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Translated Article†

SPECIFICS OF ANALYSIS OF COMPANIES OPERATING IN THE DIGITAL ECONOMY

Vera G. KOGDENKO
National Research Nuclear University MEPhI, Moscow, Russian Federation
kogdenko7@mail.ru

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Abstract

Importance The article analyzes companies operating in the quaternary sector of the economy (digital economy).

Objectives The study aims to investigate the specifics of companies operating in the digital economy and to develop proposals for improving their analysis.

Methods The methodology of the study rests on the stakeholder theory and resource-based approach to organizational analysis.

Results I developed a methodology that is in sync with the specifics of companies operating in the quaternary sector of the economy. It includes seven steps. At the first step, corporate competitive advantages are assessed. At the second step, risks generated by key stakeholders are analyzed, including those associated with intellectual capital and social and reputation capital. At the third step, intellectual capital is examined, followed by social and reputation capital and its four components. At the fifth step, company's cash flows and financial solvency are estimated; at the sixth step, efficiency of investment activities is evaluated on the basis of cash flows from operations and financing. At the final step of the analysis, value drivers that relate directly to intellectual capital and social and reputation capital, and company's intrinsic value are estimated.

Conclusions and Relevance The proposed methodology helps assess corporate operations in the digital economy through a stakeholder approach. The article may be useful for analysts involved in corporate performance appraisal using integrated reporting.

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Business analysis gets more refined and sophisticated as the information society and quarternary sector of the economy evolve and rapid changes occur in the business environment. The developments below had the most significant effect on the economy:

- growing external threats and closer relationship of entities with the business environment. According to M. Reeves, S. Levin, D. Ueda [1], this puts business at higher stake and reduces its life cycle. The average life expectancy of S&P 500 companies fell from 67 years in the 1920s down to 15 years nowadays [2];
- rearrangement of the business goal setting process, abandonment of the proprietary concept and adoption of the stakeholder value creation concept, as some Western and Russian researchers put it (R.E. Freeman [3], J.E. Post, L.E. Preston, S Sachs [4], I.V. Ivashkovskaya [5, 6]). It is the focus on stakeholders' interests that enables businesses reinforce their position, ensure sustainability and resist to external challenges;
- transition from traditional linear technologies to information-based ones, from physical to information

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substratum [2] throughout all the sectors of the economy, thus driving business from the diminishing return to the accelerating one;

- the use of Big Data for analysis and forecasting through predictive mathematical models, and identification of correlations to comprehend the business environment and behavior of economic agents [7];
- the use of the blockchain technology in the nearest future to register titles for analyzable items [8], thus making the analysis more prompt and reliable.

In addition to overall changes in the economy, the analysis should also be sensitive to distinctions of entities operating in the quarternary sector of the economy as they create and use databases and information resources, develop computer-assisted software:

- new business approaches studied by M. Malone, S. Ismail, Y. Van Geest – increased business mobility in all aspects, i.e. recruitment of temporary staff, independence on tangible assets, use of third party assets, crowdsourcing, crowdfunding, crowdlending, crowdinvesting, outsourcing [2];
- modification of the asset mix, i.e. a decrease in tangible production assets, increase in a percentage of intangible assets. The prevalence of knowledge-based (including digitized), social and reputation capital;
- change in expenditures, i.e. a decrease in tangible costs, increase in the percentage of costs for personnel, rent, IT services, etc. Expenditures feature a rise in fixed expenses, thus raising the operational leverage and profit volatility;
- continuous business renewal, material investment in business development since the sector tends to experience rapid changes in technology, consumer preferences, business model.

It is difficult to use traditional financial bases, such as non-current assets, total assets, equity and invested capital for analysis due to distinctions of the quarternary sector companies, since value of the assets is too volatile. Hence traditional indicators of financial sustainability, liquidity, turnover and profitability are no longer meaningful for information economy businesses. The analysis is now based on more reliable metrics, such as cash flows and respective indicators. Researchers emphasized the advantage of analytical indicators based on cash flow [9].

Therefore, business distinctions determine the specifics of analysis. To devise techniques for the analysis (*Fig. 1*), publicly available data of the Russian companies in the analyzable sector were used, i.e. Yandex[1], Mail.Ru Group[2], International Integrated Reporting Framework[3], Sustainability Reporting Guidelines[4], WICI materials (World Intellectual Capital Initiative)[5], in particular, Guidance for Integrated Corporate Disclosure[6].

Step 1. Analysis of Corporate Competitiveness. At this step, certain aspects of strategic SPACE-analysis are conducted to evaluate the sector development indicators, external stability factors and competitive advantages of the entity. The analysis involves sectoral data and data of benchmark identical companies, which are stored in information resources, like SPARK Interfax, for instance[7].

Coefficients of variation are gauged to evaluate the stability of the environment. They are measured against absolute values of the entity, its counterparts, sectoral indicators:

$$k = \frac{\sigma}{\bar{x}},$$

where $\bar{x}$ is the expected mean of indicators;

σ is the root mean square deviation of the indicator measured with the following formula:

[1] Yandex. Disclosure. URL: https://yandex.ru/company/prospectus/ (In Russ.)

[2] Mail.Ru Group. Financial Reports. URL: https://corp.mail.ru/ru/investors/reports/

[3] International Integrated Reporting Framework. URL: http://integratedreporting.org/wp-content/uploads/2015/03/13-12-08-THE-INTERNATIONAL-IR-FRAMEWORK-2-1.pdf

[4] Sustainability Reporting Guidelines. URL: https://www.globalreporting.org/resourcelibrary/G3.1-Guidelines-Incl-Technical-Protocol.pdf

[5] WICI – the World's Business Reporting Network. URL: http://www.wici-global.com/wp-content/uploads/2012/06/Updated-Brochure-WICI.pdf

[6] Guidance for Integrated Corporate Disclosure and Company-Investor Dialogue for Collaborative Value Creation. May 29, 2017. URL: http://www.meti.go.jp/english/press/2017/pdf/0529_004b.pdf

[7] SPARK. URL: http://www.spark-interfax.ru/

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$$\sigma=\sqrt{\frac{\Sigma\left(x_n-\overline{x}\right)^2}{n-1}},$$

where x_n is the value of the indicator in the n-period of time.

The following criteria can be used to evaluate the coefficient of variation and substantiate a conclusion on the stability of the environment. Below 10% is high stability; 10–20% is the average stability of the environment; below 20% is low stability.

Relative and absolute market shares are analyzed to substantiate conclusions on competitive advantages of an entity. Growing indicators signify that the entity strengthens its market position:

$S_A = TR / TR_A$;

$S_M = TR / TR_M$,

where S_A, S_M are relative and absolute market shares of the entity respectively;

TR is revenue of the entity;

TR_A is revenue of the benchmark entity;

TR_M is market capacity.

Afterwards long-term trends in key corporate metrics are evaluated through the average exponential growth rates. In comparison with the sectoral dynamics and indicators of the benchmark entity, it allows to evaluate the competitive advantage of business:

$$r=\left(\frac{x_n}{x_0}\right)^{\frac{1}{n}}-1,$$

where x_0, x_n indicate the baseline and n-year respectively.

The entity is deemed to have any competitive advantage if it outperforms its counterparts and sector in terms of growth rates. However, considering the rapidity of changes in the environment, advantages of previous periods cannot be a precursor of the same in the future.

Long-term growth rates are mutually compared to evaluate corporate strategic performance in the long run. If revenue and proceeds grow faster than assets, this means the entity carries out investing activities and uses its assets more productively. If net cash flow from operating activity outgrows proceeds and revenue, this signifies that expenditures and working capital are managed effectively in the analyzable period.

The first step reveals the stability level of the business environment, strategic effectiveness of the entity and its competitive advantage, if any.

Step 2. Risk Assessment in Entities Operating in the Digital Economy. Assessing the risk, it is important to remember that some risks are common no matter which sector an entity operates in [10], while the other are specific to a certain sector. The first group refers to risks associated with key stakeholders and capital they provide:

- controlling shareholders and top executives contribute to the organizational wealth meaning the knowledge of systems, procedures and protocols[8]. They are exposed to strategic risk and abuse risk[9];
- shareholders and creditors provide financial capital triggering liquidity risks[10], currency risk, interest rate risk, risk of limited access to capital;
- buyers generate the social and reputation capital, its market component, which relates to the reputational, market and credit risks;
- competitors and business partners create the social and reputation capital from perspectives of the market. Their actions may raise business and market risks;
- the State and the public create the social and reputation capital from social perspectives. They inflict country and regional risks, legal risk, social license risk.

Specific risks of entities operating in the information economy mainly affect those types of capital, which are fundamental for them, i.e. intellectual and reputation capital. What distinguishes these types of capital is that they proceed from a wide array of stakeholders, including external ones, i.e. consumers, business partners, society, governmental authorities, and

[8] International Integrated Reporting Framework. URL: http://integratedreporting.org/wp-content/uploads/2015/03/13-12-08-THE-INTERNATIONAL-IR-FRAMEWORK-2-1.pdf

[9] Pronouncement of the RF Ministry of Finance № ПЗ-11/2013 *Setting Up and Implementing the Internal Control by the Business Entity over Business Facts, Accounting and Financial Reporting*.

[10] Pronouncement of the RF Ministry of Finance № ПЗ-9/2012 *On Disclosure on Business Risks in Annual Financial Statements*.

internal ones, i.e. shareholders, managers, personnel (suppliers of intellectual capital). Hence the risks are linked with the types of capital, rather than with stakeholders.

Intellectual capital, including the digital one, is exposed to risks below [11]:

- risk of innovation generation and acquisition;
- risk of key management, personnel who are capable of generating innovation, inability to recruit innovating talent;
- risk of Internet infrastructure accessibility, development and servicing;
- risk of intellectual capital value;
- risk of intellectual property protection.

The social and reputation capital is exposed to the following risks:

- risk of brand value, inability to maintain and improve the brand;
- reputational risk in relation to a wide array of shareholders;
- risk associated with cybercrime affecting the corporate image, risk of unauthorized use of intellectual property and consumers' personal data.

The analysis thus assesses and evaluates risks of the analyzable entity and determines the efficiency of the methods to manage them.

Step 3. Intellectual Capital Analysis. *Fig. 2* depicts components of intellectual capital pertaining to the digital economy's companies. As the intellectual capital quickly lose value, innovation generation indicators become instrumental for analyzing it since innovation creates and stimulates the organizational wealth.

The analysis of the organizational wealth, which is included into the intellectual capital of the digital economy's capital, is subdivided into following interim steps:

- analysis of the innovation generation system, i.e. methods for acquiring, creating, procuring from third parties or borrowing innovation. Depending on the methods, there exist innovation generating companies, which create innovation on their own; directing companies, which order R&D from other parties; replicating companies, which copy innovation; companies acquiring innovative businesses;
- analysis of uncontrolled knowledge transformation methods. Depending on the type of knowledge, there exist codification methods based on the wide use of IT, and personalization of knowledge, which underlie the knowledge that is hard to codify.

Being the second component of intellectual capital, intellectual property is analyzed as follows:

- analysis of the composition and value of available intellectual property items. In case of the analyzable sector, software and databases are concerned;
- analysis of R&D expenditures by segment, estimation of innovation acquisition costs and their effectiveness;
- analysis of movements and condition of intellectual property items, which involves how often items are purchased and disposed of, their wear and tear measured by value indicators;
- analysis of a percentage of innovative products (services) within corporate revenue.

Reliable information on intellectual property items is crucial for purposes of intellectual property analysis. The rapidly growing blockchain technology will help solve this issue in the future. Being a tool to store transaction details, databases as publicly available blocks of information, this technology enables users to do the following [8]:

- confirm the title for intellectual property items;
- register intellectual property items (services of virtual notaries public);
- protect intellectual property items;
- make standardized transactions with intellectual property.

According to some researchers, M. Swan, for instance [8], the blockchain technology will dramatically change the relationship among agents interact, management of intellectual property item, access to them and entitlement for them.

Currently, entities are unable to create innovation internally using only their own resources. They need to share knowledge and attract new talent and knowledge

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all the time. Ongoing staff rotation, recruitment of new talent, who possess new knowledge and ideas, signal *inter alia* the ability to generate intellectual capital. The processes are gauged with the number of open vacancies. Rates of staff recruitment, attrition and turnover, which includes those employees who quit due to undesirable reasons, i.e. voluntary quitting or labor misconduct, unlike the attrition. High turnover against low attrition rates signifies an influx of new knowledge to the entity.

At this step of analysis, intellectual capital is assessed and evaluated, with the efficiency of this capital generation processes being reviewed as well.

Step 4. Analysis of Social and Reputation Capital. *Fig. 3* displays components of the social and reputation capital and estimates. Key aspects of the social and reputation capital analysis concern the corporate reputation among a wide array of stakeholders, methods to communicate with them so as to pump new knowledge and ideas into the entity, and investments the entity makes in its brand and stakeholders' loyalty[11]. Gleaning the outer exuberance and converting it into the intrinsic value, as experts put it, interfaces become a key communication channel with external stakeholders [2].

What really matters to form and develop the social and reputation capital is create the open environment based on transparency and trust [2], which is difficult to evaluate through published reports. As its crucial aspect with respect to the social and reputation capital, the analysis applies to the brand, its value indicators, trademarks, applications for trademarks, their quality and quantity, including the extent to which they influence the entity's competitive advantage, market position and barriers for other entities.

It is also important to consider factors eroding stakeholders' confidence. These issues were studied by A. Zaman [12]. In case of the analyzable sector, various types of the social and reputation capital are affected by the following factors:

1) factors destroying the capital in relationship with consumers:

- non-existent innovation;
- brand failure, negative feedback, negative publicity;
- inadequacy of the system, communication with consumers;
- ineffective interface;
- insufficient qualification of personnel and inappropriate servicing;

2) factors destroying the capital in relationship with the society:

- difficulties in regulatory compliance;
- difficulties in data protection;
- violation of the code of ethics;

3) factors destroying the capital in relationship with the personnel and shareholders:

- violation of the minority shareholders' rights;
- implementation of the personalized policy;
- non-transparent activity, dual standards of corporate policy, mismatch of the management's actions and corporate values;
- financial losses and fraud.

This step of the social and reputation analysis identifies its quality, quantity and factors for its creation and destruction.

Step 5. Analysis of Cash Flows as Part of the Stakeholder Approach. As mentioned above, cash flows of the digital economy's businesses lay the reliable financial basis to estimate analytical indicators, such as:

- corporate solvency and liquidity;
- allocation of value created;
- effectiveness and intensity of investing activity;
- intrinsic value.

Assessing the liquidity and solvency, it is necessary to consider the following aspects. Reducing working capital and inaccurate estimates of balance sheet items distorts liquidity indicators assessed through the balance sheet. High liquidity indicators can be regarded as inefficient management of working capital. Furthermore, as estimated value of total assets is volatile and inaccurate, traditional metrics of capital structure and equity-to-asset ratio, in particular,

[11] Guidance for Integrated Corporate Disclosure and Company-Investor Dialogue for Collaborative Value Creation. May 29, 2017. URL: http://www.meti.go.jp/english/press/2017/pdf/0529_004b.pdf

financial sustainability become irrelevant. Cash-flow-based indicators and liabilities seem to be more reliable. First of all, it is worth mentioning the Beaver ratio measured as net cash flow from operating activity to total liabilities. It reflects the financial coverage of the debt:

$k_B = NCF_O / L$,

where NCF_O is net cash flow from operating activity;

L is total liabilities.

$k_D = NCF_O / CL$,

where CL stands for current liabilities.

Similar principles underlie coverage ratios, which give a good view of corporate financial sustainability. For example, interest coverage ratio shows to what extent cash flow from operating activity exceeds interests paid:

$k_I = CF_O / FC$,

where CF_O is cash flow from operating activity before interest and taxes;

FC refers to interests paid.

As part of the stakeholder approach, it is critical to evaluate the way cash flows are distributed among stakeholders. To do so, as part of the resource-based approach, resource intensity of cash flows is determined as the ratio of payments to stakeholders for resources to total proceeds. The algorithm is compliant with Sustainability Reporting Guidelines[12], which is to be followed to study the economic value. As part of the analysis, the following payments are examined:

- payroll payments;
- payments to providers of intangible assets;
- payments to owners of companies upon acquisition of control over them;
- payment to providers of productive capital items;
- taxes and social security charges to governmental authorities social security funds;
- dividends to shareholders and payments for shares purchased;
- principal and interests paid to creditors;
- payments for social programs and charity to public organizations.

Resource intensity is measured with the formula, the denominator of which makes an amount of cash flows from all types of activity and opening balance of cash and cash equivalents:

$RI_i = P_i / R$,

where P_i refers to payments made in favor of the i-group of stakeholders;

R represents total cash flows from operating, investing and financial activity and opening balance of cash.

Unlike those resource intensity indicators presented in proceedings by O.V. Efimova [13], N.P. Lyubushin [14] and measured as the ratio of expenses to revenue, I suggest calculating the same on the basis of cash flows. The algorithm allows to assess the resource intensity with respect to payments as part of investing and financial activity, while computations based on expenditures focus on operating activity only.

At this step of the analysis, computations reveal corporate financial sustainability and its major stakeholders, who are beneficiaries in such cases.

Step 6. Evaluation of Investing Activity. Considering the rapid pace of changes in the economy, there should be a continuous flow of innovation and investment, which is a cornerstone for business survival and development. Hence it is crucial to evaluate the investing activity of the company as part of its financial analysis.

The mix of investments is suggested to be evaluated through a percentage of payments made to providers of intangible assets, owners of companies once control over them is assumed, providers of productive capital items. Investment in intangible types of capital turns to be most difficult since it is often attributed to current expenses. As the WICI experts note, businesses' inability to recognize and assess investment in intangible assets impedes the effective allocation of resources[13].

The ratio of negative net cash flow from investing activity to cash flow from operating one shall be analyzed to evaluate the former. The 20-percent ratio

[12] Sustainability Reporting Guidelines.
URL: https://www.globalreporting.org/resourcelibrary/G3.1-Guidelines-Incl-Technical-Protocol.pdf

[13] Guidance for Integrated Corporate Disclosure and Company-Investor Dialogue for Collaborative Value Creation. May 29, 2017.
URL: http://www.meti.go.jp/english/press/2017/pdf/0529_004b.pdf

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means highly intensive investing activity. It is also important to compare net cash flow from operating, investing and financial activities. If business is effective, carrying out the sustainable investing activity, there should be an equilibrium among the three types of activities, given the balance of cash remains unchanged. This is due to the fact that the negative balance of investing activity is financed with the positive balance from operating and current activities:

$NCF_I = NCF_O + NCF_F$,

where NCF_I, NCF_O, NCF_F stand for net cash flow from investing, operating and financial activities respectively.

The modified internal rate of return is suggested to be used in order to assess the effectiveness of investing activity. As part of this approach, the entity is viewed as a portfolio of investment projects, with the computation being based on cash flow indicators. Net cash flow from operating activity is regarded as the result of investment, while net cash flow from investing activity is considered as investment. The following formula is used:

$$MIRR = \left(\frac{\sum_{i=1}^{I} CFBI_{Oi} (1+r)^{I-i}}{NCF_{Ii} (1+d)^{-i}} \right)^{\frac{1}{I-1}} - 1$$

where $CFBI_{Oi}$ is net cash flow from operating activity before interests in the *i*-year;

NCF_{Ii} is net cash flow from investing activity in the *i*-year;

r is a reinvestment rate;

d is a discount rate.

This indicator can be construed as the return on invested capital for the past period of time (4 to 5 years). The calculation algorithm is appropriate in case of cash flow from the return on investment *CFROI*, however it still differs in a way. For example, the initial amount of investment is not assessed to modify the internal rate of return, but cash flow from investment is measured. The following difficulties arise from evaluating the efficiency of investment in intangible types of capital:

- difficulty in segregating cash flows from operating and investment activity. For example, investment in the intellectual capital and social and reputation capital is often recognized as current expenses. However, the combination of the cash flows will not distort the result if the modified internal rate of return is applied;
- difficulty in substantiating the discount rate and reinvestment rate. The discount rate shall mean weighted average cost of capital for the previous accounting period. The reinvestment rate shall be understood as weighted average cost of capital since the return on investment is impossible to be correctly assessed due to volatility of the cost of invested capital.

This step of the analysis makes a breakdown of investment and characterizes the intensity and effectiveness of investing activity for the analyzable period.

Step 7. Analysis of Value Drivers and Estimation of Intrinsic Value. Generated by key types of capital, such as organizational wealth, intellectual property, social and reputation capital, the respective factors are of the highest significance for the value of companies operating in the quarternary sector of the economy.

Please find below value drivers generated by organizational wealth:

- increasing rapidity of data processing and transfer, incentives for innovation acquisition, creation of intellectual property through ongoing market monitoring and identification of emerging innovation;
- increased efficiency of technology for knowledge codification and creation of intellectual property;
- more robust technologies for data personalization and creation of the social and reputation capital.

Intellectual property is a pipeline of Science & Technology rent:

- by infusing more innovation of products and services, generating new services, expanding their portfolio, improving the market appeal, quality, competitiveness;
- by increasing sales volume and market share through sustainable technologies and better use of assets;
- by reducing the resource intensity of products and production costs as a result of sustainable technologies.

The corporate component of the social and reputation capital influences the intrinsic value since it helps in the following tasks:

- it creates the corporate environment encouraging the staff for new innovation;
- it constantly attracts new talent, various stakeholders who stream innovation into the business.

The market component of the social and reputation capital is intended for:

- benchmarking, search for new ideas in the market, outsourcing of ideas;
- raising consumer loyalty, making sales less volatile;
- fueling innovation through an exchange of information with counterparts.

The social component of the social and reputation capital is designated to:

- ensure accessibility, development and maintenance of the Internet infrastructure;
- involve public and social institutions to support business development.

As a conclusion, it is reasonable to evaluate the intrinsic value of the entity (its invested capital) through cash flows:

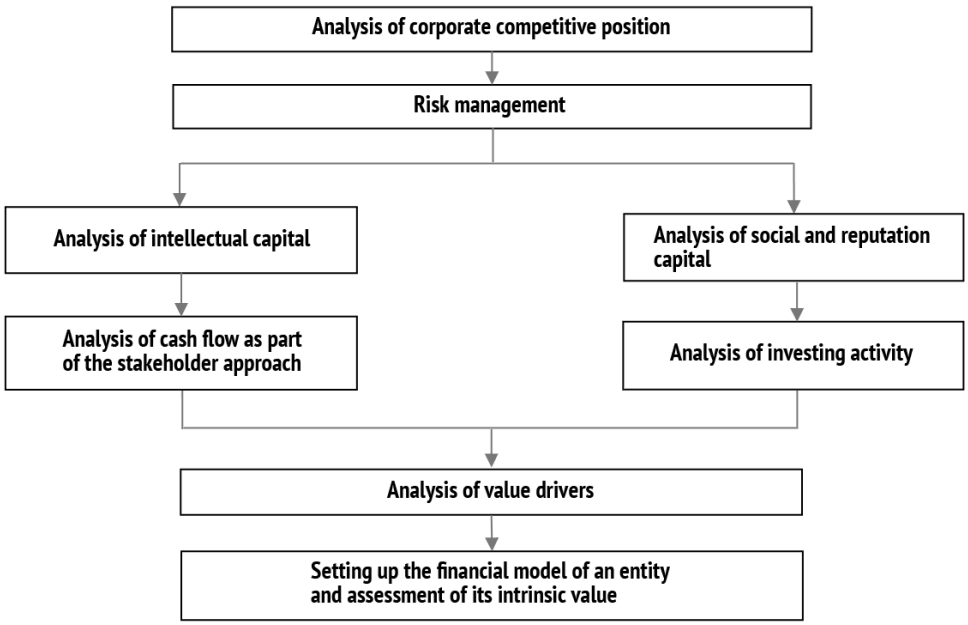
$$V_{IC} = \frac{(CFBI_O - NCF_I)(1+g)}{d-g},$$

where g is sustainable growth.

This formula embodies the fact that the intrinsic value is measured as an excess of the entity's cash flow from operating activity over that from investing one, possibilities for its growth, and discount rate.

The stakeholder approach becomes a cornerstone for evaluating the performance of entities in the digital economy. It is crucial to analyze intellectual capital and social and reputation capital and evaluate the investing activity. The framework for financial data relies upon cash flows, which determine the effectiveness of operating activity, intensity and efficiency of investing activity, ability to perform financial obligations. At this step, the intrinsic value is assessed, thus shedding light onto the current position of business and look into its future.

Figure 1
The scheme for analyzing the digital economy's entities



Source: Authoring
Figure 2

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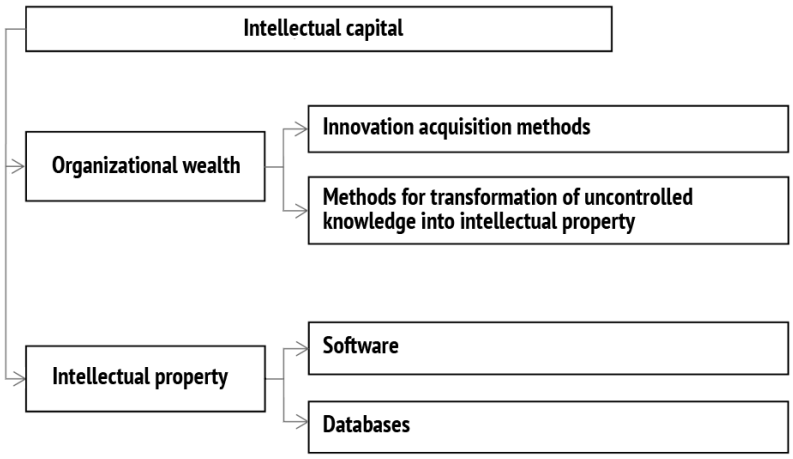
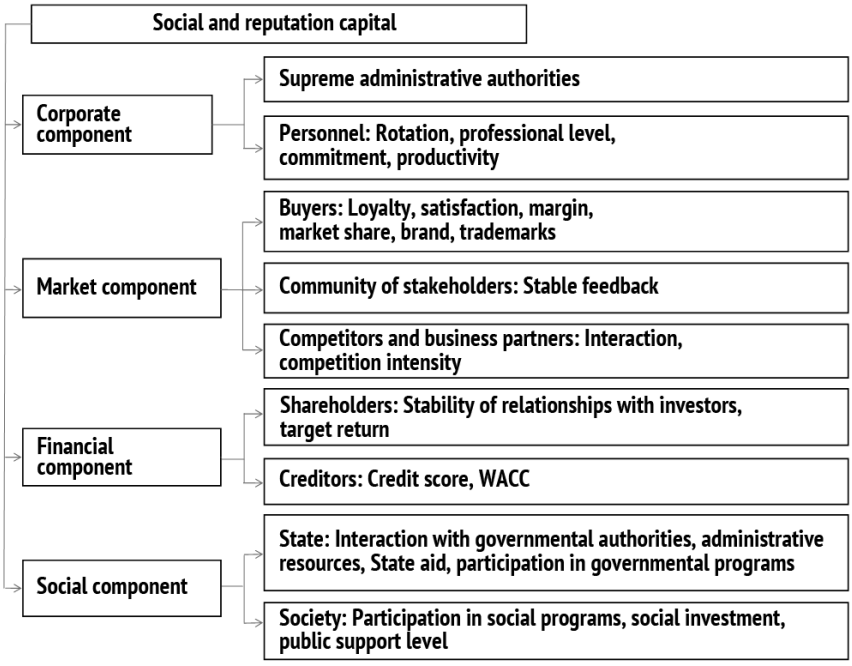
Components of intellectual capital



Source: Authoring

Figure 3
Components of social and reputation capital



Source: Authoring

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Conflict-of-interest notification

I, the author of this article, bindingly and explicitly declare of the partial and total lack of actual or potential conflict of interest with any other third party whatsoever, which may arise as a result of the publication of this article. This statement relates to the study, data collection and interpretation, writing and preparation of the article, and the decision to submit the manuscript for publication.

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Risk, Analysis and Evaluation

Translated Article†

MODELING THE EFFICIENCY OF THE STATE AID TO THE DEVELOPMENT OF ELECTRIC VEHICLES

Valerii V. IOSIFOV
Kuban State Technological University, Krasnodar, Russian Federation
iosifov_v@mail.ru

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Abstract
Importance This paper deals with the efficiency of governmental incentives to the market of electric vehicles.
Objectives The paper aims to quantify different governmental incentives through modeling.
Methods The study applies a correlation-regression analysis, test for equality of means for two independent samples, and the Mann-Whitney test.
Results The paper provides models of paired linear regression to describe how governmental subsidies for purchase of electric vehicles (EV) and EV charging infrastructure level influence the EV market volume. Based on the test for equality of means, I found out that preferential parking rates, access to public transport lanes and restricted driving zones, tax credits on EV purchase and preferential electric power supply tariff have no statistically significant impact on the annual EV market volume and EV dissemination. The results were verified through the Mann–Whitney test.
Conclusions and Relevance The received models can be used to forecast parameters of the Russian EV market provided that some governmental incentives are in place.

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Introduction

Automotive industry is an important link in the global economic architecture. It contributes about 10 percent to GDP of developed countries (Japan) and creates from one tenth (EU countries) to one sixth (USA) of the total workplaces in the overall industry. Automotive engineering consumes about a half of total oil produced worldwide, over one forth of manufactured glass, generating substantial multiplicative effects [1].

In Russia, the motor vehicle market accounts for 1.5 percent of GDP so far, including dealership and services, and employs 1.4 million people, with the share of the automotive industry not exceeding 0.5 percent of GDP.

However, demand for automotive products generates the need in high-tech products manufactured in the chemical, metallurgical, electrotechnical and other industries, thus providing jobs to over 3.5 million people[1] Therefore, the State supports the automotive industry development as one of its priorities.

During the crisis periods of 2008–2009 and 2015–2016, the governmental policy lured automotive

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[1] *Tendentsii razvitiya avtomobil'noi promyshlennosti, resul'taty 2014–2015 godov i srednesrochnye perspektivy razvitiya otrasli* [Trends in the automotive industry development. The 2014–2015 results and mid-term prospects of the industry development]. Moscow, Ministry of Economic Development of the Russian Federation, 2016.

manufacturers to localize their production, and directly backed demand. During the 2008–2010 and 2016 periods, the automotive industry received USD 130 billion and USD 113 billion in financial aid for crisis management purposes.

However, despite such considerable allotments from the budget, imported components still have a 72-percent share in automotive production costs, while production output and sales going down annually. Idle production capacities affected financial results of enterprises as their net loss reached RUB 102.3 billion in 2015.

Considering the maturity of global automotive market, the Russian enterprises have little opportunity to increment the production of conventional motor vehicles since similar products of leading manufacturers outperform it technologically and economically. Breakthrough technologies seem to be one of the promising and realistic areas for the State to support the automotive industry since they are intended to address old structural issues of the industry. Such technologies, first of all, include electric vehicle technology, automated driving systems.

Currently, leading car manufacturers actively develop electric and hybrid car programs (*Fig. 1*) and intellectual car driving systems. If the latter of the technological advancements is in limited use only (mainly in artificial driving scenarios), the first one has already passed the industrial probation.

The global market of electric cars has been rapidly growing for the recent decade, being spurred by various measures of the State aid. Many Russian [2–4] and foreign [5–10] economists delve into the efficiency of such measures. However, governmental incentives have not been quantified yet due to limited statistical data, which the new electric vehicle market has not accumulated sufficiently.

This research aims to construct econometric models to evaluate and forecast quantitative effects of various governmental incentives to electric vehicles.

The pool of information comprises analytical materials of the International Energy Agency (IEA)[2], national and regional programs for electric vehicles development in the USA, Japan, France and China [11][3].

Analysis of Global Incentives Stimulating Demand for High-Tech Products

The same principles govern States in supporting the automotive industry likewise the other innovative sectors of economy (for example, renewable energy[4]). They can be conditionally divided into measures supporting R&D, production and demand for innovative technology.

Whereas the automotive industry is a mature sector of economy, in the majority of developed countries R&D and production development are within the competence of the profit-making segment of national innovative systems [14].

Leading global auto groups make huge financial injections into R&D every year, being innovative drivers of their national economies (*Fig. 2* and *3*). For instance, Volkswagen takes the lead among 2,500 global companies benchmarked by their R&D investment (Industrial R&D Investment Scoreboard).

Maintaining demand for such auto groups' products, countries follow different strategies by supporting export and conquering foreign markets, fueling the race of standards (for example, environmental footprint) and making public procurement [2, 15].

The research referred to herein gives a detailed view of the best-in-class experience in electric vehicles support and development [2]. The scholars highlight financial support measures and various types of non-financial benefits (operational preferences), which car owners may enjoy in various countries.

I analyzed how frequently States resort to various types of governmental incentives to develop the uptake of electric vehicles. As the analysis shows, countries tend

[2] Global EV Outlook 2016. Beyond One Million Electric Cars. Paris, International Energy Agency, 2016, 51 p. URL: https://www.iea.org/publications/freepublications/publication/Global_EV_Outlook_2016.pdf; IEA. Energy Technology Perspectives. Paris, International Energy Agency, 2016.

[3] Paris Declaration on Electro-Mobility and Climate Change and Call to Action. Paris, UNFCCC, 2015. URL: http://www.iea.org/media/topics/transport/pariselectromobilitydeclaration.pdf; Compilation of the Road Map for EVs and PHVs toward the Dissemination of Electric Vehicles and Plug-in Hybrid Vehicles. Ministry of Economy, Trade and Industry, 2016. URL: http://www.meti.go.jp/english/press/2016/0323_01.html

[4] International Tax Incentives for Renewable Energy: Lessons for Public Policy. San Francisco, Center for Resource Solutions, 2005, 27 p. URL: http://dx.doi.org/10.15405/epsbs.2017.01.69

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to preferential parking rates, tax benefits for motor vehicle operation (for example, road tax), full or partial sales tax exemption and direct governmental subsidies to reimburse some costs for purchase of an electric vehicle.

As for the amount of subsidies and benefits, they considerably vary and sometimes account for 49 percent of the initial market price of an electric car (*Table 1*).

Furthermore, electric vehicle charging infrastructure is a crucial and expensive part of the State support to electric vehicle development. The EV charging infrastructure is more often than not formed and developed through the Public Private Partnership mechanism [2].

It is noticeable that demand for electric vehicles is institutionally supported not only in the countries where such vehicles are manufactured (USA, China, Japan, Germany), but also in those ones, which do not yet have EV producing enterprises (Denmark, Norway). Therefore, I did not find an empirical corroboration of the opinion circulating in the literature (for example, in researchers referred herein [2, 16–18][5]) stating that national governments support the electric vehicle development with the intention of taking the global technological lead in this area.

Modeling the Impact of Various Governmental Support Measures on the Electric Vehicle Market Indicators

To construct econometric models reflecting what impact the governmental support measures have on electric vehicles, I rely upon annual reports on the Technology Collaboration Programme on Hybrid and Electric Vehicles of IEA[6] for 2014–2015 and analytical overview of the global electric vehicle market[7].

As the first step, I conducted an investigative correlation analysis in order to trace the closest statistical relationships between quantitative variables, which reflect the situation in the most advanced national markets of electric vehicles, and governmental incentives (*Table 2*).

Afterwards I forge four models of paired linear regressions for those variables that reveal the closest correlation.

Please find below the model showing the way one-off subsidy for electric vehicle purchase influences the market volume:

$$Y = 0.017X, \quad (1)$$

where Y stands for the market volume for the year (pcs);

X is an amount of subsidies (EUR).

If viewed through F-test, the model is statistically meaningful for the level $p = 0.001$. Standard error of regression coefficient is 0.0025, coefficient of model determination $R^2 = 85\%$ (high explanatory level).

Reflecting the impact of the EV charging infrastructure level on the market volume and being built on the U.S. data, Model 1 is expressed as follows:

$$Y(t) = 38.39X(t - 1) + 30{,}559.82, \quad (2)$$

where $Y(t)$ is annual market volume within the t-period (pcs);

$X(t - 1)$ is the number of fast charge devices within the period $t - 1$.

If assessed through F-test, the model appears to be statistically meaningful at the level $p = 0.01$. By t-test, the regression coefficient is of statistical value at the level $p = 0.01$, while the model intercept behaves so at the level $p = 0.05$. Standard error of the regression coefficient and intercept is 5.22 and 10,798.88 respectively. The coefficient of R^2 model coefficient equals 93 percent (high explanatory level).

Reflecting the impact of the EV charging infrastructure level on the market volume and being based on the U.S. data, Model 2 is expressed as follows:

$$Y(t) = 4.8X(t - 1) + 30{,}564.59, \quad (3)$$

where $X(t - 1)$ is the number of slow charge devices within the period $t - 1$.

[5] Smil V. [All Cars will be electric cars in the near future]. *Glavnyi mekhanik = Chief Mechanic*, 2011, no. 3, pp. 30–32. (In Russ,); Technology Collaboration Programme on Hybrid and Electric Vehicles (HEV TCP). Hybrid and Electric Vehicles. The Electric Drive Chauffeurs. Annual Report Prepared by the Executive Committee and Task 1 over the Year. Paris, IEA, 2016–2017, 378 p.

[6] HEV TCP Annual Report over 2016: The Electric Drive Chauffeurs. URL: http://www.ieahev.org/news/annual-reports

[7] Global EV Outlook 2016. Beyond One Million Electric Cars. Paris, IEA, 2016, 51 p.
URL: https://www.iea.org/publications/freepublications/publication/Global_EV_Outlook_2016.pdf

If assessed through *F*-test, the model is of statistical value at the level p = 0.01. By *t*-test, the regression coefficient is statistically meaningful at the level p = 0.01, while the intercept of the model behaves so at the level p = 0.05. Standard error of the regression coefficient and intercept is 0.67 and 10,805.98 respectively. The coefficient of Model 2 determination equals that of Model 1, i.e. 93 percent (high explanatory level of dependent variable).

Reflecting how publicly subsidized cost of electric vehicle influences the uptake of electric vehicles, the model is expressed as follows:

$$Y = 0.265X, \quad (4)$$

where Y is the uptake of electric vehicles (percentage of all operational electric vehicles);

X is percentage of electric vehicle cost subsidized.

If assessed through *F*-test, the model appears to be statistically meaningful at the level p = 0.005. By t-test, the regression coefficient is of statistical value at the level p = 0.005. standard error of the regression coefficient is 0.073. The coefficient of determination is 55 percent (medium explanatory level of dependent variable).

To check the impact of other governmental incentives, other than quantitative one (parking benefits, access to public transport lanes, restricted driving zones, preferential electric power supply tariffs and tax credits), I carried out a series of tests for equality of means and Mann–Whitney *U* tests (the latter is advisable if analyzable samples are not that ample [19]). *Table 3* presents results of both tests performed using STATISTICA 10.0 software package.

As the test statistics show, none of the analyzable factors has a statistically meaningful impact on the electric vehicle market indicators (uptake level and market volume). However, it would be erroneous to report that these governmental incentives are ineffective. The governmental incentives are likely to be effective but if they are complemented with more powerful factors, such as subsidizing some part of market value of an electric vehicle and EV charging infrastructure development.

Conclusions

Reflecting how financial aid influences indicators of national EV markets, the proposed models can be used to forecast the development of the EV market in Russia under certain circumstances (some incentives in place) and decide on those types of incentives which are believed to generate the greatest effect per unit of investment.

