

# Sustainability study of industrial engineering markets in Russia: persistence analysis

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**Abstract.** The development of industrial engineering markets and the assessment of their sustainability is one of the elements for ensuring the sustainability of industrialization, innovation and infrastructure development. On the basis of theoretical analysis, a methodological approach to assessing market stability has been developed, based on a comprehensive assessment of the company stability, market structure and dynamics. An empirical analysis of the development of mechanical engineering in the modern economy allowed us to identify a typology of market stability: a turbulent market, an emerging market, a market with unstable profitability, and a stable market. The presented typology of the stability for the industrial market can become the basis for the formation of the strategy for innovative and technological development of a company, as well as be crucial in the formation of a new industrial policy aimed at the sustainable development of the national economy as a whole.

## 1 Introduction

In modern conditions, the most important area of research is the formation of a theory of sustainable economic development at all levels of economic interaction. The most important goals of sustainable development are industrialization, innovation and infrastructure. The UN report at the end of 2022 notes that industrialization remains a significant goal of sustainable development, both in terms of providing employment and in terms of innovation and technology development [1]. Sustainable development of industrial markets of mechanical engineering is the basis for the formation of the production base and, as a consequence, the sustainable development of industry as a whole, since it is the basis for the implementation of innovations and achievements in scientific research, the production of high-tech products of deep processing. The high turbulence of the external environment in 2020–2023 caused a break in the existing global supply chains, a revision of the attitude towards domestic industrial production on the part of the state and related industries, and the need to search for reserves for their sustainable development and growth. It is stability that becomes a condition for the survival not only of individual industrial enterprises and complexes, but also of the entire economic system of the country as a whole.

In modern economic science, "sustainability" is studied at different levels of interaction. This makes it possible to form an approach to assessing sustainability at the meso level, i.e.

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at the level of the industry market. Thus, economic stability at the level of an individual enterprise is interpreted as "financial stability" and is an integral assessment of the financial and economic results of the enterprise's activities [3]. In the context of organizational theory, sustainability is explained as synonymous with "viability" [4], the ability to consistently deliver a positive economic outcome. Within the framework of the sustainable development theory, "sustainability" is the dynamic ability of an economic system to change and grow [5].

The integration of existing approaches makes it possible to interpret market stability as a dynamic characteristic that reflects the financial stability of market participants and the dynamics of market development determined by internal and external factors of the environment and competitive behavior.

An important task of ensuring the sustainable development of the industry market is the formation of a system of indicators for assessing sustainability. The current practice of empirical research is rich in examples of methodologies for assessing sustainability at the level of individual companies [6] and industries [7]. At the same time, in most cases, the state of economic and environmental parameters is assessed without taking into account the dynamic component that forms the trends in the development of individual markets. In this regard, we will rely on the need to assess sustainability as the effectiveness of the system's behavior [8]. These provisions determined the purpose of the study – to develop methodological tools and conduct an empirical analysis for the stability of the industrial engineering markets in Russia.

## 2 Materials and methods

The current practice of assessing the stability of markets can be divided into four approaches: assessing the stability of market conditions [9], assessing the stability of the market structure [10; 11], assessment of the financial stability for market participants [12] and the stability of the market in the context of its equilibrium [13]. At the same time, in most cases, there are no dynamic and integral indicators that allow us to give a comprehensive assessment of market stability.

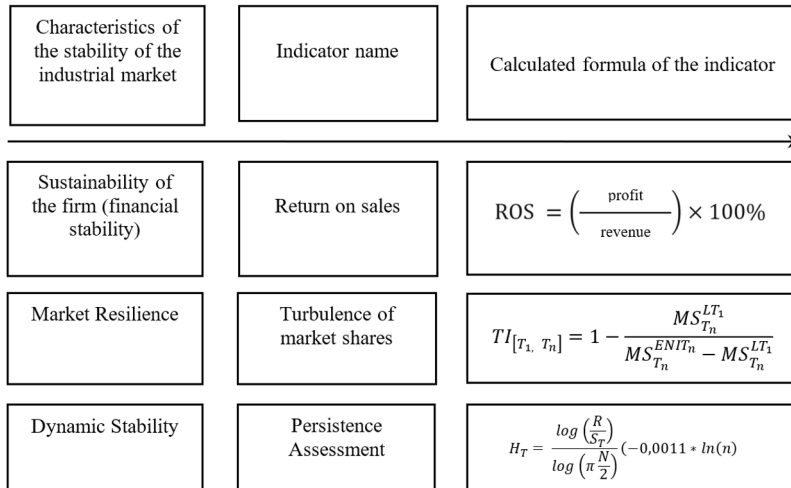
The proposed methodological tools for assessing the sustainability of the industrial market take into account the assessment of financial and market indicators of the industrial markets development and the assessment of their dynamic stability. The scheme of the implemented methodological approach to the analysis of the stability of the industrial market is presented in Figure 1 and allows us to distinguish three groups of calculated indicators.

