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Translated Article[†]

A SOCIAL INNOVATION IMPACT ASSESSMENT MATRIX



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Introduction

Being inherent in the Russian economy and embodied in both economic and political crises,

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Abstract

Importance This article focuses on developing tools to measure an impact of social innovation, taking into account commercial and social benefits of introducing social innovation.

Objectives We aim to develop our own matrix for the evaluation of the impact of social innovation.

Methods We use methods of systematization, logical analysis, regression analysis, etc.

Results The article shows possible areas of institutional development that ensure the effective performance of social and innovation activities, including the development of both efficient formal institutions and social capital.

Conclusions and Relevance The theoretical analysis, as well as the results of the application of the developed assessment matrix of social innovation at the regional level, have made it possible to identify the characteristics of social innovation. The matrix makes it possible to identify the characteristics of social innovation functioning in a given territory and also becomes an initial stage for the institutional development directions.

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unstable economic processes made the public sector and society morph significantly. This phenomenon stems from an outdated economic model used to create private and public benefits, thus pushing a search for alternative solutions to social problems. In this respect, social innovations grow even more important, since they are an effective tool to improve

societal wellbeing and quality of living. They rapidly gain more and more traction among scholars and practitioners.

The study is very opportune as Europe sees social innovation researches growing in numbers, such as CRESSI, SIMPACT, ITSOIN, SIDrive, TRANSIT, ImPRovE, ThirdSectorImpact, BENISI, SOCIALPOLIS, TEPSIE, SINGOCOM, KATARSIS, WILCO, PASHMINA. Another evidence can be illustrated with:

- Social Innovation Residency Conference in Canada;
- Social Innovation Summit in San Francisco;
- Social Innovation Forum in Turkey;
- regular thematic TACSI meetings in Australia;
- Young Foundation in London;
- White House Office for Social Innovation and Civic Participation, Washington;
- Center for Social Entrepreneurship and Social Innovation Studies (Higher School of Economics, Russia), etc.

This attention to social innovations is rather expectable. Social innovations are designated to address current social issues using more effective methods.

Analyzing global trends, we see national governments making considerable investment in social innovation development. However, the outcome often dissatisfies expectations. There is a lack of a theoretical and methodological framework which would respect institutional conditions for social innovation development, while implementing the State policy, reforms, and updating socio-economic processes. Furthermore, the balance of social and economic goals also becomes a focal point. It not only makes social and innovative projects efficient, but also draws attention of businesses and public to this phenomenon.

Therefore, this research aims to articulate our own matrix for evaluating the efficacy of social innovations. We intend to achieve this goal by providing our own definition of social innovations, analyzing development approaches, describing the specifics of social innovation development, and evaluating possible areas of their development.

The Concept of Social Innovation

Notwithstanding the relevance of social innovations, their theoretical framework is originating. Social innovation constitutes an effective vehicle to reach higher societal wellbeing [1]. The principal and most renowned examples of social innovations feature Wikipedia, Open University, Coursera, KhanAcademy, etc. Most of rather ordinary and habitual things and aspects were considered social innovations several decades ago. For example, Friedrich Fröbel's idea of pre-school education seemed innovative, being effectuated as the first kindergarten in 1837 [2].

However, scholarly literature fails to provide a generally accepted interpretation of social innovations, thus necessitating a more thorough investigation of the issue. Having analyzed definitions of social innovation, we pointed out three principal approaches.

Proponents of the **first approach** [2–5] construe social innovations as novelties intended to attain socially-important goals. The social content shall be ingrained not only in the ultimate result, but also in the process of the activity.

As part of the **second approach**, D. Chalmers [6], R. Heisala [7], M. Minks [8], J. Phills, K. Deiglmeier, D. Miller [9] and the Center for Social Innovation at the Stanford University view social innovations as novelties, which occur in the social environment. The approach emphasizes procedural, institutional and organizational changes, thus allowing to apply the framework of the institutional theory for respective researches.

Proponents of the **third approach**, such as B. Amable [10], C. Battistella, F. Nonino [11], P. Koch, J. Hauknes [12], Sang Lee, Taewon Hwang, Donghyun Choi [13], use the concept *innovation in the social sector*. It likens social innovations to social benefits. As part of this research, we suggest interpreting social innovation as new combinations of resources in social production that change the institutional context and/or inducing a more effective solution to social problems. Social innovations, virtually and essentially, enhance the use of resources so as to address social problems primarily [14].

Development Specifics of Social Innovation

Whereas there is no common theoretical and methodological framework for social innovation studies, many views are expressed concerning their role and development distinctions. On the one hand, due to nonexistent economic incentives, social innovations are often perceived as an atypical market phenomenon or consequence of one of the market failures [15]. On the other hand, social innovation development is an exclusive authority of the State. Social innovations, hence, result from civil society's activities and fill in a critical gap between the market and the State [16]. In this case, it becomes especially important to consider whether the institutional environment is effective and whether relevant mechanisms exist to encourage socio-innovative activities of the society.

As held in the theory of the Bottom of the Pyramid, social innovation becomes one of the method to mobilize the poor or marginalized layers of the society. Social innovations provide these social groups with the opportunity of addressing social problems, including public benefits [17, 18]. In other words, the poor population is offered an opportunity to create conditions for sustainable social innovations.

According to the Young Foundation [2] actively promoting social innovation worldwide, the specifics of social innovation creation and development influences the way innovative groups and sponsors supporting socio-innovative initiatives interact. The sponsorship implies the funding, advice and creation of necessary conditions. We emphasize it is important to arrange communication and cooperation institutions for innovators and sponsors, being a crucial driver of social innovation development.

