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**ASSESSMENT OF SIGNIFICANT THREATS TO IRON AND  
STEEL ENTERPRISES ECONOMIC SECURITY**

I. L. Ryabkov (a)\*, N. N. Yashalova (b)

\*Corresponding author

(a) Cherepovets State University, pr. Lunacharskogo, 5, Cherepovets, Russia, il.ryabkov@gmail.com

(b) Cherepovets State University, pr. Lunacharskogo, 5, Cherepovets, Russia, natalij2005@mail.ru

***Abstract***

Russian iron and steel enterprises represent a significant segment of the industrial production of the country. At present, they are dependent on the external economic situation, the state of domestic and export sales markets, unfair competition and protectionism manifestations. In addition to external factors that impede metallurgical enterprises stable functioning and sustainable development, there are internal threats as well, namely, fixed assets depreciation, outdated technologies, low investment activity, negative information impacts. All these threats have a significant impact on the steel industry economic security state. This fact confirms the relevance of further study of issues related to the definition, classification and the impact of threats assessment to economic security on the economy activities sectors. The aim of the study is to identify and determine the significance of threats to economic security for Russian iron and steel enterprises. The article presents the authors' classification of internal and external threats to the metallurgical enterprises economic security that have the greatest impact on their activities results. A description of development trends in the Russian iron and steel industry based on a wide range of statistics is given. The scientific novelty of the study is to propose a universal algorithm for assessing the significance of threats (using machine learning methods), implemented in modelling the sensitivity of the objective function to an array of factor variables that interpret these threats. The results will allow to start the development of a model that determines the integral level of iron and steel enterprises economic security.

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**Keywords:** Iron and steel enterprises, economic security, classification of threats, statistical analysis, indicator, modelling.



## 1. Introduction

One of the indispensable goals of an economic entity is to ensure its economic security, which requires research and understanding of the state of the subject, its external and internal environment - to identify and counter existing and potential threats. In turn, the state of economic security should not be reduced only to such a result of the business entity as profit, since the local stable position of the enterprise does not guarantee the possibility of its independent development and, therefore, stability in the long term. By definition (Oleinikov, 2004), the highest form of economic security is the stability of the subject, expressed in the ability to function and develop in a changing internal and external environment.

Stable functioning of a manufacturing company is possible only on condition that the combination of internal and external factors is optimal for it. That is why it is important to highlight the reasons for the destabilization of similar equilibrium, i.e. identify possible threats, their manifestations, conduct a quantitative assessment of their significance.

## 2. Problem Statement

The state of an enterprise economic security is determined by many factors, which, if insufficiently or belatedly regulated, can develop into threats. Under the threats to economic security for the enterprise in the framework of this study, we understand the combination of factors of the external and internal environment that contribute to the difficulty of its functioning, the destruction of organizational integrity, weakening sustainability, and damage to commercial interests. The source of such threats can be as conscious actions or inaction of individuals inside or outside the company, as well as a combination of objective circumstances.

Among the problems of ensuring economic security and countering threats, this study examines:

- the problem of determining the spectrum of possible threats to economic security for metallurgical enterprises;
- classification of such threats;
- the difficulty of selecting statistical indicators characterizing a particular threat;
- the task of choosing an indicator of the enterprise effectiveness, based on its business specifics;
- modelling of the enterprise performance indicator dependence on the data of statistical series characterizing threats to economic security.

## 3. Research Questions

The study raises the following questions:

- What interpretations of the essence of the concept "economic security of the enterprise" exist?
- What is the structure of the classification of threats to economic security that is optimally applicable to iron and steel enterprises?
- How many statistical series are needed to characterize the whole range of threats to the safety of an iron and steel enterprises?

- Which of the machine learning methods are able to better detect the relationship between the enterprise performance indicator and the indicators of threats to economic security?
- What are the quantitative coefficients of significance of one or another group of threats for iron and steel enterprises?

