Russia website and identifying the trend, it is possible to forecast future gold prices (*Fig. 6*).

[6] Moscow Exchange. Markets. URL: https://www.moex.com/ru/issue.aspx?board=TQCB&code=RU 000A107PA7&utm_source=www.moex.com&utm_term=полюс (accessed on 18.03.2024).

The forecast, using MS Excel functions, shows us a positive trend for the growth of gold prices.

By 2030, the price of 1 g of gold will be in the range of 5786.07 to 7245.03 rubles with an 80% probability of this forecast.

Considering the continuous growth in gold consumption and prices described above, further sustained increases in the price of this metal are a realistic scenario for the future [15].

CONCLUSION

Gold has many factors influencing its price, but one of the most important is inflation. The rise in gold prices and the consumer price index have a very strong direct correlation, and the "golden constant" effect only confirms this correlation over a period of about half a millennium, making gold one of the best anti-inflationary tools.

Thus, it can be concluded that the role of gold in the modern economy, although not as enormous as it was before the demonetization of gold, is still significant. This metal possesses unique natural properties that determine its rarity and usefulness in the economy, allowing its owners to achieve sufficient average annual returns to overcome inflation.

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D. S. Sotnikov — is the collection and analysis of literature.
O. V. Zhuravleva — is the formulation of the problem, the development of the concept of the article, the formation of research conclusions, scientific guidance.
S. A. Varvus — methodological base, description of the results.
A. P. Buevich — theoretical part, collection of statistical data, tabular and graphical representation of the results.

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