Social innovation development especially depends on the level of social capital and informal institutions within the respective territory. As L. Polishchuk and R. Menyashv note [19], social capital comes out if citizens can unite their efforts for solving public issues. It may substitute public institutions or supplement them. The level of social capital development becomes even more important in emerging economies, where civic cooperation may partially make up gaps in the production of common

goods. The construction of schools and hospitals supported by local communities is a good illustration of that [20]. Thus, social capital is indispensable to social innovation the society promotes.

Underlying the development of social innovations undertaken by citizens, informal institutions design collective endeavors. The researchers, such as A. Dorward, J. Kydd, J. Morrison and C. Poulton, state that each step of economic development entails respective costs and failures on the part of the public and social organizations. In this respect, information institutions play an important role in tackling information asymmetry, solving social problems and providing the society with common goods.

Following the alternative approach to social innovation studies, it is necessary to analyze factors that influence the socio-innovative process. For example, D. Chalmers [6] attempted to sort out the factors into three categories, i.e. protectionism and attitude to risk, distinctive nature of human assets, and network and cooperation (*Table 1*).

The first group of factors concerns the resistance to changes arising from social innovation. The resistance may occur in response to a social innovation or in the process of using it. Governmental officials in charge of the public sector development and immediate producers of common goods are often not interested in changes that may influence not only their habitual behavior but also affect the volume of resources they dispose of.

The public often tends to be cautious about changes, since people accept and perceive any social system as values, code of conduct and habits. The longer the system operates and provides people with the alleged security and prosperity, the more its principles strike roots in the public mind [21, 22].

The required distinctive nature of human assets underlies the **second group of factors**. Social problems are a complex and multifaceted phenomenon, for which there is no versatile mechanism or formula. It requires specific knowledge, additional efforts, high creativity of agents and, subsequently, involvement of the society. For example, a variety of social issues – from urban waste recycling to municipal wind farms – engendered the environmental movement

(environmentalism), which pursues the environmental protection. The environmental movement was propelled by multiple and various expertise and ideas of its advocates involved in the process. The environmental movement and its idea dates back to the time of forest and landscape protection movements in the 19th century and initiatives for biological diversity conservation, etc. Moreover, certain governmental officials promoted the policy for reducing wastes of large companies, thus securing the indemnification for the affected parties. *Direct-action* movements originated that time (Greenpeace and other *green* parties worldwide).

The third group of factors refers to network and cooperation issues. They include certain gaps in setting up effective communication ties throughout the stages of the socio-innovative process. We mean non-existent effective rules and principles for economic agents to cooperate and create common goods. Drawing upon social innovation studies, the researchers F. Lettice, M. Parekh [23] mentioned that such gaps had a negative impact on the psychological attitude of social innovators, impede the fund raising process and aid, whereas strong networks help innovators find their identity and establish mutually beneficial relationships with all stakeholders [6].

As D.R. Young, J.D. Lecy note [24], entities creating social values in the market environment should effectively combine the social mission and profit-making activities so as to ensure their sustainable development. We point out such forms of social innovation as social entrepreneurship, social enterprises, social responsibility of businesses, social cooperation, hybrid entities and non-profit organizations (*Fig. 1*).

Social business is oriented at strategic achievements, where the social mission facilitates the improvement of social relationships and effective cooperation with the State.

Social entrepreneurship strives to balance the creation of social value and earnings.

Non-profit entities are free from profit-making objectives, however, they may earn profit to remain a going concern. The category includes such traditional entities as non-profit theaters, hospitals,

schools, and providers of social services, etc. Please find below the main distinctions of such entities:

- costs are covered with revenue;
- profit is not a guiding principle;
- other sources of finance are used unless revenue covers costs entirely (State subsidies, financial aid from foundations, etc.).

From social perspectives, public private partnership (PPP) implies the contractual interaction of profit-making, non-profit and governmental organizations in pursuit of socially important goals. Although each party has its own goals and objectives, it is possible to trace the common socially-oriented mission and profit-making expectations. To develop this format, it is reasonable to rely upon proceedings by the 2014 Nobel Prize winner J. Tirole [25].

Hybrid entities constitute new forms and systems of contractual relationships among entities, which unite to implement long-term social projects, and use resources more effectively [26].

Social cooperation are associations of citizens focused to attain social benefits.

Social enterprises are a type of entities set up for social purposes, but governed by a profit-making strategy.

Hence, the social innovation development requires, on the one hand, methods for addressing social issues, and break-even performance, on the other hand.

Adhering to the above approaches, we suppose, social innovation evaluation criteria should be used from perspectives of private and social benefits that the producer and consumer of social innovations derive respectively.

Social benefits shall mean a certain payoff for the society or a social group. This may be a positive change in the social welfare. Social benefits have two important characteristics, i.e. quantitative and qualitative ones.

Quantitative characteristics shape the social scale and coverage of a social innovation. In the mean time, qualitative characteristics are usually gauged

through expert assessments or industry-specific metrics.

Private benefits constitute possible payoffs for agents initiating social innovation:

- profit in case of social entrepreneurs;
- tax credits, better reputation, long-term increase in corporate value, etc. in case of socially-oriented businesses;
- possible professional promotion and advancement in case of governmental employees;
- amplified pool of voters in case of politicians;
- higher ratings, expanded activities in case of research and development institutions.

To account for private and public benefits, we devise a matrix for evaluating the efficacy of social innovation (Fig. 2).

In the first quadrant, social innovations do not generate any benefits for the society and individuals. This quadrant includes new social innovations launched in the market or unsuccessful ones.

The second quadrant reflects unprofitable social business, unsustainable social enterprises. The effective institutional environment shall be created and developed so that social innovations could be attributed to the high profitability quadrant.

The third quadrant concerns two cases:

- in the first case, social innovations do not generate substantial public payoff, but they are profitable for their producer;
- in the second case, social innovations are side-effects of profit-making entities.