Furthermore, the models may help assess how much investment is needed to deploy the EV charging infrastructure and reach certain benchmarks of the national EV market.

It is noteworthy that the proposed models can (and should) be adjusted and get more sophisticated as new statistical data are collected. For example, they might include several regressors instead of one to explain the dependent variable. Presented in the formulas (1)–(4), they give just a general outlook of the most common and explicit patterns in the global EV market development. They are not yet configured to some country distinctions, such as the level and dynamics of the vehicle-to-population ratio, cost of conventional fuel (petrol, gas) and electric power tariffs, stringency of local environmental laws, etc. My further research will be dedicated to elaborating the proposed approach by collecting and analyzing new statistical data.

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Table 1
State subsidy assistance for purchasing and operating an electric vehicle in different countries

Country	Percentage of subsidies of the total price	Subsidies (total amount), EUR	One-off subsidy for EV purchase
South Korea	30	19,888	13,488
Denmark	49	19,466	19,466
Norway	45	15,907	14,113
China	23	14,469	14,469
USA	18	9,319	6,989
Spain	3	6,412	5,500
France	18	6,300	6,300
Netherlands	17	6,188	3,380
United Kingdom	15	5,508	5,298
Japan	10	4,369	4,369
Germany	13	4,360	4,000
Sweden	12	4,156	4,156
Switzerland	5	1,670	1,262
Portugal	2	925	331
Italy	0	94	94

Source: Authoring based on [22]

Table 2
Results of correlation analysis of the dependence of the EV market indicators on the State support

Indicator	Share of subsidy in the value	Total subsidies	One-off subsidy for EV purchase	Infrastructure level	Uptake of electric vehicles	Market volume
Share of subsidy in the value	1	–	–	–	–	–
Total subsidies	0.75	1	–	–	–	–
One-off subsidy for EV purchase	0.7	0.96	1	–	–	–
Infrastructure level	0.77	0.89	0.84	1	–	–
Uptake of electric vehicles	0.71	0.35	0.38	0.07	1	–
Market volume	0.7	0.84	0.85	0.95	–0.01	1

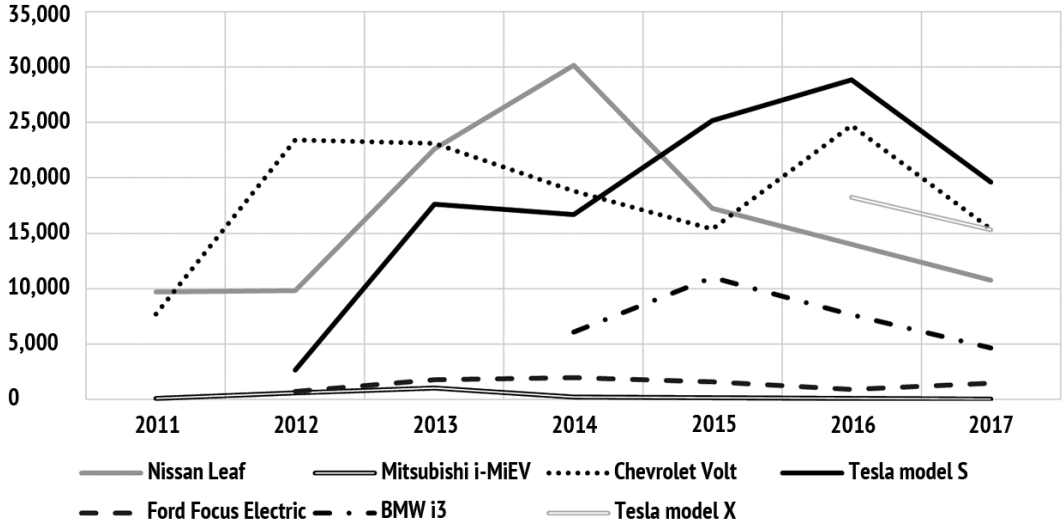
Source: Authoring

Table 3
Results of the tests for equality of means and Mann–Whitney tests

Dependent variable	Grouping variable (factor) (0 – No, 1 – Yes)	*T*-test in the test for equality of means	*p*-level of *t*-test	*Z* of the Mann – Whitney test	*p*-level of *Z*-test
Uptake of electric vehicles	Parking preferences	−0.16	0.87	0.94	0.34
	Access to public transport lanes	1.13	0.28	1.22	0.22
	Preferential electric power tariff	−0.67	0.51	−0.26	0.79
	Tax credit	0.29	0.77	−1.16	0.24
Market volume in 2015	Parking preferences	0.34	0.75	0	1
	Access to public transport lanes	0.29	0.22	1.54	0.12
	Preferential electric power tariff	1.3	0.22	0.56	0.57
	Tax credit	0.35	0.73	−0.64	0.52

Source: Authoring

Figure 1
Trends in the distribution of the leading electric vehicle brands in the U.S. market, 2011–2017, pcs



Source : Authoring based on the Inside EVs website data. URL: https://insideevs.com

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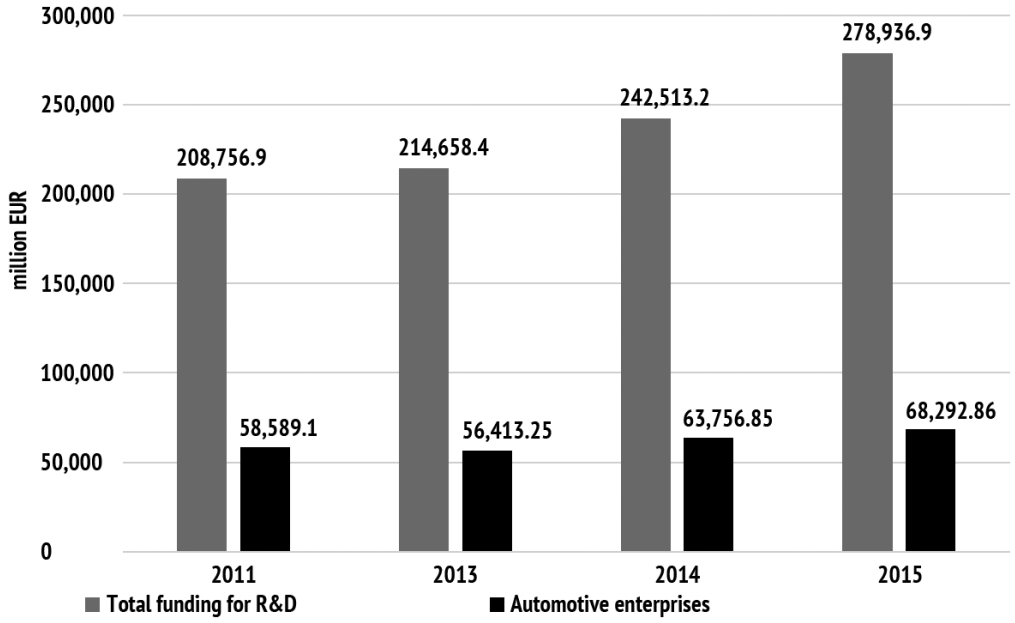
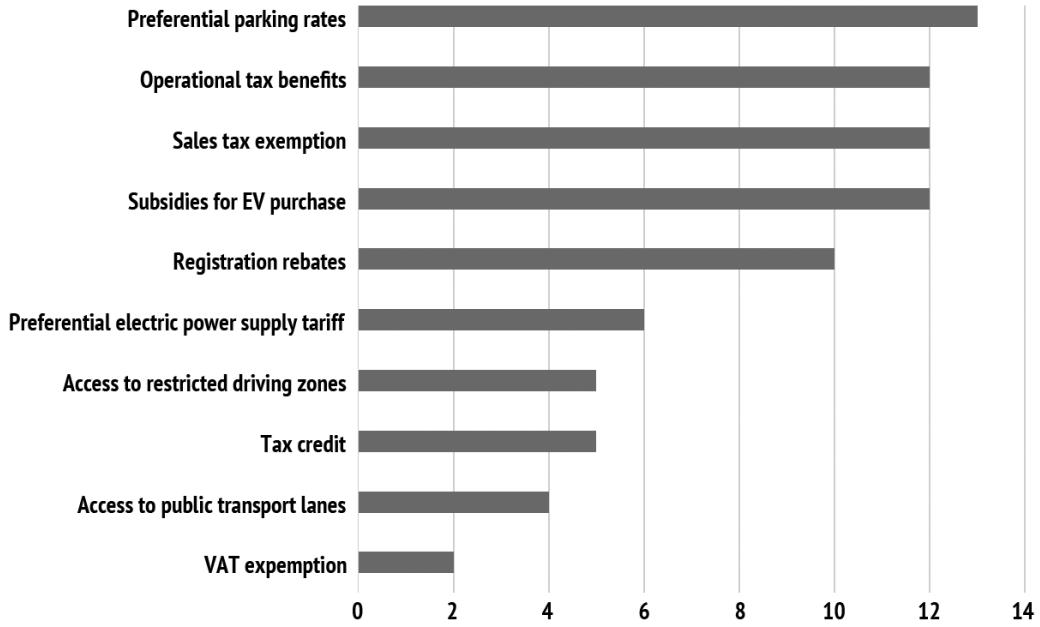
Figure 2
The share of automotive companies in total funding for R&D of companies on the Top-50 World Industrial R&D Scoreboard, 2012–2015



Source: Authoring based on the European Commission Joint Research Center data. URL: http://iri.jrc.ec.europa.eu

Figure 3
Frequency distribution of various governmental incentives for electric transport development



Source: Authoring based on [2]

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Conflict-of-interest notification

I, the author of this article, bindingly and explicitly declare of the partial and total lack of actual or potential conflict of interest with any other third party whatsoever, which may arise as a result of the publication of this article. This statement relates to the study, data collection and interpretation, writing and preparation of the article, and the decision to submit the manuscript for publication.

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Risk, Analysis and Evaluation

Translated Article†

ASSESSMENT OF INVESTMENT PROJECT RISKS IN AVIATION

Aleksandr M. BAT'KOVSKII
Moscow Aviation Institute (National Research University) (MAI), Moscow, Russian Federation
batkovsky@yandex.ru
Corresponding author

Vladislav V. KLOCHKOV
National Research Center Zhukovsky Institute, Moscow, Russian Federation
vlad_klochkov@mail.ru

Evgenii Yu. KHRUSTALEV
Central Economics and Mathematics Institute (CEMI), Russian Academy of Sciences,
Moscow, Russian Federation
stalev777@yandex.ru

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Abstract

Importance Investment projects for developing the productive potential of aviation enterprises have a protracted period of equity divestment. Throughout the period, the projected conditions may change. To adapt to such unpredictable developments, enterprises have to incur significant financial costs, thus causing unrecoverable losses. Therefore, many projects at the investment stage are exposed to material risk.

Objectives We devise a new approach to evaluating whether the productive potential of the Russian aviation industry is effectively developed. Throughout the implementation period, there come out different estimates of the demand, cost, and new technologies. Managing the implementation of protracted investment projects requires a toolkit for applying the real options approach.

Methods The research relies upon methods of logic and statistical analysis, and mathematical modeling in economics.

Results We propose a new classification of possible changes in the investment project environment. We analyzed losses by project implementation scenario at different stages. The research also considers the specifics of the aviation industry and analyzes how the technological level of production influences respective risks.

Conclusions and Relevance We assessed the effectiveness of the productive potential development in the Russian aviation industry. It would be reasonable to consider our estimates to analyze the effectiveness of adaptive management of protracted investment projects for the productive potential development. The estimates may help identify the most material risks at different stages of such projects. We also provide our recommendations for optimizing the management of such risks.

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Projects for productive capacity construction (rehabilitation) account for the main part of investment projects aviation enterprises implement. They usually take a long period of time, which may see some changes influencing the cost effectiveness of the constructed capacity. Notwithstanding this fact, while implementing investing projects, aviation enterprises and their regulators, first of all, control whether expenditures have been reasonably incurred, whereas they should better analyze their decisions on allocation of funding and its purposes.

The existing governance system for aviation enterprises fails to provide for evaluation of project marketing prospects in line with changed in the market situation, technology, foreign exchange rates, etc. This seriously affects the effectiveness of corporate potential development management. Due to the above circumstances, enterprises incur losses in an unstable business environment, when developing the pool of their tangible resources. It is reasonable to apply methodological approaches and tools offered by the real options theory to address the issues as part of corporate potential management [1, 2].

As set forth in the National Program of the Russian Federation, *Development of the Aviation Industry for 2013–2025*, the aviation industry experiences a large scale retrofitting process that requires substantial capital expenditures. Considering limited equity of enterprises, national budget (which happened to entail the adjustment of the national program and sequestration of planned investments), weakening Russian ruble, which additionally causes a reduction in procurement of expensive production equipment imported into Russia, it is sensible to focus on the quality in substantiating investment decisions and analyzing inherent risks.

Some researches [3] justify that discrete project finance is reasonable, notwithstanding high risk exposure. Under such financial schemes, funds are earmarked for certain phases of high risk projects after the previous phase is accomplished with reference to forecasts of the future market conditions for such protracted projects [4]. Some Russian and foreign researchers [5–8] review what specifically distinguishes the evaluation of investment projects implying some elements of options. Project risks are different throughout project phases, indeed [9].

Analyzing whether aviation enterprises' potential development is managed effectively, it is necessary to consider their distinctive features. In this research we do not refer to models and formulas for real options assessment that arise from the flexible management of investment projects. In the mean time, drawing upon quantitative assessments of risks arising at different phases of projects, we can build such models on assumptions about properties of random processes transforming the project environment.

Should the planned product mix be modified, productive capacity needs to be adapted to the quantity of products. Likewise if requirements to the future products are adjusted and predicted prices for necessary resources are specified, productive capacity shall be reconfigured in terms of quality[1][10].

Investment projects for productive capacity construction (rehabilitation) in aviation contain all typical phases of their performance, i.e. Research and Development (R&D), construction and mounting, testing and commissioning. It is advisable to combine all the phases to reduce the lead time of investment projects. However, the existing fiscal rules often prohibit to do so since financial control of expenditures shall be tightened. As a result, stringent control often has side effects. For example, losses since phases of investment projects are impossible to combine[11].

Capital expenditures and technological structure, which differs through segments, determine the cost of typical phases of investment projects and its respective percentage. For example, nowadays expenses for equipment account for 80–90% and 60–70% in aircraft engine manufacturing and aircraft engineering respectively. However, percentage of equipment expenditures has been increasing for recent years in aircraft engineering as manual operations become more and more automated.

[†]For the source article, please refer to: Батьковский А.М., Клочков В.В., Хрусталёв Е.Ю. Оценка рисков осуществления инвестиционных проектов в авиационной промышленности. Национальные интересы: приоритеты и безопасность. 2018. Т. 14. № 5. С. 941–954.
URL: https://doi.org/10.24891/ni.14.5.941

[1] Cedric J. A Quantitative Real Options Method for Aviation Technology Decision-Making in the Presence of Uncertainty. Georgia Institute of Technology, 2016. URL: http://hdl.handle.net/1853/54452

In the aviation industry of various countries, the technological structure of investment consists of a different percentage of buildings and facilities due to climate and other factors. For example, the percentage is lower in the USA than Russia. However, as the Russian aviation industry is technologically retrofitted and available resources grow, equipment expenditures increase as well.

If parameters of the investment project for productive capacity construction change, additional costs shall be incurred to adapt it to the new parameters. Analyzing the changes, it is reasonable to consider two phases of the project implementation that absorb greater portions of investment:

1) construction and mounting;

2) procurement and installation of equipment, testing and commissioning.

The total length of these phases can be expressed as $\tau_{R\&D+Const\&Mount}$ (this summand equals the sum of the duration of R&D and Construction & Mounting: $\tau_{R\&D+Const\&Mount} = \tau_{R\&D} + \tau_{Constr\&Mount}$) and $\tau_{Equip+Test\&Commis}$ (resulting from the duration of procurement and installation of equipment and commissioning: $\tau_{Equip+Test\&Commis} = \tau_{Equip} + \tau_{Test\&Commis}$). We denote the volume of investment as $I_{R\&D+Const\&Mount}$ and $I_{Equip+Test\&Commis}$. In most segments of the aviation industry, they correlate in the following manner: $I_{Equip+Test\&Commis} > I_{R\&D+Const\&Mount}$.

There is no definite correlation between the duration of the above phases in all investment projects for productive capacity constructions in aviation since it depends on many aspects. However, in most cases the following relation is true: $\tau_{R\&D+Const\&Mount} > \tau_{Equip+Test\&Commis}$. Total indicators of the project value and its duration equal as follows: $\tau = \tau_{R\&D+Const\&Mount} + \tau_{Equip+Test\&Commis}$; $I = I_{Equip+Test\&Commis} + I_{R\&D+Const\&Mount}$.

To simplify the analysis, we assume that work at each phase of an investment project is financed evenly. Then we can depict how the accumulated amount of investment $I_{\Sigma}(t)$ has been changing throughout the investment project period (*Fig. 1*).

We examine what if the aviation enterprise changes its plans while implementing the investment project at the phase of construction and mounting, including testing and commissioning. At this phase, buildings, facilities and engineering infrastructure are constructed or rehabilitated. That is why, if the product mix is to be altered, this will not have a strong effect on characteristics of fixed assets in progress (their passive part). If production technology is to be altered, these modification will require to specify requirements to various characteristics of production, i.e. environmental, sanitary, power engineering, etc. Characteristics of the passive part of fixed assets are most influenced by changes in planned volume of production. It is caused by low liquidity of buildings and facilities at aviation enterprises. When the planned volume of production is reduced, capital losses may arise as much as 10–30 percent of the project value.

At the following consolidated phase, when necessary procurement takes place and purchased equipment is mounted and configured, the said changes in various project parameters have an absolutely different effect. Considering the versatile and innovative nature of modern equipment, financial injections may not be significantly increased to alter the product mix at the former technological level, while keeping the general type of production, in comparison with the initial costs incurred to purchase, install and configure the equipment. Hence investment of a multi-product enterprise in purchase, installation and configuration of equipment can be classified as follows[2]:

- *general (integral) investment* intended to purchase, install and configure versatile equipment, new software and information systems, train, retrain and ensure professional advancement of managing and attending personnel, develop and manufacture structural components with the predetermined type and quality of various final products, etc;
- *special-purpose (special) investment* intended to manufacture or acquire unique facilities for producing predetermined types and dimensions of products, and elaborating and improving the software and information framework for the same purposes.

As we note above, versatile, up-to-date, highly automated innovative equipment for production make many elements of different aircraft specimens technologically convergent. The degree of technological convergence substantially increases. It means that integral investment significantly rises by 50 percent in

[2] Klochkov V.V. [Evaluating the economic viability of integration of aircraft engine construction]. *Polet* = *Flight*, 2006, no. 7, pp. 28–33. (In Russ.)

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most segments and aviation enterprises. Due to the same reason, even dramatic and continuous changes in the product mix will not require considerable special-purpose investment, which will not exceed 20 percent of the total value of the investment project.

If the technological level of production or applicable technology changes, it really can inflict unrecoverable financial losses, which would be comparable with the value of the purchased production equipment, installation and configuration costs, since such changes cause obsolescence of the purchased equipment making it almost unmarketable. When the enterprise does not expect such dramatic technological changes, but the planned output still decreases, the production equipment can be qualified as a liquid asset and sold to buyers who do need it to be working in other industries or international aircraft engineering corporations. However, we should note that due to the global decline (aviation industry worldwide) in demand for aviation products manufactured by a certain enterprise, the liquidity of the production equipment becomes low. Therefore, an excess stock of such equipment can be sold only with high discount.

Table 1 systematizes results of the analysis and evaluation of risks associated with investment projects intended to develop and upgrade the pool of resources and technologies in aircraft engineering enterprises.

Preliminary estimates and assessments may be subsequently specified over time in line with the project phase, when project parameters and respective investment in the phase change. Practical calculations should account for the uneven nature of investment cash flows, including specific phases of the investment project. However, even referring to simplified (qualitative) assessment (*Table 1*), we can see relative significance and importance of various risks that arise during investment projects pursuing the development and retrofitting of resources and technology in the aviation industry and some enterprises.

Drastic technological upgrades, new requirements to characteristics of advanced technologies and innovative production equipment during its purchase, installation, testing, commissioning and integration make respective risks the most significant and influential. Furthermore, additional costs and possible losses can reach the total value of the investment project before the production facilities are put into operation. In the last case scenario such costs will not exceed 85 percent of integral capital expenditures. At the phase of construction and mounting, the biggest losses may be incurred if the planned output is significantly reduced. However, in any case they will not exceed the value of the passive part of fixed assets used for production purposes, which account for 10–30 percent of integral capital expenditures incurred by most aviation enterprises. What causes the least important risk is changes in the product mix, with the level of aircraft engineering technologies remaining unchanged. In the other risk-exposed situation, possible losses may not exceed 15–40 percent of the integral value of an investment project, even when all the phases are completed.

Therefore, the governance system of investment projects for improvement and retrofitting of the resource and technological pool of aviation enterprises shall envisage the most critical types of risks.

Based on the analysis, it is possible to flag the way to a better quality of innovative development management in aviation enterprises.

On the one hand, it raises no doubts that it is reasonable to manage an investment project for productive capacity construction in an adaptive manner. If any condition changes in the course of the project, it is adjusted for the new conditions. However, this idea needs to be clarified.

First, it is not always reasonable to respond to such changes in certain cases since the project is funded *inter alia* with unrecoverable investment. To alter the project in any way, the following aspects should be compared:

– additional costs needed to adapt the project to new conditions of corporate development;

– losses that will be incurred in case of zero changes.

Distinctions in the quality of optimal decisions can be identified by studying similar models [12]. However, it is noteworthy that although it seems useful and reasonable to adjust the project, the reasonableness of any alterations fades away as the completion date approaches. They often turn to be unprofitable. Drawing upon theoretical principles of the traditional

options theory [13, 14], it should be kept in mind that not all options should be put in practice. Promising options should be realized only, since the holder's option constitutes the holder's right, rather than liability.

It is worth mentioning that conditions for the project implementation and managerial decision-making to analyze changes and adapt to them can change not only upon the emergence of new objects replenishing the existing pool of resources and technology in enterprises, i.e. during the period $t \in [t_0;\ t_0+\tau]$, but also until the end of the final phase of the object life cycle. Productive capacities are also renewed/retrofitted/extended/converted/reduced/shut down/sold, etc. in manufacturing various types of products. What distinguishes pre-productive phases is that most of planned investment have not yet been made in them. That is why, project parameters may be altered at much lower expense to adjust the project while running the constructed and operational productive capacity.

Second, flexible management of investment project implementation consumes various resources. That is the reason why costs and possible gain from the adoption of the real options strategy shall be compared [15, 16]. It is possible to evaluate the cost effectiveness of the adaptive management system for investment projects for improving and retrofitting the pool of resources and technologies in aviation enterprises by assessing the cost of real options, which can be adjusted through respective parameters of investment projects during various changes in predicted scenarios of their implementation.

Gains from adaptive management of projects for raising productive capacity of aviation enterprises can be quantified through estimated losses and costs proposed in this article and explained with the adaptation of innovative projects to various types of changes in project parameters as seen throughout its phases. To simplify the task, we assume conditions for a specific investment project change irrespective of its implementation process. Based on the assumption, time points of possible changes (expected demand and required product mix, cost of integrated production technologies and resources) can be considered to scatter evenly, meaning than there is equal probability that such changes may occur throughout the entire period of the investment project. Considering and applying the assumption about changing conditions, we can estimate expected costs and losses as a result of respective project adaptations. As we note above, it is necessary to accommodate the reasonableness and possibility of a flexible decision, which would depend on the project phase and volume of invested funds.

The effectiveness of flexible policy for management of the pool of resources and technologies in aviation enterprises can be evaluated (assessed) through time average of the highest possible gain for the entire life cycle of a changing project throughout the period of such changes. The project can be adjusted, if appropriate. However, if such adjustments have no sense already, they should be omitted. The average is formally embodied by integrating the time-realistic gain throughout the entire life cycle of the investment project, rather than at the phase of construction or modification of productive capacity. Afterwards the resultant integral indicators should be compared with identical integral functionality based on the assumption that no changes and adjustments of the innovative projects are not in progress. Resulting from the comparison of two estimated based on the proposed calculation methods, the estimate will reflect the effectiveness of each real option implying that parameters of projects for development and retrofitting of the pool of resources and technology in aviation enterprises can be changed. Indeed, possible changes in the project environment can have different frequency and amplitude. At different phases various changes result in various financial losses and additional costs. That is why the parameters will also require the smoothing.

Some methodological and theoretical issues arise since there are several types of risks we investigate in this article. If they are assumed to be unrelated, then the expected cost effectiveness of flexible management of investment projects is assessed as the sum of values of each option corresponding with changes in the product mix, integration of new production technologies and adjustment of the existing productive capacity. Further R&D in this sector should refer to findings indicated hereinafter [17–19].

Following the analysis and technical and economic distinctions of the aviation industry at its current technological level, we demonstrate that the most serious and perilous exposures stem from risks associated with dramatic technological retrofitting,

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modified requirements to production equipment during its purchase, mounting, testing, commissioning and implementation. When a production facility is put into operation, additional costs and losses may be incurred. During the construction and mounting, a significant reduction in the production output may induce the highest losses, but in any way the losses will not exceed the value of the passive part of fixed assets employed in the production process. The least significant risk is associated with changes in the product mix, while the technological level of the aviation industry remains the same.

Table 1

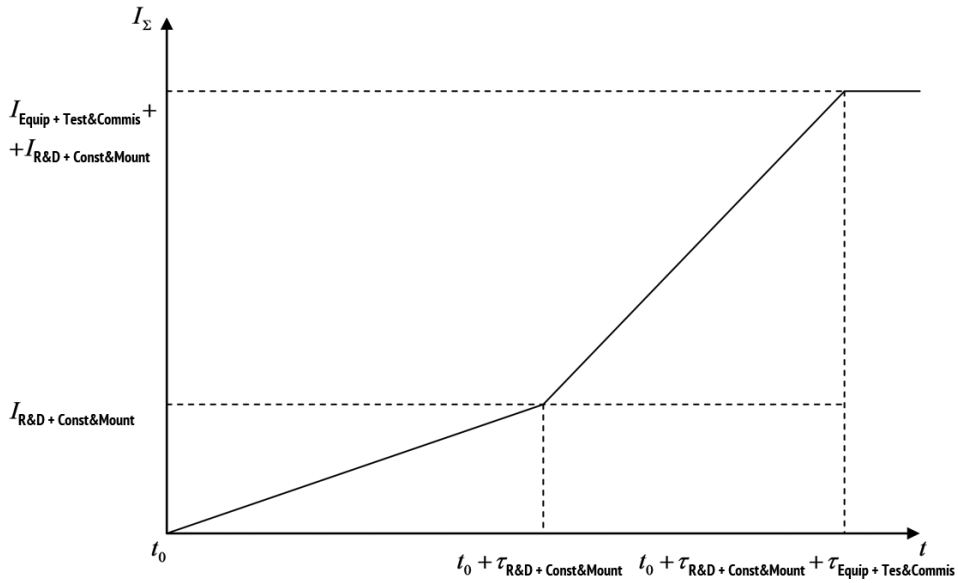
Estimates of possible unrecoverable costs and losses in case of changes in the investment project by nature of changes and implementation stage

Project phase	Construction and Mounting	Purchase and installation of equipment, testing, and commissioning
Decline in demand for products	Approximating the amount of investment in excess capacity. ***Total:*** 10–30 percent of value of excess productive capacity	Losses during the construction and mounting + cost of equipment installation, testing and commissioning + losses relating to drop value of dismantled equipment (they are significant during the industry decline) + equipment dismantling costs. ***Total:*** up to 30–40 percent of total value of excess productive capacity
Changes in the product mix (the technological level remaining unchanged)	Additional costs are negligible	Costs during the construction and mounting + costs about 10–20 percent of initial cost of equipment, its mounting, testing and commissioning. ***Total:*** up to 7–15 percent of project value
Changes in technology	Additional costs of about 30–50 percent of value of buildings, facilities engineering utilities. ***Total:*** 5–15 percent of project value	Costs during the construction and mounting + costs commensurate with financial expenditures for purchase and installation of equipment (during dramatic technological changes), testing, and commissioning ***Total:*** 70–85 percent of total project value

Source : Authoring

Figure 1

Changes in the accumulated amount of investment



Source : Authoring

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Translated Article†

SPECIFICS OF EVALUATING THE EFFICIENCY OF DEVELOPMENT INVESTMENT PROJECTS

Sergei A. FILIN
Plekhanov Russian University of Economics, Moscow, Russian Federation
Filin.SA@rea.ru
Corresponding author

Vera A. MARUSHKINA
Plekhanov Russian University of Economics, Moscow, Russian Federation
maruvera@yandex.ru

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Abstract

Importance The research identifies the specifics of evaluating the efficiency of development investment projects.

Objectives We outline an algorithm for evaluating the efficiency of development investment projects, formalize the process and give recommendations for improving the evaluation process in line with the specifics of development projects and real estate market.

Methods The article employs methods of logic study, forecasting, analysis and synthesis through a systems and information processing approach. The article provides algorithms, including the one for formalizing and evaluating the efficiency of development projects through the specifics of their performance and real estate market.

Results We showcase the way the specifics of evaluating the efficiency of development investment projects directly relates to the main trends in the real estate development in Moscow so as to make an evaluation more accurate and unbiased. We propose a formalized algorithm for evaluating whether development construction and investment projects are effectively implemented, and provide our recommendations for improving the process.

Conclusions and Relevance The formalized algorithm for evaluating the developer project efficiency helps to make informed managerial decisions on investment and project performance and mitigate weaknesses of traditional methods as if each of them was used separately.

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Introduction

Nowadays a system of social relations is indispensable without real estate, which determines the way individuals behave in different aspects of their life. Real estate is the central element of market relations, with its constituents being the main commodity satisfying a variety of personal needs and income-bearing tangible capital [1].

Growth in the national economy or an economic entity means an increase in economic capabilities, which are fostered by investment in new construction projects,

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retrofitting and re-engineering of operational enterprises[1]. As market actors sought for investment in real estate[2], including investment in residential property [2], this led to the origination of development as a special type of business [3], investment and construction activities related to real estate development projects.

According to the contemporary dictionary of economics [4], development stands for management of business, construction, real estate in pursuit of appreciation of items and benefits from them by assessing the instability, risks, successful instances of capital expenditures and seizing growth opportunities.

As set forth in Town and Country Planning Act 1990, "development" *means the carrying out of building, engineering, mining or other operations in, on, over or under land, or the making of any material change in the use of any buildings or other land*.

According to I.S. Artsybashev [5], development represents the work for development of territories and refurbishment of real estate items in order to increase their market property and competitiveness.

As A.Yu. Dudchenko puts it[3], development refers to a set of organizational, factual and legal actions as part of business activities in construction so as to create and replace real estate items and subsequently derive profit from them. From economic perspectives, development can be viewed as work pursuing the creation and transformation of real estate items and increase in their value. The work is intended to develop various investment projects for construction[4].

There are two types of development in economically advanced countries, 1) moderate (*fee-development*) implying that the developer abstains from any financial risks, 2) risky (*speculative development*) implying that the developer constructs commercial property as the sole organizer of the project, undertakes all the risks in case of the project failure. There also exist certain types of development by type of real estate item, which is the focus of the developer's activities, i.e. residential real estate, commercial real estate, real estate for shopping, entertainment and recreation, warehousing, industrial production, social and cultural purposes, land (land plots)[5].

Development constitutes a system intended for management of investment and construction projects. Based on reasonable management of project resources, developers practice a holistic approach to implementing and provisioning the project, including the sale of the finished project [6–8].

Currently, the term "development" has two types of usage in Russia. First, it refers to real estate development [9]. Second, the concise variant "development" has similar meaning.

As part of the development, developers address an array of coherent issues. Therefore, the process can be split into interim streams. *Fig. 1* depicts the model for business processes in development.

Generally, a development project can be subdivided into three main phases, i.e. conceptual, project organization and construction. However, H. Behrens, M. Vay, A. Frey and others point out the five main phases of development project. Each of the phases can be split into several interim steps [10]:

1) outlining the real estate development concept [11] and preliminary project review, (a) setting up development goals and respective algorithm; (b) articulating the main development strategy; (c) market research and determination of the suitable location for the project;
2) evaluation of the location and feasibility study of the project, (a) analysis of the demand and physical feasibility of the project; (b) preliminary consultation with regulatory authorities; (c) forecasting of the probable position of other stakeholders; (d) evaluation of the financial payback probability;
3) project design and evaluation, (a) developer's team building; (b) project business planning; (c) engineering, estimation of costs and project efficiency assessment; (d) project coordination and approval with statutory controllers; (e) project adjustments, if needed, and obtaining of final permits;

[1] Teplova T.V. *Investitsii* [Investment]. Moscow, Yurait Publ., 2012, 724 p.

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[4] Gorfinkel' V.Ya. *Ekonomika predpriyatiya* [Economics of the enterprise]. Moscow, YUNITI-DANA Publ., 2013, 664 p.

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4) conclusion of contracts and construction, (a) appointment of the contractor and contractual arrangements; (b) setting up the system for interactions of project participants; (c) setting up the system for control over the project progress;

5) marketing, management and usage of results: (a) determination of the period, method and personnel for a marketing campaign; (b) preservation and security of the project site; (c) analysis and rearrangement of sales agents' activity, if appropriate; (d) project cash flow management.

These phases may follow one by one or be concurrent. In fact, the above constituents of development projects should be regarded as steps unraveling various aspects of their performance. Sometimes some of the processes, which, say, concern marketing and management of cash flows, are not viewed as a separate phase.

The making of investment decisions becomes complicated due to a set of methods used to evaluate development projects, which generally requires or define its investment attractiveness and efficiency[6]. Professional evaluation of a development project enables investors and developers to avoid project errors and get as much return on investment as possible[7].

Thus, modified so to evaluate development projects, the Capital Asset Pricing Model (*CAPM*) helps to forecast the relationship between risks associated with an asset and expected return on the asset. For example, the following formula is used to assess the required rate of return on project or *R*-company, i.e. the cost of equity, as per the *CAPM*:

$$R = KRF + \beta(KM - KRF), \quad (1)$$

where *KRF* is a risk-free profit margin;

KM is average market margin (expected profit margin in the market as a whole);

β is a beta coefficient of security assessed in line with the real estate investment risk.

As the model provides for, investors should pursue more substantial profits from assets with higher risk exposure.

The *CAPM* is difficult to apply using the formula (1) since there should be β assessed, which would be formed to keep track of the systematic risk and for purposes of stock markets. In this case, β may serve to assess changes in the return on real estate items constructed and commissioned.

What complicates the use of *CAPM* in the real estate market is that the return hardly correlates with the return on financial indices, being almost zero. It signifies that β of real estate will also approximate zero, thus causing the underestimation of the cost of equity. This aspect grows even more onerous in Russia since there is no generally accepted market index of real estate. Furthermore, Russia lacks a leading organization or department that would able to collect data and form such an index. *CAPM* does not account for distinctions of the real estate market.

As part of real estate appraisal procedures, investors often resort to the ***income approach***. It implies that the value of real estate, including capital, shall correspond with the current quality and amount of income, which the real estate can generate:

$$V = I / R,$$

where *V* is the real estate value;

I is expected income from real estate;

R is the capitalization rate (the rate of return on investment in a real estate item as expected by the investor).

The real estate value is more often than not based on market prices. That is why the investor needs to assess the capitalization rate, including the rate of return on capital and rate of capital recovery in line with the rate of net operating income growth:

$$R = I / V.$$

Capitalization rate works well to compare an item to be acquired and other investment items since it allows to make comparative and approximate estimates of income from investment property and precise the scope of variants.

[6] *Effektivnost' investitsionnogo proekta – kategoriya, otrazhayushchaya sootvetstvie proekta tselyam i interesam ego uchastnikov i vyrazhaemaya sootvetstvuyushchei sistemoi pokazatelei. Metodicheskie rekomendatsii po otsenke effektivnosti investitsionnykh proektov* [Investment project efficiency is a category reflecting the correspondence of the project and objectives and interests of its stakeholders and constituting the respective set of indicators. Methodological guidelines for evaluation of investment projects efficiency]. Moscow, National Institute of Economics Publ., 2008. URL: http://niec.ru/Met/project03redMR.pdf (In Russ.)

[7] Teplova T.V. *Investitsii* [Investment]. Moscow, Yurait Publ., 2012, p. 14.

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The capitalization rate cannot make the investor certain of that the current income or real estate value will remain unchanged all the time. Property and respective rent may depreciate or appreciate, with expenditures concurrently rising. Therefore, capitalization rates is not in sync with the future risks.

To understand whether the development project is lucrative and efficient, groups of critical success factors are used, which determine as follows:

- attractiveness of the real estate location, including climate, geology, resources and infrastructure, demographic details, information about the city, manpower, economy, crime statistics, educational system and availability f cultural institutions;
- technical feasibility of the project on the site. It refers to the quality of resources, transport accessibility, walking accessibility, surroundings and available infrastructure;
- investment project efficiency.

The development project is impossible to evaluate without assessing the potential profitable part and expenditures. The latter includes the developer's costs at each phase of the project. The profitable part of the development project is made up of income from lease of a real estate item constructed as a result of the project and revenue from its sale after the operational period.

Analyzing and assessing the profitable part of the development project, it is necessary to measure income from real estate operations as of the resale date. The real estate value as of the sale date is the principal indicator of the profitability and value of the development project However, there is a time lag between the dates of the investment project implementation and its sale.

In this respect, the indicator is computed as follows:

1) assessment of the real estate value as of the current time and specific place, characteristics of which are similar to the item to be constructed as a result of the project;
2) forecast of changes in the value of the real estate item starting from the present date up to the project completion date.

For purposes of the real estate appraisal as of the current date, traditional methods of real estate appraisal are used. They are classified into three approaches, i.e. comparative, income and cost.

However, the cost approach is not applied to assess the final market value of an item constructed as a result of the development project since analysts primarily need to understand how much the project is worth in the market.

Being a comparison of sales, ***the comparative (market) approach*** is the most common tool for appraisal purposes. The idea behind the approach is that the real estate value results from a comparison of prices for identical items, which have been sold recently, and the real estate item subject to appraisal. The approach is used due to the following reasons:

1) problematic and time-consuming collection of reliable data because the data infrastructure of the Russian real estate market leaves much to be desired, and factual prices and selling terms are often concealed to evade State duties and taxes;
2) dependence of the appraisal accuracy on the market activity and its saturation with comparable sale-purchase transactions involving items like the item in question.

If there were few similar transactions, information about them is missing and the market changes rapidly, it is difficult to exactly measure the real market value of the item in question.

It is crucial to forecast expected cash flows and choose the appropriate discount rate for purposes of accurate valuation through the Discounted Cash Flow method (DCF method):

1) the future cash flow needs to be forecast. It is difficult to precisely estimate the future cash flows due to quite an unstable economic situation in Russia. Moreover, the longer the forecast period, the less accurate the estimates may be;
2) impact of risk factors on the forecast period. When the current value is measured, it is necessary to consider a probable risk associated with the future income from real estate. Whereas the probable risk is significant under the current circumstances in Russia, this influences the accuracy of the real estate valuation;
3) complicated collection of data on the rerun on similar items. Such information is usually confidential. Official information often fails to give a realistic view

of the situation. Under the current circumstances, it is problematic to verify the factual return on real estate items in Russia, thus affecting the accuracy of cost estimation;

4) it is rather challenging to measure all income constituents that might exist. Measurement of benefits from ownership of the item in case of construction real estate that provides convenient amenities and unique facilities.

