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Methodological Approach to the Organization of Monitoring of Cash Flow Volatility

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ABSTRACT

The study presents the author's approach to monitoring the volatility of cash flows. **The relevance of the study** is due to the fact that a high increase in volatility can have a negative impact on the stability of individual economic entities; therefore, central banks are faced with the task of organizing a system for monitoring cash flow volatility, as well as developing approaches to their regulation. **The purpose of the study** is to develop a methodological approach to organizing the monitoring of cash flow volatility. Statistical **methods**, including fractal analysis, are used in the study. The study determines the approach to classifying different levels of cash flow volatility. Three main types of cash flow — moderate, transient, and turbulent, — are defined. The study confirmed two hypotheses. First, it is proven that the volatility of cash flows is more the result of behavioural factors than institutional ones. Second, it is established that the turbulent type of cash flow occurs in more rare cases than the moderate or transient types. It is shown that the volatility of the cash flow is the result of behavioral reactions of economic entities to fluctuations in economic activity. Institutional factors determine the limits of cash flow volatility, but fluctuations within these limits are the result of the reaction of economic actors to changes in the external environment. The turbulent type of cash flows occurs during the period of simultaneous actions of all economic entities. Based on the three-sigma rule, a methodological approach to determine confidence intervals classifying cash flows by the type of movement was suggested. **It is concluded** that since the turbulent type of cash flows has the greatest negative impact on the stability of the economy, it should be of significant interest for monitoring and subsequent regulation by the Bank of Russia. **A promising direction for further research** may be the development by the Bank of Russia of a specialized refinancing instrument to compensate for the shortage of funds due to the increased level of cash flow volatility.

Keywords: cash flows; volatility; behavior; lending; risks; uncertainty; monitoring

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INTRODUCTION

This research suggests an original approach to the organisation of monitoring the volatility of cash flows. The volatility of cash flows reflects the intensity of interaction between economic entities over time. The rate of cash flow determines the volume of cash flow volatility and its fluctuations. The frequency of volatility measurement, related to the institutional conditions for making a payment, determines the volatility of cash flows. These institutional conditions include the rules of the payment system, level of continuity of its functioning [1], and adequacy of financial assets [2]. The volatility of cash flows encourages economic entities to engage in suboptimal actions, in terms of increased information asymmetry [3]. The behavioural actions of the entities may lead to financial losses, or even to default. The economic entities do not have time to adapt to the changes in cash flow, so they perform suboptimal actions that we can observe at the macroeconomic level [4]. As a result, central banks face the task of carrying out the monitoring of the cash flows' volatility, as well as developing regulating mechanisms aimed at reducing the potential negative impact.

To monitor cash flows, the Bank of Russia launched the "Monitoring of Industry Financial Flows" in 2020, but the methodology for organising this system is still under development. For example, the problem of determining the "normal" level of volatility is not fully solved. Fluctuations in the volatility are limited by structural conditions,

creating possible limits, including budget constraints [5]. It is not fully clear, what, to a greater extent, affects the volatility of cash flows, i.e., the institutional structure of the economy or the behavioural reactions of economic entities affecting the occurrence of fluctuations. The answers to these questions are also important for assessing the current state of the economy, building a strategic planning system, etc.

This study suggests that the increased volatility of cash flows is the result of changes in sentiment on the part of economic entities performing economic transactions. Economic entities demonstrate three main types of behaviour: active, adaptive, and reactive [6]. A significant increase in the volatility is the result of initiating actions on the part of entities with an active type of behaviour, as well as supporting actions on the part of entities with an adaptive and reactive type of behaviour. It is necessary to determine the factors influencing the economic entities' decision to make financial transactions and reduce the potential negative impact of excessive volatility.

The presented research consists of four sections. Firstly, a literature review is conducted, revealing the occurrence of cash flows' volatility. The second section includes an empirical approach to determining the types of cash flow. The third section performs the empirical analysis on the example of the indicator of the volume of bank loans. The fourth section examines the main factors leading to the emergence of a turbulent type of cash flow.