The production of social innovations can be common for both cases as a secondary effect of corporate operations.

The fourth quadrant is a perfect situation to achieve. Social innovations and their development in this quadrant depend on the socially-oriented institutional environment, which boosts the development and support of social innovations and creates conditions for them.

Merging all approaches, the leitmotif of social innovation development is the balance of

profit-making activities and the social mission for all social innovation sources, other than authorities and volunteers. For purposes of practical studies into socio-innovative projects combining social and commercial benefits, we proceed with a practical analysis of social innovations in the Sverdlovsk Oblast.

The Application of the Social Innovation Efficacy Assessment Matrix

To analyze the applicability of the social innovation efficacy assessment matrix, we examine twenty social enterprises' activities in the Sverdlovsk Oblast within 2012 through 2017. The analyzable innovations were implemented in various organizational forms so that we could evaluate corporate performance and social efficiency (Fig. 2).

To review the given socio-innovative projects, we construct an adapted matrix for assessing the social innovation efficacy. Considering a diversity of incentives and benefits for participants of socio-innovative projects (both developers and consumers), it is necessary to choose indicators, which would allow to quantify commercial and social benefits. Being empirically assessed, project profitability was chosen as a descriptor of commercial benefits. We count the number of project consumers to understand social benefits. The rate of return is a convenient metric reflecting the profitability (unprofitability) and the project payback, while the number of social innovation consumers reflects the magnitude of social effect the proposed innovation has. In this case, the zero rate of return was considered as the threshold between high and low private profit. Private profit is deemed high if the rate of return is positive or zero, i.e. the project covers its costs. Traits of social benefits are traced in each particular case.

Considering that social innovations are significantly different in the way they work, all the analyzable projects were divided into three groups:

- the first group includes small social innovations with the budget of RUB 100 thousand or lower;
- the second group includes medium social innovations with the budget ranging from RUB 100 thousand to 300 thousand;

- the third group includes large social innovations with the budget exceeding RUB 300 thousand.

Having analyzed small social innovation, we found the inverse dependence between the profitability and an increase in the number of consumers (Fig. 3). The dependence is expressed with the following formula:

$$R = -0,978 N + 0,051 \quad (r^2 = 0,7908), \quad (1)$$

where R is the profitability metric;

N is the number of consumers.

Having analyzed medium-scale innovations, we detected the inverse dependence between the profitability and an increase in the number of consumers too (Fig. 4):

$$R = -0,376 N + 0,144 \quad (r^2 = 0,7493). \quad (2)$$

Profitability of large social innovations is also inversely related to the number of consumers (Fig. 5) and expressed with the following formula:

$$R = -0,221 N + 0,258 \quad (r^2 = 0,705). \quad (3)$$

The analysis reveals the first distinction of the analyzable socio-innovative projects. That is the declining profitability trends against the increasing number of consumers. In particular, the profitability turns to be below zero for small social innovations with 52 consumers, 382 consumers for medium ones and 1,167 consumers for large ones.

The second distinction is the rapidity of a profitability decrease in case of the extended coverage. This is expressed with the coefficient preceding the N -variable in regression equations. If the scale and coverage increase, the profitability of social innovation dips down in the first group of projects, which have the coefficient of -0.978 . The second group has the coefficient of -0.376 emphasizing the less drastic drop in the profitability. The third group has the coefficient of -0.22 , being the lowest drop in the profitability among all the groups. Drawing upon the results, we conclude that each 100 consumers of small social innovations make the profitability drop by 9.78 percent, while this indicator is 3.7 percent for medium ones and 2.2 percent for large ones.

Summing up the analysis outcome, we make the following conclusions.

1. Social innovation support institutions prove to be ineffective, thus affecting the profitability amid an increasing social effect.
2. Notwithstanding the substantial unprofitability, social innovations still generate social payoff, thus confirming high demand for them. It is evidence of the formation and development of social capital in the analyzable area.
3. We determine the issue of the growing scale of social innovators' activities. Assuming that the recouplement of social innovation is the critical basis for sustainable development, its decrease and concurrent growth in social benefits signify the existing barriers impeding the expansion of socio-innovative activities.

It is possible to provide various explanations concerning the way the increased number of consumers of social innovations affects their profitability. On the one hand, the profitability may decrease as social innovations are more oriented at poor and marginalized layers of the population, thus engendering the inverse effect due to the scale effect. On the other hand, it may stem from the infancy stage of social innovation from practical and theoretical perspectives. In both cases, it may be necessary to design a system of institutions in order to alter the trends we reveal.

Designing Institutional Changes in Social Innovation

Adhering to theoretical and methodological principles of institutional engineering and social innovation development, and data of the empirical study, we shall spotlight initiative development issues, issues of scaling and diffusion of social innovations [6, 27, 21].

As socio-innovative activities in the Sverdlovsk Oblast, more often than not, result in losses, we conclude on a certain reluctance of undertaking social innovation projects. Moreover, it is accompanied with the following circumstances [6]:

- high risks arising from the non-transparency of social institutions;

- lack of knowledge and expertise in social innovation;
- insufficient support from the State;
- resistance of the population and State to innovation.

The issues of social innovation scaling inflict difficulties in raising the number of consumers. In this respect, the aspects below increase the scale of social innovation:

- chaotic and poor dissemination of information;
- imperfect mechanisms for financial support;
- lack of social innovation support institutions;
- insufficient confidence level in the region.

The above factors and respective solutions are given in *Table 2*.

As mentioned before, the confidence level plays an important role in finding a collective solution to social issues. As the researcher M. Fafchamps [20] mentioned, the confidence level can be raised by two options, i.e. by setting up robust social institutions or developing social capital. The efficient-formal-institutional environment can be created in the long run only. That is why social capital development turns out to be the best tool in the short run. Furthermore, setting up unions, associations of social innovators, development and implementation of effective models for public involvement in social processes are of special significance.