Due to sanctions and global financial and economic crisis, the instability of the Russian economy mainly impedes valuation through the income approach since it blurs estimated income from construction real estate considering that the income approach strongly depends on the discounting of such income.

However, the income approach appears to be effective in case of investment valuation since it implies the comparison of income and expenses for the investment project. The approach is applicable to measurement of income-bearing real estate items, such as office and warehouse premises, trading facilities, hotels and production building, residential premises on rent.

The principle distinctions of the real estate market should be taken into account to evaluate the efficiency of projects.

1. Specifics of the market volume (through the circulation of titles). The physical immobility of real estate is one of the most crucial reasons why the real estate market offers not only real estate items, but rather titles for them, whether they are full or partial [12].
2. Specifics of the life cycle. The long life cycle of real estate items results from the durability of their creation and operation. The durability causes an uneven and complicated structure of cash flows generated by income-generating real estate.
3. Mismatch of trends in the value of real estate constituents, i.e. land and its improvements (buildings and facilities). The land tends to appreciate, while the value of buildings and facilities demonstrate some decrease. It is noteworthy that any decrease in the value of a certain real estate item stands against the opposite trend of an inflation—driven increase in the value.
4. The market and investment value of real estate are influenced by various forms of investment. The fact is seen in that multi-tiered investment is inherent in income-generating real estate, with equity- and borrowing-based investment prevailing. Moreover, the investment process may be organized differently, i.e. share in equity, time of investment. Mortgage lending is the most common method of investment. Equity and borrowings are investment, with the real estate being pledged for them. It considerably influences the usage and investment opportunities of real estate and, ultimately, its market and investment value.
5. Low liquidity. Real estate (capital construction items) is much less marketable than, say, financial assets as a result of substantial time it takes to sell the item in the market.
6. Insufficient elasticity of real estate supply. The real estate supply can significantly exceed the respective demand than in other market segments.

Revenue from sales as part of the development project can be assessed with the information on prices for real estate, rather than sales plan and area of apartment in construction by period only. Having analyzed trends in average prices in the first-time home market of New Moscow, we managed to choose a two-parametric model of Holt's exponential smoothing as a forecasting method. This is an additive model of linear growth since this time series had no seasonality and demonstrated an explicit trend. The model is expressed with a system of recurrence relations [13]:

$$\begin{cases} S_t = \alpha_1 Y_t + (1-\alpha_1)\cdot(S_{t-1}+T_{t-1}) \\ T_t = \alpha_2\cdot(S_t - S_{t-1}) + (1-\alpha_2)\cdot T_{t-1} \\ \hat{Y}_{t+k} = S_t + kT_t \end{cases},$$

where Y_t is a certain price for one square meter of residential area as of the time t;

$\hat{Y}_{t+k}$ is the forecast price for one square meter of residential area for k steps ahead;

S_t is a smoothed level of the series as of the t-time;

T_t is a smoothed additive trend;

α_1, α_2 are parameters of smoothing for the level of the series and trend.

In this model the level and trend are smoothed exponentially, with different coefficients α_1 and α_2 assessed through available prices. Our forecast is based on the data series made up of average monthly prices for one square meter (147 observations) for the period

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from January 2005 through March 2017. The forecast covers the time span of 45 months (max k = 45). Optimal values of coefficients α_1 and α_2 were selected using Solver, MS Excel add-in program with the special-purpose function $MSE = \sum(Y_t - \hat{Y}_t)2/n \rightarrow min$ and in line with a system of constrains:

$$\begin{cases} \alpha_1 \geqslant 0 \\ \alpha_2 \geqslant 0 \\ \alpha_2 \leqslant -2 + 4\alpha_1 \end{cases} . \quad (2)$$

The two opening constraints in the system (2) are ordinary in terms of this forecast method. The third one – J. Mc Clain & L. Thomas's constraint – makes the model more stable [14]. Attempts to minimize the mean squared prediction error *MSE* led us to the following estimates of smoothing parameters α_1 = 1.23 and α_2 = 0.41. Mean Absolute Percentage Error (*MAPE*) was 4.293 percent meaning that the predicted results deviate from factual values by 4.3 percent on average. *Fig. 2* graphically visualizes the prediction results (in values as of January of corresponding year).

According to the forecast, in January 2018, 2019 and 2020 the average price for one square meter of real estate in New Moscow will be RUB 87,625.7, RUB 90,230.6, RUB 92,835 respectively. Values predicted by the model and presented in *Table 1* will be fitted to a district of the city and type of apartments (one, two, three rooms) and subsequently used to calculate revenue from sale of the apartments.

To set confidence interval for predicted values, the following formula is used as it provides for a more ample prediction interval and extended prediction horizon k [13]:

$$\hat{Y}_{\text{ННТ}} = \hat{Y}_{t+K} \pm t^{\text{ст}}_{(N-n-1,1-\theta)} \cdot S_p \sqrt{k} ,$$

where $\hat{Y}_{t+k}$ is point prediction as of the time ($t + k$);

$t^{\text{ST}}_{(N-n-1,1-\theta)}$ is Student's t-test (t_{ST} = 1.977);

t is the time series length;

k is the prediction period;

S_p is standard error of the prediction.

There is a 95-percent probability that the price for one square meter of real estate will fall within the computed intervals in each of the periods (*Fig. 3*).

Once the average predicted prices are computed, adjustments shall be made for a district of the city and type of apartments (the number of rooms). The average price for one square meter of residential area in Novo-Peredelkino accounted for 0.786 of the average price for one square meter of residential area in Moscow. Besides, one square meter of a one-room apartment in Non-Peredelkino is 12.2 percent as expensive as the average one square meter of residential area in the same district (*Table 2*).

Therefore, the final adjustment for a one-room apartment in Kommunarka Administrative and Business Center can be presented as 0.786 · 1.122 = 0.882, i.e. one square meter of a one-room apartment in Kommunarka Administrative and Business Center is 12-percent as cheap as the average one square meter of residential area in New Moscow. Based on the apartment sales plan and average area of apartments as envisaged in the development project, proceeds from sales are generated by period.

The discount rate shall be assessed as one of the main steps of investment project efficiency evaluation, that makes asynchronous flows comparable. The appropriate discount rate will increase the precision of the principal metrics of the project cost efficiency and make the computations adequate in terms of economic conditions of the market where the project is to be implemented. Economically, the discount rate is represented with the rate of return on investment in items with comparable risk exposure. The Weighted Average Cost of Capital model (*WACC*) can be used to assess the discount rate in case of mixed finance of a development project since it accounts for the amount of loan interests reducing the taxable base for purposes of income tax [15]. As per Article 269 of the RF Tax Code[8], starting from January 1, 2011, the ceiling of interests qualified as expenses equals the refinance rate of the Central Bank of Russia but multiplied 1.8 times:

$$WACC = W_e \cdot k_e + W_d \cdot k_d \cdot \left(1 - T \cdot \frac{1{,}8 \cdot R_{ref}}{R}\right) , \quad (3)$$

where W_e and W_d stand for a percentage of equity and borrowings;

k_e and k_d are the cost of equity and borrowings respectively;

R_{ref} is the refinance rate;

[8] Tax Code of the Russian Federation (Par Two) of August 5, 2008 № 117-ФЗ (Edition of April 3, 2017) (as amended and supplemented and enacted as of May 4, 2017).

R is the interest rate on loans.

The cost of the development project equity k_e is calculated by the formula (1). Assuming that the project corresponds with the core activity of the company, β coefficient is considered as equal to β coefficient of stocks held by the development project initiator, while predicted values of the capital structure adjusted for the project investment are taken as percentages. The risk-free rate is represented with the zero coupon yield rate. The average market yield was assessed by the RTS index [16] for the period of retrospective analysis from April 1, 2013 through April 1, 2017. The following formula was used:

$$R_m = \sqrt[n]{\frac{RTSI_1}{RTSI_0} - 1} \ ,$$

where $RTSI_0$ and $RTSI_1$ are RTS index as of the beginning and end of the period respectively;

n is the number of observation periods (in this case *n* = 4).

Whereas the RTS index as of the beginning and end of the period was 832.87 and 1,423.34 respectively, the average market rate of return R_m accounted for 14.36 percent. Considering the financial scheme of the development project, equity and borrowings are 0.412 and 0.588 respectively. Thus, to calculate *WACC* using the formula (3), the following figures were obtained:

R_{ref} = 5.5%; β = 1.1; R_m = 14.3%; *R* =15.22%.

W_e = 0.5882; k_d = 23.02%; W_d = 0.4118; R_{ref} = 8.25%.

Being measured by the formula (3), the average annual discount rate amounted to 17.208%. The discount rate (quarterly) was used to discount cash flows and assess net present value of the development project.

To perform a scenario analysis of market risks, we shall determine the scope and likelihood of future events, which may modify the known trends in prediction intervals of the average prices for one square meter of real estate in New Moscow (*Fig. 3*).

Based on the expert method, we predefined six factors, which would be able to influence the situation in the market and prices for real estate in New Moscow:

1) increase pace of population growth, immigration;
2) betterment of economic and investment opportunities of New Moscow, geographical extension;
3) decreasing growth in average income per capita of the population (a drop in the solvent demand);
4) mid- and long-term decline in prices for oil, RUB exchange rate, investment activity and hereby prices for one square meter of real estate;
5) rising prices for oil, strengthening of the RUB exchange rate and increase in real estate prices;
6) development of mortgage lending, increasing demand for real estate.

These events are qualified as rather probable, with their effect on average prices and real estate market being generally strong.

Hereinafter we apply the simulation modeling algorithm. Each of the six events were randomly assigned to the number ranging from 1 to 100. If the event likelihood exceeded a random number in a certain period of time, the event took place. Then we assessed the total effect on the price trend as an algebraic sum of all the effects in each of the prediction periods. These interactions were repeated many times (2,000 instances). We calculated the maximum and minimum per each period and the average effect on the price. *Fig. 4* visualizes the result of simulation modeling (Monte–Carlo method).

Calculated through modeling by the Monte–Carlo method, the average prices exceed the previous forecast, indicating the predominance of optimistic scenarios in the initial set of factors. However, the gap between the minimum and maximum prices for one square meter (prediction interval) significantly grew in comparison with the initial data extrapolation (*Fig. 3*). Indeed, the biggest deviation of the floor and ceiling of prices from the predicted (planned) ones accounts for 24 percent and 25 percent respectively, with the uncertainty rising at the end of 2018.

After the primary trend is fitted to possible events and the three probable scenarios of real estate prices are determined, adjustments for a district and type of apartments are taken into account. Afterwards net present value of the development project is remeasured on the basis of the most probable prices

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under the scenarios. Assessed through simulation modeling, the minimum prices will be regarded as the worst case scenario, while the maximum ones will be taken as the best case scenario. The new adjusted trend in averages will be considered as an expected scenario.

To evaluate the efficiency of development projects, we propose the following algorithm:

1) collection of historical data, primary data extrapolation of prices for one square meter of residential area in accordance with the planning horizon and determination of the project cash flows;
2) identification of key internal and external factors through the sensitivity analysis, their ranking by significance;
3) expert judgment on a set of the future events, which might change the way prices behave, their likelihood and effect (measurement);
4) simulation of probabilities of some events within the given parameters of their allocation (Monte–Carlo method);
5) fitting of the primary trend to possible events, reassessment of the average (expected scenario), maximum (best case scenario) and minimum prices (worst case scenario);
6) preparation of scenarios for other key risk factors of the project and expert assignment of probabilities;
7) construction of a scenario tree, assessment of the integral indicator of net present value and analysis of results (*Fig. 5*).

Drawing upon the analysis, we make the following conclusions.

First, whereas unforeseen and uncontrolled changes in prices for one square meter of real estate constitute the most influential risk factor of a development project, profound techniques for scenario analysis are useful in case of this key factor. However, in case of the other factors, the intuitive logic method could be used, determining their probability and range of variables on the basis of expert knowledge. The development project efficiency evaluation allows to mitigate drawbacks of each method if they were used separately.

Second, the development project efficiency evaluation algorithm helps find a more nuanced project solution. If integral NPV turns to be higher than the predicted indicators, including all pessimistic and optimistic scenarios, the project efficiency is likely to exceed the benchmark. Such opportune investment in the project will raise profitability to a new level and the corporate value. Using the algorithm, it will be possible to consider the market risk associated with the price for one square meter of real estate. Therefore, once the market slowdown takes place, the company will not suffer from a dramatic lack of funds. This development project efficiency algorithm may be critically important in the following cases, i.e. a) experts seriously diverge on price forecasts; b) the project needs substantial investment, while having a protracted life cycle or weak viability; c) the company does not possess big capital stock or deals with construction and sale of real estate only.

Third, scenario analysis for purposes of the development project efficiency values may be constrained due to unavailable historical data on prices for a long-term period. The proposed algorithm may be unreasonable for risk assessment purposes, if the project is short-term and there is a low probability of events that may influence the price trend during the prediction period.

Table 1
Quarterly forecast of average values for one square meter of real estate in New Moscow

Period	Average price, RUB
Q3 2017	86,540.32
Q4 2017	87,191.54
Q1 2018	87,842.76
Q2 2018	88,493.98
Q3 2018	89,145.2
Q4 2018	89,796.42
Q1 2019	90,447.63
Q2 2019	91,098.85
Q3 2019	91,750.07
Q4 2019	92,401.29
Q1 2020	93,052.51
Q2 2020	93,703.73
Q3 2020	94,354.94
Q4 2020	95,006.16

Source : Authoring

Table 2
Assessment of the final adjustment for types of apartment and city district, RUB

City district	Type of apartment			Average price
	One room	Two rooms	Three rooms	
Kommunarka District	74,546.9	66,069.8	58,685.5	66,434.07
New Moscow	86,558.2	84,254.7	82,710.7	84,507.87
Adjustment for type of apartment (Kommunarka District)	1.122	0.995	0.883	–
Final adjustment	0.882	0.782	0.694	–

Source : Authoring

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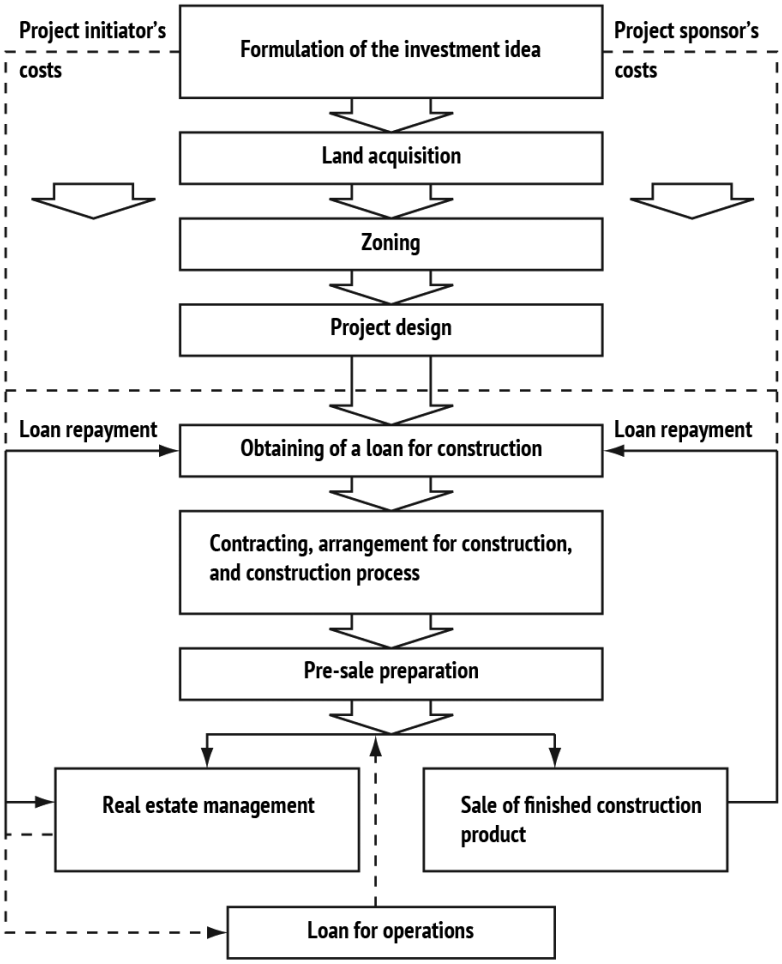
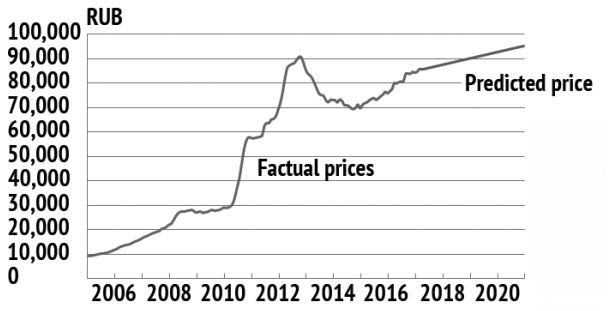
Figure 1
A conceptual model of the developer's activities



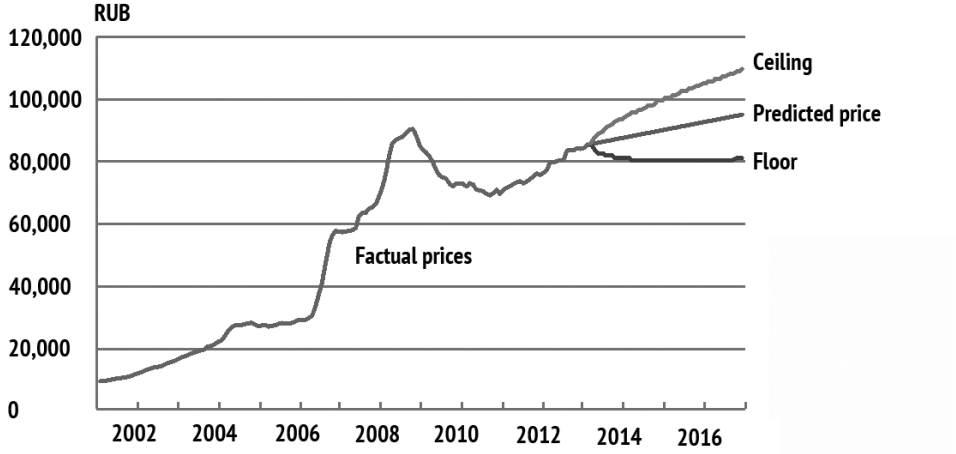
Source : Authoring

Figure 2
Forecast of prices for one square meter of real estate in the primary real estate market of New Moscow



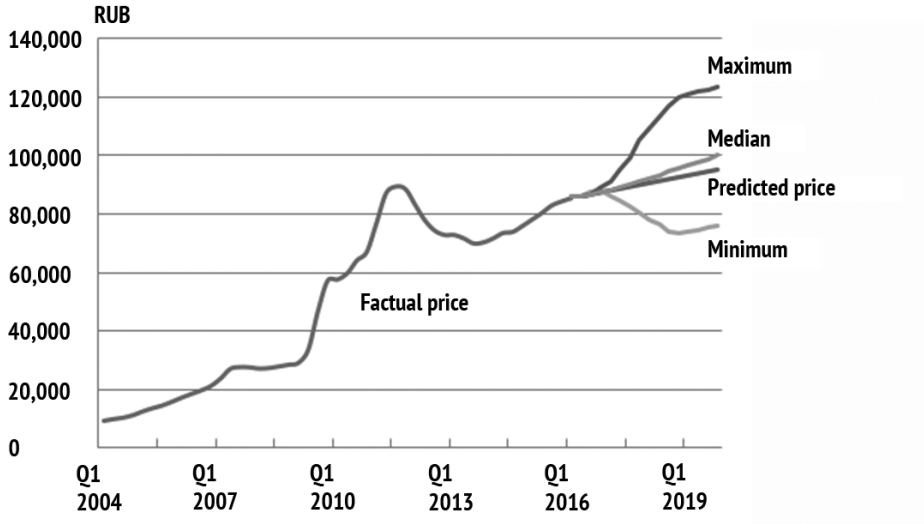
Source : Authoring

Figure 3
Setting of prediction intervals for average prices for one square meter of real estate in New Moscow



Source : Authoring

Figure 4
Comparison of simulation modeling results by the Monte Carlo method and primary extrapolation of prices for one square meter of real estate (Holt's method)



Source : Authoring

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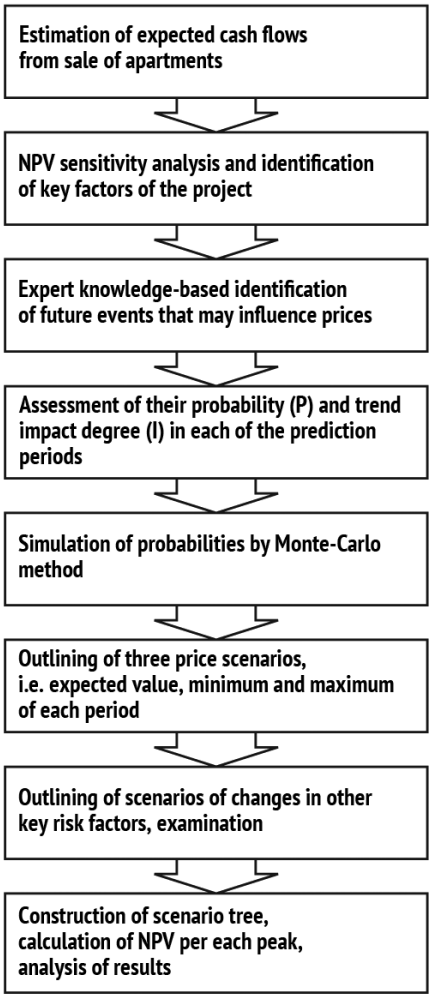
Figure 5
The algorithm for evaluating the efficiency of developer projects



Source : Authoring

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Conflict-of-interest notification

We, the authors of this article, bindingly and explicitly declare of the partial and total lack of actual or potential conflict of interest with any other third party whatsoever, which may arise as a result of the publication of this article. This statement relates to the study, data collection and interpretation, writing and preparation of the article, and the decision to submit the manuscript for publication.

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Innovation and Investment

Translated Article†

FACTORS INFLUENCING THE FINANCIAL POTENTIAL OF CORPORATE INNOVATIVE DEVELOPMENT

Ayaz A. ALIEV
Plekhanov Russian University of Economics, Moscow, Russian Federation
ayaz.797@mail
https://orcid.org/0000-0003-1476-9702

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Abstract

Importance The article discusses an array of theoretical issues that arise from analysis of the financial potential of corporate innovative development. They contribute to a system of factors influencing the respective financial potential of corporate innovative development (global, local and corporate).

Objectives I trace factors influencing corporate innovative development and arrange them into a system so as to apply it as part of financial and investment policies.

Methods The methodological underpinning is based on analysis and synthesis, induction and deduction, summary of theoretical principles for outlining a balanced scorecard, comparing them with the practice. As part of the comprehensive approach, I use methods of grouping and comparison, assessment and analytical methods. The research also involves a comparative analysis of macroeconomic indicators.

Results I determine the population of factors and merge them into a system of factors that features global, local and corporate ones. I also set up a system of factors influencing the financial potential of corporate innovative development.

Conclusions and Relevance The article presents a comparative characteristics of various factors influencing the financial potential of corporate innovative development. I also determine that the State is an active driver of innovative development at the micro- and macrolevels. The governmental financial policy for corporate innovative development plays a key role in financing this system of factors. The system of financial potential factors will allow for an early detection of weaknesses in entities' financial policy and adjust it so as to outline an effective strategy for financing the innovative development. The findings can be used to formulate financial and investment policies and delivering analytical and accounting classes.

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Authorized translation by Irina M. Vechkanova

Forming the financial potential of corporate innovative development is strategically important for any management to make effective business decisions. Trying to make the financial policy of corporate innovative development effective, it is necessary to examine factors that influence the financial potential.

To assess the innovative development and boost the financial potential of entities, it is reasonable to determine the main conditions and factors that configure the finance of innovative development.

There are several approaches. Generally, a factor (the Latin word '*factor*' meaning '*who/which acts, produces*') shall be understood as a driving force of any process, which contributes to its nature or distinctions[1].

†For the source article, please refer to: Алиев А.А. Факторы, влияющие на финансовый потенциал инновационного развития компаний . Экономический анализ: теория и практика. 2017. Т. 16. № 7. С. 1370–1381.
URL: https://doi.org/10.24891/ea.16.7.1370

[1] Definition of the term '*factor*'.
URL: https://slovar.cc/enc/bse/2052720.html (In Russ.)

According to the contemporary dictionary of economics, factors shall mean conditions, reasons, parameters, indicators, which have an impact and effect on an economic process and respective results[2].

Authors referred to herein [1] enumerate some factors at the regional level, which are believed to have the strongest effect on the innovative development mechanism. The financial mechanism for innovative development depends on the factors below to the greatest extent:

- resources, raw materials (weighted average endowment of reserves of key natural resources);
- production (comprehensive result of business activity in the region);
- consumption (gross purchasing power of the region's population);
- infrastructure (economic and geographic position and sufficiency of available infrastructure);
- knowledge (educational background of the population);
- institutions (development level of leading market institutions);
- innovation (degree of S&T implementation).

Whereas, D.I. Kokurin subdivides the factors into those ones that influence the financial mechanism for innovative development, and external and internal ones. In his opinion, internal factors shape the objective internal cross-institutional relations, featuring the ownership, business and legal structure, size and industry of innovation agent, etc. [2]

E.A. Divaeva points out the following factors of inner substance, scale and pace of changes in the financial mechanism for innovative development [3]:

- renewal and upgrade of products to make them more competitive in the domestic and foreign markets;
- revival of international cooperation in science and technology, promotion to the global market;
- fast implementation and wide proliferation of R&D results, etc.

[2] Definition of the term '*factor*'.
URL: http://vslovare.ru/slovo/jekonomicheskiij-slovar/faktorjy (In Russ.)

In this research factors of the financial potential of corporate innovative development shall mean reasons and conditions for the potential to increase.

Reviewing foreign practices of evaluating the factors that influence the financial potential of corporate innovative development, I should mention the research referred to herein [4]. It states the factors have the following constituents:

- financial;
- S&T;
- organizational;
- HR;
- production and technology;
- consumption.

However, the above authors do not focus on effects of each constituent.

Ş. Şuşu, M. Birsan [5] claim that the financial potential of corporate innovative development is impacted by:

- strategic priorities of corporate development;
- alternative methods to raise earnings;
- competitive advantages of the entity;
- corporate risks of innovation finance.

The authors of the above approach consider the financial constituent as the central one, believing that sufficient financial resources of the entity will facilitate the development of the other constituents. This is believed to ultimately ignite innovation.

What should be done to evaluate the financial potential of corporate innovative development is identify and analyze factors influencing the innovative development and circulating in global practices [6], with the main ones including the following aspects:

- efficiency of the current economic and financial policy;
- investment and innovative opportunities of the business entity;
- development level of financial institutions (banking, investment, trading, insurance);
- existing taxation principles;
- degree of investment and innovative project risk;

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- conditions for attracting domestic and foreign investment;
- availability of the State financial aid to innovation, and eligibility conditions;
- regulatory and legislative background;
- profitability of entities, fiscal revenue, etc.

In this respect, the hierarchy of factors influencing corporate innovative development and financial potential [7] should be viewed as a coherent system of global, country and corporate factors.

Global trends in corporate innovative development and corporate innovative capabilities can be traced by analyzing the innovative development of leading countries of the world [8].

1. Considering the innovative sector as the most lucrative in terms of profit and financial risks. According to the global capitalization and profitability rating, *Top-10 stocks* feature only entities from the same sector, which global investors qualify as fundamentally stable and effective. Constituting the core of the sixth wave of innovation, the innovation sector crowns the top of the pyramid resting upon the national economy and sustainable economic development [9]. This sector drives the economic development, with its needs circumscribing the strategic cooperation with other industries. Financial flows and resources of the high-tech sector may become financial resources underlying the financial potential of corporate innovative development.
2. Ceasing to be a theoretical paradigm, the innovative economy morphs into an imperative to create relationships among consumers and producers of goods and services. It becomes a key factor of market relations, foundation for competitiveness of the State and companies.
3. Innovative constituent defines consumer demand for high quality goods and services.
4. Intensifying globalization processes of the global economy are concurrent with the reallocation of free financial resources into highly profitable innovative projects.
5. Growth in revolutionizing innovation dramatically changes the competitive environment of any product, service or type of activity, fostering an increasing supply of new goods and services.
6. Although national economies still depend on energy resources, the 20-20-20 energy strategy gradually rearranges the structural balance, with innovation-driven industry prevailing.

Global trends in innovative development are considered to macroeconomically and strategically reshape the way countries worldwide develop their national economies and companies, bringing innovation to the frontline [10].

According to Ernst & Young studies[3], the leading innovative companies have been outperforming innovative companies with the lowest ratings by 16 percent for the recent three years.

Fig. 1 shows the nexus between a long-standing growth of companies and their innovative activities.

As part of the market economy, any structure (private or public) [11] constitutes an open economic system, maintaining its production and business in a consistent country-specific environment. To strengthen its positions nationally and globally, increase the financial sustainability and capabilities, the entity should be in sync with trends in corporate innovative development and finance as they are in advanced economies [2].

Supporting their innovation processes, countries of the world[4] adhere to national long-term and mid-term strategies for economic and technological advancement [12, 13]. The countries set up development priorities, financial mechanisms and volume of financial resources earmarked for innovative development [14].

Such strategies are implemented by Japan, Germany, USA, China, Great Britain, Brazil, India and other leaders in innovation and innovative development [12, 13] (*Table 1*).

The finance of corporate innovative development abroad basically depends on the following factors[5] [4, 5, 12–14]:

[3] Ernst & Young. URL: http://www.ey.com/ru/ru/home (In Russ.)

[4] *Translator's Note.* The author hereinafter refers to countries, other than Russia, comparing it with global trends and practices.

[5] Nekhorosheva L.N., Egorov S.A. *Modeli gosudarstvennogo regulirovaniya razvitiya venchurnoi deyatel'nosti: mirovoi opyt i problemy stran* [Models of State regulation of venture activity development: Global experience and challenges of the CIS]. URL: http://iee.org.ua/files/alushta/32-nehorosheva-modeli_gos.pdf (In Russ.)

- investment of budgetary resources in authorized capital of venture capital funds and other special-purpose financial organizations involved into corporate innovative development;
- tax benefits to innovative companies;
- granting beneficial public loans and guarantees (insurance) to innovative-driven companies;
- implementation of special-purpose governmental programs for procurement of innovative goods and services;
- finance of technological parks, business incubators and other targets of innovative development.

The Russian economy is impacted by similar factors of corporate innovative development, financial capabilities for innovation and their increase[6].

The finance of corporate innovative development and increase in financial capabilities are currently subject to the following factors:

- financial aid at initial, preparatory steps of innovation. The mechanism is deployed, to a certain extent, in State-financed programs for supporting small innovative businesses;
- setting up mechanisms to involve innovative companies and private business in outlining and implementing innovative development policies based on the Public-Private Partnership model, and mechanisms for financial support of such alliances, associations and companies.

However, this will definitely not suffice. Evaluating innovative activities of the Russian entities, I should admit that their innovative development [14] significantly falls behind that of companies operating in advanced countries. Hence Russia unavoidably has to import knowledge-intensive goods and technologies (*Table 2*).

Table 2 reflects considerable differences between companies' motivation for developing innovative activity. There are fewer technological innovators in Russia than in Germany, Sweden, Italy and Finland, accounting for a 400-percent difference on average. The Russian companies manufacture an incommensurately lower percentage of innovative industrial goods than the Western ones. Thus, despite being financially capable, the Russian industrial sector is not motivated for active innovative development.

The Russian companies are reluctant to invest and innovate [15] since the corporate sector's innovation is subject to financial restrictions, thus making innovative development economically unattractive for many Russian companies. What impedes the finance is unstable economic development of Russia, sectoral economic sanctions of the Western countries, limited information on rival innovative projects. High uncertainty risks of corporate innovation extend the payback period of such projects and raise the benchmark rate of return (*Table 3*).

Whereas, many Russian companies treat innovation as an important success factor, striving to develop and unlock their innovative potential. *Table 4* indicates the significance of innovative development for companies.

The following features are common for active innovators, which take the lead in innovative development:

- purposeful innovative activity;
- clear strategy for innovative development;
- view of innovation management as an important business function; well organized innovation process at the corporate level;
- innovative goods accounting for a high percentage of revenue and net profit;
- venture capital financing for purposes of innovative project development.

As the research reveals, financial results of the leading foreign and Russian companies mainly depend on their innovative development strategies and financial constituents, first of all. Following its financial strategy, the company shall choose and make the most effective financial investment in order to increase its financial potential for corporate innovative development, ensure a continuous growth in capitalization, reaffirm its competitive advantages nationwide and worldwide. Concurring with their long-term investment policy,

[6] Kharin A.A., Kolenskii I.L. *Upravlenie innovatsiyami: v 3-kh kn. Kniga 1. Osnovy organizatsii innovatsionnykh protsessov* [Innovation management: Three books. Book One. Organizational principles of innovation processes]. Moscow, Vysshaya shkola Publ., 2003, 252 p.

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the financial strategy is supposed to help companies attain their long-term development goals.

The sound and adopted financial strategy for corporate innovative development is to clarify financial sources of innovative projects, internal rate of return (*IRR*) and payback period. These indicators tend to be 12 percent and 5 years respectively in advanced countries. However, these criteria appear to be higher in Russia since innovative projects are exposed to high risks there. Hence the main focus is put on innovative projects with the high rate of return and short payback period. The majority of the Russian companies (60 percent) invest from 6 to 20 percent of their net profit in innovative projects, while companies from advanced countries earmark about 25–35 percent of their net profit for innovative projects. Revenue is one of the sources the Russian companies use to finance their innovative development, while innovative programs are the main driver of revenue in advanced countries. Revenue and net profit *inter alia* influence the innovative development of the Russian companies. According to Ernst & Young experts, innovation will absorb from 15 to 25 percent of the Russian companies' revenue within the coming five years. On the other hand, innovative activity of the European companies will help ensure a 61–100 percent growth in their revenue [16].

It is important to note that the financial strategy of the company necessitates substantial financial resources to be drawn from special-purpose (venture capital) funds. These are such financial resources that used to feed innovative projects of active innovators, such as Apple Computers, Microsoft, Sun Microsystems, Intel [17]. Currently, many medium-sized innovative companies resort to venture capital in order to implement innovative R&D [18].

Russia sees the first instances of innovative projects funded by major venture capital funds and supported by their financial and organizational capabilities.

Fig. 2 depicts my own approach to setting a system of factors influencing the financial potential of corporate innovative development.

To make dramatic rearrangements in venture capital financing of corporate innovative development in Russia, the favorable investment environment should be created. There should be a regulatory and legislative framework and mechanisms to insure venture capital financing of the Russian companies' innovative projects.

Scrutinizing the factors influencing the potential for corporate innovative development, I make up a system of global, country and corporate factors (*Fig. 3*).

Therefore, as the research shows, the State aid fosters the highest upsurge in innovative activities in the Russian market. Despite the existing global trends and opportunities for the Russian companies, private organizations fail to actively finance and promote promising innovations due to an underdeveloped tax incentive mechanism for innovative development, lending to investment and innovative projects, high risks associated with the innovation policy.

Having examined how corporate investment development is financed in the Western countries, I found out that robust financial institutions, taxation and venture capital financing of corporate innovative development and subsequently lower risks allow companies to invest in their innovation, treating it as an important business function. Hence profit from innovative goods and services account for a substantial percentage of revenue. These facts contributed to the system of factors influencing the financial potential of corporate innovative development. Based on the system, innovation-driven companies will be able to detect drawbacks in their financial policies for innovative development and adjust it, thus forming the adequate financial potential for financing the innovative development.

Table 1

Measures to support innovative development in developed countries

Supportive measures	Country
Financial backing to joint ventures of business structures and research institutions	USA, Germany, Sweden, Denmark, United Kingdom
Incentives for SMEs to use innovative technology	USA, China, France, United Kingdom
Financial backing to development of technological parks and technological incubators	Denmark, Germany, India, Sweden, China
Setting and implementing the methods for direct financial backing to innovative production enterprises (grants, loans on beneficial terms)	United Kingdom, Germany, France, India, China, Denmark, Norway, USA
Financial backing to venture capital funds and companies in the innovation sector	Sweden, Norway, Germany, India
Tax incentives to innovative companies	Norway, France, Germany, Spain
Venture capital financing of corporate innovative development	United Kingdom, USA, Norway, Germany

Source : [4, 5, 12–14]

Table 2

Innovative activity of Russian and foreign companies, percentage

Metrics	Russia	Germany	Sweden	Italy	Finland
Companies implementing technological innovation out of total companies in the industrial and servicing sectors	9.7	60.9	36.3	44.8	46.8
Innovative industrial products out of total industrial products	0.5	7.1	18.7	27.2	–

Source : Decree of the Government of the Russian Federation *On the Concept of Long-Term Socio-Economic Development of the Russian Federation up to 2020* of November 17, 2008 № 1662-p; Ministry of Economic Development of the Russian Federation. URL: http://www.ved.gov.ru/ (In Russ.)

Table 3

Sources and criteria of corporate innovation financing

Sources of finance	Benchmark RR, %	Lead time of investment, year	Key financing tools
Business angels. Governmental foundations	> 40	3–7	Personal funds, special-purpose governmental programs
Venture capital funds	30–40	3–5	Venture capital
Direct investment funds. Bank lending	20–30	1–2	Venture capital, resources of the fund, bank loans
Foundations for promising researches. Issue of stocks	10–20	1–2	Resources of the fund, equity

Source : [17]

Table 4

Importance of innovative development for companies in 2016, and the 2020 forecast, percent

Degree of importance	Foreign companies		Russian companies	
	2016	2020	2016	2020
Not important	2	1	0	0
Not very important	3	3	0	0
Ambiguous	11	8	8	7
Rather important	40	37	30	20
Motivated by competition	43	51	62	73

Source : Ernst & Young. URL: http://www.ey.com/ru/ru/home (In Russ.)