LITERATURE REVIEW

The volatility of cash flows reflects the degree of change in the volume of transactions performed over a certain period of time. The volume of volatility varies, depending on the type of cash flow. In accordance with the Order of the Ministry of Finance of the Russian Federation, dated 02.02.2011, No. 11n "On Approval of the Accounting Regulations 'Statement of Cash Flows' (PBU 23/2011)", it is possible to distinguish three categories of cash flows: cash flows from current operations, cash flows from financial operations, and cash flows from investment operations. This classification of cash flows reflects the fact that there are institutional differences in the reasons for the formation of the cash flows, as well as in the mechanism for fulfilling obligations. The volatility of cash flows will differ, depending on the parameters of the external and internal environment. It affects the decisions and reasons for the direction and volume of funds by economic entities. When determining the factors of cash flow volatility, it is advisable to take into account the purpose of its formation, as well as the motivation of all stakeholders. Changes in cash flows, in some cases, are accounted for, using financial indicators, reflecting the sustainability of economic entities [7]. When assessing cash flows, it is possible to take into account the indicators of balances, reflecting the results of cash flows.

The volatility is the result of the economic actions of entities with different types of behaviour. It is possible to distinguish entities with an active type of behaviour, entities with an adaptive type of behaviour, as well as entities with a reactive type of behaviour [8]. During a period of economic growth, all entities can profit from their economic operations. However, entities with an active type of behaviour are better at taking into account the change in the economic situation [9]. They observe changes in the economic situation, have the financial resources to make significant economic transactions. At a certain point in time, entities with an active type of behaviour take actions aimed at changing the external environment in order to generate additional income. Entities with an adaptive type of behaviour, observing the beginning changes in the economy, make a decision to implement adaptive actions. The actions of entities with an adaptive type of behaviour lead to increased volatility of cash flows. In the future, the volatility of cash flows may increase, or decline. A decrease in the volatility occurs if the impact of entities with an active type of behaviour has not had a significant impact on the critical mass of entities with an adaptive type of behaviour. The entities with the adaptive type of behaviour did not believe in the change in the economic situation, associated with the actions of the entities with the

active type. They have not started to make economic transactions, and the volatility has returned to normal parameters. In the second case, entities with adaptive behaviour support entities with active behaviour. They start to invest more cash, which leads to a significant increase in the volatility of cash flows. Subsequently, economic transactions are started by entities with a reactive type of behaviour. The volume of funds invested by entities with a reactive type of behaviour determines the further increase in the volatility. The volatility is the result of the simultaneous actions of all three categories of entities. Fluctuations in cash flows depend on the individual reactions of economic entities. It is possible to put forward the following hypothesis:

Hypothesis 1. Behavioural factors play a stronger role producing volatility in cash flows than institutional factors.

The role of institutional factors is quite high, but they create boundaries within which fluctuations in cash flows occur. These boundaries can only change if the institutional structure of the economy changes [10]. Behavioural factors determine the different responses of economic entities to changes in the external environment. The share of entities as well as the amount of free cash available to them determines the possible size of fluctuations in cash flows [11]. It is advisable to define three types of cash flows: moderate, transitional and turbulent (*Table 1*).

A moderate type of cash flow occurs in a situation where all categories of economic entities perform *standard operations*. Each of the categories of economic entities receives a profit. As a result, transactions are carried out evenly and the volatility of cash flows is at an acceptable level. When performing actions by entities with an active type of behaviour, as well as supporting actions of entities with an adaptive type of behaviour, there is an increase in volatility. This type of cash flow can be characterised as "transitional". Economic actions are performed by two categories of entities. After, the volatility of cash flows can increase, due to additional cash injections from entities with an adaptive type of behaviour. The most dangerous is the turbulent type of cash flow. It occurs in a situation where the actions of entities with an active and adaptive type of behaviour are supported by entities with a reactive type of behaviour. In terms of information asymmetry, entities with a reactive type of behaviour commit subsequent actions, creating additional economic losses. This type of cash flow can be characterised as "turbulent" because the speed and volume of transactions increases and some economic transactions lead to significant losses. Taking into account the fact that the turbulent type of movement is the result of simultaneous actions of all categories of economic entities, it is possible to put forward the following hypothesis:

Hypothesis 2. The turbulent type of cash flow occurs rarer than moderate or transitional types.