Most models for public need satisfaction become outdated and ineffective in the current circumstances. However, the overwhelming majority of population and authorities resist to changes, since they always bring uncertainty. As V.L. Tambovtsev believes [28], direct and indirect stimulation methods are applicable in this case.

Direct stimulation methods shall include advocating that is, in fact, active and streamlined activity for explaining the substance and advantages of social innovation, substantiating and stimulating the public involvement into the activity. Unlike simple endorsements and promotion, advocating represents a specially trained team of professionals who are skilled in maintaining understandable and effective communication and public involvement.

Indirect stimulation methods represent a regulatory link between private benefits and social payoff.

Chaotic and insufficient dissemination of information is a particular case of its asymmetry impeding the social innovation development (the adverse effect of the issue is partially decreased). Furthermore, information support institutions for social innovations will also have a positive impact.

Social innovation development is difficult to imagine without effective financing mechanisms. For this purpose, foundations and special lending conditions shall be created for social innovation. Developing PPP institutions is of paramount importance. For instance, it is necessary to amend the federal law on concession agreements since the existing procedure restricts private investors' rights, since terms of contracts with authorized governmental bodies are difficult to amend. Moreover, investors can be lured into the area by ensuring the transparency of the social sector, introducing innovator activity insurance programs and creating powerful incentives for social entrepreneurship and social business to evolve.

Conclusion

Intended for the development of our own social innovation efficacy assessment matrix, this research leads to the following conclusions.

First, it is necessary to substantiate the interpretation of social innovation as new combinations of resources in social production that change the institutional context and/or fostering a more effective solution to social production issues.

Second, the social innovation efficacy assessment matrix should be devised, implying public and private benefits and allowing to systematize possible forms of social innovation by given criteria.

Third, it is reasonable to identify trends in the development of small, medium-sized and large social innovations at the regional level and demonstrate the way they decrease if the project scale grows. This phenomenon may result from ineffective conditions for the social innovation development in the analyzable region.

Forth, it is advisable to outline key paths for the institutional development of social innovations.

From theoretical perspectives, this research amplifies the existing principles of the innovation theory in relation to the social sector and the social innovation concept. From practical perspectives, the findings are significant and meaningful since they

can be used to improve regional development programs and outline entrepreneurship activation measures in the analyzable regions and social sector, in particular.

Table 1

Factors for the social innovation development by D. Chalmers

Group	Factors
Protectionism and risk attitude	Confidence level
	Public resistance to innovation
	Risk assessment
	Dissemination of information on social innovation
	Reproduction of the best socio-innovative practices
Specifics of human assets	Knowledge and skills
	Road map
	Institutions for public private and municipal private partnership
Network and cooperation issues	Measures for the State support for social innovation
	Involvement of private investors in the social sector

Source: [6]

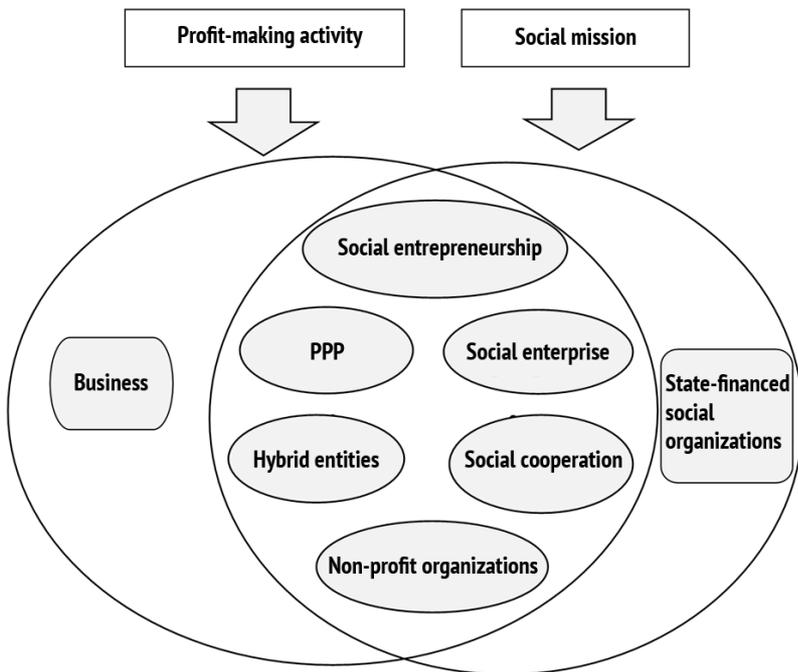
Table 2

Factors for the social innovation development

Social innovation development factors	Development area
Confidence level	Development of robust formal institutions, social capital
Resistance of the public and authorities to innovation	Designing institutions for communication and involvement the public into socio-innovative activities
Dissemination of information on social innovation	Setting up institutions for information dissemination. Creating the platform for social entrepreneurs
State support for social innovation	Amending the law on concession agreements. Outlining PPP programs for social entrepreneurs purposefully. Supporting investment projects in the social sector (affordable loans, reimbursement of expenses, etc.)
Investment attractiveness of the private sector	Ensuring the transparency of social activities. Implementing programs for insurance of social innovators
Accessibility of knowledge and skills needed for layout of the institutional design of social innovation	Development of social innovation support institutions, introduction of innovators' road map