The first group of indicators characterizing the stability of a firm includes revenue as a final indicator of production activity and profit as an indicator of value added created [14]. It is proposed to use return on sales (ROS) as an indicator reflecting the ratio of revenue to profit within industrial markets. The positive dynamics of this indicator reflects the growth in the efficiency of individual participants in the industrial market.

To assess market stability (the second group) as the stability of the market structure, the authors propose to use the turbulence of market shares [15; 16]. This indicator is an integral assessment of the market structure stability, taking into account the influence of institutional factors and barriers to entry.

The third group of indicators includes dynamic analysis, which allows you to assess the stability of the trends. For these purposes, the persistence indicator is used, which is an assessment of the stability for the analyzed trend, taking into account the internal potential of the economic system to maintain it in the conditions of turbulence of the external environment. The Hurst score is used to estimate persistence [17].

In most cases, the technological and economic features of industrial markets may be spontaneous in the short term, while in the long run they may be determined and reactionary. As part of the analysis of the industrial market, persistence makes it possible to determine the level of stability and long-term trends in the development of the industry, to confirm the stability of the existing market structure and its dynamics.



**Fig. 1.** The logic of the methodological approach to assessing the sustainability of the industrial market

The combination of these estimates makes it possible to fully describe the financial and market development of the industrial market. The criteria for assessing the indicators are presented in Table 1.

**Table 1.** Criteria for Assessing the Dynamic Stability of the Industrial Market

Index	Criteria for assessing the indicator
Return on Sales (ROS)	It allows you to determine the operational efficiency of the company: with positive dynamics, the company is assessed as growing, with negative dynamics as stagnating.
Turbulence of market shares	The range of values of the market share turbulence indicator is from 0 to 1. The closer the value of the indicator is to 0, the more stable the market structure is. With the value of this indicator tending to 1, it can be stated that the market is unstable.
Persistence	The value of the indicator in the range from $0 < H < 0.5$ will characterize the lack of trends stability, such a state of the industrial market can be described as a "return to the mean". The closer the value of the Hirst indicator is to 1, the more stable the trend is, the more stable the growth of the analyzed industrial market is.

The integration of the obtained indicators makes it possible not only to assess the stability/instability of the industrial market, but also to determine the type of stability determined by the production parameters (financial) or market parameters of the system.

The choice of industrial engineering markets as an object of research is determined by their strategic importance for ensuring the sustainable development of the entire economy in the country. Therefore, the analysis is modern and relevant in the context of today as a basis for decision-making in the field of determining the goals, objectives, and priorities of industrial policy.

In accordance with the purpose of the study, a sample of companies in eight industries related to the field of heavy, medium engineering and instrumentation for the period 2000-2022 was formed. The company's revenue and profit data were compiled on the basis of the SPARK-Interfax database. The parameters of the initial sample are enlarged to three sectors, including enterprises with only positive revenues, they are presented in Table 2. The industrial engineering market is considered as an oligopoly market.

**Table 2.** Empirical Study Sampling Parameters

Mechanical Engineering Market Segment	Number of companies in the sample						
	2000	2005	2010	2015	2020	2021	2022
Heavy Machinery	486	606	798	1055	1009	1004	994
Medium-sized mechanical engineering	473	620	670	711	677	669	680
Instrumentation	233	334	460	456	443	433	597

The general dynamics of the industrial engineering market is positive, but the dynamics of the domestic market segments is determined by the technological features of production and integration into production value chains, including global ones.

### 3 Results and discussions

Implementing the methodological approach, we will present the dynamics of indicators of the stability for the industrial engineering market (Table 2).

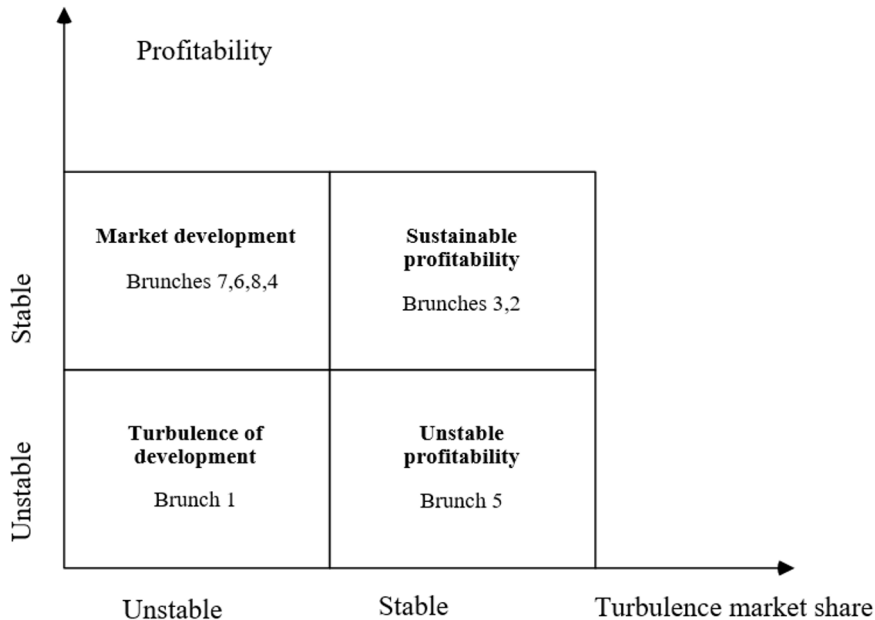
According to the first group of indicators, the analysis of market participants stability, based on the profitability of sales, showed the stability of the participants, resulting from the advancing technological progress in the industry, the continuity of the production system and the presence of a cumulative trajectory for the development of mechanical engineering as a conservative industry, which was reflected in stable profitability values.