It should be noted that, although the turbulent type of cash flow is the rarest, it poses the greatest threat to the sustainable activities of economic entities with a reactive type of behaviour. In the conditions of increasing volatility, economic entities with a reactive approach do not have time to adapt to the emerging changes. Entities with a reactive type of behaviour, due to increasing information asymmetry, perform suboptimal actions leading to financial losses. A change in the mood of economic entities can also be the result of a change in the information background [12]. Thus, it is necessary to determine the factors influencing the formation of a turbulent type of cash flow. To test the hypothesis, it seems appropriate to conduct an empirical analysis.

DATA DESCRIPTION AND RESEARCH METHODOLOGY

To analyse the mechanisms of the occurrence of cash flow volatility, as well as the level of volatility, the study uses the indicator: "Loans granted, taking into account the revaluation and adjustment of the value of the provided (placed) funds — total" (the lending indicator). The data for calculating the indicator were taken from the website of the Bank of Russia, for the period from 01.02.2008 to 01.08.2020 on a monthly basis. The choice of this indicator is due to the fact that loans have a direct impact on the sustainability of economic development. It is the loan cash flow that is the key source of liquidity for making

Table 1

Types of cash flows

Types of movement	Description
Moderate	It is the result of uniform actions of all three categories of entities. The volatility of cash flows is persistent
Transitional	It is the result of actions of entities with an active type of behaviour, as well as supporting actions on the part of entities with an adaptive type of behaviour. It is characterised by an increased level of volatility
Turbulent	It is the result of the actions of entities with adaptive and reactive behaviours. It is characterised by excessive levels of cash flow volatility, creating additional imbalances in economic interaction

Source: compiled by the author.

economic transactions in Russia. According to the Association of Russian Banks on 01.04.2019, the volume of loans to non-financial organisations reached 48.9 trillion rubles [13]. In this regard, there is a question: What determines the volatility of cash flow — the decisions of economic entities or the institutional characteristics associated with taking out a loan (for example, the parameters of monetary policy [14])?

To test the hypothesis about the degree of influence of behavioural and institutional factors on the level of cash flow volatility, it is advisable to use fractal analysis (*Table 2*). The use of fractal analysis allows us to determine the characteristic of a time series. It is possible to distinguish between a persistent process and a anti-persistent process. A persistent process assumes that the previous values determine the current values. Accordingly, if the cash flow is a persistent process, it is possible to conclude that it is more influenced by institutional factors. If the time series represented a cash flow as a anti-persistent process, then the cash flow is more dependent on the behavioural responses of economic entities. The latter is due to the fact that the anti-persistent process is determined by the current values. To define the type of time series, it is advisable to calculate the Hurst index using the ordinary least squares [15]. The Hurst index (H) is calculated using the following formula, based on the application of the ordinary least squares:

$$Ln(R/S) = ln(c) + H * ln(m),$$

where R/S is the average value of the normalised span, H is the Hurst index, m is the number of observations in a group (the time series is divided into groups with a certain number of observations), and c is a constant. The calculation of these indicators is based on the methodology of R/S analysis [16]. If H is less than 0.5, then the time series is an anti-persistent process.

The second important issue is the calculation of confidence intervals for determining the moderate, transitional and turbulent types of cash flow. When determining confidence intervals, it is necessary to classify indicators of cash flow volatility. Here it is possible to use the three-sigma rule, assuming the calculation of averages and standard deviations.

EMPIRICAL ASSESSMENT

The role of behavioural factors in the formation of cash flow volatility

It is advisable to use fractal analysis to determine the dominant factors affecting the volatility of cash flows. For this purpose, the increments of the lending indicator were calculated. During the fractal analysis, a sample was taken from 01.01.2009 to 01.08.2020. Subsequently, the entire time series was divided into 6 groups with an equal number of observations. The resulting series was transformed into a logarithmic series, the accumulated deviations were calculated etc. As a result, we obtained values allowing us to estimate the Hurst index (*Table 2*).