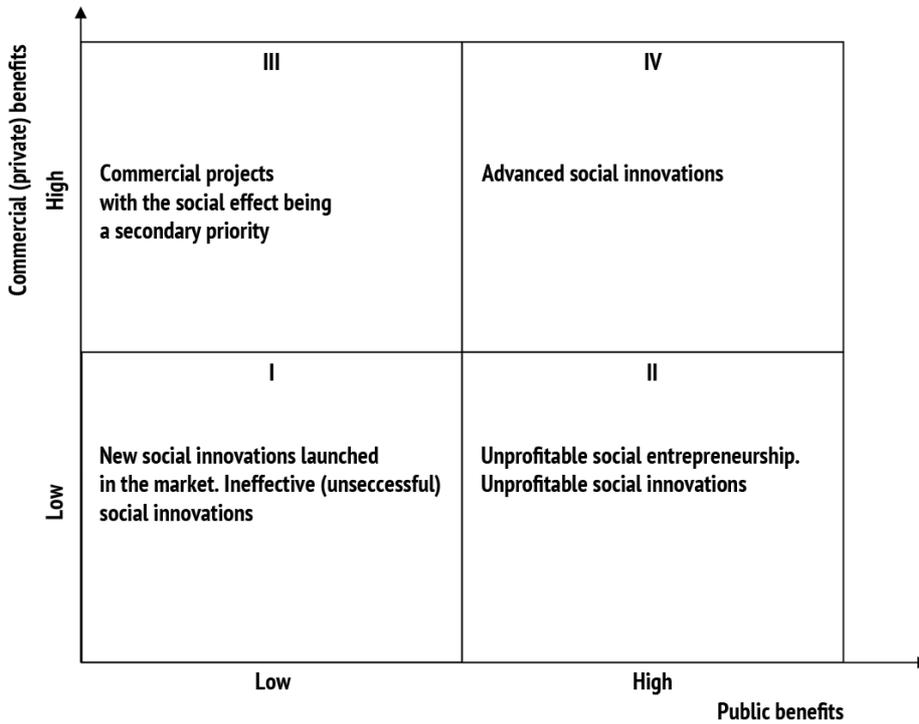
Source: Authoring

Figure 1
The forms of social innovation organizations



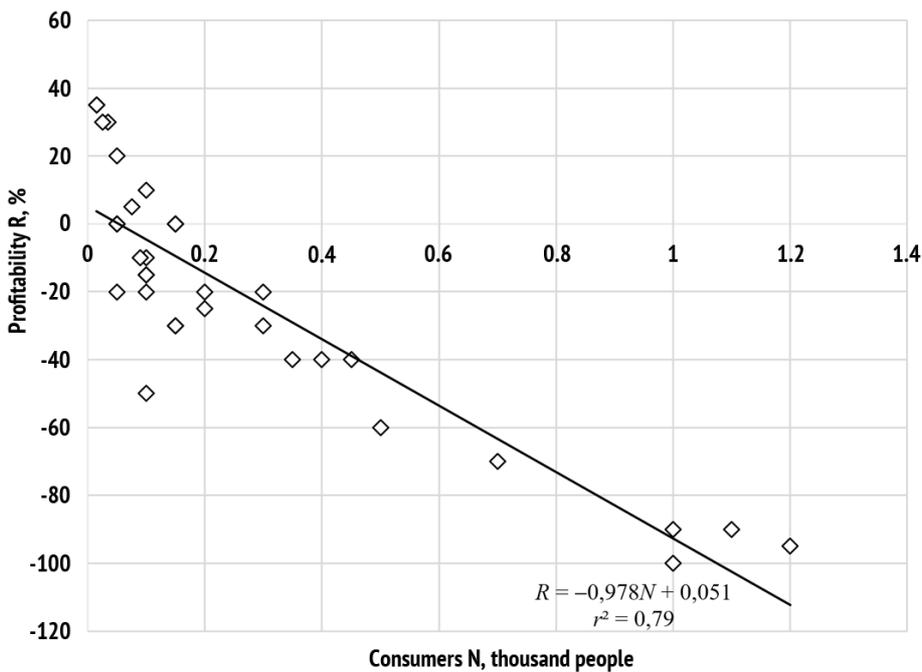
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Figure 2
Social Innovation Impact Assessment Matrix



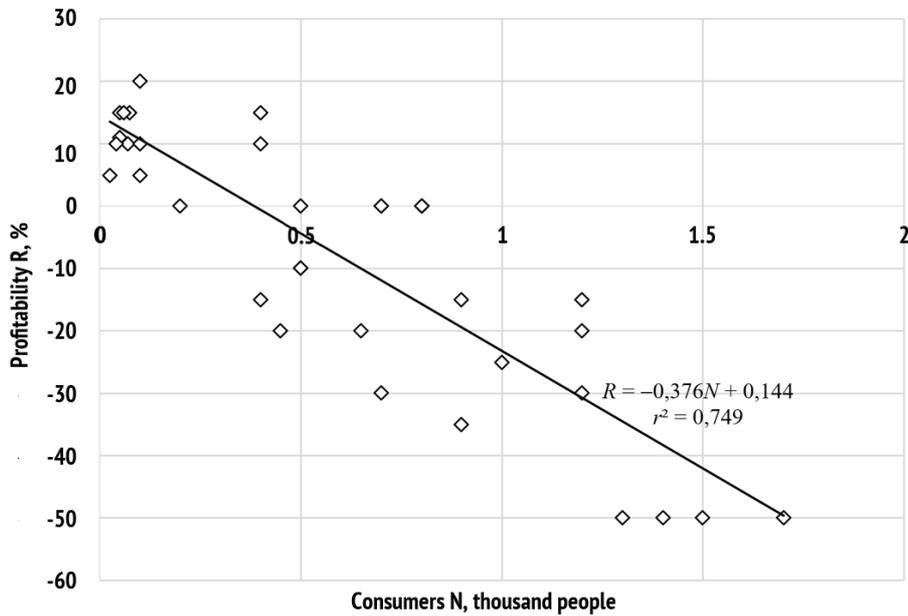
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Figure 3
The dependence of profitability on smaller social innovation consumers