#### **4. Purpose of the Study**

The main goal of the study is to determine the range of significant threats to economic security, to determine the quantitative value of their impact on the activity indicator of iron and steel enterprises. The object of the study are the leading Russian iron and steel producers, included in the list of fifty leading world companies: PJSC “NLMK” Group, PJSC “MMK” Group, PJSC “Evraz” Group and PAO Severstal.

#### **5. Research Methods**

##### **5.1. Theoretical foundations of the study of threats to economic security**

A large number of Russian researches studies is devoted to the consideration of the essence of economic security for enterprises. A review of scientific papers shows that there is a significant differentiation of views on the subject of economic security of the enterprise, at the same time it seems possible to group these views on:

1) Characterizing economic enterprises security solely as a regime for maintaining commercial and industrial confidentiality and protecting information and material resources.

2) By the economic security of the enterprise the protection from unwanted changes under the influence of the external and internal environment is meant.

3) Identifying economic security with such a state of the enterprise, when its sustainable development, achievement of business goals, observance of economic interests, in the face of variability of the environment, is ensured.

Representatives of the first scientific views group (Yarochkin & Buzanova, 2005) in their research regarded a well-functioning information protection system of all kinds as a necessary condition for observing the economic security of the enterprise. As the main threat, they named the weakest link in this system - personnel, on which the safety of the enterprise ultimately depends. Obviously, this approach is simplified and covers only a very narrow range of possible threats.

Among the views of the second group of researchers, the point of view of Lantsman (2010) on the nature of the economic security of the organization can be singled out - by it she means the state of protection of the enterprise from external and internal threats, guaranteeing stable economic and financial activity. Ivanov (2012) also correlates the economic security of an economic entity with the ability to maintain functioning under conditions of the active influence of undesirable factors (threats) and to neutralize such an effect. Senchagov (2002) additionally introduces the preservation of activity and development potential in conditions of great environmental uncertainty as a necessary condition of the state of economic security.

Generalized theses of the third group of scientists can be found in the works of the following researches:

- Ivanova (2013) - understanding of economic security as having advantages over other enterprises, matching goals, objectives and potential to realize them;
- Evseeva and Kotik (2012) - economic security as the state of the enterprise and its resources, in which it is possible to achieve the best performance indicators, while fulfilling all goals and satisfying interests;
- Bezuglaya (2010) - economic security as an ideal state of the enterprise's functioning, in which the self-regulation of the processes to achieve goals takes place.

Studies on modelling the impact of threats on the economic security of the enterprise are very numerous, the methodology used by researchers is diverse.

Troshin (2019) proposes a concept for managing the process of assessing threats and risks, which is a system of factor sub models and functional complexes. Ivantsova and Kuzmin (2014) consider in their study the methodology for creating a fuzzy-logical model that allows, based on a set of high-quality expert assessments on various factors, to obtain an integrated assessment of economic security.

To assess the significance of economic factors, foreign researchers more often apply the methodology of mathematical modelling, building an algorithm using massive statistical samples. In the article written by a team of such authors as Gogas et al. (2015), a non-linear classification method of machine learning was used to predict a decline in the production activity of enterprises. Researchers Rafie and Adeli (2016) propose using the Boltzmann genetic algorithm for short-term prediction of factor price dynamics, and Livieris (2019) describes an algorithm for classifying data on economic factors using recurrent neural networks.