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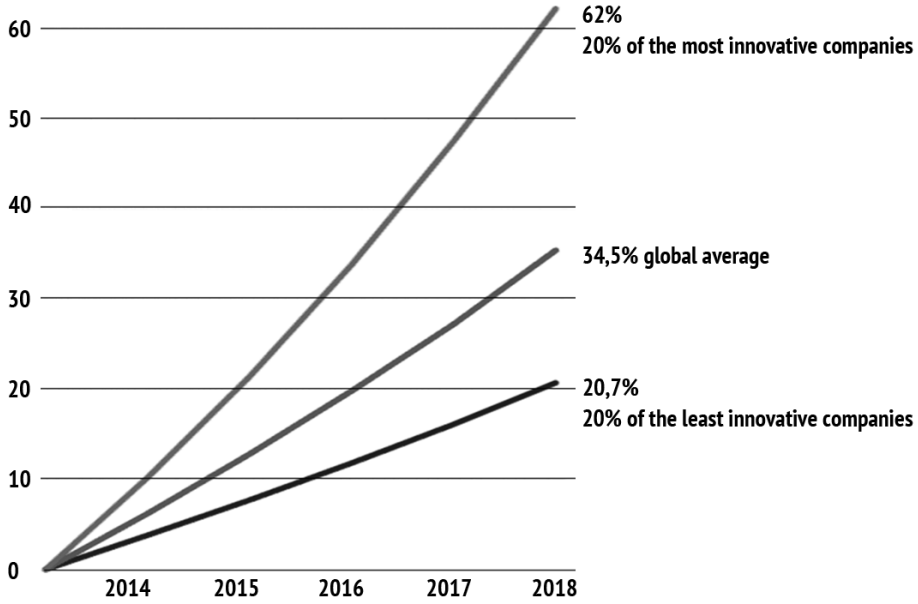
Figure 1

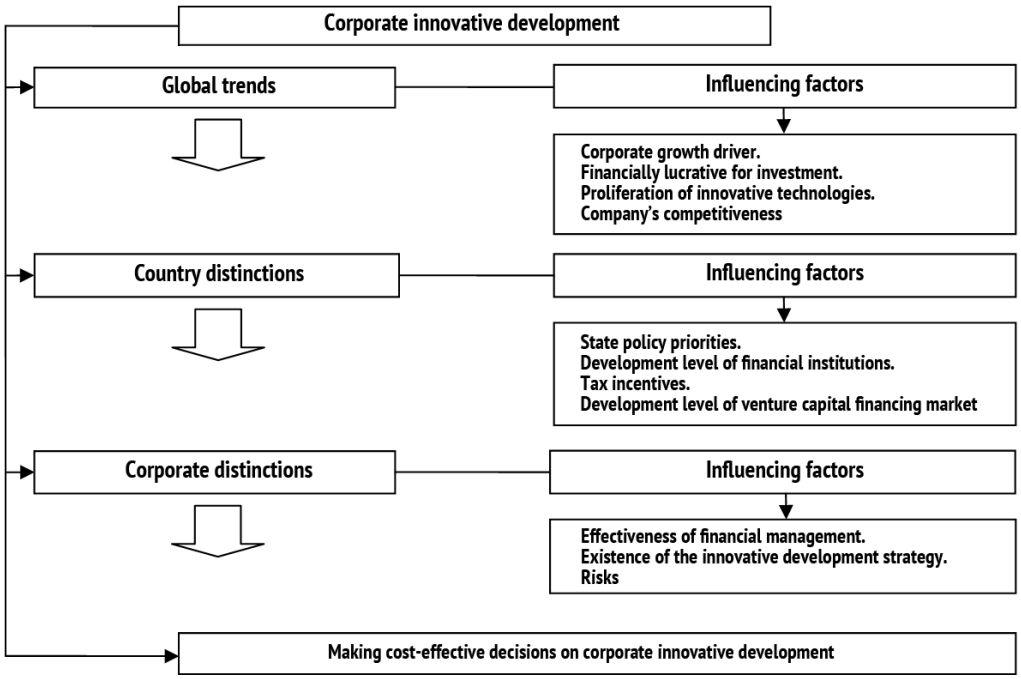
Relationship between a long-term growth of companies and their innovative activities from 2014 to 2018, percentage



Source : Ernst & Young. URL: http://www.ey.com/ru/ru/home (In Russ.)

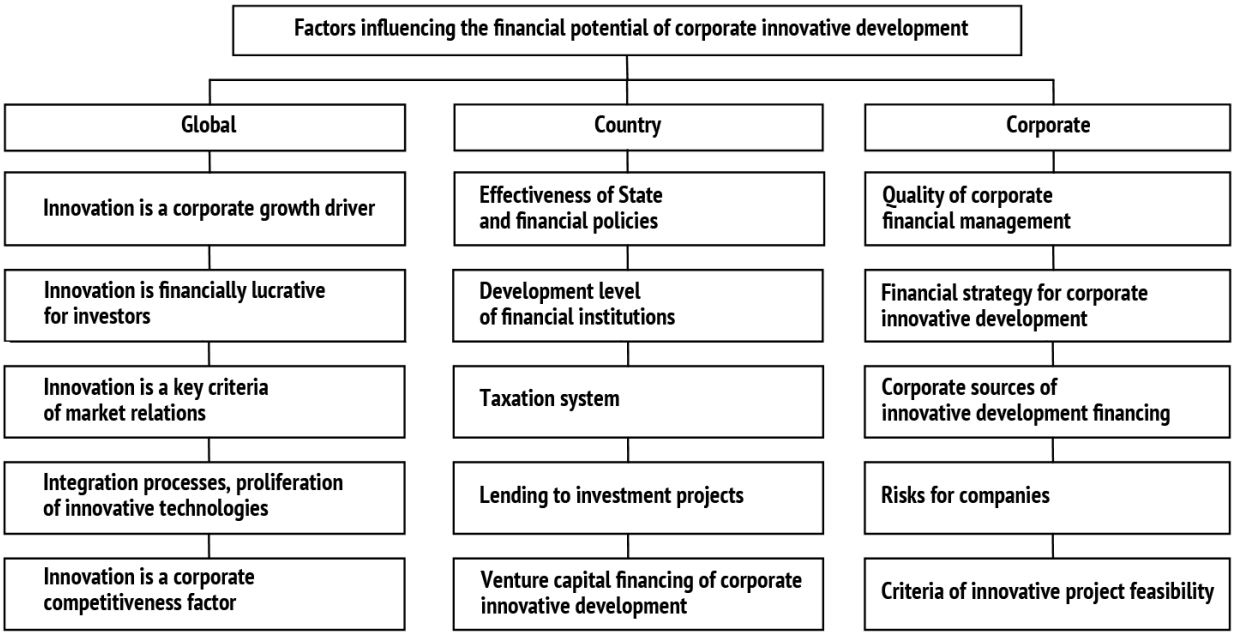
Figure 2

An approach to shaping a system of factors influencing the cost-effective solutions related to corporate innovative development



Source : Authoring

Figure 3
A system of factors influencing the financial potential of corporate innovative development



Source : Authoring

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Conflict-of-interest notification

I, the author of this article, bindingly and explicitly declare of the partial and total lack of actual or potential conflict of interest with any other third party whatsoever, which may arise as a result of the publication of this article. This statement relates to the study, data collection and interpretation, writing and preparation of the article, and the decision to submit the manuscript for publication.

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Securities and Financial Markets

Translated Article†

EVALUATION OF THE MONTH-OF-THE-YEAR EFFECT ON THE SECURITIES MARKETS OF THE BRICS NATIONS

Sergei V. VATRUSHKIN
National Research University – Higher School of Economics, Moscow, Russian Federation
VSV001@ya.ru

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Abstract

Importance This article considers and discusses the issues related to the determination of the month-of-the-year effect on the securities markets of the BRICS nations. For it is known that temporal effects indicate a stock market's low efficiency.

Objectives The article aims to obtain results of a cross-country analysis of the month-of-the-year effect on the stock markets of the BRICS countries and determine the efficiency of the markets under consideration.

Methods For the study, I used the regression and econometric analyses approaches applying the Microsoft Excel and Gretl software.

Results I examined the stock exchanges of the BRICS countries and determined the stability of the month-of-the-year effect. The latter is defined only for the IBOV, RTS, and TOP40 indexes, which are the major market ones in the Brazilian Stock Exchange (BM&FBOVESPA), Moscow Exchange, and the Johannesburg Stock Exchange Limited, respectively. Based on the findings, I present the estimated degree of information efficiency of each of the analyzed markets. The obtained results may also be used to develop a trading strategy to increase the profitability of multinational investment portfolio.

Conclusions and Relevance The article concludes that the month-of-the-year effect is individual concerning only several indexes under consideration. This contradicts the efficient-market hypothesis, according to which the financial asset quotes get formed independently.

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Introduction

The leading hypothesis of pricing on stock markets is the *Efficient-Market Hypothesis* by Eugene F. Fama [1]. According to this hypothesis, there are three forms of market efficiency.

1. *Weak Form Efficiency*. The value of the asset reflects all past information regarding the asset.
2. *Semi-Strong Form Efficiency*. The value of the asset reflects past information plus all available public information.
3. *Strong Form Efficiency*. The value of the asset reflects all the information: past, public, and the insider one.

Considering the given classification, it is clear that it is not possible to build a trading strategy with profitability surpassing the market profitability on the strong form securities market, as all information is already reflected in prices.

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However, in practice, repeated quote movements were found, depending on a certain period of time, which were later called *Temporal effects*. Their existence testifies to the weak form of the stock market efficiency, and it potentially allows to derive excess return.

This article discusses the *Month-of-the-year effect*, which refers to the unequal distribution of profitability depending on the month of the year. The most common type is the *January effect*, which suggests an abnormally high yield in this month compared to others.

The article aims to obtain certain results of a cross-country analysis of the Month-of-the-year effect on the stock markets of the BRICS countries, as well as determine their effectiveness.

The Month-of-the-Year Effect Study Coverage

The basic provisions of the random-walk theory of stock market prices on the securities markets were formulated by L. Bachelier in 1900 [2]. This formed the basis for the definition of the mentioned three forms of efficiency of E.F. Fama.

The first observations of unequal distribution of prices were made in the U.S. market back in the 1930s. For example, F.C. Kelly noted that *Monday* was the worst day for securities purchases [3]. Around that time, M.J. Fields presented the results showing that the best day for investment was *Saturday*, the week-end day (at that time, the U.S. stock markets were open and trading six days a week) [4].

Later, the researchers began studying the relationship between the *January effect* and the *Monday effect*. R.J. Rogalski was one of the first to consider simultaneously the *Company size*, *Monday effect*, and the *January effect* [5]. He found that in January, the average yield for all sizes of companies was positive, and in other months, it was negative.

R.A. Ariel says that the hypothesis of the relationship between the *January effect* and the *Holiday effect* has not been confirmed and the increased profitability of January can not be explained by the Holiday effect [6]. The relationship between the *Day-of-the-week effect* and *Small companies*, and the *Holiday effect* was not found, either.

Chan-Wung Kim and Jinwoo Park say about the independence of the *January effect* from the *Holiday effect* in the UK, Japan, and the USA [7]. Therefore, we can say that there is no relationship between the formation of the *Month-of-the-year effect* and other *Calendar anomalies*.

At the same time, A. Agrawal and K. Tandon conducted one of the most significant studies in terms of the coverage of countries and temporal effects studied [8]. They covered five temporal effects (*Holiday effect, Turn-of-the-month effect, Month-of-the-year effect, Friday the 13th effect, End-December effect*) for 18 countries, including ten European countries (Luxembourg, Denmark, France, Germany, Belgium, Italy, Sweden, Netherlands, Switzerland and the United Kingdom), three Asian countries (Japan, Hong Kong and Singapore), and two Latin American countries (Mexico and Brazil), as well as Australia, Canada and New Zealand. Together with the USA, these countries make 95 percent of the world exchange capital. The researchers determined a high yield in January in most countries and significant seasonality by month in nine countries.

E. Balaban found the January effect in Turkey [9].

At the same time, the considered temporal effect is defined not only for stock markets. For instance, S.D. Jordan and B.D. Jordan were studying the *Month-of-the-year effect* on the basis of Dow Jones Composite Bond Average [10]. They showed that the yield of bonds had seasonality different from the securities market's one, and thus confirmed the existence of the January effect for corporate bonds.

A.L. Redman, H. Manakyan and K. Liano consider the January effect of real estate market indexes through the study of Real Estate Investment Trusts (REIT) and Center for Research in Security Prices Value-Weighted and Equal-Weighted indexes – CRSP-VW index and CRSP-EW index [11]. The researchers find that the January effect is characteristic for CRSP EW and REIT.

The impact of news can be called one of the main explanations of temporal effects, including the January effect. If the temporal effects really depend on the news, the market where firms report their profits,

must be more seasonal than the index, where they do not.

D.R. Peterson checked this hypothesis concerning the January effect [12]. As a result, the index with no news, shows a greater seasonality compared to the index with the news. Therefore, it is unlikely that seasonality in yield is caused by the news about returns.

Zainudin Arsad and J.A. Coutts published an article that dealt with the UK stock market, namely the FTO index of the London Stock Exchange (LSE) over a 60-year period [13]. They aimed to confirm the existence of the January effect, as well as determine the possibility of gaining additional profits through temporal effects. The January effect was confirmed, but it turned out that given the persistence of temporal effects, it is impossible to gain excess return because of transaction costs.

W.S. Compton and R.A. Kunkel studied the feasibility of profit making from the *Weekend effect*, *January effect*, and the *Turn-of-the-month effect*, using individual pension accounts [14]. They reviewed the data of the Teachers Insurance and Annuity Association – College Retirement Equities Fund (TIAA-CREF) and used six strategies. The first two *Buy-and-Hold* strategies are used for two pension funds of the stock and bond market. The other four ones use a strategy based on the transfer of money between the equity account and the money account, and between the money account and the equity or bond account. The researchers show that investors can win through the strategy of switching pension accounts. The Turn-of-the-month effect strategy surpasses the strategy based on the Weekend effect. However, there are several problems. First, there is a *free-rider problem*. The strategy gets funded through the buy-and-hold strategy. Second, managed funds, which are to sell and buy, face the various challenges.

Chin-Chen Chien, Cheng-few Lee and A.M.L. Wang argue that the use of a dummy variable model leads to incorrect conclusions [15]. As a rule, the null hypothesis of equality of returns in all months is incorrectly rejected, as soon as the yields of shares show greater volatility for the period under review. The detection of the January effect can be associated with the use of a wrong statistical technique, which is proved when considering the CRSP-VW index.

The Investigated Data

As the data for study, we take the values of the indexes of IBOV, MICEX, RTS, SENSEX, NIFTY, HSI, SHCOMP, and TOP40, which are the major market ones for the Brazilian Stock Exchange (BM & FBOVESPA), the Russian Exchange (PAO Moskovskaya Birzha – Moscow Exchange), Bombay Stock Exchange Ltd. (BSE), National Stock Exchange of India Limited (NSE), Hong Kong Exchanges and Clearing Limited (HKEx), Shanghai Stock Exchange (SSE), and the Johannesburg Stock Exchange Limited (JSE Limited). Thus, all the stock markets of the BRICS nations are under consideration.

Simultaneous considering of several trading floors helps diversify risk, and also take into account the peculiarities of formation of the Turn-of-the-month effect for each particular country.

In order to determine the stability of the considered temporal effect for each country, the total sample is divided into five-year sub-periods. All the data taken cover the period from the beginning of data publication till June 30, 2015. *Fig. 1* shows the periods of study of each particular index as a time axis.

The Research Methodology

The GARCH (1,1) model (which stands for *Generalized Autoregressive Conditional Heteroscedasticity*), first developed by T. Bollerslev (1986) [16], is used as the principal one. Its distinctive feature is that it takes into account the heteroscedasticity, revealed by the results of testing time series of stock indexes.

Using the other two models with conditional heteroscedasticity GRJ-GARCH (or TGARCH) developed by L.R. Glosten, R. Jagannathan and D.E. Runkle [17], and EGARCH developed by D.B. Nelson [18] is inexpedient, as it was confirmed by E.A. Fedorova and E.V. Gilenko [19], because the factors that are responsible for the effect of negative values of the previous series are insignificant.

The index yield is a dependent variable, which gets calculated by the following formula

$$R_t = \ln\left(\frac{l_t}{l_{t-1}}\right) \cdot 100,$$

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where R_t is the index yield on day t, calculated as a yield in logarithmic form from the previous trading day closing to the current trading day closing;

I_t is the I-index value at-the-close of day t;

I_{t-1} is the I-index value at-the-close of day t – 1.

When considering the Month-of-the-year effect, the values of the daily yields in one of the months of the year are used as independent variables.

The GARCH model for determining the Month-of-the-year effect is as follows:

$$R_t = D_{\text{Jan}} R_{\text{Jan}} + D_{\text{Feb}} R_{\text{Feb}} + D_{\text{Mar}} R_{\text{Mar}} + \\ + D_{\text{Apr}} R_{\text{Apr}} + D_{\text{May}} R_{\text{May}} + D_{\text{June}} R_{\text{July}} + \\ + D_{\text{Aug}} R_{\text{Aug}} + D_{\text{Sept}} R_{\text{Sept}} + D_{\text{Oct}} R_{\text{Oct}} + \\ + D_{\text{Nov}} R_{\text{Nov}} + D_{\text{Dec}} R_{\text{Dec}} + \varepsilon_t,$$

where D_{Jan} ... D_{Dec} is the dummy variable equal to 1, if the yield on the studied day falls on a certain month of the year, and 0, if otherwise;

R_{Jan} ... R_{Dec} are the regression coefficients.

In the model, the smoothing is as follows:

$$\varepsilon_t \sim N(0, \sigma_t^2),$$

where $\sigma_t^2 = \omega + \alpha \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2$, ω is the constant; α is the short-term shock incidence; β is the long-term shock incidence.

Because the conditional variance must be non-negative, the following conditions are applied to the model:

$$\omega > 0, +\alpha \geq 0 \text{ и } \beta \geq 0.$$

Also, the model removes the constant in order to avoid full multicollinearity, for if maintaining it, the sum of the dummy variables would be equal to the constant.

The hypothesis on equality of coefficients is tested (constant return is independent from the month of the year):

$$H_0: \\ R_{\text{Jan}} = R_{\text{Feb}} = R_{\text{Mar}} = R_{\text{Apr}} = R_{\text{May}} = R_{\text{June}} = \\ = R_{\text{July}} = R_{\text{Aug}} = R_{\text{Sept}} = R_{\text{Oct}} = R_{\text{Nov}} = R_{\text{Dec}};$$

$$H_1: \\ R_{\text{Jan}} \neq R_{\text{Feb}} \neq R_{\text{Mar}} \neq R_{\text{Apr}} \neq R_{\text{May}} \neq R_{\text{June}} \neq \\ \neq R_{\text{July}} \neq R_{\text{Aug}} \neq R_{\text{Sept}} \neq R_{\text{Oct}} \neq R_{\text{Nov}} \neq R_{\text{Dec}}.$$

If the null hypothesis is rejected, then the yield distribution in each of the months of the year is unequal, which indicates the existence of the Month-of-the-year effect.

The Research Findings and the Interpretation

The descriptive statistics of the Month-of-the-year effect on the stock markets of the BRICS countries are presented in *Table 1*.

When considering the IBOV index of the Brazilian Stock Exchange, it should be noted that two significant negative coefficients are found in May from 2010 to 2015 and in October from 1970 to 1974. All other significant coefficients are positive.

Concerning the general period, we can see that in January, the significant coefficient has the greatest value, which confirms the January effect. Moreover, in most sub-periods, there is also a significant positive coefficient. This indicates the stability of the January temporal effect for the Brazilian Stock Exchange.

When considering the results of the RTS index of the Russian market, the hypothesis of the existence of the January effect is not confirmed, even in spite of the significant positive coefficient for the whole period, because no significant positive coefficient has been found for any of the sub-periods. This indicates the volatility of the temporal effect. However, the February effect is clearly observable, as in this month, there are significant positive coefficients in all periods except 1995–2000.

The Moscow Exchange MICEX index does not confirm the January effect either, as unstable results have been obtained. However, significant and positive coefficients in January and February are typical for the general period and the last time segment.

If we consider the results of the SENSEX index of the Bombay Stock Exchange, we can say that the significant coefficients are distributed fairly equally, and it is not possible to reveal any pattern. For this

reason, it is impossible to talk about the existence of a certain Month-of-the-year effect.

The NIFTY index of the National Stock Exchange of India Limited has been considered also. It is evident that the positive coefficients are significant at the end of the year, mainly, but the stability of their formation does not support this or that temporal effect of the month.

Quite a number of positive and significant coefficients are characteristic of the Hong Kong Exchanges and Clearing Limited HSI index. However, they depend heavily on the time period under review. Therefore, it is impossible to declare the existence of the temporal effect of any month, although in January, only positive coefficients are significant.

A large number of positive and several negative significant coefficients are also observed on the Shanghai Stock Exchange SHCOMP index. However, they depend heavily on the time period under consideration, so it is not possible to speak of a month's temporal effect.

The Johannesburg Stock Exchange Limited TOP40 index is the final one in the list to consider. Only positive coefficients are significant here. All of them belong to the second half of the year. So we can talk about the existence of the second half of the year effect, or more strictly, the December effect.

Thus, the January effect is confirmed only for the IBOV index of the Brazilian Stock Exchange. In addition, the February effect for the RTS index and the December effect for TOP40 index were found. For all the rest indexes, there is an equal distribution of positive coefficients during the year, which does not allow to state the effect of any month.

Conclusion

The article achieved the main objective in the form of the results of the cross-country analysis of the Month-of-the-year effect on the stock markets of the BRICS countries. As well, it determines the estimated form of information efficiency of the markets under consideration.

The objects of the study were the Russian Exchange (PAO Moskovskaya Birzha – Moscow Exchange), Brazilian Stock Exchange (BM & FBOVESPA), Bombay Stock Exchange Ltd. (BSE), National Stock Exchange of India Limited (NSE), Hong Kong Exchanges and Clearing Limited (HKEx), Shanghai Stock Exchange (SSE), and the Johannesburg Stock Exchange Limited (JSE Limited).

To achieve the goal, the previous results in the field of the Month-of-the-year effect research were summarized. A unique econometric model was built. It helps get the most relevant results.

Table 2 presents the main conclusions about the existence and stability of the Month-of-the-year effect.

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Table 1

Evaluation of the Month-of-the-year effect on stock indexes of the BRICS countries

Month	All-time Period	Till 1970	1970–1974	1975–1979	1980–1984	1985–1989	1990–1994	1995–1999	2000–2004	2005–2009	2010–2015
Brazil / BM&FBOVESPA / IBOV											
January	0.28***	0.42**	−0.04	0.36***	1.19***	0.12	2.37***	0.56***	0.02	0.14	−0.09
February	0.25***	0.92***	0.21	0.09	0.39***	1.34***	2.55***	0.31	−0.01	0,12	0.04
March	0.15***	0.21	0.35**	0.02	0.09	1.52***	0.77*	0.41**	−0.03	−0.02	0.09
April	0.22***	0.55*	0.31*	0.02	0.48***	1.04***	0.89**	0.31*	−0.04	0.31*	−0.02
May	0.22***	1.01**	−0.08	0.27**	0.56***	0.61*	1.51***	0.29	0.002	0.23	−0.2*
June	0.05	−0.29	−0.18	0.04	0.28***	0.45	1.25***	0.3	−0.009	−0.04	−0.09
July	0.15***	0.19	0.54***	0.14	−0.14	0.81**	1.27***	0.06	−0.04	0.1	0.19
August	0.2***	0.23	0.25	0.19**	0.24**	0.54*	0.93***	−0.07	0.2	0.04	0.09
September	0.22***	0.48**	−0.003	0.23*	0.28*	1.26***	0.84**	0.23	−0.17	0.32**	0.03
October	0.04	−0.11	−0.37**	−0.18	0.72***	1.12***	−0.13	0.03	0.21	0.16	0.09
November	0.03	−0.21	−0.19	−0.19	0.02	−0.03	0.65*	0.34**	0.33*	0.23	−0.08
December	0.17***	−0.02	0.16	0.05	0.45	0.48	1.15***	0.37*	0.35**	0.19	0.04
Russia / Moscow Exchange / RTS											
January	0.16*	–	–	–	–	–	–	0.14	0.18	−0.01	0.21
February	0.34***	–	–	–	–	–	–	0.23	0.32*	0.38**	0.3*
March	0.03	–	–	–	–	–	–	−0.15	0.27	0.004	−0.08
April	0.1	–	–	–	–	–	–	−0.06	0.27	0.19	−0.06
May	0.01	–	–	–	–	–	–	0.3	0.23	0.2	−0.34**
June	0.15	–	–	–	–	–	–	0.92***	0.11	0.11	0.05
July	0.08	–	–	–	–	–	–	0.27	−0.14	0.19	0.07
August	0.15*	–	–	–	–	–	–	−0.17	0.49***	0.17	−0.11
September	0.1	–	–	–	–	–	–	−0.37*	0.1	0.28	0.21
October	0.2**	–	–	–	–	–	–	0.27	0.3	0.15	0.13
November	0.07	–	–	–	–	–	–	0.15	−0.04	0.29**	−0.12
December	0.16*	–	–	–	–	–	–	0.08	0.13	0.28	0.22
Russia / Moscow Exchange / MICEX											
January	0.19**	–	–	–	–	–	–	−0.45	0.26	0.17	0.22**
February	0.37***	–	–	–	–	–	–	0.66	0.24	0.27	0.37***
March	0.01	–	–	–	–	–	–	0.58	0.32*	0.01	−0.16
April	0.06	–	–	–	–	–	–	−0.08	0.32*	0.15	−0.09
May	0.03	–	–	–	–	–	–	−0.79	0.29	0.19	−0.14
June	0.1	–	–	–	–	–	–	0.8	0.03	0.09	0.1
July	0.04	–	–	–	–	–	–	−0.64	−0.25	0.19	0.06
August	0.11	–	–	–	–	–	–	−0.51	0.35**	0.16	−0.04
September	0.11	–	–	–	–	–	–	−0.32	−0.04	0.18	0.18
October	0.24***	–	–	–	–	–	–	1.56***	0.25	0.18	0.16
November	0.07	–	–	–	–	–	–	0.64	−0.08	0.25*	−0.004
December	0.16	–	–	–	–	–	–	0.22	0.07	0.26	0.12
India / BSE Ltd / SENSEX											
January	0.02	–	–	–	–	0.24	0.29	−0.23	0.01	0.13	−0.01
February	0.02	–	–	–	–	−0.08	0.16	0.33**	0.19	0.09	−0.03
March	0.02	–	–	–	–	−0.06	0.02	0.02	−0.29*	0.04	0.13
April	0.04	–	–	–	–	0.36*	−0.02	0.32*	−0.32**	0.15	0.002
May	0.08	–	–	–	–	−0.09	0.13	0.05	0.17	0.23*	0.02
June	0.15***	–	–	–	–	0.15	0.12	0.18	0.16	0.09	0.15*
July	0.05	–	–	–	–	−0.04	0.33**	0.04	0.05	0.21	0.001
August	0.08	–	–	–	–	−0.08	0.59***	−0.08	0.11	0.14	−0.01

September	0.15***	–	–	–	–	0.17	–0.03	0.04	0.06	0.35***	0.26***
October	0.04	–	–	–	–	0.02	–0.09	–0.19	0.07	0.03	0.16
November	0.11**	–	–	–	–	–0.29	–0.0005	–0.27*	0.42***	0.26**	0.06
December	0.12**	–	–	–	–	0.21	–0.16	0.32**	0.26***	0.21	–0.01
India / NSE / NIFTY											
January	0.01	–	–	–	–	–	–	–0.12	0.02	0.17	–0.003
February	0.06	–	–	–	–	–	–	0.37*	0.17	0.04	–0.03
March	0.06	–	–	–	–	–	–	0.02	–0.28*	0.1	0.14
April	0.01	–	–	–	–	–	–	0.38*	–0.29**	0.08	0.01
May	0.1	–	–	–	–	–	–	–0.01	0.18	0.24*	0.03
June	0.15***	–	–	–	–	–	–	0.23	0.17	0.07	0.14
July	0.01	–	–	–	–	–	–	0.05	–0.005	0.16	–0.005
August	0.06	–	–	–	–	–	–	–0.13	0.13	0.16	–0.02
September	0.16**	–	–	–	–	–	–	–0.02	0.03	0.32**	0.27***
October	0.09	–	–	–	–	–	–	–0.24	0.07	0.03	0.16
November	0.17***	–	–	–	–	–	–	–0.25	0.41***	0.27**	0.06
December	0.16***	–	–	–	–	–	–	0.35**	0.26***	0.22	–0.005
China / HKEx / HSI											
January	0.14***	–	0.23**	0.017	0.41**	0.25**	0.14	0.15	0.01	0.08	0.08
February	0.09**	–	0.003	0.067	–0.09	0.21	0.3**	0.23	0.004	0.09	0.05
March	–0.05	–	0.02	0.162	–0.3	0.01	0.09	–0.09	–0.22*	–0.14	–0.09
April	0.16**	–	0.25**	0.147	0.4**	0.25**	0.01	0.02	0.02	0.22**	0.12
May	0.09**	–	0.21	0.053	0.1	0.12	0.34***	0.21*	0.08	0.0005	–0.1
June	0.04	–	0.21	–0.004	0.15	0.18	–0.08	0.02	–0.03	0.1	–0.09
July	0.16***	–	0.26*	–0.044	0.12	0.31***	0.19*	–0.0006	0.04	0.25**	0.2**
August	–0.01	–	0.05	0.033	–0.12	–0.09	0.34	0.003	0.15	0.02	–0.08
September	0.04	–	–0.07	–0.052	–0.52**	0.18*	–0.15	0.22*	–0.06	0.16	0.14
October	0.2***	–	0.01	0.033	0.34*	0.76***	0.3**	0.19	0.08	0.05	0.18*
November	0.11***	–	–0.04	0.066	0.28*	0.02	–0.03	0.27**	0.23**	0.1	0.02
December	0.11***	–	0.28***	0.261**	0.11	0.16	0.16	0.11	–0.02	0.04	–0.007
China / SSE / SHCOMP											
January	0.09	–	–	–	–	–	0.25***	–0.13	–0.07	0.19	–0.06
February	0.15**	–	–	–	–	–	0.31***	–0.71***	0.09	0.23	0.15
March	–0.001	–	–	–	–	–	0.08	0.26*	0.18*	–0.05	–0.06
April	0.05	–	–	–	–	–	–0.38***	0.2	–0.04	0.3*	0.02
May	0.09	–	–	–	–	–	0.05	2.64***	0.11	0.14	–0.08
June	0.01	–	–	–	–	–	0.66***	0.08	–0.08	0.19	–0.21**
July	0.01	–	–	–	–	–	–0.08	0.03	–0.02	0.12	0.07
August	0.06	–	–	–	–	–	0.95***	0.08	–0.05	0.08	–0.01
September	–0.02	–	–	–	–	–	0.19	0.1	–0.18*	0.14	0.11
October	0.11*	–	–	–	–	–	0,85***	0.01	–0.02	0.01	0.13
November	0.13**	–	–	–	–	–	0.79***	–0.22*	0.09	0.13	–0.04
December	0.14**	–	–	–	–	–	0.59***	–0.2	–0.06	0.29**	0.08
SAR / JSE Limited / TOP40											
January	0.07	–	–	–	–	–	–	–	0.03	0.08	0.08
February	0.08	–	–	–	–	–	–	–	–0.07	0.08	0.08
March	0.01	–	–	–	–	–	–	–	–0.19	–0.001	–0.001
April	0.01	–	–	–	–	–	–	–	–0.13	0.05	0.05
May	0.08	–	–	–	–	–	–	–	0.28	–0.01	–0.01
June	–0.01	–	–	–	–	–	–	–	–0.17	0.01	0.01
July	0.12**	–	–	–	–	–	–	–	–0.03	0.11	0.11
August	0.09	–	–	–	–	–	–	–	0.32**	0.002	0.002

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September	0.12*	–	–	–	–	–	–	–	0.04	0.12	0.12
October	0.12**	–	–	–	–	–	–	–	0.06	0.17**	0.17**
November	0.07	–	–	–	–	–	–	–	0.15	0.05	0.05
December	0.16**	–	–	–	–	–	–	–	0.12	0.16*	0.16*

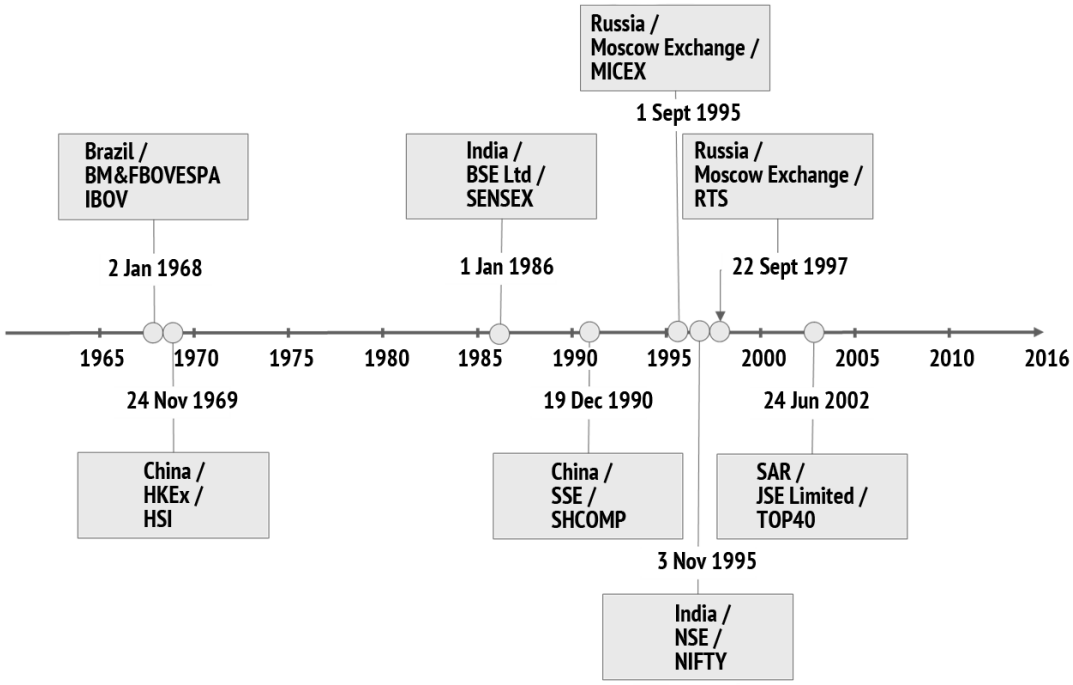
*, **, *** – Significance level: 10%, 5%, and 1%, respectively.
Source: Authoring

Table 2
The Month-of-the-year effect for the BRICS countries

The Market under Consideration (Country / Exchange / Index)	The Result
Brazil / BM&FBOVESPA / IBOV	January effect
Russia / Moscow Exchange / RTS	February effect
Russia / Moscow Exchange / MICEX	Not observed
India / BSE Ltd / SENSEX	Not observed
India / NSE / NIFTY	Not observed
China / HKEx / HSI	Not observed
China / SSE / SHCOMP	Not observed
SAR / JSE Limited / TOP40	December effect

Source: Authoring

Figure 1
The periods of consideration of the BRICS countries' indexes in 1965–2016



Source: Authoring

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Conflict-of-interest notification

I, the author of this article, bindingly and explicitly declare of the partial and total lack of actual or potential conflict of interest with any other third party whatsoever, which may arise as a result of the publication of this article. This statement relates to the study, data collection and interpretation, writing and preparation of the article, and the decision to submit the manuscript for publication.

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Translated Article†

CALENDAR ANOMALIES IN THE RUSSIAN STOCK MARKET: TRENDS OF THE RECENT DECADE

Danila V. VAL'KO
South Ural Institute of Management and Economics, Chelyabinsk, Russian Federation
valkodv@inueco.ru
https://orcid.org/0000-0002-8058-7539

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Abstract

Importance The article discusses calendar anomalies (behavioral effects) in the Russian stock market and the so called *Day-of-the-week effect* and *Monday effect.*

Objectives The research analyzes the Day-of-the-week effect and Monday effect, referring to 2007–2017 data of the Russian stock market and identifies behavioral differences between stock markets in Russia and economically developed countries.

Methods The research employs a set of systemic methods, such as structural-logical and factor analysis. I analyze empirical patterns using standard statistical methods.

Results Featuring abnormally low profitability on Wednesday, the Day-of-the-week effect also perseveres after the consolidation of trading platforms of the Moscow Exchange (MICEX) and Russian Trading System (RTS). In the mean time, although earlier studies captured the Friday effect, significantly high return has been recorded on Monday for the recent decade.

Conclusions and Relevance The Russian stock market resembles those ones of the most developed countries in terms of the Day-of-the-week effect and other behavioral characteristics. However, the domestic stock market is subject to ratchet effects that are observed in ties with other financial centers and economic cycles as a whole. This explains why Friday and Monday effects switch to Monday and Wednesday respectively.

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Introduction

Several recent decades have seen the Nobel Prize be awarded to scholars specializing in behavioral finance. These are H. Simon [1] (1978), R Selten [2] (1994) and D Kahneman [3] (2002). Their proceedings ignited researches into the way economic agents make decisions and stock markets behave. Notwithstanding the different nature of such studies (samples, markets, analyzable period), scholars recorded similar phenomena, which failed to meet the hypothesis of effective market and contradicted the Capital Asset Pricing Model (*CAPM*), pricing model for non-current assets[1].

Traced in the process of stand-alone observations of breaches in the rational economy principles or efficient market models, such phenomena can be conditionally qualified as anomalies. Nowadays a critical mass of such empirically proven observations of anomalies has

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converted into systemic constructs, which are classified or persuasively construed from perspectives of behavioral economics.

Influencing the behavior of prices and depending on repeating constituent of time, calendar anomalies were the first phenomenon that was discovered, i.e. month-of-the-year effect, day-of-the-week effect, year-end or year-beginning effect, holiday effect (after-holiday), etc. [4]. The Monday effect was one of the first phenomena that was discovered in all analyzable markets during certain periods under study, thus being the most interesting one. It was subsequently generalized to become the *day-of-the-week effect*.

The Monday effect causes a negative trend in a stock market, such as a stock index decline, drop in quotations of some companies' stocks at the beginning of a business week in comparison with other days. Basically it seldom demonstrates any direct relationship with the market closing. The effect is believed to have been discovered by M.J. Fields [5] (1931) and subsequently verified by F. Cross [6] (1973) and K. French [7] (1980), while studying weekly return on the U.S. companies' stocks for the period within 1953 to 1977.

Afterwards, in 1988 J. Lakonishok and S. Smidt screened the 90-years data (1897–1987) for such an effect [8]. Like K. French, they found out that the return was much less than nil on Monday. Later on, analyzing the U.S. Standard & Poors 500 (S&P500) in 1977, A. Kamara [9] demonstrated that the stock index was still exposed to the Monday effect, albeit to a lesser extent. Furthermore, A. Kamara figured out that the effect had been gradually declining from 1962 up to 1993 with respect to portfolio of shares held by the U.S. mid caps.

It is not only the U.S. stock market where such calendar anomalies were found. In one of the recent researches into the identification of calendar anomalies, A. Agrawal and K. Tandon conducted an ample analysis of stock markets in 19 countries [10], which totally accounted for 95 percent of total capitalization of stocks worldwide. The research verified the day-of-the-week effect in most of the developed markets. However, the effect is recorded on different days. The holiday effect is seen in the USA, United Kingdom, Canada, Germany, Italy, Brazil. The Tuesday effect is traced in Japan, France, Australia, Hong Kong, Belgium, Singapore, while the Friday effect is common almost for all the developed and emerging economies.