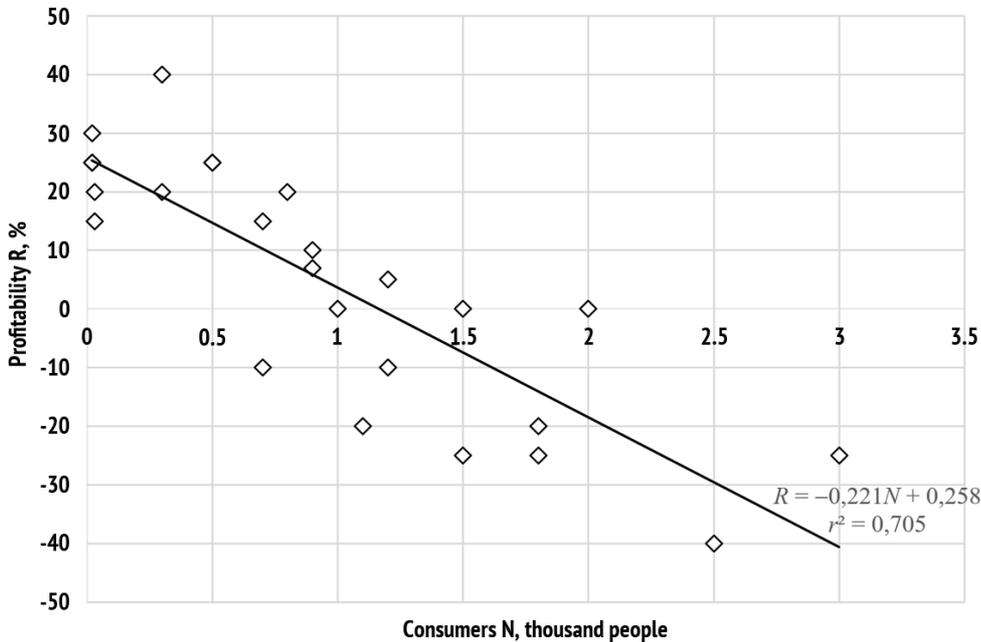
Source: Authoring

Figure 4
The dependence of profitability on medium-sized social innovation consumers



Source. Authoring

Figure 5
The dependence of profitability on major social innovation consumers



Source. Authoring

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References

1. Moore M.-L., Westley F.R. Public Sector Policy and Strategies for Facilitating Social Innovation. *Horizons: Innovative Communities, Agents of Change*, 2011, vol. 11, iss. 1, pp. 1–11.
URL: <http://www.sosyalinovasyonmerkezi.com.tr/yayin/1020110007.pdf>
2. Murray R., Caulier-Grice J., Mulgan G. The Open Book of Social Innovation. The Young Foundation, 2010, 224 p. URL: <https://youngfoundation.org/wp-content/uploads/2012/10/The-Open-Book-of-Social-Innovating.pdf>
3. Moolaert F., MacCallum D., Mehmood D., Hamdouch A. (Eds). General Introduction: The Return of Social Innovation as a Scientific Concept and a Social Practice. The International Handbook on Social Innovation: Collective Action, Social Learning and Transdisciplinary Research. 2013, pp. 1–6.
URL: <https://www.elgaronline.com/view/9781849809986.00008.xml>
doi: <http://dx.doi.org/10.4337/9781849809993.00008>
4. Nicholls A., Ziegler R. An Extended Social Grid Model for the Study of Marginalization Processes and Social Innovation. *CRESSI Working Papers*, 2014, no. 2/2015, pp. 1–13.
URL: http://www.sbs.ox.ac.uk/sites/default/files/research-projects/CRESSI/docs/CRESSI_Working_Paper_2_D1.1_Ch2_18Nov2014.pdf
5. Pol E., Ville S. Social innovation: Buzz Word or Enduring Term? *The Journal of Socio-Economics*, 2009, vol. 38, iss. 6, pp. 878–885. URL: <http://doi.org/10.1016/j.socec.2009.02.011>
6. Chalmers D. Social Innovation: An Exploration of the Barriers Faced by Innovating Organizations in the Social Economy. *Local Economy*, 2012, vol. 28, iss. 1, pp. 17–34.
URL: <https://doi.org/10.1177/0269094212463677>
7. Heiscale R. Social Innovations: Structural and Power Perspectives. In: *Social Innovations, Institutional Change and Economic Performance*. Edward Elgar Publishing, 2007, pp. 52–79.
8. Minks M. Social Innovation : New Solutions to Social Problems. Georgetown University Washington, D.C., April 11, 2011, 80 p.
URL: <https://repository.library.georgetown.edu/bitstream/handle/10822/553359/minksMichaelLee.pdf?sequence=1&isAllowed=y>
9. Phills J., Deiglmeier K., Miller D. Rediscovering Social Innovation. *Stanford Social Innovation Review*, 2008, no. 6, pp. 33–43.
URL: https://ssir.org/images/articles/2008FA_feature_phills_deiglmeier_miller.pdf
10. Amable B. Institutional Complementarity and Diversity of Social Systems of Innovation and Production. Discussion Paper FS I 99-309, Wissenschaftszentrum Berlin für Sozialforschung, 1999, 36 p.
URL: http://www.ssoar.info/ssoar/bitstream/handle/document/12915/ssoar-1999-amable-institutional_complementarity_and_diversity_of.pdf?sequence=1