## **5.2. Identification of threats to economic security**

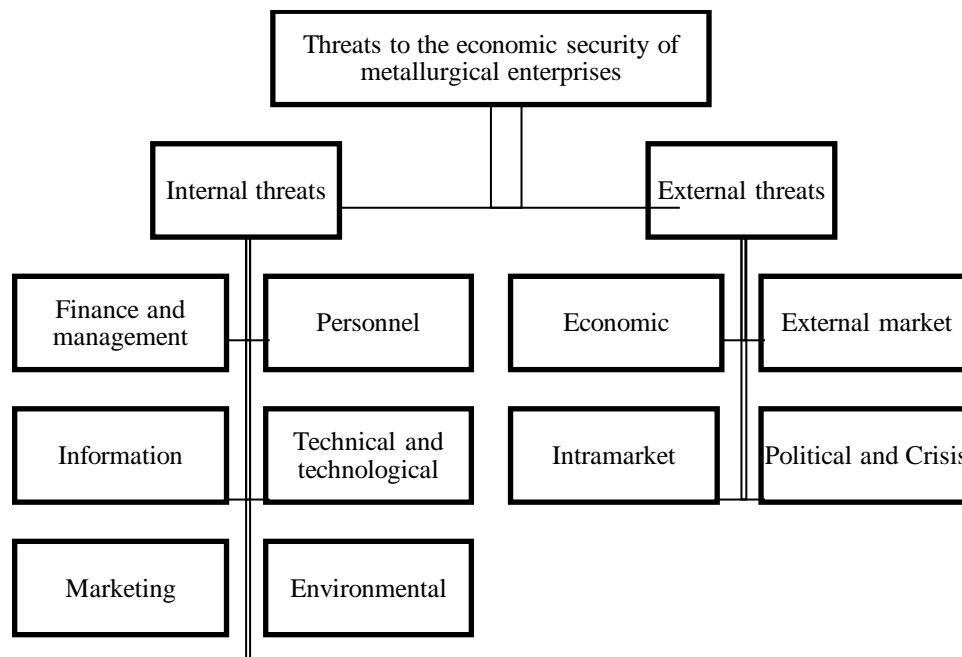
Classification of threats to economic security, as a rule, is carried out on several grounds, for example, the nature of the action (objective, subjective), the scope of the action (universal, specific). The most common criteria are the source of the threat (internal or external) and the scope of the threat (finance, personnel, information, etc., fig. 1), and for each individual industry, the set of such threats will be individual.

For domestic metallurgic enterprises, considering them as entities economically connected with a large number of counterparties in the domestic and export markets, external threats to economic security are important. The development of iron and steel enterprises is also significantly affected by the general global economic situation and industry prerequisites (Ilyin & Povarova, 2019). It is worth highlighting four blocks of the most important threats from the outside:

- economic (economic conditions in which the business operates, including inflation, gross domestic product (GDP) growth rate, key rate, exchange rates, tax rates);
- external market (factors determining interactions in foreign markets, including technological and economic dependence on leading countries in the industry, excess production capacity, volatility of prices for rolled metal and raw materials, steel consumption in export markets, logistics costs, protectionism and anti-dumping policies duties);

- internal market (possible threats to doing business in the national market, including the magnitude of metal-intensive demand in the construction, engineering and energy sectors, the number of large investment projects, the behaviour of domestic oligopolistic competitors, their pricing policy, the volume of rolled metal imports, seasonal factors, relationships with clients);
- political and crisis (instability of the international economic and political situation, closure of sales markets, the imposition of sanctions against countries and manufacturers, speculation on the metal trade market, monopolization of the industry, global environmental and economic threats, natural disasters).

No less important are the internal threats to the economic security of metallurgical enterprises, associated with the main activity, determining the efficiency of management and the pace of development of the subject.



**Figure 01.** Classification of threats to economic security for metallurgical enterprises  
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Among the distinctive internal factors of metallurgical enterprises, the following ones are stressed out (Figure 01):

- financial and managerial (high volume of problem receivables; increase in terms of inventory turnover and work in progress; poor coordination of sales, planning and production units; quality of management of basic production assets; adequacy of production / sales plan formation, efficiency of commercial activities);
- marketing (erroneous pricing policy, inadequate to the current market conditions; poor communication with customers; limited activity to promote b2b products);

- informational (violation of compliance with the regime of maintaining trade secrets, disclosure of personal data, loss of technological documentation, attacks on information systems from the outside);
- personnel (shortage of highly qualified personnel in production and management; loss of competence due to a difficult exchange of knowledge);
- technical and technological (obsolescence of production technology; long development and launching of new types of products on the market; untimely standardization of products for various sales markets; insufficient budget for modernization and updating of BPA; reduction in the quality of rolled metal products);
- environmental (violation of environmental standards, increased penalties, increased volumes of untreated emissions and industrial effluents, non-compliance of manufactured products with environmental requirements).