The day-of-the week effect was detected in the Russian stock market within the period from 1998 through 2007. However, the horizon of such researches is not enough to determine what circumstances and aspects make the market behave this way. There is some gap in empirical studies into this effect covering the period from 2007 up to the date.

This research is an attempt to analyze how the day-of-the-week effect and Monday effect were developing in the Russian market for the period of 2007–2017, respectively identifying behavioral differences between the Russian stock market and those ones in economically advanced countries. Pursuing this objective, I scrutinize key studies into the effect on stock markets of developed economies and pay attention to the Russian one.

Monday Effect in Stock Markets of Advanced Economies

In 1987, J.F. Jaffe, R. Westerfield, C. Ma [11] released their research stating that untypically low return on Monday follows a stock market decline seen the previous week. Indeed, they observed the correlation of the Monday and Fridays effects. The first almost fades away provided that the market rose earlier (on Friday). To say it in other words, there is a positive correlation between return on Monday and return on Friday that preceded it. The research relied upon daily data on stock exchange indices of some advanced countries, such as S&P 500 (USA, about 1,300 observations) from January 2, 1930 through December 30, 1962, NIKKEI (Japan, about 650 observations) from January 5, 1970 through April 30, 1983, TSX (Canada, about 400 observations) from January 2, 1976 through November 30, 1983, Statex Actuaries Index (Australia, about 550 observations) from March 1, 1973 through November 30, 1982, and Financial Times Ordinary Share Index (United Kingdom, about 1,600 observations) from January 2, 1950 through November 30, 1983.

Having analyzed the data sets, I found that return on Monday seriously depended on that registered the previous week. Return on stocks in each analyzable period is higher on Monday on average (about 0.08), if

the index behaved positively the previous week and vice versa (on average –0.22, with some distinctions in the United Kingdom). The authors explain such distinctions of the Monday effect as follows.

1. First of all, the correlation may be deceitful, with its higher value arising from autocorellation and aggregated data used for analysis purposes, rather than individual transactions. To verify the statement, the authors corroborated the significance of relationship between return on Monday after the market grows and before the market falls. It debunked the assumption about a false correlation.
2. Another explanation refers to an increase in the risk (associated with return) on Monday after the market growth the previous week and some decline in case of the market slowdown the previous week. However, this reason does not correspond with estimated standard deviation as a risk metric. In each of the analyzable countries, standard deviation of return on Monday is higher after the stock market fall the previous week than after its growth.
3. Similar effect exists throughout the whole week. The authors verified this explanation by constructing a regression model, where return on a particular day is a dependent variable of return recorded for the previous week. As a result, the model appeared to be meaningful for four of the five countries (by *t*-test) on with respect to Monday.

In 2001, J.M. Steeley [12] released his research on the United Kingdom, where he mentioned that the end-of-the-week effect disappeared in the UK markets in the 1990s. The research analyzes FTSE100 by daily records from April 3, 1991 through May 19, 1998 (about 1,800 observations). Whereas inputs do not report on any substantial difference between yields by day of the week, these authors and their followers examine negative sets of yields by day. As a result, in addition to the above observation, they traced a statistically significant return not only on Monday, but also on Friday (–0.0068) in comparison with the middle of the week (average –0.0053). Indeed, they did not detect any considerable day-specific changes in case of positive return.

To elucidate the observations, I analyzed trends reflecting how the British stock market learns about macroeconomic developments. This information appears to come mainly from Tuesday through Thursday, while Monday and Friday are much less informative. In this respect, it is possible to conclude that the absence of news during those days brings the return to lower levels since brokers are generally inclined to buy. It is primarily Monday when they lure investors to sell. This explanation is quite reasonable upon the whole.

Furthermore, in 2001, S. Mehdian and M.J. Perry presented their work on the Monday effect in the U.S. stock market within 1964–1999. The study drew upon daily records on the closing of market trade with respect to five principal indices of large corporations in the U.S. stock market: Dow Jones Composite Average (DJCOMP), New York Stock Exchange index (NYSE), S&P500, stocks of smaller companies (small caps' stocks), i.e. National Association of Securities Dealers Automated Quotation (NASDAQ) and Russell 2000 (RUSSELL). The sample period lasts from June 4, 1964 through February 6, 1998 and comprises 8,301 daily observations, except for RUSSELL, which is counted starting from January 2, 1979.

This research points out that during the period up to 1987 return on Monday was considerably negative for all the five U.S. stock indices analyzed herein (NYSE, S&P500, DJCOMP, NASDAQ, RUSSELL). It corroborates conclusions of the previous researches. In case of the period after 1987, the Monday effect was found to be distorted in relation to high caps' indices, i.e. higher return on Monday. Moreover, the U.S. stock indices of high caps (NYSE, S&P500, DJCOMP) and small caps (NASDAQ, RUSSELL) were considerably different in terms of the Monday effect.

The main conclusion is that the Monday effect is unstable, changing over time. Many empirical studies for the period of the complete samples within 1964 through 1998 and 1964 through 1987 proved to be true. These are:

- return on Monday is negative or much lower than return during the rest of the week (average –0.06 and –0.11 for respective periods);
- return on Monday has a positive correlation with the return of the previous week;
- negative Monday effect is mainly observed during the last two weeks of a month.

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In the mean time, the following observations of the period after 1987 were made:

- on Monday three high caps' indices generate positive return (about 0.09), with negative or insignificant return being derived from indices that mainly pertain to small caps (about – 0.03);
- statistically meaningful differences of Monday return from DJCOMP, S&P500 и NYSE and return for the rest of the week were not found. On the contrary, Monday return and return for the rest of the week are not that different in case of NASDAQ and RUSSEL (about 0.02), but statistically meaningful;
- Monday return does not correlate with return for the previous week in case of all the indices, except for NASDAQ and RUSSEL;
- positive Monday effect is registered in case of DJCOMP, S&P500 and NYSE during the first three weeks of a month, while in case of NASDAQ and RUSSEL Monday return is negative during the last two weeks of a month, being significantly low in comparison with Monday during the first three weeks of a month.

The latter results generally validate the above conclusions made by A. Kamara stating that the Monday effect decreased considerably. It was also confirmed that the traditional Monday effect morphed in the U.S. stock markets in case of high caps. The detected difference between Mondays of the same month corresponds with the findings made by K. Wang, Y. Li, J. Erickson, et al. In 1997 [14], indicating that the calendar-based nature stems from the size (capitalization) of a company. Furthermore, the positive Monday effect in case of S&P500, DJCOMP and NYSE may result from low market efficiency, that is not considered as an anomaly in the stock market since return on Monday is not much higher than the return of the rest of the week, without depending on the market situation.

Monday Effect in the Russian Stock Market

In 2004, M. Kurashinov [15] carried out a similar research into the Russian stock market referring to two national indices – RTS index and MICEX index. The RTS and MICEX indices were analyzed from August 1, 1998 through August 31, 2004, and July 1, 1999 through August 31, 2004. Friday is showed to be the most income generating day of the week (increment in RTS and MICEX indices is 0.35 and 0.3 respectively). In this respect the Russian stock market resembles most of the Western stock markets, but the average return is much lower than that on the other days of the week. Moreover, the Wednesday return is obviously lower than nil (average –0.27), while the return of the other days is positive. It allows to reveal the explicit form of the Wednesday effect, which has not been registered in the Western stock markets.

Thus, it is possible to conclude that more successful traders, who support the trend, capture their profit, while other actors worry about a possible loss of their current profit, thus closing their positions as soon as the trend rebound shows off. As a result, the market adapts.

In the research by M. Kantolinskii[2] in 2010, the average daily return of RTS index (September 1, 1995 through April 28, 2007) and MICEX Index (September 22, 1997 through April 28, 2007) indices was analyzed to identify the day-of-the-week effect. The both indices were reviewed by day of the week, without reference to trading on Saturday and Sunday. Having checked the data, the author indicates that signs of the Wednesday effect are detected, considering a small percentage of explained variance, i.e. abnormally low return in the Russian stock market on Wednesday. RTS index demonstrates distinctly negative return on Wednesday (–0.17 against 0.21). The same situation was observed in case of MICEX Index (–0.12 against 0.24).

As the author puts it, the anomaly exists due to the deferred Monday effect and Tuesday effect in developed markets and some of developing ones. This testifies that the behavior of the Russian stocks is of secondary nature with respect to foreign securities. Liquidity flows shape the price trends with a certain lag, while the market depends on the way foreign investors act.

Empirical studies does not describe the subsequent period of transactions in the Russian stock market. Moreover, the recent decade witnesses not only the merger of the two major national trading platforms –

[2] Kantolinskii M.I. [Anomalies in the Russian stock market]. *Moskovskaya mezhdunarodnaya konferentsiya po issledovaniyu operatsii (ORM2010): materialy konferentsii* [Proc. Int. Sci. Conf. Moscow International Conference on Operation Research 2010]. Moscow, MAKS Press Publ., 2010, pp. 488–490.

the Moscow Exchange (MICEX) and Russian Trading System (RTS), but also a big impact the global financial crisis has on Russia. In my opinion, this provides the rationale for further researches into behavioral effects in the Russian stock market.

Methods and Inputs of This Research

The framework of this research includes data on daily values of MICEX Index at the end of the trading day as published on the MICEX website for the period from January 10, 2007 through January 26, 2018. MICEX Index is price-specific, composite, weighted by market capitalization. It covers 50 most marketable stocks belonging to the largest and rapidly growing issuers from Russia, economic activities of which relates to the fundamental economic sectors listed on the Moscow stock exchange. The list of issuers and their percentage in the index are revised on a quarterly basis. *Fig. 1* shows how MICEX Index changes throughout the said period.

The (*r*) index return on the current day is calculated through the following formula:

$$r_t = \frac{MICEX_t - MICEX_{t-1}}{MICEX_{t-1}}.$$

There were 4 and 13 trading sessions on Sunday and Saturday respectively for the analyzable period. Respective data were rejected as insufficient to determine meaningful statistics. I determined whether days of the week differ significantly using conventional methods. Unfortunately, it is problematic to build a regression model (following the method proposed in [7]) to evaluate the share and significance of return of certain days in the total return for the week due to a small percentage of explained variance using the available data.

Results and Discussions

Table 1 presents the average return of the analyzable index by day of the week and main sampling parameters. *Fig. 2* compares the average return by day of the week and the average return for the week.

As the analysis of the findings shows, the Wednesday effect, which was discovered by M. Kantolinskii and M. Kurashinov, persists in the Russian stock market even after the Moscow Exchange MICEX and Russian Trading system RTS merged. If the earlier proceedings feature the Friday effect, i.e. abnormally high return on Friday, I reveal that high return has been registered on Monday for the recent decade. If the average value is analyzed by logarithmic scale, Tuesday will be a turning point for it to become negative. Relatively high return on Monday and relatively low return on Wednesday are recorded among only positive and only negative values, thus defying the explanation about a serial correlation (*Table 1*).

The market behaves this way due to its persistence, or memory [16]. The phenomenon of market memory was pioneered by B. Mandelbrot [17], who unraveled the persistence of market prices, that is the ability of a certain trend to persevere in the market for a period exceeding the process which engendered it.

As the analysis reveals, financial markets have a long-standing memory, which is embodied as persistence or anti-persistence of time series of prices. In case of an anti-persistent and stochastic process, after some variable grows (price is concerned in this case), it usually decreases, and increases in the opposite case.

Market persistence is mainly examined through R/S analysis (Rescaled range analysis), which was devised by the British hydrologist H. Hurst [18]. The Hurst exponent can be located within the section [0, 1] and calculated within the following range:

- $0 \le H < 0.5$ signifies heavy tails in the distribution of variables, anti-persistent series, i.e. negative correlation in return dynamics, pink noise with frequent changes in directions;
- $H = 0.5$ signifies that return changes are incidental, dynamics of prices for financial assets exemplifies the Brownian motion. Time series are adequately distributed. There is no correlation between changes in the value of assets (memory), with the white noise being validated;
- $0.5 < H \le 1$ signifies that there are heavy tails in the distribution of variables, persistent series, i.e. a positive correlation in the way return changes, black noise as evidence of market trends.

To identify the persistence of the analyzable market, it is necessary to pay attention to the Hurst exponent assessed for the entire sample and by day of the week (*Table 2*).

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Analyzing *Table 2*, it is possible to observe that *H* is somewhat higher than 0.5 (except for Thursday). It means that the market return trend is not random in this sense. The fact may be due to two reasons. First, market developments do not have an immediate impact on prices (explanation concerning the invalidity of the market efficiency hypothesis). Second, after a certain period of time ends, the developments have a lower impact on prices for financial assets. This is the case of the market memory, being a well-known behavioral phenomenon. The effect is believed to fade away by the end of a financial week, and the cycle recommences afterwards.

Conclusion

Having reviewed the main outcome of empirical researches analyzing calendar anomalies in stocks markets of developed countries and Russia, I conclude that the behavioral effect originates and develops (it is behavioral economics that allows for the most plausible explanations) in quite a different way in developed and developing markets, as well as in case of developed and developing trading practices. The chronological periods may be linked with the origination of professional participation in the stock market and subsequent predominance of a collective (institutional) investor (mutual trust, non-governmental pension funds, etc.). The collective investor is not an individual, thus behaving in a more balanced and deferred manner to respond to market development, while the professional broker (or other person), which represents it, protects someone else's emotionally charged interests, rather than the broker's own ones.

As for the findings of the empirical results of this research, it is fair to note that the Russian stock market resembles those in most of developed countries in terms of the extent to which the day-of-the-week effect is apparent, and other behavioral distinctions. However, it lacks a consolidated source of macroeconomic information. Moreover, the Russian stock market is exposed to persistence effects emerging from relationships with other financial centers and economic cycles as whole. In my opinion, this is the reason why the Monday and Friday effects morph into the Monday and Wednesday ones, respectively, in Russia. All in all, further researches should be undertaken to clarify whether and how behavioral effects should be used to articulate an investment strategy.

Table 1
Average values of return by day of the week

Metric	Monday	Tuesday	Wednesday	Thursday	Friday	All days
Average return	0.002909	0.000011	−0.000273	0.000221	0.000483	0.000646
Standard deviation	0.063415	0.038152	0.020651	0.020964	0.021222	0.036445
Number of observations	506	532	534	539	533	2,644
Positive values						
Average return	0.018397	0.015133	0.012093	0.013764	0.012353	0.014344
Standard deviation	0.082915	0.029209	0.013953	0.017768	0.019934	0.041439
Number of observations	264	273	266	261	269	1,333
Negative values						
Average return	−0.013987	−0.015928	−0.012547	−0.012494	−0.011612	−0.013281
Standard deviation	0.019366	0.039992	0.018828	0.014908	0.014669	0.023425
Number of observations	242	259	268	278	264	1,311

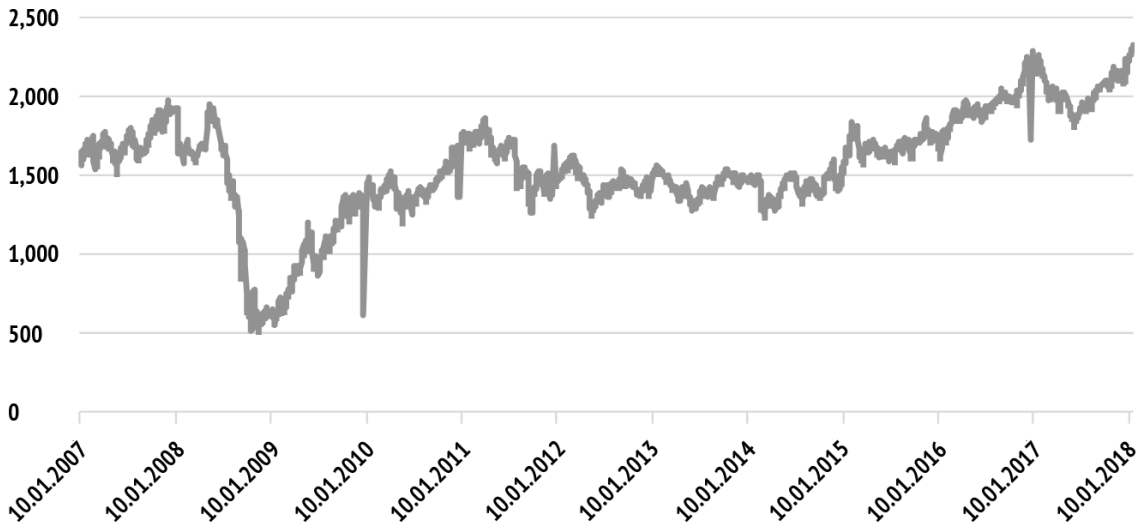
Source: Authoring

Table 2
The Hurst exponent for return by day of the week

Metric	Monday	Tuesday	Wednesday	Thursday	Friday	All days
The Hurst exponent (H)	0.574	0.5549	0.5023	0.4699	0.5383	0.5486

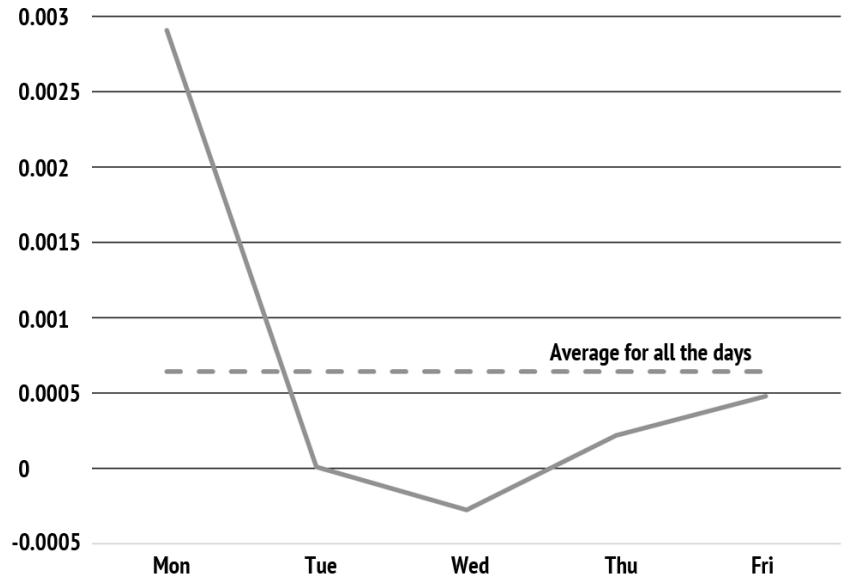
Source: Authoring

Figure 1
MICEX trends



Source: Moscow Exchange

Figure 2
Comparison of average return by day of the week



Source: Authoring

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Conflict-of-interest notification

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Translated Article†

IMPROVEMENT OF RATING METHODOLOGY

Petr N. BRUSOV
Financial University under Government of Russian Federation, Moscow, Russian Federation
pnb1983@yahoo.com
Corresponding author

Tat'yana V. FILATOVA
Financial University under Government of Russian Federation, Moscow, Russian Federation
tvfilatova@fa.ru

Natal'ya P. OREKHOVA
Southern Federal University, Rostov-on-Don, Russian Federation
fet_mir@bk.ru

Veniamin L. KULIK
Financial University under Government of Russian Federation, Moscow, Russian Federation
venya.kulik@mail.ru

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Abstract
Importance The article focuses on rating methodologies, their drawbacks and improvement methods.
Objectives The research generalizes the new approach to the rating methodology adjusting it for the Brusov – Filatova – Orekhova modern theory of capital cost and capital structure in relation to corporations of any age.
Methods The research is based on the Brusov – Filatova – Orekhova modern theory of capital cost and capital structure (BFO theory).
Results The article analyzes methodological and systemic drawbacks of the existing credit ratings of non-financial issuers. We incorporate financial ratios used for rating into the general case of the BFO theory. The article also examines how the Weighted Average Cost of Capital depends on coverage and leverage ratios.
Conclusions and Relevance The proposed approach will make ratings more accurate and unbiased. The findings may prove useful to international and Russian rating agencies to evaluate the solvency of issuers.

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Introduction

In our previous article, we set out a conceptually new approach to the rating methodology. It provides for an appropriate application of discounting to cash flows, which is almost neglected in the existing rating methodologies, use of rating ratios while discounting, correct assessment of discount rates in line with financial ratios. The research delved into the perpetuity limit of the Brusov – Filatova – Orekhova modern theory of capital cost and capital structure (BFO theory), which was modified for rating purposes.

As noted in researches referred to hereinafter [1–27], the Modigliani–Miller theorem, the perpetuity limit of the BFO theory, underestimates the cost of capital, thus resulting in overstated estimates of the corporate capitalization. Furthermore, the perpetuity limit fails to account for a timing factor, which is very critical. Hence it omits the concept of corporate age, the life cycle of a company being taken as indefinite (perpetuity).

In this research, we generalize the earlier proposed approach[1] and fit it to the BFO theory and corporations of arbitrary age, i.e. a general case of the BFO theory. This made us considerably modify the BFO theory, which is much more complex than the perpetuity limit[2], since the concept of leverage in financial management (a ratio of loan to equity) substantially differs from the leverage in rating practices (a ratio of loan, loan interests to various amounts of generated income) and inverse ratios are used (ratios of different amounts of generated income to loan or loan interests), i.e. the so called coverage ratios (debt, interests).

If modified for rating purposes, the BFO theory allows to adequately discount financial flows at correct discount rates, in accordance with rating ratios while discounting, and timing factor, which is missing on the perpetuity limit, through being critical. Therefore, the company's age (as per BFO-1) or its life cycle (BFO-2) shall be taken into consideration.

[†]For the source article, please refer to: Брусов П.Н., Филатова Т.В., Орехова Н.П., Кулик В.Л. Совершенствование методологии рейтингования. Финансы и кредит. 2018. Т. 24. № 3. С. 652–678. URL: https://doi.org/10.24891/fc.24.3.652

[1] Brusov P.N., Filatova T.V., Orekhova N.P., Kulik V.L. [Incorporation of rating parameters into the perpetuity range of the Brusov–Filatova–Orekhova modern theory of capital structure]. *Finansy i kredit = Finance and Credit*, 2017, vol. 23, no. 40, pp. 2378–2397. URL: https://doi.org/10.24891/ fc.23.40.2378 (In Russ.)

[2] Ibid.

Existing Credit Rating of Non-Financial Issuers: Analysis of Methodological and Systemic Weaknesses

We analyzed methodological and systemic weaknesses of the existing credit rating of non-financial institutions, covering the methodologies of the Big Three credit rating agencies (Standard & Poor's, Fitch and Moody's) and national rating agency.

Discounting

Despite being ample and detailed, the existing rating methodologies do still have many drawbacks. As mentioned in our previous research, what *inter alia* impairs all the rating methodologies is that they do not arrange for discounting or envisage it for a very narrow usage. Even if the discounting procedure is in place, it is performed not quite correctly since the discount rate is erroneously chosen to discount cash flows. The timing factor shall evidently be taken into consideration because it relates to the time value of money. In the financial part of the rating process, proceeds (generated income) are compared with debt and interests paid. Whereas there is a time gap between the moment income is received and debt and interests are repaid, the discounting proves to be vital to compare the income, debt and interest and assign appropriate credit ratings to issuers. Hence it raises the question about the discount rate used. The question has always been on the agenda and complicated in many aspects, i.e. corporate finance, investment, business valuation, where it is especially important as even a slight change in the discount rate significantly influences the company's capitalization. *Mala fide* appraisers make use of it for making companies artificially bankrupt. The question is also crucial in rating practices in assigning credit ratings to issuers and forecasting.

Hence once financial flows are concerned, discounting shall be taken into account. Otherwise, the time value of money is neglected. Therefore, discounting shall be an inevitable aspect to consider as part of analysis of financial flows.

Discounting shall be taken into account, when rating practices require that financial statements for a three or five years' time are used (under GAAP), assuming the flat behavior of indicators outside the purview of the period.

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Dividend Policy of Company

Dividend policies shall be kept in mind for rating purposes since ratings always refer to financial policies. However, the existing rating methodologies evaluate the stability of dividend policies only, without questioning its reasonableness and correspondence of dividends paid with their economically adequate amount.

Dividend policies are evaluated by comparing the amount of dividends paid and their economically adequate amount, that is the cost of the company's equity. The cost of equity is rather difficult to calculate. The BFO theory allows to adequately evaluate the cost of equity and hereby compare the amount of dividends paid by the company with their economically adequate amount. Therefore, the reasonableness of dividend policies is reviewed, which definitely relates to the creditworthiness of the issuer.

For instance, discretionary cash flow (DCF, S&P) shall be compared with the economically adequate amount, thus influencing the rating.

Leverage Level

Currently, rating agencies refer to leverage ($L = D / S$) solely to evaluate the financial stability and bankruptcy risk. In fact, it influences the principle financial indicators of corporate performance, i.e. the cost of equity, *WACC*. In other words, it has an impact on the cost of fundraising and capitalization. If this impact is overlooked as part of financial reporting analysis, this will lead to incorrect conclusions.

Investment projects and investment programs of companies can be rated in accordance with the effect of leveraged finance, which is assessed by the BFO theory, on the efficiency of investment projects for various cost of capital.

Taxation

Taxation significantly influences issuers' ratings. Companies and their investment programs can be assigned ratings in accordance with the effect of taxation (corporate income tax rate) on financial results of the company, efficiency of investment projects, which is assessed by the BFO theory. In case of changes in the corporate income tax rate, the assessments also apply to forecast estimates and analysis of the country risk.

Forecasts and analysis of the country risk can be based on the effect of the base interest rate of the Central Bank of Russia, loan interest rates of commercial banks on the efficiency of investment projects, creation of the favorable investment climate in the country, which is assessed by the BFO theory.

Attention to Sectoral Distinctions of the Issuer

The existing rating methodologies provide for sectoral distinctions of the issuers, especially in case of newly incorporated businesses drawing upon predecessors' experience. As per the ACRA Methodology for Credit Ratings Assignment to Regional and municipal Authorities of the Russian Federation, the company's creditworthiness shall be determined in line with sectoral distinctions of the company. To assess the sectoral risk factor, ACRA classifies sectors into five groups by their cyclicity, entry barrier, sectoral risk statistics, development trend and prospect. The sectoral risk profile factor is weighted individually for each group, varying by credit risk level. This creates the ceiling of ratings for companies operating in sectors with high risk exposure, providing premiums to sectors with lower risk exposure.

However, sectoral distinctions of issuers obviously need to be considered more thoroughly. Rating methodologies shall focus on sectoral distinctions of issuers' financial flows more profoundly. In particular, it is very important to determine whether the entity needs working capital, which directly contributes to financial stability, solvency and creditworthiness. The latter is a key metric in rating.

Inattention to Issuer's Distinctions

The existing methodologies disregard the issuer's salience, specifics of its financial reporting, taxation, regulatory and financial systems, sacrificing it to a full comparability of financial reports and smoothing the differences (Moody's).

Financial Ratios

How many financial ratios are needed? How many ratios would be enough? What particular financial ratios shall be in place? Such questions seem to have been left behind. However, the quantity and quality of financial ratios, their correlation or independence significantly determine the financial risk and state of the issuer.

Some ratios fail to give a definite view of the issuer. For example, the cash flow to leverage ratio is high no matter whether cash flow is high or leverage is low. The thing is that to what extent the two states of the issuer equally correlate with the credit risk, considering that there are associated with the same financial risk.

As admitted in the ACRA methodology, in certain cases some characteristics of a factor/subfactor may formally be attributed to several categories for evaluation, being typical of qualitative factors. In such circumstances, rating is assigned on the basis of expert opinion accounting for the most crucial parameters.

In this respect, it is worth mentioning that it is of paramount importance *inter alia* to formalize experts' opinions in order to improve the rating methodology and hereby make the expert judgment more unbiased and reliable. There may be several options to address the issue, i.e. the use of the modern measurement theory and its results, reliance on the formalism of fuzzy sets and fuzzy logic, etc.

Tabulating the composition of different risks (for instance, in Corporate Industry and Country Risk Assessment – CIRCA (S&P methodology) results in a 6x6 matrix comprising 36 elements. That is, CICRA shall have 36 different values, but their total number is 6. Is that reasonable? We believe it is evidence of unreasonableness or existence of other reasons, but they should be very well substantiated.

We may refer to a myriad of identical cases. Indeed, as per the ACRA Methodology for Credit Ratings Assignment to Microfinancial Organizations on the National Scale for the Russian Federation, *Table 1* presents a 5x5 matrix comprising 25 elements, i.e. there shall be 25 different states, but only five states are observed. The same question of reasonableness arises. The presence of the five states indicates the lack of reasonableness.

As per S&P methodology, compositions of different ratios have been tabulated not quite correctly so as to determine the financial risks:

– *FFO/debt*(%), *Debt/EBITDA*(x), *FFO/cash interest*(*x*), *EBITDA/interest*(*x*), *CFO/debt*(%), *FOCF/debt*(%), *DCF/deb*t(%);

– minimal: 60+, Less than 1.5, More than 13, More than 15, More than 50, 40+, 25+;

– modest: 45–60, 1.5–2, 9–13, 10–15, 35–50, 25–40, 15–25;

– intermediate: 30–45, 2–3, 6–9, 6–10, 25–35, 15–25, 10–15;

– significant: 20–30, 3–4, 4–6, 3–6, 15–25, 10–15, 5–10;

– aggressive: 12–20, 4–5, 2–4, 2–3, 10–15, 5–10, 2–5;

– highly leveraged: less than 12, greater than 5, less than 2, less than 2, less than 10, less than 5, less than 2.

The relations are at least not correlated completely, being used as such though. So, we can see that the two line *Minimal* and *Models* do not let parameters of the lines mix, though such cases are quite possible. For example, 60+, 1,5–2, More than 13, More than 15, More than 50, 40+, 25+.

Such aspects constrain the applicability of rating agencies' methods. Rating agencies adopt them in order to simplify the rating procedure, intentionally or not, and unify methods for various systems of financial reporting, countries, for purposes of comparable results.

The said ambiguity of assessments has already been noticed when assigning ratings to Gazprom (S&P).

Modification of the BFO Theory for Corporations of Arbitrary Age for Rating Purposes

We hereinafter modify the BFO theory for corporations of arbitrary age for rating purposes. This appears to be a much more complicated task than the modification of the perpetuity limit of the BFO theory.

The BFO formula proves to be inapplicable in this case [1]:

$$\frac{[1-(1+WACC)^{-n}]}{WACC}=\frac{[1-(1+k_0)^{-n}]}{k_0[1-\omega_d T(1-(1+k_d)^{-n})]}.$$

The formula does not account for cash flows *CF* and loan *D*, while the leverage level *L* = *D*/*S* (as though it is understood in financial management) is presented only through the percentage of borrowings *wd* = *L* / (*L* + 1).

To modify the BFO general theory for rating purposes, we shall refer to initial assumptions underlying the BFO formula.

According to the Modigliani–Miller theorem providing for corporate taxes [3–5], which we generalize [1] for the final period of time, i.e. companies and corporations of arbitrary age, the capitalization of a leveraged company, which uses debt financing, V_L equals that of a non-leveraged company, which is free from debt financing V_0, plus a tax shield amount for the final period of time TS_n.

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$$V_L = V_0 + TS_n, \quad (1)$$

where the capitalization of a financially dependent company is as follows:

$$V_L = \frac{CF}{WACC}\left(1-\left(1+WACC\right)^{-n}\right); \quad (2)$$

capitalization of a financially independent company is as follows:

$$V_0 = \frac{CF}{k_0}\left(1-\left(1+k_0\right)^{-n}\right); \quad (3)$$

and the tax shield for *n* years:

$$TS_n = tD\left(1-\left(1+k_d\right)^{-n}\right). \quad (4)$$

CF is income for the period, *D* is an amount of loan, k_d is the loan interest rate, k_0 is the cost of the financially independent's equity and *n* is the company's age.

Inserting the formulas (2)–(4) into (1), we get the formula (5), which will be used subsequently to modify the BFO theory for rating purposes:

$$\frac{CF\left(1-\left(1+WACC\right)^{-n}\right)}{WACC} = \frac{CF}{K_0}\left(1-\left(1+k_0\right)^{-n}\right) + tD\left(1-\left(1+k_d\right)^{-n}\right). \quad (5)$$

Let us call the equation (5) the BFO-3 model (the BFO theory for rating purposes). BFO-1 applies to companies of the ultimate age remaining in the market, while BFO-2 refers to those ones of the final life cycle that left the market [1]. Afterwards we make the first attempt to incorporate rating parameters into the BFO modern theory of capital cost and capital structure[3].

In this research, two types of rating ratios are considered, i.e. coverage ratios and leverage ratios.

We suggest starting with debt coverage ratios and respective interests.

Coverage Ratios

We examine three types of coverage ratios, i.e. debt-service coverage ratio, interest coverage ratio and debt-and-interest coverage ratio. Please note that we introduced the latter type of the coverage ratios for the first tome to more comprehensively describe the issuer's ability to pay off debts and respective interests.

[3] Brusov P.N., Filatova T.V., Orekhova N.P., Kulik V.L. [Incorporation of rating parameters into the perpetuity range of the Brusov–Filatova–Orekhova modern theory of capital structure]. *Finansy i kredit = Finance and Credit*, 2017, vol. 23, no. 40, pp. 2378–2397. URL: https://doi.org/10.24891/ fc.23.40.2378 (In Russ.)

Debt-Service Coverage Ratio

Dividing the both parts of the formula (5) by the loan *D*, we introduce the debt-service coverage ratio into the BFO general theory:

$$\frac{CF}{D} = i_1;$$

$$i_1 A = i_1 B + tC;$$

$$\frac{i_1 * \left(1-\left(1+WACC\right)^{-n}\right)}{WACC} = \frac{i_1\left(1-\left(1+k_0\right)^{-n}\right)}{k_0 + t\left(1-\left(1+k_d\right)^{-n}\right)}.$$

Therefore,

$$A = \frac{\left(1-\left(1+WACC\right)^{-n}\right)}{WACC};$$

$$B = \frac{\left(1-\left(1+k_0\right)^{-n}\right)}{k_0};$$

$$C = \left(1-\left(1+k_d\right)^{-n}\right).$$

The coverage ratio i_1 can be used to assess such rating parameters as *DCF/Debt*, *FFO/Debt*, *CFO/Debt*, *FOCF/Debt*, etc.

The following denotations are used:

EBITDA stands for earnings before interests, taxes, depreciation and amortization;

EBITDAR stands for earnings before interests, taxes, depreciation, amortization and restructuring or rent costs;

FFO stands for operating cash flows before changes in working capital;

Debt is the outstanding amount;

CFF is cash flows from financing activities;

FCF is free cash flow;

NFCF is net cash flow;

DCF is discounted cash flow;

CFO is cash flow from operations.

We suggest analyzing the dependence of *WACC* on the debt-service coverage ratio i_1 for companies aged $n = 3$ and $n = 5$ provided that $k_0 = 8\%$; $k_d = 4\%$; $t = 20\%$; i_1 ranges from 0 to 10.

Fig. 1 and *2* depict the dependence of *WACC* on the coverage ratio i_1.

Interest Coverage Ratio

We suggest analyzing the dependence of *WACC* on the loan interest coverage ratio i_2. Dividing both parts of the formula (5) by the amount of loan interests k_dD, we introduce the loan interest coverage ratio *i* into the BFO general theory.

$$i_2=\frac{CF}{k_d D}.$$

$$i_2 A=i_2 B+\frac{tC}{k_d}.$$

$$\frac{i_2\left(1-\left(1+WACC\right)^{-n}\right)}{WACC}=\frac{i_2\left(1-\left(1+k_0\right)^{-n}\right)}{k_0}+ +\frac{t\left(1-\left(1+k_d\right)^{-n}\right)}{k_d}. \quad (6)$$

The loan interest coverage ratio i_2 is used to assess such rating parameters as *FFO/cash interest*, *EBITDA/interest,* etc.

Based on the equation (6), we study the dependence of *WACC* on the loan interest coverage ratio i_2 for companies at age three (*n*=3) and five (*n*=5).

Fig. 3 and *4* depict the dependence of *WACC* on the loan interest coverage ratio i_2.

Debt-and-Interest Coverage Ratio

The next step is to scrutinize the dependence of *WACC* on the debt-and-interest coverage ratio i_3. Please note that we introduced this ratio for the first time to more comprehensively describe the issuer's ability to pay off debts and respective interests.

Dividing the both parts of the formula (5) by the amount of debt and interests $(1+k_d)D$, we insert the debt-and-interest coverage ratio into the BFO general theory.

$$\frac{CF}{D\left(1+k_d\right)}=i_3.$$

$$i_3 A=i_3 B+\frac{tC}{1+k_d}.$$

$$\frac{i_3\left(1-\left(1+WACC\right)^{-n}\right)}{WACC}=\frac{i_3\left(1-\left(1+k_0\right)^{-n}\right)}{k_0}+ +\frac{t*\left(1-\left(1+k_d\right)^{-n}\right)}{1+k_d}. \quad (7)$$

Based on the equation (7), we examine the dependence of *WACC* on the debt-and-interest coverage ratio i_3 for companies at age three (*n*=3) and five (*n*=5).

Fig. 5 and *6* depict the dependence of *WACC* on the debt-and-interest coverage ratio i_3.

Fig. 7 and *8* show the dependence of *WACC* on the debt coverage ratio, interest coverage ratio and debt-and-interest coverage ratio totally.

Conclusions. Having analyzed *Tables 2–4* and *Fig. 1–5*, we see *WACC* increase as debt coverage ratios i_1, i_2, i_3 grow in all the companies of any age. We considered those ones at age three and five. However, companies of other age are obvious to face a similar situation. The more debt coverage ratios grow, the more *WACC* values converge. *WACC*(i_1) and *WACC*(i_3) are close to one another, albeit not being equal, but *WACC*(i_2) significantly differs from them. These conclusions stem from a low interest rate on the loan k_d, an increase of which will make *WACC*(i_1) and *WACC*(i_3) more divergent, while *WACC*(i_2) becomes less different from them. Curves of dependencies *WACC*(i_j) for older companies are located higher. If we compare the results with cases of perpetuity companies[4], it is evident that curves of dependencies *WACC*(i_j) reach the saturation point more smoothly in case of companies at definite age, than in case of perpetuity companies, where they reach the saturation point provided coverage ratios are about 1. This is certainly true for *WACC*(i_1) and *WACC*(i_3), while *WACC*(i_2) smoothly depends on the interest coverage ratio even within the perpetuity limit. As a result, real (rather than perpetuity) companies need to assess dependencies of *WACC*(i_j) in case of companies of definite age and apply them as discount rates to financial flows for rating purposes.

Leverage Ratios

This part of the research is devoted to three types of leverage ratios, i.e. the leverage ratio of the loan (debt), leverage ratio of loan interests and leverage ratio of debt and interests. We hereinafter analyze how *WACC* depends on leverage ratios (l_1, l_2, l_3) in case of companies at age three and five and cost of capital accounting for k_0 = 10%, k_d = 6% under t = 20%, with leverage ratios l_i ranging from 0 to 10.