The development of market relations and the behavior of industrial market participants (the second group of indicators) is reflected in the dynamics of the indicator for turbulence of market shares. The turbulence index was calculated for the 8 largest companies in the industrial engineering market and showed that in the period 2000–2015, the turbulence of market shares was higher, because of the general growth trend in the Russian economy and the formation of a competitive environment. The decrease in turbulence since 2015 is due to the global economic crisis, the restrictions imposed and the completion of the market formation process.

**Table 2.** Persistence of industrial markets of mechanical engineering for 2000-2022

Mechanical Engineering Segment	Industry	Average profitability of the sector, %	Turbulence of market shares	Persistence	
				In terms of profitability	By turbulence of market shares
Heavy Machinery	Branch 1	3,7	0,64	0,38	0,45
	Branch 2	7,8	0,24	0,79	0,84
	Branch 3	8,3	0,25	0,84	0,76
Medium-sized mechanical engineering	Branch 4	6,9	0,43	0,67	0,41
	Branch 5	3,5	0,26	0,48	0,69
	Branch 6	4,05	0,4	0,74	0,38
Instrumentation Industries	Branch 7	6,9	0,47	0,77	0,46
	Branch 8	11,81	0,67	0,69	0,41

In fact, the stability of markets in the face of uncertainty makes it possible to assess the persistence indicator. In general, for the enlarged sectors of the industrial engineering market, their development can be assessed as sustainable. The analysis in the context of industries showed the presence of instability in some market segments, which allowed us to identify four types of stability and integrate them into the matrix (Fig. 2).



**Fig. 2.** Matrix of sustainability types for engineering markets

The first type, unstable profitability, is an industrial market with an established structure and agent relations, but with an unstable increase in profitability. Such a market is not attractive for business, it is difficult for surviving. It is inexpedient to actively develop production in the domestic market due to the lack of significant economies of scale and the small volume of the domestic market.

The second type, development turbulence, is characterized by growth with unstable sales profitability. Such a market can be considered promising, but it will require its participants to search for effective mechanisms for implementation and adaptation to changes.

The third type of sustainability, sustainable profitability, is characterized by an established market structure and a steady increase in profitability. The stable state of such industrial markets is determined by the "memory effect" and will be largely determined by the preservation of the general trends in the development of the production chains where they are integrated. The emergence of new entrants or an increase in competition in such markets is not expected, and probable trends include further integration and enlargement within vertically and horizontally integrated structures, and an increase in the share of state ownership.

The fourth type is sustainable market development - there is a steady increase in profitability, which attracts business. This type of market is characterized by product diversification, high demand, and also follows the general economic trend.

Thus, the proposed methodological approach can be considered as a tool for analyzing the sustainability of industrial markets in the context of sustainable development goals. The proposed system of indicators makes it possible to ensure the sustainable development of

individual firms, promoting the introduction of innovations and technologies, on the one hand, and maintaining the stability of the firm, on the other. Also, the persistence analysis of the industrial market opens up opportunities for the implementation of industrial policy in order to ensure the sustainable development of the economy as a whole, to provide employment and to solve other production problems.

## 4 Conclusion

Theoretical analysis has shown that ensuring sustainable development requires the development of indicators system based on a comprehensive assessment of the stability for industrial markets. Resulting from the analysis of approaches to assessing sustainability, a methodological approach has been developed to assess the sustainability of development trends based on the calculation of the persistence index. This methodical approach is universal and can be applied not only to a wide range of market indicators, but also to various markets.

The empirical study of the industrial engineering market showed a high level of stability of this market and enabled to identify four types of stability for industrial markets: turbulent market, emerging market, market with unstable profitability and stable market. The presented typology of the stability for the industrial market can become the basis for the formation of a strategy for the innovative and technological development of a company to ensure sustainable company growth not only from the standpoint of financial indicators, but also from the standpoint of stability in the market environment. In addition, the typology of sustainability can be crucial in the formation of a new industrial policy aimed at the sustainable development of the national economy as a whole.

In general, the analysis of the problem on assessing the stability of markets is an important and promising area of study in the context of sustainable development and requires not only integrated approaches but also interdisciplinary research.

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