One of the important properties of the identified threats is their constant presence in the conditions of enterprises, albeit with a time-varying influence, which allows a more accurate determination of the spectrum of threats and, accordingly, reduction of possible negative effects (Engerer, 2009). The procedure for assessing the impact of threats to economic security on the performance indicators of an enterprise will be of particular importance, in order to protect the potential of enterprises, ensuring anti-crisis development and a guarantee of economic growth and security (Bendikov, 2000).

### **5.3. Selection of indicators for interpreting threats to economic security and the objective function**

To conduct a study evaluating the importance of economic threats to metallurgical enterprises, a selection of indicators corresponding to the above-described groups of threat types was carried out. When choosing data series for each factor variable, open statistical data were used (Federal State Statistics Service, data from industry and international analytical agencies, financial statements of research objects). A total of 113 data series were selected (see a brief list of indicators in table 1), in dynamics from 2016 to 2018. for which the interpolation procedure was carried out when necessary.

As the target variable, the sensitivity of which for the threats to economic security is planned to be investigated, we chose the TSR indicator (total shareholder return), which was adopted as a business goal in all research objects. This indicator, referring to the category of market assessments, reflects the value of the company's performance and is used as a benchmark between the main players in the industry. The advantage of this indicator of economic efficiency over traditional ones (gross profit, EBITDA per tonne) is the reflection of the impact of business value, including non-economic factors (Emilsson et al., 2012). To obtain the time series of the objective function for each research object, calculations were carried out using the exchange value of shares and the amount of dividends recommended for payment.

**Table 01.** Comparison of groups of threats to the metallurgical enterprises economic security and indicators characterizing them

| Source of threats to economic security | Economic security threat groups | Indicators                                                                                                                                                                   |
|----------------------------------------|---------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Internal threats                       | Finance and management          | Equity return on, amount of borrowed capital, revenue, profit, return on disposable assets, asset turnover ratio, value of overdue receivables, investment in fixed assets   |
|                                        | Personnel                       | The average annual number of employees, the average level of wages (in absolute terms and in comparison, with the average for the region), the level of wage arrears         |
|                                        | Technical and technological     | Profitability of production, material consumption, reject rate, depreciation of fixed assets, % of output of high value-added products                                       |
|                                        | Marketing                       | The level of sales prices, the share of presence in the markets and consumption segments, the volume of the portfolio of orders                                              |
|                                        | Environmental                   | The volume of pollutants emissions (neutralized and active), the amount of penalty payments                                                                                  |
| External threats                       | Economic                        | Inflation rate by economic sector, GDP of the most important metallurgical regions, business activity indices, cost of government securities, other macroeconomic indicators |
|                                        | External market                 | Steel prices on foreign markets, metal export volumes, foreign production and consumption, restrictive quotas and anti-dumping duties                                        |
|                                        | Intramarket                     | The volume of domestic production and import of rolled metal products, the value of secured demand, the investment value of projects with sustainable metal consumption      |

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#### 5.4. Results of target sensitivity to factors analysis

After the stage of interpreting threats through the selection of statistics, as well as the formation of a series of target and factor variables, a sensitivity analysis model was formalized. One of the advanced analytical techniques was used namely the construction of self-improving models of machine learning. For each object, an attempt was made to assess the impact of a set of factor variables (matrix X, dimensions  $m \times f$ , where  $m$  is the number of factors (113 indicators),  $f$  is the length of the series (800 observations)) on the objective function (matrix Y, dimensions  $1 \times f$ ) (Krakovsky & Luzgin, 2017). The study was conducted in the Jupyter Notebook software framework using the Python programming language.

To implement the model, the technique of ensemble algorithms was chosen, the “bagging” method in particular (Breiman, 1994). This method allows you to search for dependencies through the formation of many random training samples (a set of factors + objective function). The results of these samples are subsequently averaged, thereby improving the quality and accuracy of the analysis (Elliot et al., 2013). The basic algorithm, relying on a subset of training matrices (of the form  $X_i$ , dimensions  $m \times g$ , where  $g < f$ , are formed by random order from X), seeks to construct the predictors  $D_i(m, X_i)$ . Predictors are used to find

the maximum number of matches (positive answers) in order to minimize the quality loss of the explanation of the objective function (Polikar, 2006).