The estimation of the Hurst index enabled us to obtain a target value for the lending growth indicator of 0.389. This value of the Hurst index allows us to classify the series as an anti-persistent process. The volatility of the cash flow is largely determined by the individual assessments of

Table 2

Calculation of the values required to estimate the Hurst index

Name of indicators	1	2	3	4	5	6
m (number of observations in the group)	10	14	20	28	35	70
R/S (the average value of the normalised span)	2.269408	2.7189	3.098122	3.52119	3.577471	5.026532
ln(m)	2.302585	2.639057	2.995732	3.332205	3.555348	4.248495
ln(R/S)	0.819519	1.000227	1.130796	1.258799	1.274656	1.61473

Source: compiled by the author.

economic entities, taking into account the current situation.

In fact, it is possible to conclude that the volatility of the cash flow depends more on behavioural factors than on institutional ones. When analysing fluctuations in cash flows, it is necessary to take into account this group of parameters. The hypothesis that the volatility of cash flows is more the result of behavioural factors than institutional ones is confirmed. The regulation of the volatility of cash flows should be aimed at compensating for possible losses associated with the rash actions of entities with a reactive type of behaviour. However, the use of these tools is advisable at a certain point in time. There is a question about how to determine the boundaries of confidence intervals allowing us to classify the cash flows.

Empirical estimation of confidence intervals for classification of cash flow types

The fractal analysis demonstrated that the volatility of cash flows is largely determined by behavioural factors, connected with the current situation in the economy. The change in the types of cash flow depends on the volume of funds and the number of entities involved in economic transactions. It is legitimate to assume that the moderate type of cash flow will be the most common since it does not imply the existence of simultaneous actions of a group of economic entities. The turbulent type of cash flow will be the least common because it occurs in a situation of simultaneous transactions by entities with a reactive type of behaviour. This situation is only possible during periods of panic actions of the specified category of entities. It is quite rare.

The classification of cash flow is possible by calculating the confidence intervals. The three-sigma rule assumes that a deviation of values above three standard deviations must be considered to be anomalous [17]. Since turbulent cash flow occurs periodically, it is possible to assume that it occurs in the range of two standard deviations. The transition type of cash flow will occur in the ranges from one to two standard deviations. The moderate type of cash flow was in the range of one standard deviation. These characteristics were calculated for the lending indicator. To calculate the confidence intervals, the values of standard deviations were calculated, as well as the average values (*Table 3*).

The three-sigma rule assumes that 95.44% of observations are within the average (plus/minus) of two standard deviations. In turn, within one standard deviation, 68.26% of the values, it is possible to assume that values that are within one standard deviation will characterise a moderate type of cash flow. Values that are in the range of one to two standard deviations are transitional. All meanings that are higher should be considered as turbulent (*Fig. 1*). To calculate the intervals, we used the data from 01.02.2008 to 01.08.2020.

As a result of the calculations, the following intervals were obtained:

1) If the growth values of the lending indicator fall in the range from — 0.74% to 2.9%, then this type of cash flow is moderate;

2) If the values of the lending indicator fall in the range of — 2.56% to — 0.74% inclusive and from 2.9% inclusive to 4.7%, then this type of cash flow is transitional;

Table 3

Values of indicators for calculating confidence intervals

Indicator	Meaning
Average value	1.079701
Standard deviation	1.815662
The average values, minus and plus standard deviation	–0.735961154 (minus the standard deviation) 2.895364 (plus standard deviation)
The average values, minus and plus two standard deviations	–2.551623561 (minus two standard deviations) 4.711026 (plus two standard deviations)

Source: compiled by the author.