11. Battistella C., Nonino F. Open Innovation Web-Based Platforms: The Impact of Different Forms of Motivation on Collaboration. *Innovation: Management, Policy & Practice*, 2012, vol. 14, iss. 4, pp. 557–575. URL: <https://doi.org/10.5172/impp.2012.14.4.557>
12. Koch P., Hauknes J. On Innovation in the Public Sector. NIFU STEP, Oslo, 2005, 102 p. URL: <https://ep.bib.mdh.se/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=edsref&AN=IPSSPR.KOCH.NIFUSTEP.BJJF&site=eds-live>
13. Sang M., Hwang T., Choi D. Open Innovation in the Public Sector of Leading Countries. *Management Decision*, 2012, 22 p. URL: https://www.researchgate.net/publication/235260881_Open_innovation_in_the_public_sector_of_leading_countries doi: 10.1108/00251741211194921
14. Popov E., Stoffers J., Omonov Z., Veretennikova A. Analysis of Civic Initiatives: Multiparameter Classification of Social Innovations. *American Journal of Applied Science*, 2016, vol. 13, iss. 11, pp. 1136–1148. URL: <https://doi.org/10.3844/ajassp.2016.1136.1148>
15. Sachs J.D. *The End of Poverty: Economic Possibilities for Our Time*. New York, The Penguin Press, 2005, 448 p.
16. Boettke P.J., Rathbone A. Civil Society, Social Entrepreneurship, and Economic Calculation: Towards a Political Economy of the Philanthropic Enterprise. In: Working Paper 8, The Philanthropic Enterprise, 2002, 26 p. URL: <http://www.conversationsonphilanthropy.org/wp-content/uploads/boettkerathbone-1.pdf>
17. Prahalad C.K. *The Fortune at the Bottom of the Pyramid: Eradicating Poverty through Profits*. Revised Edition. Wharton School Publishing, 2004, 423 p.
18. Simanis E., Hart S. The Base of the Pyramid Protocol: Toward Next Generation BoP Strategy. Center for Sustainable Global Enterprise, Johnson School of Management Cornell University, Ithaca, 2008, 57 p. URL: https://www.johnson.cornell.edu/portals/32/sge/docs/BoP_Protocol_2nd_ed.pdf
19. Menyashev R., Polishchuk L. Does Social Capital Have Economic Payoff in Russia? Moscow, HSE Publ., 2011, 44 p. URL: https://isc.hse.ru/data/2011/03/31/1211874471/WP10_2011_01f.pdf
20. Fafchamps M. Development and Social Capital. *Journal of Development Studies*, 2006, vol. 42, iss. 7, pp. 1180–1198. URL: <https://doi.org/10.1080/00220380600884126>
21. Dorward A., Kydd J., Morrison J., Poulton C. Institutions, Markets and Economic Co-ordination: Linking Development Policy to Theory and Praxis. *Development and Change*, 2003, vol. 36, iss. 1, pp. 1–25.
22. Mulgan G. The Process of Social Innovation. *Innovations: Technology, Governance, Globalization*, 2006, vol. 1, iss. 2, pp. 145–162. URL: <http://www.mitpressjournals.org/doi/abs/10.1162/itgg.2006.1.2.14> doi: 10.1162/itgg.2006.1.2.145
23. Lettice F., Parekh M. The Social Innovation Process: Themes, Challenges and Implications for Practice. *International Journal of Technology Management*, 2010, vol. 51, iss. 1, pp. 139–158. URL: <https://doi.org/10.1504/IJTM.2010.033133>
24. Young D.R., Leczy J.D. Defining the Universe of Social Enterprise: Competing Metaphors. *Voluntas*, 2014, vol. 25, iss. 5, pp. 1307–1332. URL: <https://doi.org/10.1007/s11266-013-9396-z>

25. Tirole J. Market Power and Regulation. Economic Sciences Prize Committee of the Royal Swedish Academy of Sciences, 2014, 54 p. URL: http://www.ecgi.org/documents/sciback_ek_en_14.pdf
26. Menard C. The Economics of Hybrid Organizations. *Journal of Institutional and Theoretical Economics*, 2004, vol. 160, pp. 345–376. URL: <http://www.dse.univr.it/documenti/OccorrenzaIns/matdid/matdid425733.pdf>
27. Cressey P., Totterdill P., Exton R., Terstriep J. Stimulating, Resourcing and Sustaining Social Innovation: Towards a New Mode of Public Policy Production and Implementation. *SIMPACT Working Paper Series*, 2015, vol. 3.
28. Tambovtsev V.L. [The State as Initiator of Development of Civil Society]. *Obshchestvennye nauki i sovremennost' = Social Sciences and Contemporary World*, 2007, no. 2, pp. 69–77. URL: http://opuo.ru/wp-content/uploads/drupal/nko_doc/gosudarstvo_kak_iniciator_razvitiya_go.pdf (In Russ.)

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.

Translated Article[†]

MACROECONOMIC DETERMINANTS OF THE CURRENCY AND STOCK MARKET SHOCKS: A PANEL VAR APPROACH

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Nizhny Novgorod, Russian Federationborochkin@yandex.ru**Article history:**Received 1 March 2017
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Available online 14 December 2017**JEL classification:** E44, F31, F45, G14**Keywords:** currency shock, Panel Vector
Autoregression, VAR, monetary policy**Abstract****Importance** The article addresses the currency and stock market volatility caused by market participants' perception of macroeconomic news that central banks across opened economy countries take into account when making decisions on changes in the monetary policy.**Objectives** The study aims to offer a quantitative approach to assessing a reaction of the currency and stock market to macroeconomic news publication.**Methods** The study employs descriptive statistics methods. Basic calculations rest on the Panel Vector Autoregression method.**Results** News about changes in interest rates, inflation and industrial production instantly trigger financial market volatility in all analyzed countries. I found volatility spillovers from currency to stock markets and vice versa. The aftermaths of the news-related shocks are absorbed by the market during 3–4 days.**Conclusions and Relevance** The modern monetary policy of central banks implies no immediate measures against inflation spikes, therefore, the reaction of markets to publication of price indices is quite slow as compared to official announcements about interest rate changes. Financial markets respond slowly to publication of important macroeconomic news if the latter can be predicted on the basis of leading indicators.