[4] Brusov P.N., Filatova T.V., Orekhova N.P., Kulik V.L. [Incorporation of rating parameters into the perpetuity range of the Brusov–Filatova–Orekhova modern theory of capital structure]. *Finansy i kredit = Finance and Credit*, 2017, vol. 23, no. 40, pp. 2378–2397.
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Leverage Ratio of Debt

As per the BFO theory, the dependence of *WACC* on the leverage ratio of debt l_1 is expressed with the following formula:

$$\frac{(1-(1+WACC)^{-n})}{WACC}-\frac{(1-(1+K_0)^{-n})}{K_0}-$$
$$-t[1-(1+K_d)^{-n}]l_1=0,$$

where $l_1=\frac{D}{CF}$,

where l_1 is the leverage ratio of debt;

t is the corporate income tax rate;

k_0 is the cost of a non-leveraged (financially independent) company's equity;

k_d is the cost of debt;

n is age of a company;

CF is income for the period;

D is the amount of debt.

This ratio can be used to assess such rating parameters as *Debt/EBITDA*, etc.

We make a table visualizing the dependence of *WACC* on l_1.

Fig. 9 and *10* illustrate the dependence of *WACC* on the leverage ratio of debt (l1) in case of companies at age 3 (n = 3) and five (n = 5) respectively.

Leverage Ratio of Loan Interests

As per the BFO theory, the formula below expresses the dependence of *WACC* on the leverage ratio of loan interest l_2:

$$\frac{(1-(1+WACC)^{-n})}{WACC}-\frac{(1-(1+K_0)^{-n})}{K_0}-$$
$$-\frac{(t\cdot l_2[1-(1+K_d)^{-n}])}{K_d}=0,$$

where $l_2=\frac{K_d D}{CF}$;

K_dD stands for loan interests in kind.

Let us measure the dependence of *WACC* on the leverage ratio of loan interests l_2.

Fig. 11 and *12* illustrate the dependence of *WACC* on the leverage ratio of loan interests l_2 as per the BFO theory in case of companies at age three (*n* = 3) and five (*n* = 5) respectively.

As per the BFO theory, the dependency of *WACC* on the leverage ratio of debt and interests l_2 is expressed with the following formula:

$$\frac{(1-(1+WACC)^{-n})}{WACC}-\frac{(1-(1+K_0)^{-n})}{K_0}-$$
$$-\frac{t\cdot l_3[1-(1+K_d)^{-n}]}{K_d+1}=0,$$

where $l_3=\frac{(k_d+1)D}{CF}$, $(k_d+1)D$ is the amount of debt and respective interests.

We make a table visualizing the dependence of *WACC* on l_3.

Fig. 13 and *14* illustrate the dependence of *WACC* on the leverage ratio of debt and interest l3 as per the BFO theory in case of companies at age three *n* = 3 and five *n* = 5.

Fig. 15 and *16* depicts consolidated graphs of the dependency of *WACC* on l_1, l_2, l_3 in case of *n* = 3 and *n* = 5.

Conclusions. Having analyzed *Tables 5–7* and *Fig. 6–16*, we concluded that the higher the leverage ratios l_1, l_2, l_3 in case of company of any age (we consider companies at age three and five, but the situation will definitely be identical in case of companies of other age), the lower *WACC*. The more the leverage ratios grow, the more divergent *WACC*-values (they spring from the point (0, *k*)). *WACC*(l_1) and *WACC*(l_3) are close to one another, albeit not being equal, decreasing almost in a linear way as the leverage ratios increase. The dependence of *WACC*(l_2) significantly differs from *WACC*(l_1) and *WACC*(l_3). Both conclusions stem from a low interest rate on loan k_d, an increase of which will make *WACC*(l_1) and *WACC*(l_3) more divergent, while *WACC*(l_3) becomes less different from them. Curves of dependencies of *WACC*(l_j) for older companies run higher, signifying their slower decrease. If we compare the results with cases of perpetuity companies[5], it is evident that the negative slope coefficient of dependencies of *WACC*(l_j) is more than twice as high (by

[5] Brusov P.N., Filatova T.V., Orekhova N.P., Kulik V.L. [Incorporation of rating parameters into the perpetuity range of the Brusov–Filatova–Orekhova modern theory of capital structure]. *Finansy i kredit = Finance and Credit*, 2017, vol. 23, no. 40, pp. 2378–2397. URL: https://doi.org/10.24891/ fc.23.40.2378 (In Russ.)

module) as the identical slope coefficient of companies with definite age. It means that *WACC*(l_j) decreases faster in case of companies with definite age that in perpetuity cases[6].

Conclusion

In this research, we analyzed methodological and systemic drawbacks of the way ratings are assigned to non-financial issuers. We modified the Brusov–Filatova–Orekhova modern theory of capital cost and capital structure for rating purposes. As part of the modified BFO theory, we incorporated financial ratios used for rating purposes (rating ratios) into the general case of the BFO theory. We investigated the dependence of *WACC* on two types of rating ratios, i.e. coverage ratios and leverage ratios, and substantiated the importance of discounting for rating of issuers.

Following the devised method for assessing discount rates in line with rating ratios, it is possible to apply correct discount rates to financial flows for rating purposes. The findings of the two researches we presented herein allow to bridge a gap between fundamental theories of capital structure and rating methodologies. Methods of well elaborated and verified theories open new opportunities for the rating sector, enabling it to abandon the qualitative method of creditworthiness evaluation and opt for quantitative ones, thus enhancing the quality and accuracy of ratings. Both researches we release herein frame a new approach to rating methodologies.

[6] Ibid.

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Table 1
Assessment of funding and liquidity

Funding assessment	Liquidity assessment				
	1	**2**	**3**	**4**	**5**
1	1	2	2	3	4
2	1	2	3	3	4
3	2	2	3	4	5
4	3	3	3	4	5
5	3	3	4	5	5

Source: Authoring based on the Analytical Credit Rating Agency (ACRA) data

Table 2
Dependence of *WACC* on i_1 for companies at age three (n =3) and five (n =5)

t	k_0	k_d	i_1	*WACC* (n =3)	*WACC* (n =5)
0.2	0.08	0.04	1	0.075356711	0.07663868
0.2	0.08	0.04	2	0.077705469	0.0783126
0.2	0.08	0.04	3	0.078412717	0.0788732
0.2	0.08	0.04	4	0.078808879	0.079154
0.2	0.08	0.04	5	0.079046807	0.07932264
0.2	0.08	0.04	6	0.079205521	0.07943518
0.2	0.08	0.04	7	0.079318935	0.0795156
0.2	0.08	0.04	8	0.079404022	0.07957594
0.2	0.08	0.04	9	0.079470216	0.07962287
0.2	0.08	0.04	10	0.07952318	0.07966043

Source: Authoring

Table 3
Dependence of *WACC* on i_2 for companies at age three (n =3) and five (n =5)

t	k_0	k_d	i_2	*WACC* (n =3)	*WACC* (n =5)
0.2	0.08	0.04	1	–0.021238089	0.00793717
0.2	0.08	0.04	2	0.02529016	0.04111354
0.2	0.08	0.04	3	0.042483465	0.0533843
0.2	0.08	0.04	4	0.051456351	0.05974575
0.2	0.08	0.04	5	0.056965593	0.06365738
0.2	0.08	0.04	6	0.060692181	0.06630611
0.2	0.08	0.04	7	0.063380861	0.06821315
0.2	0.08	0.04	8	0.065412245	0.06966377
0.2	0.08	0.04	9	0.067001115	0.07078076
0.2	0.08	0.04	10	0.068277865	0.07168658

Source: Authoring

Table 4

Dependence of *WACC* on i_5 for companies at age three (*n* =3) and five (*n* =5)

t	k_0	k_d	*i*	*WACC* (*n* =3)	*WACC* (*n* =5)
0.2	0.08	0.04	1	0.075536724	0.07676703
0.2	0.08	0.04	2	0.077796177	0.07837722
0.2	0.08	0.04	3	0.078473634	0.07891638
0.2	0.08	0.04	4	0.078854621	0.07918642
0.2	0.08	0.04	5	0.079083426	0.07934861
0.2	0.08	0.04	6	0.079236052	0.07945683
0.2	0.08	0.04	7	0.079345114	0.07953417
0.2	0.08	0.04	8	0.079426934	0.07959218
0.2	0.08	0.04	9	0.079490586	0.07963732
0.2	0.08	0.04	10	0.079541516	0.07967343

Source: Authoring

Table 5

Dependence of *WACC* on l_1 for companies at age three (*n* =3) and five (*n* =5)

l_1	*t*	k_0	k_d	*WACC* (l_1) (*n* =3)	*WACC* (l_1) (*n* =5)
0	0.2	0.1	0.06	0.1	0.1
1	0.2	0.1	0.06	0.0928	0.0948
2	0.2	0.1	0.06	0.0857	0.0898
3	0.2	0.1	0.06	0.0787	0.0848
4	0.2	0.1	0.06	0.072	0.0799
5	0.2	0.1	0.06	0.0654	0.0752
6	0.2	0.1	0.06	0.0587	0.0705
7	0.2	0.1	0.06	0.0523	0.066
8	0.2	0.1	0.06	0.0461	0.0615
9	0.2	0.1	0.06	0.0399	0.0571
10	0.2	0.1	0.06	0.0339	0.0528

Source: Authoring

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Table 6

Dependence of *WACC* on l_2 for companies at age three (n =3) and five (n =5)

l_2	t	k_0	k_d	*WACC* (l_2) (n =3)	*WACC* (l_2) (n =5)
0	0.2	0.1	0.06	0.0998	0.1
1	0.2	0.1	0.06	−0.0036	0.0259
2	0.2	0.1	0.06	−0.0804	−0.0296
3	0.2	0.1	0.06	−0.1403	−0.0732
4	0.2	0.1	0.06	−0.1888	−0.1089
5	0.2	0.1	0.06	−0.2289	−0.1388
6	0.2	0.1	0.06	−0.2629	−0.1643
7	0.2	0.1	0.06	−0.2922	−0.1865
8	0.2	0.1	0.06	−0.3178	−0.2061
9	0.2	0.1	0.06	−0.3404	−0.2235
10	0.2	0.1	0.06	−0.3605	−0.2391

Source: Authoring

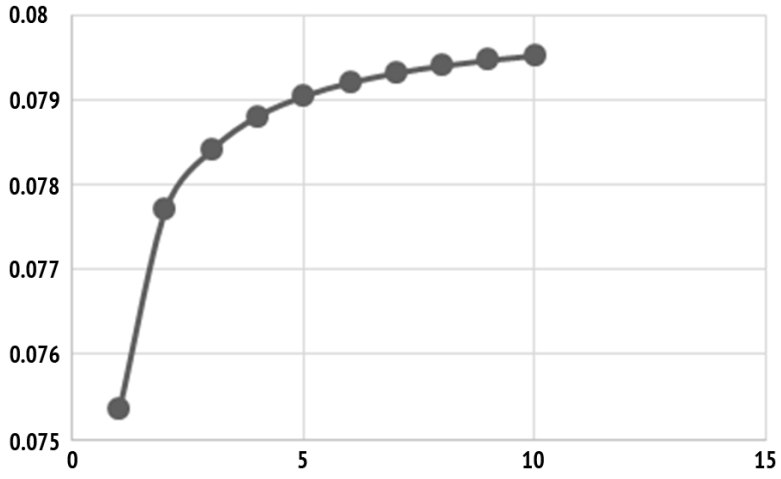
Table 7

Dependence of *WACC* on l_3 for companies at age three (n =3) and five (n =5)

l_3	t	k_0	k_d	*WACC* (l_3) (n =3)	*WACC* (l_3) (n =5)
0	0.2	0.1	0.06	0.1	0.1
1	0.2	0.1	0.06	0.093	0.0951
2	0.2	0.1	0.06	0.0864	0.0903
3	0.2	0.1	0.06	0.0798	0.0856
4	0.2	0.1	0.06	0.0734	0.081
5	0.2	0.1	0.06	0.0671	0.0765
6	0.2	0.1	0.06	0.0608	0.0721
7	0.2	0.1	0.06	0.0548	0.0678
8	0.2	0.1	0.06	0.0489	0.0635
9	0.2	0.1	0.06	0.043	0.0593
10	0.2	0.1	0.06	0.0371	0.0552

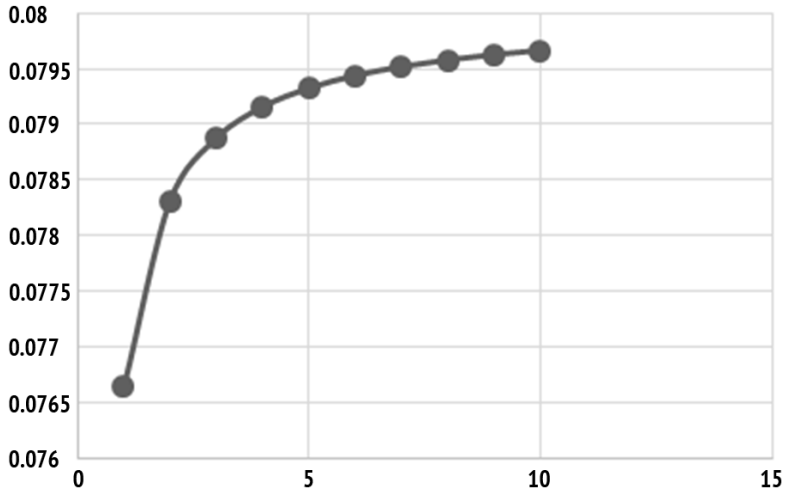
Source: Authoring

Figure 1
Dependence of a company's weighted average cost of capital (*WACC*) on the debt-service coverage ratio i_1 for a company at age three (n =3)



Source: Authoring

Figure 2
Dependence of a company's weighted average cost of capital (*WACC*) on the debt-service coverage ratio I_1 for a company at age five (n =5)



Source: Authoring

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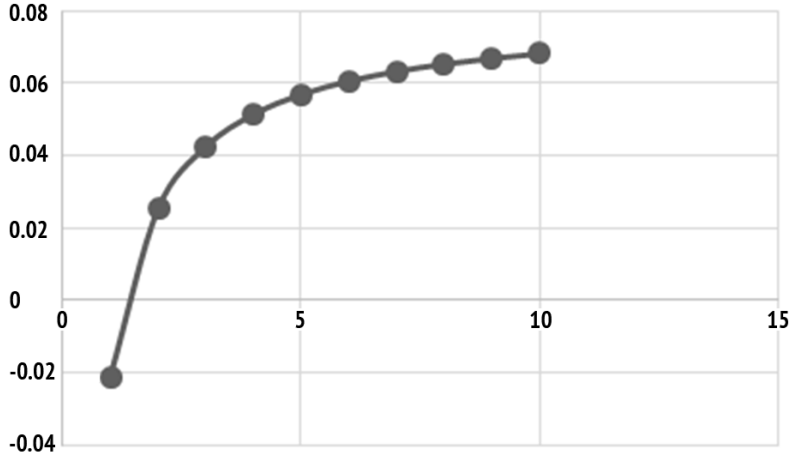
Figure 3

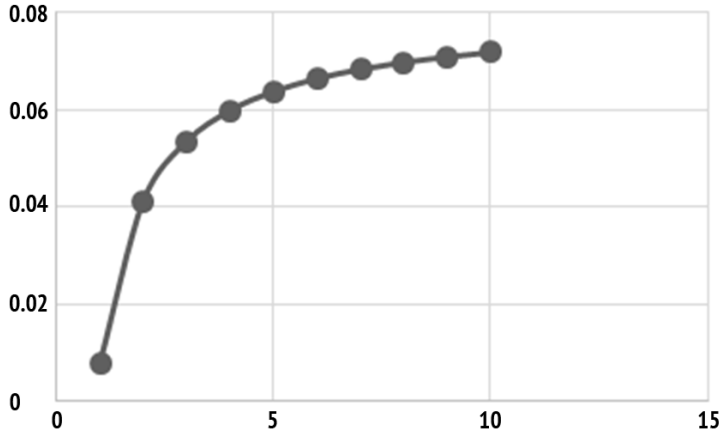
Dependence of a company's weighted average cost of capital (*WACC*) on the debt-service coverage ratio I_2 for a company at age three (n =3)



Source: Authoring

Figure 4

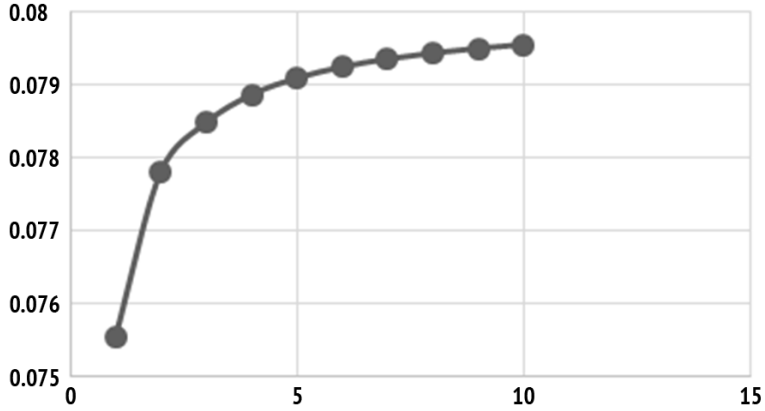
Dependence of a company's weighted average cost of capital (*WACC*) on the debt-service coverage ratio I_2 for a company at age five (n =5)



Source: Authoring

Figure 5

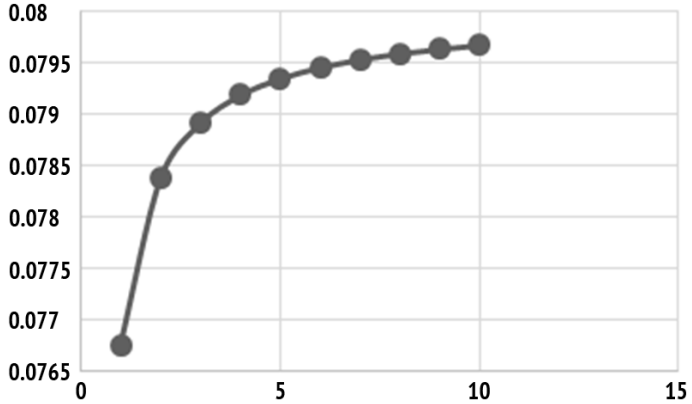
Dependence of a company's weighted average cost of capital (*WACC*) on the debt-service coverage ratio I_5 for a company at age three (n =3)



Source: Authoring

Figure 6

Dependence of a company's weighted average cost of capital (*WACC*) on the debt-service coverage ratio I_5 for a company at age five (n =5)



Source: Authoring

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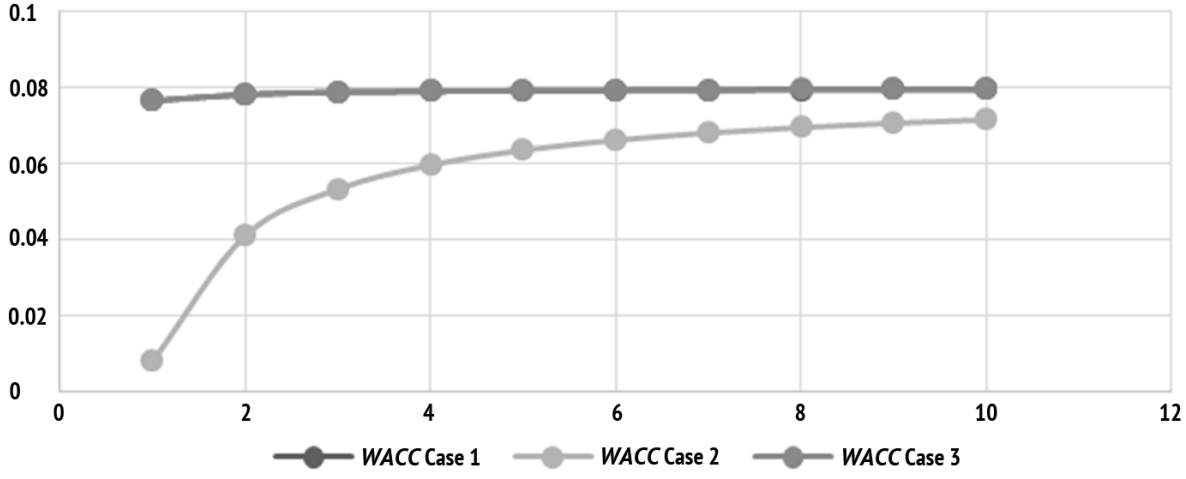
Figure 7

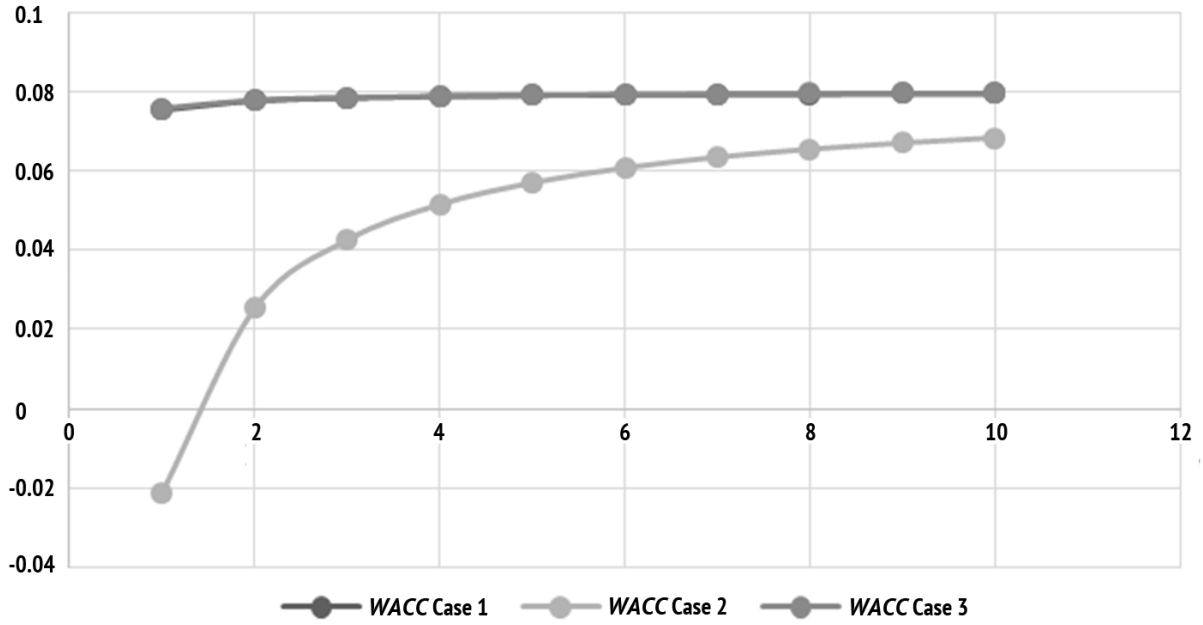
Dependence of a company's weighted average cost of capital (*WACC*) on the debt-service coverage ratios l_1, l_2, l_3 for a company at age three (n =3)



Source: Authoring

Figure 8

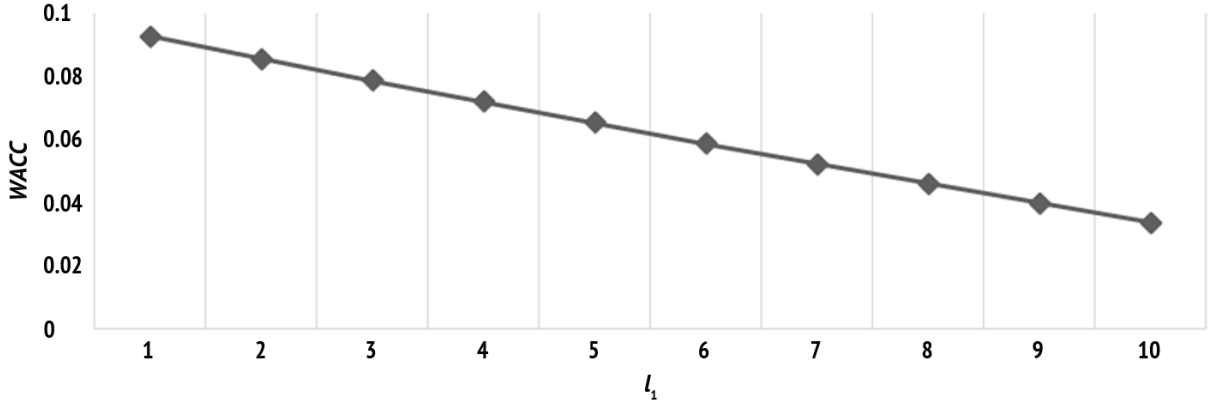
Dependence of a company's weighted average cost of capital (*WACC*) on the debt-service coverage ratios l_1, l_2, l_3 for a company at age five (n =5)



Source: Authoring

Figure 9

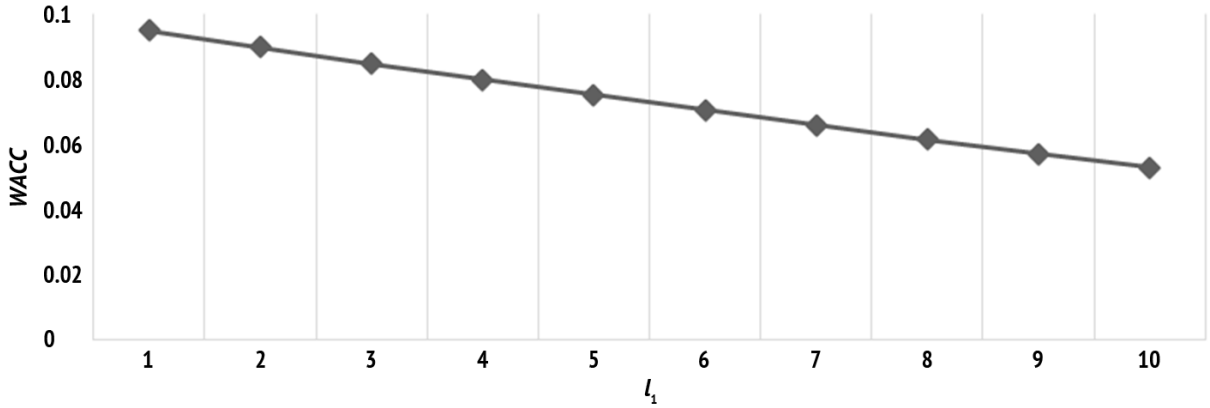
Dependence of a company's weighted average cost of capital (*WACC*) on the leverage ratio of debt l_1 for a company at age three (n =3)



Source: Authoring

Figure 10

Dependence of a company's weighted average cost of capital (*WACC*) on the leverage ratio of debt l_1 for a company at age five (n =5)



Source: Authoring

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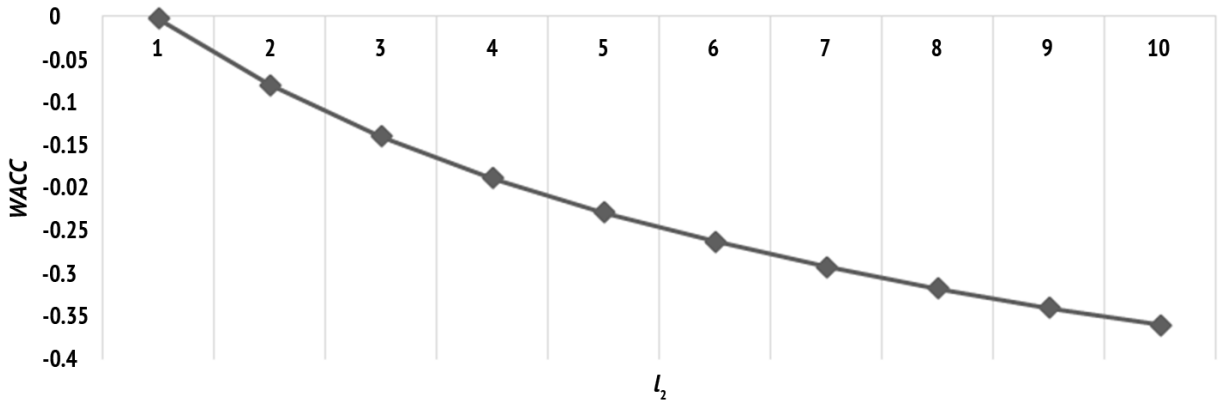
Figure 11

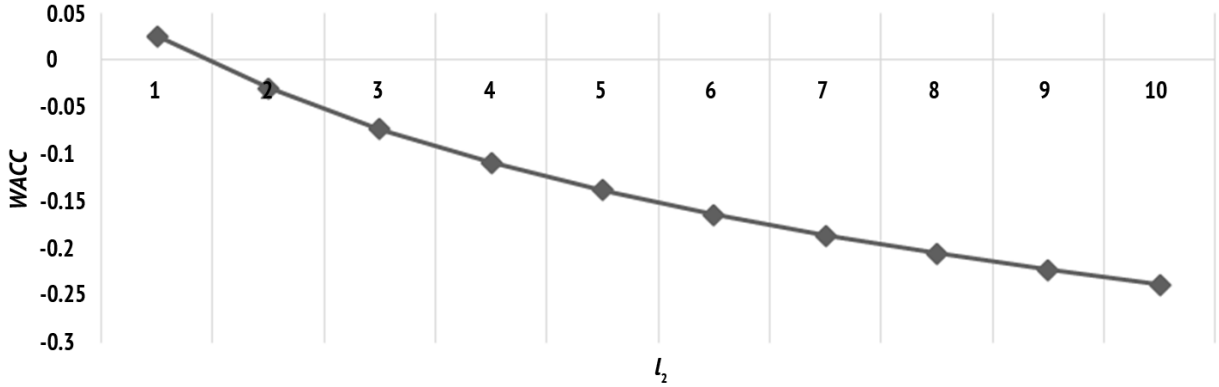
Dependence of a company's weighted average cost of capital (*WACC*) on the leverage ratio of loan interests l_2 for a company at age three (n=3)



Source: Authoring

Figure 12

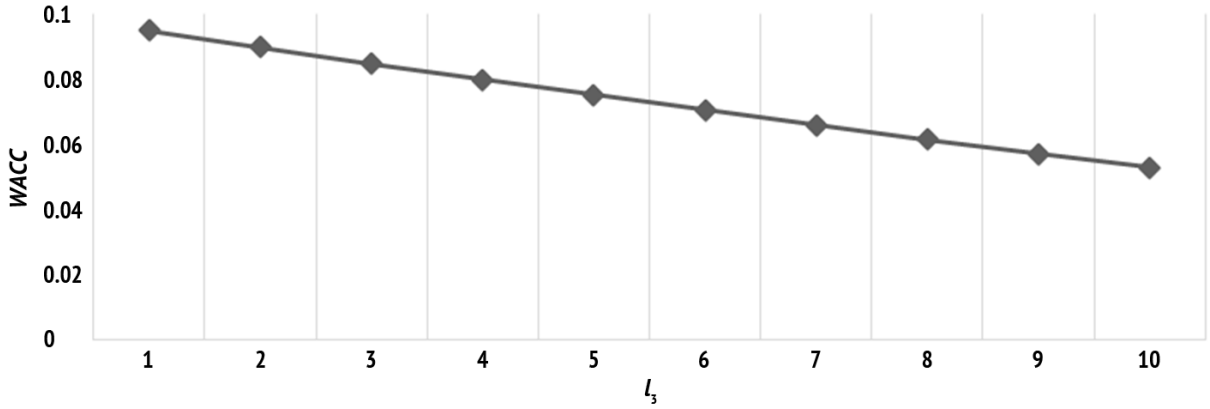
Dependence of a company's weighted average cost of capital (*WACC*) on the leverage ratio of loan interests l_2 for a company at age five (n=5)



Source: Authoring

Figure 13

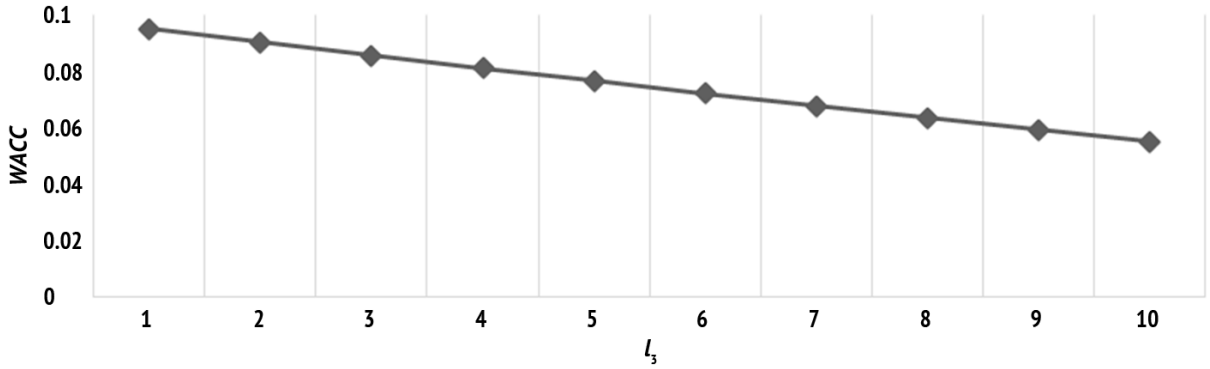
Dependence of a company's weighted average cost of capital (*WACC*) on the leverage ratio of debt and interest l_3 for a company at age three (n=3)



Source: Authoring

Figure 14

Dependence of a company's weighted average cost of capital (*WACC*) on the leverage ratio of debt and interest l_3 for a company at age five (n=5)



Source: Authoring

Please cite this article as: Brusov P.N., Filatova T.V., Orekhova N.P., Kulik V.L. Improvement of Rating Methodology. *Digest Finance*, 2018, vol. 23, iss. 2, pp. 191–211.
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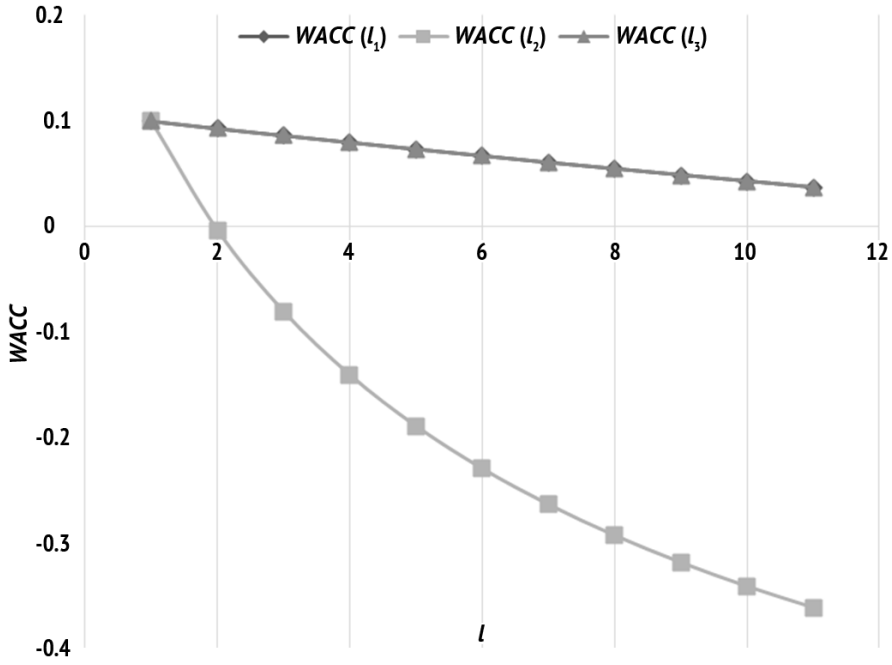
Figure 15

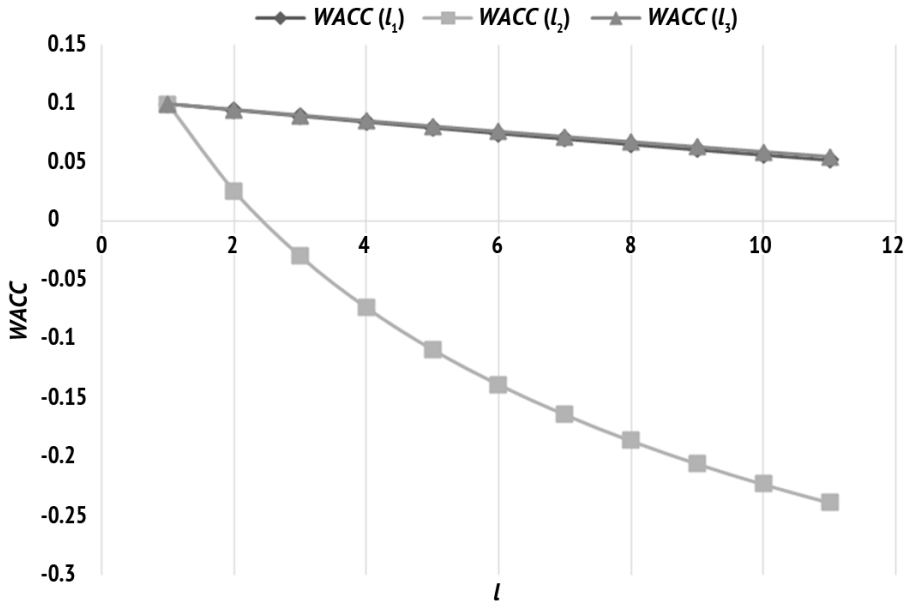
Consolidated graphs of dependencies of a company's weighted average cost of capital (*WACC*) on the leverage ratios l_1, l_2, l_3 for a company at age three (n=3)



Source: Authoring

Figure 16

Consolidated graphs of dependencies of a company's weighted average cost of capital (*WACC*) on the leverage ratios l_1, l_2, l_3 for a company at age five (n=5)



Source: Authoring

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Translated Article†

MODELS TO FORECAST REVENUE OF FAST FOOD RESTAURANTS

Ekaterina B. GRIBANOVA
Tomsk State University of Control Systems and Radioelectronics, Tomsk, Russian Federation
katag@yandex.ru
Corresponding author

Ekaterina S. SOLOMENTSEVA
Tomsk State University of Control Systems and Radioelectronics, Tomsk, Russian Federation
katerinkas_1995@mail.ru

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Abstract

Importance The article addresses changes in revenue of fast food restaurants.

Objectives The research develops and investigates models for forecasting revenue of fast food restaurants, considering the specifics of operations, changes in revenue on week days and holidays.

Methods We apply methods for statistical processing of findings and a regression analysis. We have built an autoregressive model, seasonality- and trend-specific model and a trend based on grouped data. The model parameters are evaluated by the least squares method.

Results We use data for two years' time to build three regression models to predict corporate revenue during business days, evaluate errors and significance of equations. To forecast the amount of revenue during holidays, we devised an algorithm to select a group of data that corresponds to a certain day of the week based on the analysis of outlying cases. We also present a case study on forecasting the revenue on a holiday, using the developed algorithm. The results of the analysis may be useful to study financial performance of fast food restaurants.

Conclusions and Relevance We suggest using different models to forecast revenue on holidays and other days. Our experiments show that this approach contributes to more precise forecast of revenue.

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Authorized translation by Irina M. Vechkanova

Revenue is a key performance indicator of any firm. It is of paramount importance for any business to identify and forecast how their revenue will behave in the future so as to manage their income and expenditures, thus ultimately defining the effectiveness. To assess the indicator, we used such methods as exponential smoothing, moving average, regression analysis, factor analysis. The article also discusses some proceedings on revenue forecasting.

N.P. Lyubushin and N.E. Babicheva [1] approach to forecasting the tourist agency's revenue in terms of seasonality. The time interval expansion method, moving average and trends models are used to evaluate the way this indicators changes.