The result of the model for each research object is the generated matrix Yr, which includes only significant factors affecting the target indicator of the company, and a quantitative concept of significance (it can take a value on the interval [0; 1], the total value will be equal to 1). Metric R2 (determination coefficient), which reflects the total share of variances of the factors under consideration (Chernyshova & Samarkina, 2019), was chosen as the criterion for assessing the quality of the obtained dependences. Aggregated simulation results are shown in Table 02.

**Table 02.** The significance of groups of threats to metallurgical enterprises economic security

| Source of threats to economic security | Economic security threat groups | PJSC “MMK” | PJSC NLMK Group | PJSC Severstal | PJSC Evraz Group |
|----------------------------------------|---------------------------------|------------|-----------------|----------------|------------------|
| Internal threats                       | Finance and management          | 9,4%       | 10,3%           | 15,5%          | 16,9%            |
|                                        | Personnel                       | 2,1%       | 5,9%            | 3,9%           | 9,7%             |
|                                        | Technical and technological     | 16,7%      | 18,7%           | 8,1%           | 12,1%            |
|                                        | Marketing                       | 15,4%      | 16%             | 12,5%          | 13,4%            |
|                                        | Environmental                   | 6,3%       | 7,1%            | 11,3%          | 9,8%             |
| External threats                       | Economic                        | 9,5%       | 7,5%            | 13,4%          | 15,2%            |
|                                        | External market                 | 14,8%      | 8,4%            | 21,2%          | 14,6%            |
|                                        | Intramarket                     | 25,8%      | 26,1%           | 14,1%          | 8,3%             |
| Determination coefficient $R^2$        |                                 | 98 %       | 97%             | 95%            | 99%              |

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## 6. Findings

In the course of the study, a model to assess the significance of threats to economic security for the largest Russian iron and steel enterprises was built. At the initial stage, the maximum possible range of threats to the industry was identified and classified, then, based on statistics for 2010-2018 the main global and Russian trends in the development of ferrous metallurgy were characterized, an expert attempt to highlight the most significant threats was made.

To create a model of sensitivity analysis of the target performance indicator (TSR), statistics of time series from 2016 to 2018 was collected, their pre-processing and reference to one or another group of threats was assembled. The simulation was carried out using an ensemble nonlinear technique of machine learning (bagging) and its result for four objects of research were the matrices in which each threat was assigned its own influence coefficient.

Based on the results of modelling of the economic security threat groups significance, it can be noted that for metallurgical enterprises, the spectrum of financial, economic, technical, technological and marketing threats that are endogenous, as well as exogenous internal and external market threats, are identified as the most important threats. Each of the examined objects of the research has its own individual specificity. In this regard, some groups of threats are characteristic of only one or two enterprises, but such a result should not completely exclude less significant threats from consideration and monitoring. Also, as part of the development of a sensitivity analysis model, it is planned to expand the number of factor



variables and increase the number of observations. In the future, knowledge of the spectrum of the main threats and the degree of their impact on the iron and steel industry will help create an integrated model for assessing economic security and, knowing the approximate trends of threat factors, make forecast scenario plans for business development.

## 7. Conclusion

The metallurgical enterprises considered in the study, by being representatives of industrial giants, are sensitive to a whole range of threats. Understanding of the spectrum and classification of possible threats is an important step in analysing their impact on the iron and steel enterprises economic security. A necessary analysis tool is the classification of such threats proposed in the study with the identification of the main groups according to the external and internal source of influence. The developed quantitative assessment of the importance of economic security factors showed particularly vulnerable zones for iron and steel enterprises. The study as a whole is of great practical importance and in the future will allow to reliably and efficiently determine the range of primary challenges and threats to economic security that must be contained.

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