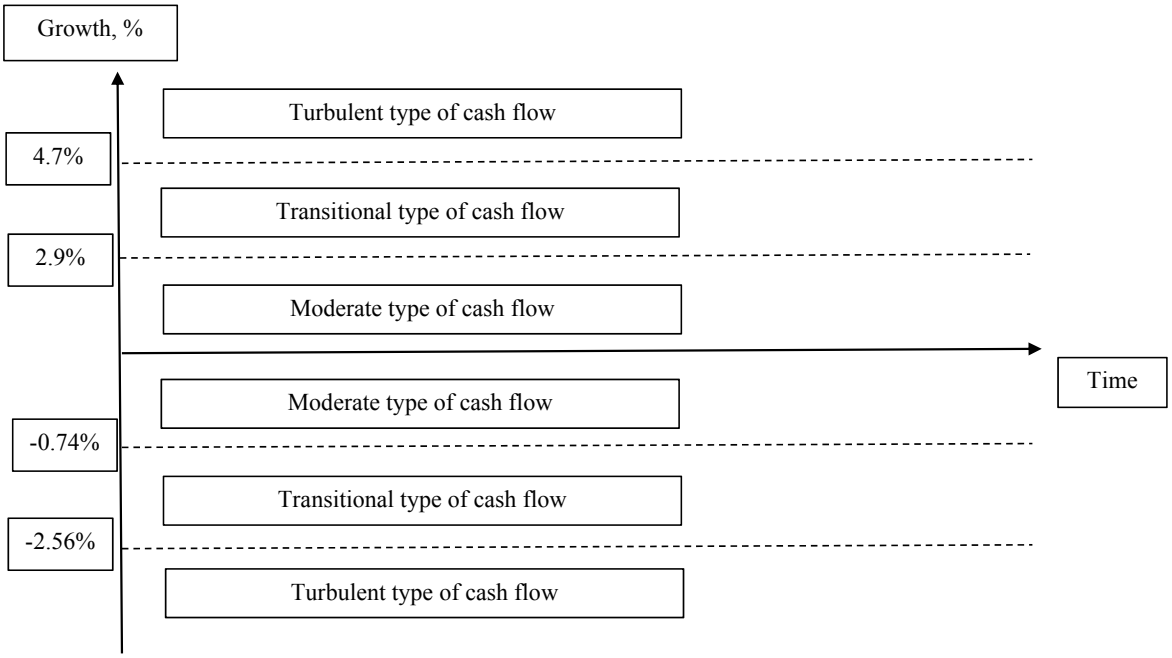

Fig. 1. **Values of confidence intervals for determining the types of cash flow**

Source: compiled by the author.

3) If the values of the lending indicator fall in the range up to — 2.56% inclusive and from 4.7% inclusive, then the type of cash flow is classified as turbulent.

It was found that the turbulent type of cash flow occurs only in 6% of cases. The moderate type occurs in 71.3% of cases (*Table 4*). Thus, the assumption about the distribution of critical values of cash flow volatility has been confirmed. It is possible to use the proposed approach to classify the volatility of cash flows as moderate, transitional and turbulent.

It should be noted that the turbulent type of cash flow can cause the greatest harm. In times of crisis, it is the subjects with a reactive type of behaviour, performing catch-up actions, which bear the greatest losses. This type of entity, during the period of increasing volatility, cannot unambiguously assess the incoming information. The Bank of Russia faces the task of organising the monitoring of cash flows, as well as developing tools to reduce the potential negative impact from the increased level of volatility. To achieve this, it is necessary to determine the factors leading to the transition to a turbulent type of cash flow.

FACTORS DETERMINING THE OCCURRENCE OF A TURBULENT TYPE

The volume of volatility in the economy is determined by two main parameters, i.e., the speed of operations, as well as the size of the performed operations. Depending on the

Table 4

Distribution of the number of months, depending on the type of lending cash flow

	Number of months	Share, %
Moderate type	107	71.3
Transitional type	34	22.7
Turbulent type	9	6
Total	150	100

Source: compiled by the author.

specific situation, the degree of influence of behavioural and institutional factors affects the two parameters in different ways. The turbulent type of cash flow occurs in case of a significant increase in the speed and volume of transactions. This increase is largely due to the impact of the following key factors: the smooth functioning of payment systems; the amount of available funds, i.e. budget constraints that the entities have; the expectations of the entities; the distribution of entities by type of behaviour and the system of institutional regulation (*Table 5*).

Smooth functioning of payment systems. Disruption of the smooth functioning of payment systems limits the ability to make a payment. The amount of money to transfer may accumulate, leading to jumps in the volume of performed transactions. As a result, the probability of a turbulent type of cash flow increases. This aspect is most often associated with a group of institutional factors, rather than behavioural ones.