† For the source article, please refer to: Грибанова Е.Б., Соломенцева Е.С. Модели прогнозирования выручки ресторана быстрого питания. Экономический анализ: теория и практика. 2018. Т. 17. № 4. С. 754–767.
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Based on performance results of a company specializing in sale of truck tires and wheels, N.N. Odiyako, N.Yu. Golodnaya [2] constructed an additive and multiplicative model which features levels of time series as the sum of trend, seasonal and random components.

Indeed, L.R. Weatherford, S.E. Kimes [3] compared methods for hotel revenue forecasting, i.e. exponential smoothing, moving average, linear and logarithmic regression reflecting a correlation between the number of rooms booked at a certain point of time in the future and the number of rooms books at the current moment. They also examined an additive and multiplicative pickup-models showing how many rooms booked at a certain point of time in the future will be equivalent to the sum of rooms booked at the current moment of time and average change in bookings within the analyzable points of time.

Based on data on financial activities of 33 machine building plants and principle component analysis (PCA), A.A. Mitsel' and E.V. Telipenko [4] evaluated the effect of various factors on corporate revenue (labor productivity, return on assets, inventory turnover, etc.). The regression equation can be used to predict revenue depending on performance indicators.

In their article E.O. Trusova, I.V. Baranova. N.A. Kulagina [5] forecast revenue of a company generating electricity and thermal power. The forecast was based on a regression equation, where the average heat season temperature and Consumer Price Index for paid services are exogenous variables.

S.O. Musienko proposed the model which refers to the amount of fixed asses, inventories, cash and accounts receivable to assess revenue of small businesses [6].

C. Hu, M. Chen, S.-L.C. McCain [7] attempt to predict the revenue of a restaurant in a casino using the method of moving average and exponential smoothing, regression model implying the seasonal and trend components, and multivariate regression (independent variables include the number of rooms occupied in the hotel, marketing events and dummy variable in accordance with a day of the week).

In their article V.S. Timofeeva, A.Yu. Kolesnikova [8] determine sales volume of retailers through the pace of purchases, which are typical of different types of buyers.

Revenue prediction is concerned in researches by I.V. Orlova, E.S. Filonova, S.V. Grigor'eva, N.V. Noakk, I.V. Nevolin, A.S. Tatarnikov [9–11].

Therefore, regression models are so frequently used for revenue prediction purposes. Indeed, there is no versatile model which would demonstrate the highest precision in all datasets. In this respect several models shall be considered for different tasks, with the most suitable one being chosen for the purpose.

A combination of several methods or models (the-wisdom-of-the-crowd principle) is taken into consideration. This approach is employed in researches referred to herein [12–14].

Regression model also helps address other tasks, for example, when it is necessary to determine what conditions should be in place so that the analyzable indicator be equal to the target value [15].

This research focuses on short-term prediction of revenue of a fast food restaurant situated in a shopping mall.

Such revenue depends on human behavior, which is often spontaneous and driven by many factors (menu, price, location). These aspects are considered in proceedings by E.N. Myasnikova, N.V. Mordovchenkov, A. Laske, N. Cercone, J. Suanders [16–18].

For purposes of this research, we refer to data on daily revenue for a two years' time (2015, 2016).

Fig. 1 shows how revenue changes during two weeks. It demonstrates regular fluctuations due to an increase in customers at weekends as compared with business days. As the revenue analysis reveals, revenue on holidays may be considerably different from a dataset corresponding to a certain day of the week.

Fig. 2 indicates values of revenue on Monday. Relating to holidays, the two of them are evidently higher than the others (February 23 and March 9). Considering the way revenue changes, we predict the analyzable indicator on holidays and other days (non-holidays).

To forecast revenue on non-holidays, we examined three regression models[1]:

- autoregressive model;

[1] Solomentseva E.S. [Regression models for revenue prediction]. *Informatsionnye tekhnologii v nauke, upravlenii, sotsial'noi sfere i meditsine: materialy IV Mezhdunarodnoi nauchnoi konferentsii* [Proc. Int. Sci. Conf. Information Technology in Science, Management, Social Sphere and Medicine]. Tomsk, TPU Publ., 2017, pp. 230–232. URL: http://portal.tpu.ru/appnews/files/18083/ik_cbornik.pdf

- season- and trend-specific model;
- trend model (formed per each day of the week).

The autoregressive model describes the dependence of the resultant indicators on the value at previous points of time. The *p*-model is expressed as follows[2]:

$$y_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 y_{t-2} + \ldots + \beta_p y_{t-p} + \varepsilon_t,$$

where y_t is a dependent variable at the *t*-time;

β stands for regression parameters to be assessed;

ε_t is closing error.

In the analyzable case revenue is a dependent value, with the *t*-time corresponding to the ordinal number of a day.

To assess β-parameters of the regression, we apply the least squares method. The first-, second- and seventh-order regression equation are expressed as follows:

$$y_t^{(1)} = 15{,}030.6 + 0.48\, y_{t-1} + \varepsilon_t;$$

$$y_t^{(2)} = 19{,}574.5 + 0.6100\, y_{t-1} + 0.2971\, y_{t-2} + \varepsilon;$$

$$y_t^{(7)} = 5{,}168.11 + 0.3369\, y_{t-1} - 0.1663\, y_{t-2} + \\ +0.0315\, y_{t-3} + 0.0213\, y_{t-4}\, 0.1182\, y_{t-5} + \\ +0.2009\, y_{t-6} + 0.5187\, y_{t-7} + \varepsilon_t.$$

The resultant equations describe the dependence of revenue at the *t*-time on its value at previous moments of the time *t* – 1, *t* – 2, *t* – 7.

The season- and trend-specific model can be presented in additive and multiplicative format. If seasonal fluctuations vary within a constant range, the additive model is used, while the multiplicative model works in case of variable range. In this case revenue variance within a week is regarded as seasonal.

In the analyzable dataset, the range of variance is permanent. Hence the additive model is applied:

Y = *S* + *T* + *E*,

where *Y* is estimated revenue;

S is a seasonal component;

T is a trend component;

E is a casual error of the model.

When the model is being built, the initial series is smoothed by the moving average method. Deviation between the resultant values and real revenue are determined.

The difference contributes to the formation of the seasonal component. Each day of the week is assigned the average deviation. Afterwards values are adjusted so that their sum be nil. Seasonal components of Monday, Tuesday, Wednesday, Thursday, Friday, Saturday and Sunday turned to be –6,376.87, –7,346.91, –7,032.28, –5,243.63, –1,812.15, 14,966.1 and 12,985.3 respectively.

Values of the seasonal components are subsequently deducted from initial values of revenue. Based on the resultant series, the trend equation is made.

Therefore, the trend component is as follows:

T = 33,676.82 – 14.67*t*.

The predicted revenue equals the sum of the trend and seasonal components.

The third model is constructed by grouping data by day of the week and forming the trend equation of each group:

$$y_t^{(j)} = \beta_0 + \beta_1 t + \varepsilon_t,$$

where *j* is the ordinal number of a day of the week (1 for Monday, 2 for Tuesday, etc.).

The resultant regression functions of each day of the week are as follows:

$$y_t^{(1)} = 26{,}763.53 - 90.45\, t + \varepsilon_t;$$

$$y_t^{(2)} = 31{,}777.25 - 73\, t + \varepsilon_t;$$

$$y_t^{(3)} = 40{,}555.31 - 80.01\, t + \varepsilon_t;$$

$$y_t^{(4)} = 54{,}273.54 - 93.95\, t + \varepsilon_t;$$

$$y_t^{(5)} = 64{,}171.88 - 88.45\, t + \varepsilon_t;$$

$$y_t^{(6)} = 135{,}222.8 - 178.43\, t + \varepsilon_t;$$

$$y_t^{(7)} = 110{,}830.4 - 114{,}34\, t + \varepsilon_t.$$

A function is chosen in line with a day of the week at the predicted moment of time.

[2] Aivazyan S.A., Mkhitaryan V.S. *Prikladnaya statistika i osnovy ekonometriki* [Applied statistics and principles of econometrics]. Moscow, YUNITI Publ., 1998, 256 p.

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To assess the accuracy of the regression models, we involve the mean error formula:

$$\delta = \frac{1}{n}\sum_{t=1}^{n}\left|y_t - y_t^*\right|,$$

where *n* is sample size;

y_t is real value of revenue at the *t*-time;

y_t^* is predicted revenue at the *t*-time.

Table 1 presents values of errors of the analyzable models and *F*-test. All the equations are statistically meaningful for a 99-percent confidence interval. The least error is recorded in case of the seventh-order autoregressive model.

It is more difficult to predict revenue on holidays due to the following reasons:

- revenue is not the same on different holidays (January 25, March 8, etc.), i.e. the same equation is inapplicable to all the holidays;
- there are scarce data on revenue on a particular holiday. For example, data on the analyzable company's performance are available for two years' time only. Hence two values of revenue are known for each holiday;
- long time interval between holidays (year), during which revenue trends and level may well change;
- revenue may fit values of a day during the week of the holiday, or be different from them.

For revenue prediction in this case, we use an approach based on data grouping by day of the week, and outlier analysis. Outlier shall mean value, which strongly deviates from other values of the dataset. As depicted in *Fig. 2*, revenue on holiday pertains to a higher level, that is outlier. Outliers are detected through statistical procedures, with one of them being based on the assessment of quartiles *Q*1 and *Q*3. A value is qualified as outlier if it does fall within the interval:

$$[Q_1 - 1.5(Q_3 - Q_1), Q_3 + 1.5(Q_3 - Q_1)].$$

Before such verification starts, all the values of revenue on holiday are taken away from the sample.

Tables 2 and *3* present the outcome of outlying test of some values of revenue on holidays. Outliers are seen to include only those values of revenue that relate to business days. It signifies that there is a certain threshold value of the fast food restaurant's revenue, which depends on the number of people serviced that day. This number constitutes a certain limit that results from the time it takes to cook the ordered meal, and capacity of the dining space. In other words, revenue on holiday is not higher than on weekends.

To predict revenue on holiday of the current year on the year-on-year basis, we use a dataset grouped by day of the week. The group (day of the week) can be chosen in several ways.

1. A day of the week when the sum of squared deviation of revenue from its value on holiday the previous year is minimum:

$$\sum_{i=1}^{n}(x_i^{(j)} - y_h)^2 \rightarrow \min,$$

where *n* is the number of elements in the *j*-group;

$x_i^{(j)}$ stands for values of revenue in the *j*-group (training set);

y_h stands for values of revenue on holidays the previous year;

j is the group number corresponding to a day of the week.

2. A day of the week which is holiday the current year.

3. A day of the week which was holiday the previous year.

4. A day of the week when the sum of squared deviation of revenue from its values on holidays is minimum:

$$\sum_{h=1}^{m}\sum_{i=1}^{n}(x_i^{(j)} - y_h)^2 \rightarrow \min,$$

where *m* is the number of holidays.

In revenue forecasts two scenarios are possible:

- value will not be outlier (for the rest of revenue values falling onto a day of the week when there is a holiday);
- value will be outlier.

In the first case scenario, the regression is build on the data on the day of the week, which is holiday the current year (the second option of data selection is applied, *Fig. 3*). Thus, we use the approach considered in forecast of non-holidays.

In the second case scenario, the option of data selection depends on the fact whether the value of revenue on holiday the previous year was outlier. In this case, three scenarios should be taken into consideration:

- the value of revenue on holiday the previous year was not outlier. For example, the holiday was Sunday

the previous year, but it is a weekday the current year. Therefore, to forecast the respective value, it is necessary to apply the third option for data collection, using the data on the day of the week which was holiday the previous year;

- value of revenue on holiday turned out to be outlier the previous year. For example, the holiday takes place on a weekday the previous and current year. In this case, to predict the value, it is necessary to apply the first option of data collection, using the data on the day of the week when the sum of squared deviations of revenue on holiday the previous year is minimum;
- there are no data on revenue on holiday the previous year since the company started its operations after this point of time. Thus, to predict the value, the forth option of data collection should be applied, using the data on the day of the week when the sum of squared deviations of revenue from its value on holiday is minimum (if there are data on values of revenue on other holidays).

The paragraphs below show an example of revenue prediction for March 8, 2016. The value in 2015 is known, without being qualified as outlier. If the value is outlier the current year, it will be necessary to use the data on the day of the week which was holiday the previous year (Sunday). Built on the recent 24 values of revenue on Sunday (half year), the trend equation is expressed as follows:

$y_t = 53{,}063.07 - 530.875t$.

The predicted revenue is as follows:

53,063.07 – 25 · 530.875 = RUB 39,791.18.

If the value of revenue is not outlier, it will be necessary to use the data on a day of the week which is holiday the current year (Tuesday). The resultant trend equation is expressed as follows:

$y_t = 19{,}122.28 + 211.497t$.

The predicted value of revenue will equal

19,122.28 + 25 · 211.497 = RUB 24,409.74.

The real value of revenue was RUB 36,269 on March 8, 2016. In both options forecasting errors will be as follows:

|36,269 – 39,791.18| = RUB 3,522.18;

|36,269 – 24,409.74| = RUB 11,859.26.

Therefore, more precise forecast was made on the assumption that revenue is outlier. *Fig. 4* shows errors arising in case of using the non-holiday prediction model to forecast the revenue on March 8.

Hence we made an attempt to forecast the fast food restaurant's revenue. Three regression models were applied to assess the value on non-holidays, i.e. the first-, second- and seventh-order autoregressive models, season- and trend-specific model and data grouping trend. All the equations proved to be statistically meaningful, with the least error being detected in case of the seventh-order autoregressive model. To predict revenue on holidays, we devised the value selection algorithm based on outlying analysis. As per the algorithm, we form two options of possible revenue by assuming that the value is or is not outlier. The article also provides an example of predicting revenue on holiday.

Table 1
***F*-test and errors**

Type of model	Value of error	*F*-test
First-order autoregression	8,081.41	196.34
Second-order autoregression	7,797.91	137.18
Seventh-order autoregression	5,722.87	157.38
Season- and trend-specific model	6,098.87	898.56
Trends based on data grouping:		
– Monday	6,658.41	7.9
– Tuesday	5,412.12	7.24
– Wednesday	5,869.1	7.27
– Thursday	6,298.24	12.39
– Friday	6,736.03	11.3
– Saturday	8,070.73	23.66
– Sunday	8,168.66	10.57

Source: Authoring

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Table 2
Outlying cases in 2015

Indicator	January 25	February 23	March 8	May 1	May 9	June 12	April 4
Day of week	Sunday	Monday	Sunday	Friday	Saturday	Friday	Wednesday
Outlying	No	No	No	No	No	Yes	Yes

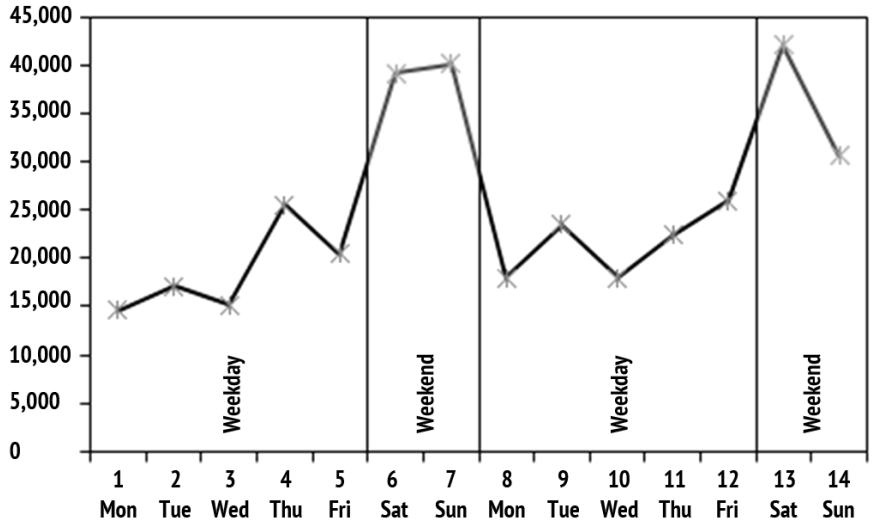
Source: Authoring

Table 3
Outlying cases in 2016

Indicator	January 1	January 7	January 25	February 23	March 8	May 1	May 9	June 12	November 4
Day of week	Monday	Thursday	Monday	Tuesday	Tuesday	Sunday	Monday	Sunday	Friday
Outlying	No	Yes	No	Yes	Yes	No	No	No	No

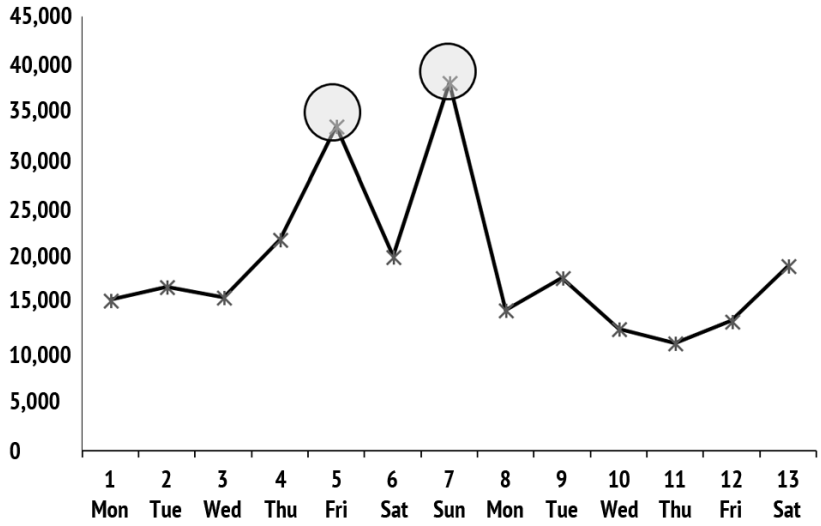
Source: Authoring

Figure 1
Changes in the fast food restaurant's revenue for two weeks, RUB



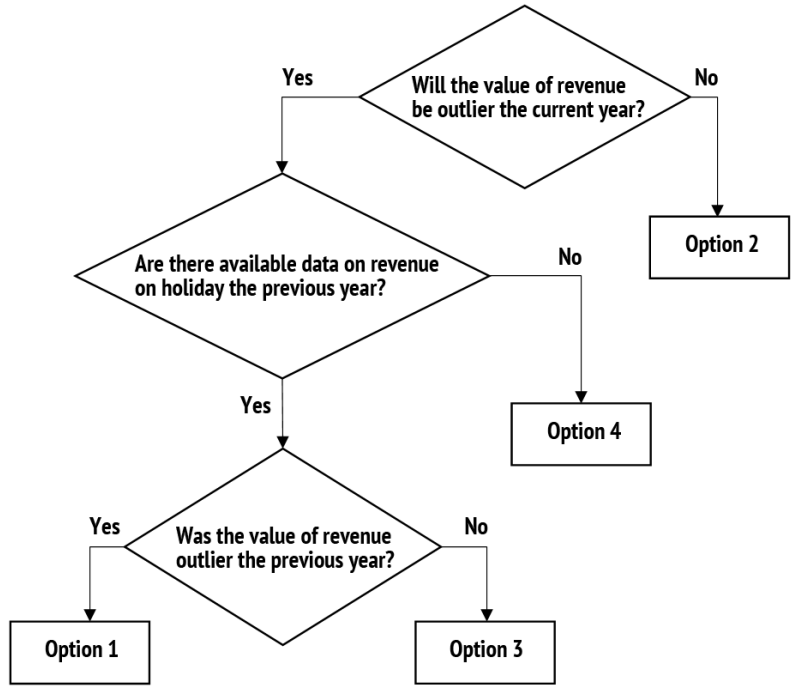
Source: Authoring

Figure 2
The fast food restaurant's revenue on Monday, RUB



Source: Authoring

Figure 3
The data selection algorithm for revenue prediction



Source: Authoring

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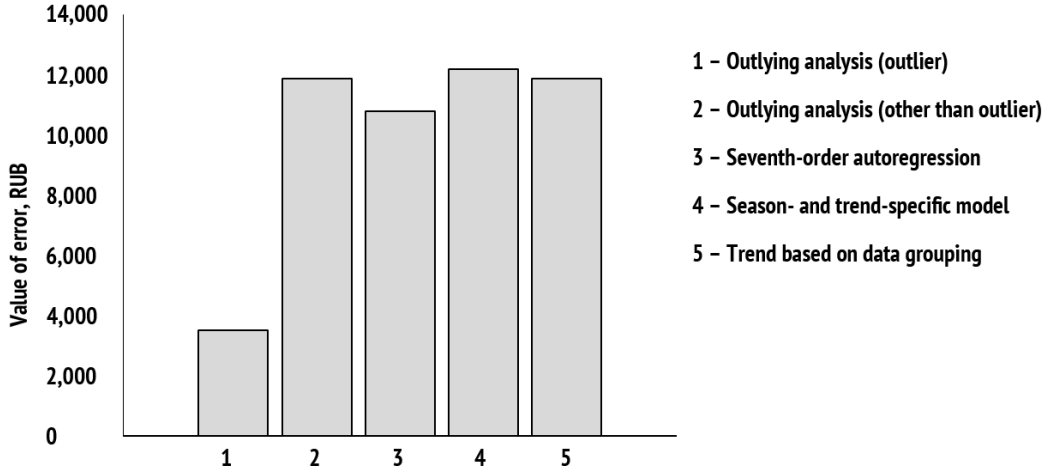
Figure 4
Values of errors



Source: Authoring

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Insurance

Translated Article†

INSURANCE MARKET OF UZBEKISTAN AND NEED FOR MUTUAL INSURANCE COMPANIES

Kamariddin M. KULDASHEV
Tashkent Financial Institute, Tashkent, Republic of Uzbekistan
KuldashevKM@gmail.com

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Abstract

Importance The article reviews mutual insurance, its distinctions, advantages and demand for it in Uzbekistan.

Objectives The research determines the position of Uzbekistan's insurance market and identifies its development issues. I substantiate advantages of mutual insurance and benefits if it is implemented in certain sectors of the economy, including agriculture.

Methods The methodological underpinning comprises basic research in insurance. The research employs structural, logic and systems approaches.

Results I analyze and compare the current situation in Uzbekistan's insurance market and those in other countries. Drawing upon the previous research, I determine distinctions of the situation, weaknesses and issues of Uzbekistan's insurance market. The article also points out general and specific traits of mutual and commercial insurance, emphasizing the advantage of mutual insurance. Mutual insurance companies seem to be one of the development solutions for the insurance market, especially in case of agriculture.

Conclusions and Relevance Based on the findings, I provide my recommendations for developing the insurance market and improving the quality of services. To ensure the concurrent promotion of the insurance market and commercial insurance, mutual insurance should be introduced in agriculture.

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Insurance is a crucial element of an economic system. Its future development will unavoidably induce reforms of the entire economic system. Insurance implies that entities accumulate a portion of their assets and use them to recover losses from unfavorable weather conditions and other risks. There is no other sector like insurance where the State plays such a decisive role. The State performs insurance functions and oversees respective operations. Insurance is so sensitive due to its public importance. Any insurable event is often perceived as a catastrophe for the insured, thus giving rise to an insurable event in the national economy, and production chain gap.

Entering into an insurance contract, the insured can recover its property status quite quickly, mend disrupted business relations ties for reproduction. Considering the global nature of insurance, reinsurance and globalized economic processes in particular, it is necessary to examine each functional part of the Uzbek economic system from global perspectives.

Scholars conducted multiple studies into the role of insurance, including mutual insurance in economic and social development. Some researches determine

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the position and functional role of mutual insurance in the modern insurance market, i.e.:

- mutual insurance is justified as a method for creating competitive products in the insurance market, outlining effective approaches to insurance against various risks in sectors of the modern economy [1];
- the initial pool of mutual insurance companies' funds constitutes organizational costs, guarantee capital and production capital for mutual insurance companies to cover losses and incur current expenditures respectively[1];
- mutual insurance companies are proved to deliver insurance services of higher quality to its members for an affordable price by applying the reduced structure of gross insurance premium under an insurance plan [2];
- analysis covered sources of insurance law, conceptual framework, protection of customers' rights with respect to insurance companies, insurance companies, insurance process, insurance of property, responsibility and reinsurance [3];
- activities of insurance companies are analyzed from perspectives of political economy, finance, governance, law and accounting [4];
- substance of mutual insurance is unveiled [5].

The insurance market originated not so long ago in Uzbekistan. The Law *On Insurance* was adopted in the Republic of Uzbekistan in 1993. In 2002, the new Law *On Insurance Activity* was enacted, still being effective. Moreover, dozens of rules and regulations on insurance were passed.

Compulsory insurance is on the upswing. This rise resulted from laws on compulsory liability insurance of car owners (2008), employers (2009) and carriers (2015). The Uzbek insurance companies raise the volume of insurance premiums every year. There is a persistent declining trend in insurance premium concentration, i.e. insurance activities continue to grow in the regions of Uzbekistan.

It is getting clear that insurance is one of the rapidly growing industries in the Republic of Uzbekistan. However, insurance evolves not so fast as it should to increase its potential in the overall economy. Insurance still makes little contribution to the national economic development. The percentage of the insurance sector has been accounting for 0.3–0.4 percent of GDP for 10–15 years (*Table 1*). It is several times as high as in the European countries, USA and Japan (8–12 percent). Unfortunately, despite a fast pace of growth, insurance is not able to catch up with rapidly rising macroeconomic indicators of Uzbekistan.

Insurance has not yet occupied its niche in the Uzbek economy. People and business are reluctant to deal with insurance companies, having little confidence in them. The potential insured are not certain that they will receive insurance coverage on a timely basis in case of insurance events. This statement is corroborated with the fact that insurance coverage of insurable events accounts for 18 percent of total insurance premiums collected by insurers for a year (*Table 2*).

The government provides aid and tax incentives to the insurance sector. However, as I see it, insurance companies' performance, information on new products, strategic plans for relations with customers and market actors leave much to be desired.

The insurance market experience a high concentration of actors. In particular, over 55 percent of total insurance premiums are held by only five major companies of Uzbekistan, and 76 percent in case of 10 companies respectively (*Table 3*).

What else distinguishes the insurance sector is that there are no regional insurance companies in Uzbekistan. Almost all of them are registered in Tashkent, the capital of Uzbekistan. However, this disadvantage is compensated with multiple regional representatives of the companies. I believe the issue cannot be totally resolved this way. Regional insurance market has the potential for further development.

The State has been paying much attention to business for the recent years. Business increased its share in GDP, concurrently experiencing a rise in business risks. Businessmen's attitude to insurance remains almost unchanged. Insurance companies also overlook the business sector. For example, neither insurance company has an insurance contract for production disruption. In the mean time, this type of insurance became quite common abroad long ago.

[1] *Strakhovoe delo. V 2 tomakh. T. 1* [Insurance. Two Volumes. Volume One]. Moscow, Ekonomist Publ., 2004, 447 p.

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Having analyzed multiple statistical and descriptive materials, I found a number of alternative ways for insurance development. In Uzbekistan, as part of the *State-as-the-main-reformer* initiative, there are many benefits for streamlining and developing commercial insurance. Substantial support of the State can be proved by comparing data with insurance preferences and benefits in the CIS countries.

Ensuring priority development of insurance in comparison with GDP, it is necessary for the State to develop and implement alternative options of insurance based mainly on moral principles. Insurance benefits the State grants shall also be effectively utilized.

Long-standing confidence of the public can be won by developing absolutely new insurance products, which would provide tangible and financial advantages for the insurers and insured. It is also very important to adhere to the principle of equal financial rights, interest of all the parties in the ultimate goal.

Following this course, it is crucial to reasonably exercise the existing legislative framework. For example, Article 960 of the Civil Code of the Republic of Uzbekistan *Mutual Insurance* is still pending.

To set up and run mutual insurance companies in Uzbekistan, even this document will be initially enough to address the issue. Later on there should be articulated and adopted the new law *On Mutual Insurance*.

Agricultural insurance is one of the insurance segments that is almost absent in Uzbekistan.

The agricultural sector enters a new phase of its development, striving to higher quality and competitiveness of products, assuming an innovative course, i.e. technical and technological retrofitting and renewal, decentralized governance, improvement of market relations and increase in the export potential of the sector and profits of agricultural producers.

Agricultural insurance is voluntary in Uzbekistan. Voluntary insurance unfolds rather slowly because agricultural producers lack available funds to make insurance contributions and understanding of insurance as a mechanism for farmers to protect their financial well-being.

Considering the expertise of other countries, there shall be formulated a law on agricultural risk insurance, which would define the legislative principles and specifics of insurance of agricultural risks, apply to agricultural property and harmonize the Uzbek laws on agriculture. The law should pursue the creation and maintenance of political, economic, social, environmental and legislative conditions for profitable performance of agricultural enterprises, increased profit of farms, development of market relations, economic and food security, strengthening of the Uzbek agricultural sector.

Mutual insurance may become the best-fit method to promote insurance in agriculture and other segments. This insurance option will allow to reduce insurance premiums, on the one hand, and raise the confidence of the insured. That is why the law should envisage this type of insurance in agriculture.

Mutual insurance is one of the insurance protection forms. Local people provide voluntary and public support to each other for centuries, when people help one of the community members on a regular basis so as to improve his or her socio-economic position. Such actions are called *Hashar* (Arabic word meaning 'charity'). In fact, mutual insurance principles are based on such concepts to a certain extent.

Unlike profit-making insurance companies, mutual insurance companies do not pursue profit. That is why all their reserves are kept by the founders, i.e. the insured.

Historically, the insurer and insured are the same person, thus constituting the first organizational form of mutual insurance and conveying its non-profit nature[2].

As part of mutual insurance and protection of property interests, community members combine their money to make a pool of insurance funds. The right of each insured morphs into a right of joint ownership pertaining to the entire community of insured/insurers [6]. What distinguishes mutual insurance is that each insured, as a stakeholder, actively participates in administrative, financial activities of the community and has a voting right. Members of mutual insurance company can determine the company development policy, risks subject to insurance coverage, cost of services, formation of insurance reserves, etc. Tangible resources may be merged with resources of other

[2] Pinkin Yu.V. *Spravochnik strakhovshchika* [Insurer's Handbook]. Rostov-on-Don, Feniks Publ., 2007, 173 p.

insured that have a similar intention to insure property interests. Such a combination takes place upon consent of the stakeholders. To create insurance products, the stakeholders make contributions to a pool of insurance funds, with each of them keeping the ownership right to the funds [7].

The main provisions of the theory of eventual needs were logically complemented by A. Manes, the German scholar who put the money saving mechanism to the forefront of the insurance theory since it allowed for contribution-based participation of many persons [8].

Scrutinizing the indicia that define the mutual nature of insurance relations, many researchers underlined, first, the equal position of the insured, second, participation of the insured in their mutual insurance company management, third, the so called solidarity ties that unite the members on the reciprocity principles [9].

The reciprocal responsibility of the community members for their insurance activity is one of the fundamental economic principles [10].

Even the State puts the national solidarity and reciprocity at the basis of the national insurance system. For example, France. There every resident pays an equal insurance premium no matter whether he or she is exposed to a risk, thus contributing to insurance coverage of those residents who live in areas exposed to various insurance risks [11].

Regular preventive measures are the main tool to decrease the amount of an individual contribution. Hence mutual insurance companies often resort to preventive actions as one of the main organizational measures.

The process is different in joint-stock companies. According to the Russian analysts, joint-stock company almost neglect preventive measures to reduce their risks and avoid insurable events. As a result of non-existent preventive actions, insurable events cause greater damage and detriment to the inflicted persons and subsequently inhibit the overall economic growth [12]. Currently, the same situation is observed in the national insurance market of Uzbekistan occupied by profit-making insurance companies only.

Initial phases of mutual insurance actually witnessed the fold-insurance system implying that the community members were not supposed to make contributions but equally shared losses and expenses in case of insurable events. As economic relationships evolved, the fold-insurance system gradually transformed into a preliminary payment system. The mutual insurance method originated in the life insurance segment, since the reciprocity method was easier to implement in personal insurance, rather than property one [13].

As seen in practice, the form of mutual insurance in the USA, Japan and some European countries is not less significant and effective than its profit-making format. Currently, six in ten wealthiest insurance companies pertain to the mutual insurance segment[3], with two of them operating in Japan (*Table 4*). The Japanese insurance market goes second in the world after the USA by amount of insurance premiums. The Japanese life insurance market accounts for about 16 percent of total insurance premiums collected in the segment worldwide[4].

Nowadays, mutual insurance turns into a global phenomenon. Mutual insurance companies occupy a special niche in markets of most industrially advanced nations.

Such mutual insurance as *Takaful* is rather well developed in many Muslim countries. This financial tool helped not only accumulated idle resources within countries but also diversify the global financial market.

There are countries promoting the *Takaful* development as an alternative insurance mechanism that are in agreement with the Sharia laws and ethics [14].

Takaful, or Islamic insurance, represents a system based on mutual help principles (*Taawun*) and voluntary donations (*Tabarru*), which calls for joint and voluntary allocation of risks among the community members. *Takaful* constitutes a form of insurance which is

[3] *Resolyutsiya II Mezhdunarodnoi nauchno-prakticheskoi konferentsii po srakhovaniyu v Rossiskom ekonomicheskom universitete im. G.V. Plekhanova 'Vzaimnoe strakhovanie: mirovye tendetsii I perspektivy razvitiya v Rossii* [Resolution of the 2nd International Scientific and Practical Conference on Insurance in the Plekhanov Russian University of Economics ' Mutual Insurance: International Trends and Development Prospects in Russia]. URL: http://finvector.ru/wp-content/uploads/2012/04/%D0%98%D0%BD%D1%84%D0%BE%D1%80%D0%BC%D0%B0%D1%86%D0%B8%D0%BE%D0%BD%D0%BD%D0%BE%D0%B5-%D1%81%D0%BE%D0%BE%D0%B1%D1%89%D0%B5%D0%BD%D0%B8%D0%B5.pdf (In Russ.)

[4] Japan's Insurance Markets: A Sea of Change. Swiss Reinsurance Company Economic Research and Consulting. SwissRe. Sigma, 2000.

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compliant with the Islamic law, meaning *reciprocal guarantee* in Arabic[5].

Takaful lays the basis for a new line of global insurance development. Considering that the majority of the Uzbek population are Muslims, I believe it would be reasonable to introduce *Takaful* into the insurance system of Uzbekistan.

Some advantage of mutual insurance companies stems from the status of profit-making companies, which do not pay income tax since it does not exist as is. That is why their tariffs are lower than insurance companies offer. The difference between mutual insurance and profit-making companies are presented in *Table 5*.

Mutual insurance companies provide coverage only for their own members. The insured of the mutual insurance company acts as its member at the same time. A member of the mutual insurance company is not its shareholder, fund investor or stakeholder since the mutual insurance company sets up a joint-stock capital (unit investment, pooled capital) or other types of capital divided in unit investments or shares, without forming authorized capital (non-profit companies do not have authorized capital).

Agriculture is one of the most promising areas for mutual insurance.

Agriculture is a strategic sector of the economy. Its effective development mainly depends on the extent to which the State interferes into its management, and amount of the State aid. The State often uses insurance as one of the methods to economically influence the agricultural sector and recover losses of agricultural producers in case of natural risks.

Uzbekistan draws on hand-on experience of agricultural insurance in industrially advanced countries. There the State supports agricultural businesses through market mechanisms of insurance, being a component of the governmental policy in agriculture.

In other countries the State provides subsidies for insurance premiums of agricultural insurance companies, reimburses damages, arranges for the governmental system of reinsurance on a commercial and gratuitous basis in domestic and foreign markets [15].

Following the expertise of developed countries, mutual insurance companies could play a special role in agriculture of Uzbekistan, being virtually a form of agricultural cooperation.

Mutual insurance suits farming because it rests upon ideas of community and mutual help, which are traditional for the Uzbek mentality. This may drive farmers into the insurance sector.

As globally observed, mutual insurance may become the most powerful and protective shield from most agricultural risks. Putting up a part of their funds together within a mutual insurance company, farmers do not have to give their money to someone else.

There are few insured farms in Uzbekistan so far. This especially affects farmers in years of poor crops, undermines the stability of agricultural production. The abolishment of compulsory insurance of agricultural crops eroded this type of insurance within the total volume of insurance in Uzbekistan.

Proceeds from agricultural crop insurance decreased tenfold [16]. Such a negative effect can be overwhelmed by setting up mutual insurance companies. The State should financially support farmers who participate in mutual insurance companies at least by paying some of their insurance contributions. Budgetary backing can be crucial in the emergence of agricultural mutual insurance companies which mainly cease to develop due to limited finance.

Any agricultural mutual insurance company reasonably needs to quickly erect the vertical structure at the regional and even republican level. If there is a republican system of mutual insurance companies in agriculture, this will allow to reallocate risks throughout a considerable area, thus making mutual insurance companies more sustainable. They could provide coverage in case of droughts, floods, poor crops. Insurance coverage has a little share in total insurance premiums in the national market today. Referring to the USA, EU and Japan, the indicator is expected to reach at least 80 percent of total insurance premium, which is the main advantage of mutual insurance in comparison with commercial one.

[5] Engku Rabian Adaviah Engku Ali, Odierno Hassan Scott P. Essential Guide to Takaful (Islamic Insurance). Kuala Lumpur, Malaysia, CERT Publication Sdn. Bhd., 2008.

At the current phase of economic development, insurance gets more significant since business activities are influenced by destabilizing transformation, economic and environmental processes. Insurance markets of developed and developing countries demonstrate contradictory development trends. They stem from the global financial and economic crisis and its effect on national production, lower income, response of national economies to new development challenges.

It is worth mentioning that insurance has been stable in Uzbekistan for several recent years in terms of the composition of insurance market actors and components of insurance activities.

I should note some positive trends. The State intervenes insurance activities less frequently, while the regional network of branches expands. What brings hopes is a growth in the number of private companies in insurance. The regional insurance market demonstrates some growth in investing activities. However, some growth in the market volume was offset with inadequate changes in quality:

- low key performance indicators of insurance (percentage of insurance premium in GDP, insurance coverage of GDP);
- poor quality of investment mix and regional disparities in investment;
- life insurance accounts for a little share in the overall insurance portfolio.

Insurance community in Uzbekistan shall be prepared for an arduous work in order to cultivate market relations in the segment. Moreover, it is necessary to create conditions for quality indicators of insurance to grow. Doing so, the market actors should strengthen and expand the base for compulsory insurance, promote all types of agricultural insurance in all the regions of Uzbekistan, various types of voluntary medical insurance. They also should advance the educational level of insurance specialists and develop an appropriate attitude of the population to insurance.

Furthermore, domestic insurance companies should integrate with foreign ones for the sake of further development of the insurance market.

It is also very important to establish mutual insurance companies in different sectors and specifically in agriculture. Mutual insurance companies operate where commercial insurers are reluctant to work due to substantial overhead expenses and small insurance contributions. Therefore, competition should not be regarded as an obstacle since the Uzbek insurance market is not explored yet, being accessible for all willing entrants

Currently, Uzagrosugurta Company is the sole insurance company operating in the agricultural sector. In the mean time, its insurance premiums has been proceedings for the recent years from other types of insurance, rather than from agriculture. It means that the majority of farms still carry on without being insured and protected from risk exposures.

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Table 1

The share of collected insurance premiums in GDP of the Republic of Uzbekistan

Year	GDP, billion UZS	Insurance premiums, billion UZS	Percentage of insurance premiums in GDP	Trends, percentage points
2012	97,929.3	256.3	0.26	–
2013	120,861.5	338.5	0.28	0.02
2014	145,846.4	439.1	0.3	0.02
2015	171,808.3	551.5	0.32	0.02
2016	199,325.1	692.6	0.35	0.03

Source: Ozbekiston Respublikasi Davlat statistika qo`mitasi. URL: https://stat.uz/uz/

Table 2

The volume of collected insurance premiums and insurance payments in the insurance market of the Republic of Uzbekistan in 2008–2016

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016
Insurance premiums collected, billion UZS	88	146.1	175.5	221.8	285.9	338.5	439.1	551.5	692.6
Insurance payments, billion UZS	15.5	20.7	27.6	45.1	46	66.9	74.6	99.8	130.5
Percentage of insurance payments	17.6	14,2	15.7	20.3	16.1	19.8	17	18.1	18.8

Source: Data of the State Insurance Supervision of the Republic of Uzbekistan

Table 3

The shares of ten insurance companies in the insurance market of the Republic of Uzbekistan

Insurance company	Insurance market share, %
Uzagrosugurta	19.9
Uzbekinvest	14.5
Kafolat	10.5
ALSKOM	5.8
Asia Insurans	5.1
Alfa Invest	4.9
Kapital sugurta	4.9
Ozbekinvest Hayot	4
Temiryol-Sugurta	3.7
Agro invest sugurta	2.9

Source: Data of the State Insurance Supervision of the Republic of Uzbekistan

Table 4

The number of mutual insurance companies compared to joint stock companies among the ten largest insurance companies

Company	Country	Assets, billion USD	Legal and business structure
AXA	France	407.9	Joint-stock company
Nippon Life	Japan	323.3	Mutual insurance company
Allianz	Germany	293.7	Joint-stock company
Prudential Insurance Company	USA	259.5	Mutual insurance company
Zenkyoren	Japan	245.4	Mutual insurance company
Dai-Ichi Mutual Life Insurance	Japan	219.6	Mutual insurance company
Metropolitan Life	USA	201.9	Mutual insurance company
American International Group (AIG)	USA	194.4	Joint-stock company
Sumitomo Life	Japan	182.6	Mutual insurance company
Prudential	UK	178.9	Joint-stock company

Source: Pinkin Yu.V. *Spravochnik strakhovshchika* [Insurer's Handbook]. Rostov-on-Don, Feniks Publ., 2007, 173 p.

Table 5

Specific features of a mutual insurance company (non-profit organization) and an insurance company (profit-making organization)

Insurance company	Specifics
Mutual insurance company	A non-profit entity aims to ensure the real insurance coverage for its members and promote the social development as a whole. Every member of a mutual insurance company is the insurer and insured at the same time, without igniting any conflict of interests. Mutual insurance company makes its financial activities transparent for equal members. Mutual insurance company cannot be bought, sold, split, with the corporate policy depending on all the members. Any individual and legal entity can accede the mutual insurance company. According to the corporate policy, each member is allowed to invest his/her money in insurance plans, propose projects, take an active part in corporate activities and set up representative offices of the company. General meeting is the supreme executive body. All the members constitute the company and have voting rights. Mutual insurance company is not bound to obtain licenses for its activities and insurance plans. This preserves corporate flexibility in each particular case so as to satisfy corporate interests. Mutual insurance company has flexible pricing policy. The price for an insurance service may be lower than the market average because of the unity of members' goals, low administrative and other expenditures
Joint stock company	Profit-making company provides insurance coverage to its customers but also strives to derive as much profit as possible for shareholders' interests. The insurer and insured pursue divergent interests due to different goals. Financial transparency of the company is improbable since it contradicts shareholders' interests and engenders the risk of customers' confidence loss. Joint-stock insurance company can be bought, sold, split, with its policy being adaptable to owners in case of their change. The clientele may include individuals and legal entities, but they do not participate in outlining insurance plans, joint projects. General meeting of shareholders is the supreme executive body in joint stock companies. Its decisions cannot be argued by customers. Profit-making insurance company shall obtain license for its activities and each insurance company. Joint stock companies adhere to a stringent policy of tariffs since the insurers and shareholders' interests (profit from insurance operations) prevail those of customers

Source: Pinkin Yu.V. *Spravochnik strakhovshchika* [Insurer's Handbook]. Rostov-on-Don, Feniks Publ., 2007, 173 p.

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Conflict-of-interest notification

I, the author of this article, bindingly and explicitly declare of the partial and total lack of actual or potential conflict of interest with any other third party whatsoever, which may arise as a result of the publication of this article. This statement relates to the study, data collection and interpretation, writing and preparation of the article, and the decision to submit the manuscript for publication.

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Banking

Translated Article†

A STUDY OF THE MARKET SHARE OF CREDIT PORTFOLIO THROUGH A NEURAL NETWORK

Nikolai I. LOMAKIN
Volgograd State Technical University, Volgograd, Russian Federation
tel9033176642@yahoo.com
Corresponding author

Yuliya V. FEMELIDI
Volgograd State Technical University, Volgograd, Russian Federation
yul010294@gmail.com

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Abstract

Importance The article studies the evolution of credit portfolios of the Russian banks during the analyzable using the self-organizing map (SOM).

Objectives The article aims to prove or refute the hypothesis that by using a neural network, i.e. self-organizing map, it is possible to predict changes in the market share of bank's credit portfolio.

Methods For the study, we used the self-organizing map.

Results We have developed and now present a neural network model that helps predict the market share of a credit portfolio in a changing market under economic uncertainty environment.

Conclusions and Relevance The application of the self-organizing map is important for obtaining some statistical information on commercial banks in the model clusters, as well as for forecasting the market share of the organization in a changing market environment. The findings can be used in bank marketing to predict the market share of the bank when the size of its portfolio changes.

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In current circumstances , the bank's credit portfolio management determines the effectiveness of strategic marketing in terms of credit risks under the market uncertainty, and competitiveness of the bank, trends in its market share as the portfolio size changes, being a fundamental metric of competitiveness.

The novelty of the research is an attempt to build a mathematical model – the Kohonen map, that would allow to predict the credit portfolio share of a commercial bank.

It is noteworthy that some credit portfolio management (CPM) aspects have not been studied sufficiently as yet, thus raising the practical value of the issue.

As seen in other researches, CPM stands at the crossroads of management, banking, investment,

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lending and marketing. It proves how many aspects this problem involves in case of the market uncertainty.

These aspects can hardly be called understudied. Issues of management, including strategic one, are investigated by such researchers as I. Ansoff, M. Porter, A.J. Strickland et al. [1–3]. Overviewing contemporary Russian and foreign literature, we can point out some researches by Russian and foreign economists.

Scrutinizing what distinguishes effective management of a credit portfolio, T.V. Grebennik focused on the process quality and relevant issues [4, p. 145]. Doing so, she referred to methodological principles of quality, which were found by B.A. Raizberg, L.Sh. Lozovskii, E.B. Starodubtseva[1].

The methodology for managing an investment portfolio, to which loans can be easily attributed, is studied in proceedings by H. Markowitz, W. Sharpe, N. Lomakin[2].

Russian scientists V.K. Silaeva, D.A. Krykhtina view portfolios of banks as a separate item to be managed[3]. The credit portfolio risk, the most critical metric, was examined by A.I. Grishankin [5], V.A. Korotina[4] et al.

Considering the market uncertainty, it is important to enhance an evaluation of a credit portfolio in a commercial bank. It became the subject of researches by S.N. Yakovenko, A.S. Markelov [6, pp. 596–601].

M.J. Miranda and S. Gonzalez-Vega gained deeper insights into the issue, unraveling the concept of inherent risk and index insurance risks in the appropriate management of an agricultural credit portfolio [7, pp. 399–406]. J. Marshall investigated some CPM issues [8, pp. 122–124] and formulated effective management policies through the systems approach to risk assessment.

The scholarly team led by A. Lucas proposed their own analytical view to the credit risk of major corporate bonds and loan portfolios [9, p. 1635].

We should single out A.N. Kadyrov among the Russian scholars dealing with this aspect since he devised a technique for classifying the borrower's risk [10, pp. 46–51]. According to O.N. Maksimova, innovative approaches to competition and marketing are in sync with the current challenges [11, p. 184].

Many scholars discussed similar issues. Such renown scholars as S.L. Brue, J. Keynes, J. Robbins and A. Smith made an invaluable contribution to the theory of competition. For instance, F. Knight presented his classic concept of relationship between risk and uncertainty [12].

Despite giving proper respect to the above researches, we still emphasize that strategic management issues are insufficiently elaborated in relation to credit portfolios through artificial intelligence systems.

Certain authors address the use of neural networks in financial markets. For example, the stock price forecast based on the neural network helped estimate future prices for the asset within a 5-percent error threshold [13]. Neural networks also worked for analyzing the volatile value of IBM in the stock exchange[5]. However, practical processes engender new challenges as all the types of risks grow under the market uncertainty.

As studies show, the recent years have seen a significant reduction in the number of the Russian credit institutions, and this trend gains momentum. The total number of credit institutions fell from 1,311 down to 623, or by 46.5 percent, within 2001–2017. It is a sign of considerable transformation processes in banking driven by internal and external factors.

Determining aspects of the Russian banking are important to study not only to make forecasts of the nearest and distant future. There is a strong

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[3] Krykhtina D.A., Silaeva V.K. et al. [Assessing the bond portfolio of a commercial bank]. *Vzaimodeistvie predpriyatii I vuzov – nauka, kadry, novye tekhnologii: materialy konferentsii* [Proc. Sci. Conf. Interaction of enterprises and universities: Science, talent, new technology]. Volgograd, VolSTU Publ., 2016, pp. 163–169.

[4] Korotina V.A., Lomakin N.I., Razumnyi A.S., Biryukov A.R. [Managing the financial risk through neural networks and fuzzy algorithms]. *15-ya nauchnaya konferentsiya prepodavatel'skogo sostava VPI: materialy konferentsii* [Proc. Sci. Conf. 15th Conference of Academic Professors of Volgograd Politechnical Institute]. Volgograd, VolSTU Publ., 2016, part 1, pp. 225–227.

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likelihood that there will be less commercial banks left in the market.

Having processed data in a Microsoft Office Excel document, we got a polynomial equation expressing how the quantity of banks varies year by year:

$y = -2.0267x^2 - 5.762x + 1{,}346.4$,

where x means the period expressed in years.

The accuracy of approximation $R^2 = 0.9825$ signifies that the relationship is strong ($R^2 \geq 0.75$) and the resulting feature (the number of banks) is 98.25-percent dependent on the factorial feature of time.

Using the correlation equation, we can reliably assess the number of banks in the future by the method of extrapolation. Inserting $x = 18$ (the following observation goes eighteenth), we arrive at:

$y = -2.0267 \cdot 324 - 5.762 \cdot 18 + 1{,}346.4 = 586$.

It is very close to factual values, since, as of January 1, 2017, there were 623 banks, while only 567 ones are left as of March 1, 2017.

In practice, the Central Bank of the Russian Federation applies the method of grouping, thus forming six groups by amount of assets (*Table 1*).

As fewer commercial banks remain operational, it is vital to study trends in the market share of a credit portfolio in order to improve marketing communications.

We obtain input data from the website of the Central Bank of Russia and present them as a graph (*Fig. 1*).

As the analysis reveals, assets are predominantly concentrated in five banks of the first group (55.8 percent) and 15 banks of the second one (21.2 percent). Such concentration is typical of oligopolies. We got rather curious results by analyzing trends in groups of banks (*Fig. 2*).

What we also found out was that Top-50 banks demonstrated sustainable development in the analyzable period (first, second, third groups). For example, banks of the first group raised their assets by 10.4 percent, while their loan portfolios increased by 23.9 percent.

Mid-range banks make up an unsustainable group on the rear of Top–200. In this group, assets shrank by 1.6 percent and credit portfolio rose by 13 percent. The fifth and sixth groups represented with a myriad of small banks (423) face the toughest situation. Assets reduced by 21.1 and 60.3 percent respectively. Identical movements are registered in their credit portfolios, 23.9 and 65 percent respectively.

It is reasonable to analyze trends in credit portfolios using the Kohonen Self-Organizing Map (SOM). We randomly pick up banks' indicators within the period from August 1, 2015 through August 1, 2016. We make up a file, which will present factorial features of the neural network:

- bank's portfolio as of August 1, 2016, thousand RUB;
- market share as of August 1, 2016, %;
- bank's portfolio as of August 1, 2015, thousand RUB;
- market share as of August 1, 2015, %;
- portfolio changes, thousand RUB;
- portfolio changes, %.

We introduce input data of 583 banks included into the population (*Table 2*).

Processed with the mathematical algorithm of the neural network via the Deductor platform developed by Base Group, tabular figures are as follows as given in (*Fig. 3*).

For example in case of Sberbank, we have the following electronically processed data:

- cell number is 31;
- distance to the cell center – 7.029853;
- cluster number – 0;
- distance to the cluster center – 0.0877995946116151.

To analyze statistical parameters of each commercial bank, we draw upon capabilities of the Deductor software, with the input data being processed through the neural network.

The Kohonen SMO represents a variety of neural network algorithms. What distinguishes this technology is that it implies unsupervised learning. The outcome depends only on the composition of input data. Such neural networks are frequently used to address

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a spectrum of tasks ranging from data analysis to pattern recognition, for example, in finance[6].

To say it in other words, SOM enables users to project multivariate space into the other of lower dimensionality. When the algorithm is used, initially similar vectors happen to run alongside in the resultant map (*Fig. 4*).

The cross denotes coordinates of an input vector. Coordinates of the map nodes are colored grey upon their modification. The grid after modification are depicted with dashed lines. In a training set, the maximum error threshold is 0.009 percent, while it is 0.018 percent for the test set. The trained model generates data which reflect the composition and structure of the entire population of banks (*Fig. 5*).

To modify weight coefficients, the following formula is used:

$$W_i(t+1) = W_i(t) + hc_i(t)[x(t) - w(t)]w_i(t+1) =$$

$$= W_i(t) + hc_i(t)[x(t) - w(t)],$$

where t is the epoch number (discrete time);

$x(t)$ is a vector that is randomly picked up out of the training set during the iteration t;

$h(t)$ is the adjacency function of neurons.

Resulting from the processing of input data, the view of clusters reflects a concentration of major banks in the upper right-hand part of the rectangular pictures. The cluster profile shall be pointed out among properties the neural network program infers.

The table is based on a grouping of clusters 0–10, which includes values (absolute, relative and percentage-of-total). The program computes the following parameters per each cluster, such as significance, confidence interval and standard error (*Fig. 6*).

Surveying cluster statistics, we conclude on the extremely uneven distribution of banks, i.e. the principal part of banks – 540 small banks (92.8 percent) – are attributed to Cluster 5, while Cluster 6 is made up of 17 banks (2.9 percent) and onward to Cluster 0 occupied by giant Sberbank (0.2 percent) (*Table 3*).

Researchers state that the volume of credit portfolios demonstrates some deviation in different clusters (*Fig. 7*).

Let us look at credit portfolio trends of iMoneyBank added to Cluster 6 on a random basis.

Throughout the 2015–2016 period, the credit portfolio decreased down to RUB 3,237,447 thousand, or by 12.26 percent. Therefore, the market share of the bank's credit portfolio shrank from 0.0344 down to 0.0314 percent.

As part of operations with the Kohonen SMO, Deductor's what-if function helps assess trends in the market share of iMoneyBank if its portfolio reduces by RUB 452,194 thousand, i.e. keeping the same step as last year. That is, the bank's share will diminish to 0.0284 percent.

As our assessments show, Cluster 6 banks need to have a credit portfolio of at least RUB 800 billion to ensure their sustainable development. Such forecasts are important for competition in order to refine the development strategy.

As of January 1, 2017, the value of iMoneyBank's credit portfolio actually fell by 25.07 percent, i.e. the credit portfolio and the market share decreased to RUB 2,425,668 thousand and 0.0203 percent respectively.

According to researches, the Kohonen SMO facilitates predicting what will happen with the market share of a credit portfolio. Innovative assessment methods provide us with new opportunities. However, to use the opportunities, we need to supplement the model with more factors, thus improving the proposed neural network model [14, p. 197].

Commercial banks may rely on findings of theoretical studies, including the credit risk pattern recognition, to outline their development strategies in current circumstances. For example, the credit portfolio quality can be enhanced through special algorithms, which are validated with certificates of computer program registration[7].

[6] Lomakin N.I., Orlova E.R. et al. Analysis Order Book with a Card of Kohonen. URL: http://conf.ostis.net/images/ 7/77/50._lomakin-AnalyOBwCoK.pdf

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Considering the escalating market uncertainty, banks should put more effort into improving their marketing policy. It shall stipulate a possible response to economic developments driven by modern information technology. As competition gets tougher in banking, the market share is difficult to occupy without advanced financial products.

Referring to the above statements, we can make the following conclusions:

- the use of the Kohonen SMO is critical to obtain certain statistical information on commercial banks;
- neural network algorithms facilitate forecasting the market share in a constantly changing market environment;
- it is important to study the Russian market of banks in current circumstances since an in-depth analysis of a particular commercial banks open possible opportunities for its development;
- the national banking system evolves under certain laws and changing factors, which can be detected and evaluated with the Kohonen SMO;
- neural network helps not only visualize detailed statistical data on each grouping of banks, but also forecast values of a certain parameter.

Tolochko N.I., Goncharova E.V. *Svidetel'stvo o gos. registratsii programmy dlya EVM № 2015619932 ot 17.09.2015. RF. Otsenka kreditosposobnosti klientov fizicheskikh lits s pomoshch'yu neiroseti* [Certificate of Computer Program Registration № 2015619932 of September 17, 2015. Russian Federation. Evaluating the personal solvency of individuals using a neural network]. Volgograd, VolSTU Publ., 2015.

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Table 1

Groups of commercial banks ranked by the Central Bank of the Russian Federation by value of assets (in descending order)

Year	Indicators, thousand RUB	Grouping by number of banks						Total
		1–5	6–20	21–50	51–200	201–500	501–623	
2015	Assets (liabilities)	40,411,253	15,951,580	8,226,817	7,785,677	2,133,048	332,940	74,841,315
	Loan portfolio	24,674,904	8,674,414	4,187,901	3,847,660	1,082,698	163,953	42,631,529
2016	Assets (liabilities)	44,633,141	16,964,047	8,935,107	7,664,417	1,683,255	132,130	80,012,097
	Loan portfolio	30,580,049	9,465,601	5,140,543	4,348,337	823,601	57,396	50,415,529

Source: The Bank of Russia data

Table 2

Loan portfolio and market share trends: a fragment

Bank	Portfolio as of August 1, 2016, thousand RUB	Market share, %	Portfolio as of August 1, 2015, thousand RUB	Market share, %	Amount of change, thousand RUB	Change (+, –), %
Absolut Bank	46,058,877	0.447	33,587,303	0.3129	12,471,574	+37.13
Avangard	6,231,216	0.0605	8,515,979	0.0793	–2,284,763	–26.83
Avers	3,791,341	0.0368	3,032,991	0.0283	758,350	+25
Avtogradbank	1,283,998	0.0125	1,490,150	0.0139	–206,152	–13.83
Avtokreditbank	105,804	0.001	87,474	0.0008	18,330	+20.95
Avtotorgbank	574,486	0.0056	1,319,126	0.0123	–744,640	–56.45
Agropromkredit	4,666,521	0.0453	6,693,820	0.0624	–2,027,299	–30.29
Agroros	394,062	0.0038	394,214	0.0037	–152	–0.04
Agrosoyuz	1,407,510	0.0137	1,685,881	0.0157	–278,371	–16.51

Source : Authoring

Table 3

Parameters of bank factors by cluster

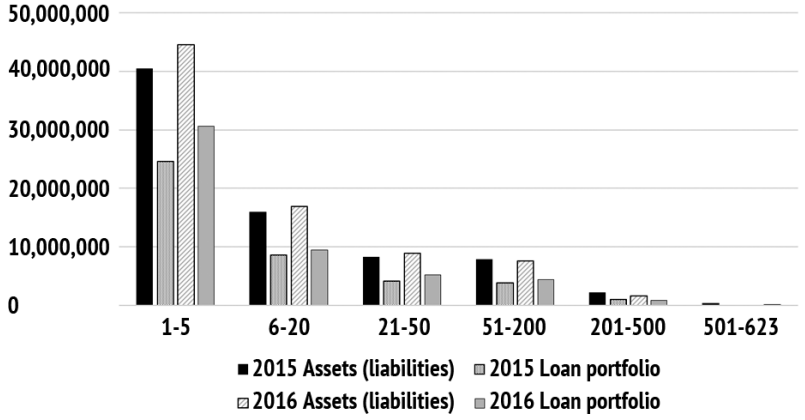
Indicator	Cluster 5	Cluster 6	Cluster 4	Cluster 9	Cluster 7
The number of banks	540	17	9	8	3
% of the total	92.8	2.9	1.5	1.4	0.5
Mean	1,859,610	46,945,422	72,445,287	111,562,226	134,200,806
Standard deviation	4,718,922	28,165,987	26,787,343	44,852,583	33,647,592
Standard error	230,070.1	6,831,255.2	8,929,114.4	15,857,783	19,426,446.3
Minimum	0	1,010,058	38,363,451	21,943,432	111,604,406
Maximum	45,368,176	93,890,221	111,500,127	157,598,722	172,870,752
Amount	1,004,189,201	798,072,165	652,007,581	892,497,808	402,602,418
% of the total	9.7	7.7	6.3	8.7	3.9

Continued from the above table

Indicator	Cluster 8	Cluster 2	Cluster 1	Cluster 0	Cluster 3
The number of banks	2	1	1	1	0
% of the total	0.3	0.2	0.2	0.2	
Mean	305,928,966	221,480,590	1,492,998,210	4,226,267,488	
Standard deviation	8,029,637	0	0	0	
Standard error	5,677,810.5				
Minimum	300,251,155	221,480,590	1,492,998,210	4,226,267,488	
Maximum	311,606,776				
Amount	611,857,931				
% of the total	5.9	2.1	14.5	41	

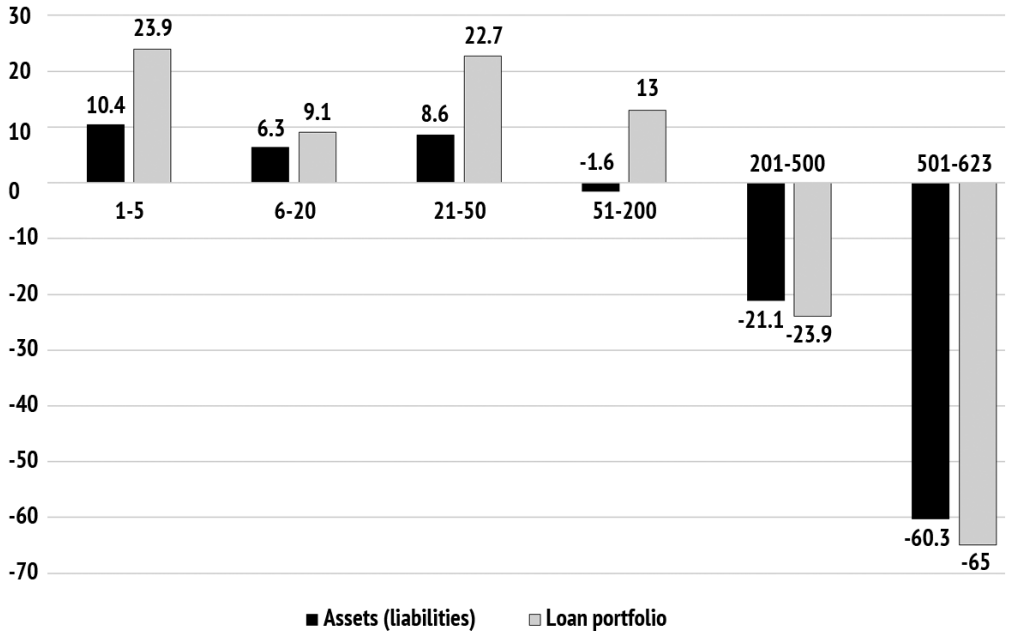
Source: Authoring

Figure 1
The grouping of banks by asset and credit portfolio value in 2015–2016, thousand RUB



Source: The Bank of Russia data

Figure 2
Changes in assets and credit portfolio values of banks for 2015–2016, percentage point



Source: The Bank of Russia data

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https://doi.org/10.24891/df.23.2.230

Figure 3

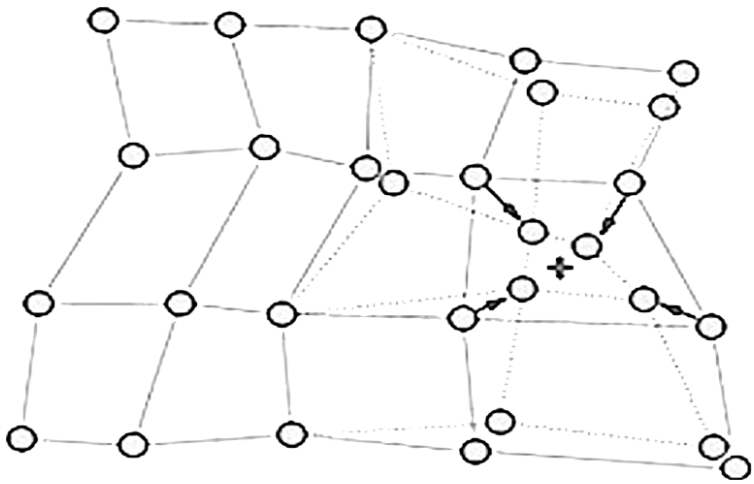
Mathematical properties of the Kohonen self-organizing map by bank: a fragment, computer visualization

Наименвание	Портфель / 01/08/16	Доля рынка, %	Портфель 01/08/15 т. р.	Доля рынка, %	Изменение (+,-)	Изменение (%)	Изменение (%)_OUT	Номер ячейки	Расстояние до центра ячейки	Номер кластера	Расстояние до центра кластера	Изменение (%)_ERR
СБЕРБАНК РОССИИ	4226267488	41,0183	4069443070	37,9129	156824418	3,85	3,85	31	7,02985357939986E-7		0,0877995946116151	0
ВТБ 24	1492998210	14,4904	1350117517	12,5783	142880693	10,58	10,58	46	4,59144356642152E-7	1	0,192517665116362	0
РОССЕЛЬХОЗБАНК	311606776	3,0243	269407531	2,5099	42199245	15,66	15,66	93	5,66418554852841E-5	8	0,0688997163405672	0
ГАЗПРОМБАНК	300251155	2,9141	285793233	2,6626	14457922	5,06	5,06	79	3,25108268613597E-5	8	0,0353065004937919	0
ВТБ	221480590	2,1496	180835	0,0017	221299755	122376,62	122376,62	13	4,39574743148136E-7	2	0,113612135331791	0
РАЙФФАЙЗЕНБАНК	172870752	1,6778	186517033	1,7377	-13646281	-7,32	-7,32	111	2,07997287522022E-5	7	0,0139434659828952	0
РОСБАНК	157598722	1,5296	204759286	1,9076	-47160564	-23,03	-22,735	191	0,00847598674880482	9	0,0584664914609622	5,80146460296017E-12
ХКФ БАНК	148162254	1,438	191038528	1,7798	-42876274	-22,44	-22,735	191	0,00847644380845961	9	0,0584664914609622	5,80146460296004E-12
РУССКИЙ СТАНДАРТ	147738200	1,4339	184298046	1,717	-36559846	-19,84	-20,8433333333333	190	0,0154245296541131	9	0,0149074964462381	6,71095144425662E-11
ВОСТОЧНЫЙ	125079325	1,214	156737580	1,4602	-31658255	-20,2	-20,8433333333333	190	0,00707046796455122	9	0,0149074964462381	2,75908908673321E-11
ЮНИКРЕДИТ БАНК	118127260	1,1465	133022187	1,2393	-14894927	-11,2	-12,025	126	0,00321491819139415	7	0,0283283404110597	4,53734196540042E-11
МОСКОВСКИЙ КРЕДИТНЫЙ БАНК	111604406	1,0832	128055286	1,193	-16450880	-12,85	-12,025	126	0,00321442557541859	7	0,0283283404110597	4,53734196540044E-11
ДЕЛЬТАКРЕДИТ	111500127	1,0822	98611182	0,9187	12888945	13,07	13,455	92	0,00098998765153867	4	0,0148145206288864	9,88132250242759E-12
ХАНТЫ-МАНСИЙСКИЙ БАНК ОТКРЫТИЕ	111175085	1,079	143435666	1,3363	-32260581	-22,49	-20,8433333333333	190	0,0095701400773315	9	0,0149074964462381	1,80761111538571E-10
ТИНЬКОФФ БАНК	109940200	1,067	96576929	0,8998	13363271	13,84	13,455	92	0,000983251392769392	4	0,0148145206288864	9,88132250242759E-12
ТРАСТ	100515258	0,9756	122201553	1,1385	-21686295	-17,75	-17,75	174	1,24276504731818E-5	9	0,0354289220990866	0
СЕТЕЛЕМ БАНК	93890221	0,9113	95844178	0,8929	-1953957	-2,04	-1,765	124	0,00173868393322274	6	0,0282428576671089	5,04149107266714E-12
РУСФИНАНС БАНК	91080397	0,884	96994533	0,9036	-5914136	-6,1	-6,1	125	9,80819392459958E-6	6	0,0221376708827766	0
ПРОМСВЯЗЬБАНК	88759579	0,8615	90099823	0,8394	-1340244	-1,49	-1,765	124	0,00174809863578811	6	0,0282428576671089	5,04149107266715E-12
ПОЧТА БАНК	84429557	0,8194	57634408	0,5369	26795149	46,49	46,49	44	1,51182202479668E-5	4	0,048414538491537	0
СВЯЗЬ-БАНК	83187967	0,8074	69578306	0,6482	13609661	19,56	19,56	76	1,54285212518875E-5	4	0,00144681288123071	0
ОТП БАНК	80285532	0,7792	112653257	1,0495	-32367725	-28,73	-44,085	159	0,0141688639768122	9	0,0258217926264628	1,57178542173414E-8
РЕНЕССАНС КРЕДИТ	79226263	0,7689	78756114	0,7337	470149	0,6	-1,765	124	0,0101539299884731	6	0,0282428576671089	3,72868679734462E-10
СКБ-БАНК	69367115	0,6732	63249028	0,5893	6118087	9,67	9,67	91	9,10610866519012E-6	4	0,0290084384479887	0
СОВКОМБАНК	61213574	0,5941	61890472	0,5766	-676898	-1,09	-1,5	123	0,00338238852405201	6	0,0222464802588504	1,12062763545831E-11
БАНК "САНКТ-ПЕТЕРБУРГ"	59307778	0,5756	52146469	0,4858	7161309	13,73	13,73	75	9,2076265615989E-6	4	0,0263775278967127	0
АЗИАТСКО-ТИХООКЕАНСКИЙ БАНК	50317596	0,4884	56766344	0,5289	-6448748	-11,36	-11,36	156	8,32035057152 41E-6	6	0,00259771741580504	0
ВОЗРОЖДЕНИЕ	49852509	0,4838	38256585	0,3564	11595924	30,31	33,72	26	0,00193534561877822	4	0,016814944956318	7,75179667333E-10
КРЕДИТ ЕВРОПА БАНК	49114974	0,4767	63054874	0,5874	-13939900	-22,11	-22,11	189	6,61472857773048E-6	6	0,0272604109839578	0
СИТИБАНК	47152798	0,4576	48069773	0,4478	-916975	-1,91	-1,5	123	0,00340129905186375	6	0,0222464802588504	1,12062763545831E-11
АБСОЛЮТ БАНК	46058877	0,447	33587303	0,3129	12471574	37,13	33,72	26	0,00192245439955206	4	0,016814944956318	7,75179667333302E-10
АК БАРС	45368176	0,4403	42571197	0,3966	2796979	6,57	6,57	107	2,7826085349 85E-6	5	0,0209341906804771	0

Source: Authoring

Figure 4

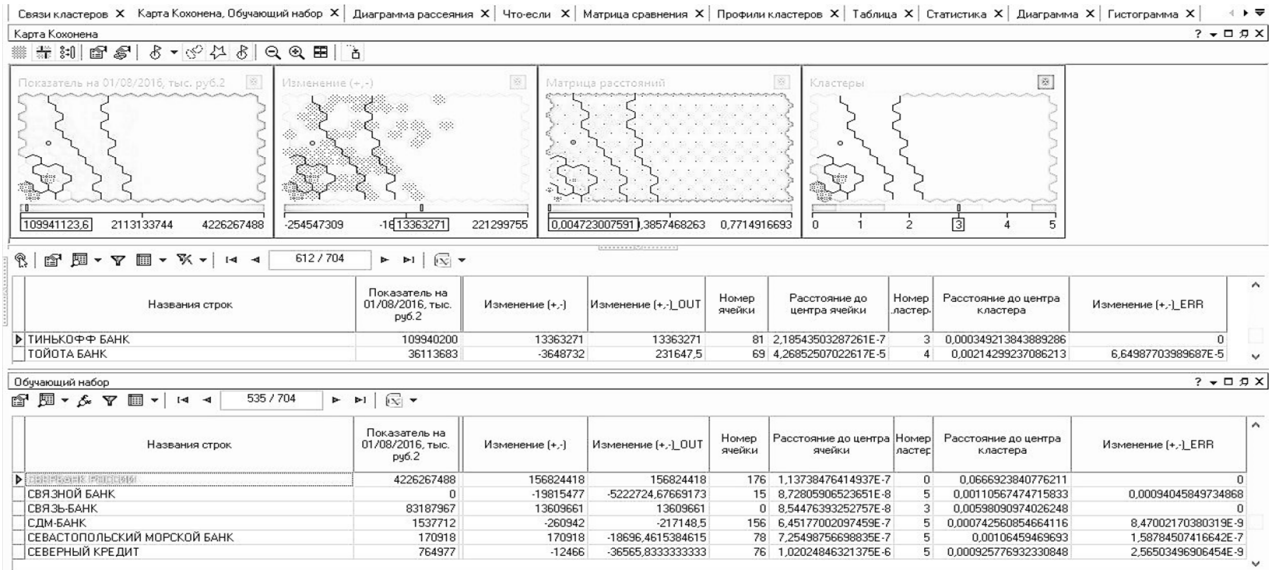
Adjusting the weights of the wining neuron and its neighbors



Source: Authoring

Figure 5

Changes in the composition and structure of credit portfolios of commercial banks in the neural network of the Kohonen self-organizing map: computer visualization



Source: Authoring

Figure 6

Cluster profiles: computer visualization

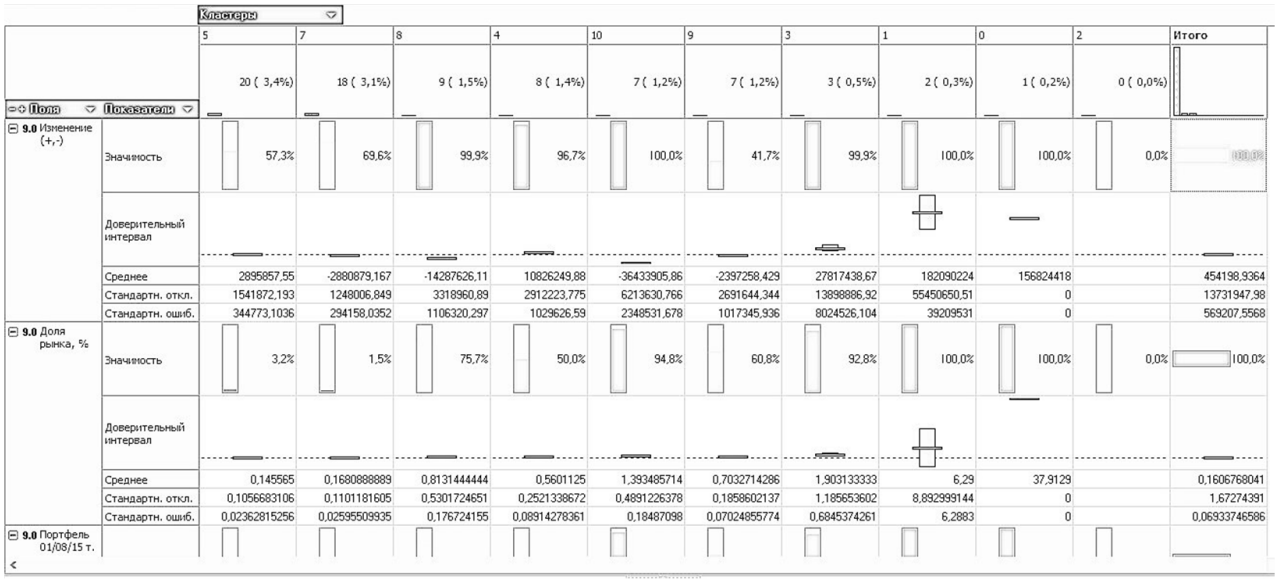


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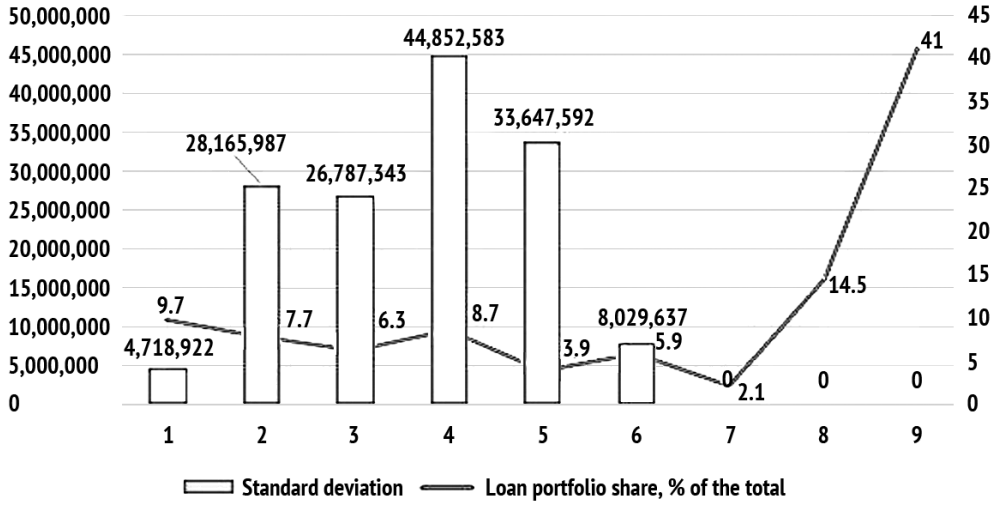
Figure 7
Distribution of risk (standard deviation) and value of portfolio share (right-hand scale) by cluster of the self-organizing map



Source: Authoring

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Conflict-of-interest notification

We, the authors of this article, bindingly and explicitly declare of the partial and total lack of actual or potential conflict of interest with any other third party whatsoever, which may arise as a result of the publication of this article. This statement relates to the study, data collection and interpretation, writing and preparation of the article, and the decision to submit the manuscript for publication.

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