The amount of available funds. Free cash determines the potential economic impact that the entities can have when the transaction is necessary. The entire set of available funds cannot be promptly withdrawn from circulation. In this regard, the key role for volatility is played by the volume of free cash.

The expectations of stakeholders. A significant change in the expectations of economic entities may trigger their simultaneous actions. The existing opportunities for rapid transfer of funds create significant risks for economic entities, as the time between receiving information and making the transaction, especially in the context of the development of digital technologies, is reduced.

Distribution of entities by type of behaviour. The appearance of a turbulent type of movement is associated with the simultaneous actions of entities with a reactive type of behaviour [18]. If entities with a reactive type of behaviour do not have the ability to perform operations, then the turbulent type will not occur. The latter can occur in a situation of high-income diversification of economic entities. Entities with an active type of behaviour will initiate an increase in volatility. This is the main source of money redistribution. It should be noted that the usage of digital technologies does not always reduce the institutional boundaries. Due to the imperfection of organizational process, the effect of "digital bureaucracy" may occur, reducing the ability of entities to perform economic operations.[1]

The system of institutional regulation. The existing institutional constraints are the boundaries for entities. The occurrence of a turbulent type may be limited by the rules for making a payment, the rules for withdrawing funds (for example, deposits), ownership questions [19] etc. In the case of significant restrictions, the entities will not be able to quickly increase the amount of available funds. Moreover, mandatory compliance with financial and regulatory requirements also reduces the amount of available free funds [20]. As a result, it reduces volatility.

Monitoring the above factors will create a comprehensive system for controlling the volatility of cash flows. Taking into account the existing experience of the Bank of Russia, it is possible to use the available data in the national payment system when organising monitoring.

[1] "Digital bureaucracy" is the creation of additional electronic procedural barriers to obtaining public services through the use of state information systems (or state digital platforms).

Table 5

Classification of key factors affecting the transition to a turbulent type of cash flow

Main factors	Description
Smooth functioning of payment systems	To make payments, the entities must have the technological ability to make it. The probability of a turbulent type depends on the characteristics of the payment system, the periods of the operating day, etc
Amount of available funds	The probability of a turbulent type depends on the amount of funds available to entities with a reactive type of behaviour. The lack of funds will not allow the entities to make economic transactions, which will limit the level of volatility
Expectations of entities	Changing expectations of economic entities encourages them to perform suboptimal actions. A sharp change in expectations contributes to the onset of a turbulent type of cash flow. Expectations of economic entities are related to the availability of incoming information
The distribution of entities by the types of behaviour	The volatility of cash flows is the result of the actions of entities with different types of behaviour. The greatest influence is exerted by the actions of entities with a reactive type of behaviour. The distribution of entities and the amount of funds available to each group directly affects the transition to a turbulent type
The system of institutional regulation	It creates institutional conditions or boundaries limiting potential fluctuations in the cash flows. An example of such restrictions is the limits on cash withdrawal on payment cards

Source: compiled by the author.

CONCLUSION

The presented research defines an approach to classifying different levels of cash flow volatility. It is possible to distinguish three main types of cash flow: moderate, transitional, and turbulent. The turbulent type of cash flow causes the greatest harm to economic sustainability and is associated with the insufficient speed of adaptation of economic entities to the changes in the financial market. The research proves two hypotheses:

Hypothesis 1. Behavioural factors play a stronger role producing volatility in cash flows than institutional factors.

Hypothesis 2. The turbulent type of cash flow occurs rarer than moderate or transitional types.

It was found that the volatility is more determined by behavioural factors than by institutional ones. Institutional factors determine the limit of volatility of cash flows, but fluctuations within these limits are the result of the reactions of the entities to the changes. The turbulent type occurs during the period of simultaneous economic operations by all entities. Therefore, it is the rarest.

To regulate the volatility of cash flows, the Bank of Russia should try to minimize the potential consequences associated with suboptimal actions of entities. It is possible to develop a mechanism compensating for the lack of funds for a certain period of time meeting highly efficient monetary policy requirements [21]. The time period should be sufficient to obtain additional available funds and meet the obligations. This mechanism can be represented by a specialised refinancing instrument, the development of which should be the object of another study.

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