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Introduction

High volatility of the currency and stock markets poses a serious problem for central banks and businesses. There are a lot of macroeconomic indicators, such as interest rates, inflation indices, labor market indices, business cycle phase (recession or economic growth), perception indices, which are assessed in the majority of open economies with similar methods. The indicators can be used to detect key factors of the volatility in financial markets internationally.

Contemporary researches delve into the volatility of financial markets with reference to certain economies or markets of certain assets. For example, E.V. Chirkova, M.S. Sukhanova [1] proved no correlation exists between the Russian companies' announcements and volatility of their stocks in metallurgy and mineral fertilizers. The scholar D.I. Kondratov [2] examines the volatility of the Russian Ruble exchange rate so as to determine how it will be used worldwide as a reserve currency, and overviews approaches to reforming the global currency system [3].

Scholars J.C. Reboredo, M.A. Rivera-Castro [4] focus on the volatility of the global gold market; S. Nazlioglu, U. Soytaş, R. Gupta [5] on the volatility

[†]For the source article, please refer to: Борочкин А.А.Макроэкономические факторы шоков валютного и фондового рынков: метод панельной авторегрессии. Финансы и кредит. 2017. Т. 23. Вып. 15. С. 882–899. URL: <https://doi.org/10.24891/fc.23.15.882>

of the oil market; F. Jawadi, W. Louhichi, H.B. Ameer, A.I. Cheffou [6] on the volatility of the USD exchange rate; I. Turhan, E. Hacıhasanoglu, U. Soytaş [7] on the volatility of emerging markets.

This article investigates an immediate response of the financial market to macroeconomic announcements, which various open economies assess using the identical methodology. For instance, it would be interesting to observe how the volatility of an exchange rate and a national stock market are influenced by the central bank's announcement on the key interest rate, inflation and labor market. Basic macroeconomic indicators have a long-term effect on the financial market, however, quotations mostly demonstrate slight fluctuation within a short-term run, while considerable changes take place as a response to new information.

Contemporary Studies of the Market Volatility

Cash flows, international trade volumes, similar cultural background, proximity of time zones, macroeconomic changes may cause the volatility spillovers between financial markets of several countries (D.A. Agudelo, M. Gutiérrez, L. Cardona [8]). During the global financial crisis, starting from Q3 2007 through Q2 2010, basic macroeconomic variables, such as international trade, capitalization of neighboring countries' stock markets had a lower impact on the volatility spillover among countries if compared with announcements on the situation in the largest financial markets of the world (D.E. Allen, M. McAleer, R.J. Powell, A.K. Singh [9]).

High volatility of the national currency exchange rate is usually regarded as a negative factor for any economy (P. Della Corte, T. Ramadorai, L. Sarno [10]). In the mean time, the case of Turkey proves smaller entities can benefit from high volatility of the foreign exchange rate (C. Tuñç, M.N. Solakoğlu [11]).

Scholars M. Rambaldi, P. Pennesi, F. Lillo [12] observe how macroeconomic news influence the trade dynamics and the role of surprising announcements on forecasted or expected estimates. J. Barunik, T. Krehlik, L. Vacha emphasize the long-term nature of fluctuations in financial markets [13]. They relied upon high-frequency (intraday) data showing how the foreign exchange rates fluctuate so as to evaluate spiking effects of the

volatility. For instance, S. Tian, S. Hamori [14] assess that price shocks are usually cushioned by the market within two to three days. However, the volatility shocks have a gradual and transitional effect on other markets, becoming record high within five to ten days. It is evidence of the long-term memory of volatility time series. W.B. Omrane, C. Hafner [15] observe high-frequency quotations of exchange rates in correlation with basic macroeconomic indicators. The authors registered over a 95-percent cumulative response within six hours after an announcement of any market information.

Although market prices movements can be theoretically explained with basic-indicators models, the Random Walk Hypothesis is also believed to clarify some variance of the exchange rate under certain circumstances. For example, before monetary policy announcement are made, the exchange rate may deviate from fundamentally explained levels due to noisy shocks (C. Redl [16]). Such information shall ignite market behavior studies during news releases that can turn the trend back. The market, more often than not, does not demonstrate any agitation before news releases. The volatility soars just after the announcement. The inverse situation is also possible. During the financial turmoil, high volatility is usually expected in the market. However, some crucial announcements may *calm markets down*, thus decreasing the volatility. D. Kenourgios, S. Papadamou, D. Dimitriou [17] identified an intraday *calming down impact* that official announcements about monetary policies had before and after their release.

Data

Estimates are based on daily quotations of currencies and stock indices in 22 countries¹ in Europe, Asia, Americas, Africa and Asia Pacific (*Table 1*). I also use basic economic indicators of the above counties (*Table 2*) from Q1 2008 through Q4 2016. I checked not only reporting period – economic news relates to, but also the exact time of its release. It helps to quantify the response of financial markets to occurrences. I use exchange

¹ The Eurozone is regarded as a separate country with the Euro as its currency. Basic economic indicators are applied to the Eurozone, as a whole, rather than to each country of the currency union, in particular.

rates of local currencies against USD as the foreign exchange rates for this study. As for the USA, I apply the Trade Weighted U.S. Dollar Index: Major Currencies. Local stock indices reflect the capitalization of the most marketable listed companies from traditional and highly developed sectors in those countries. For example, S&P500 (USA), EuroStoxx (Eurozone), FTSE100 (United Kingdom).

The macroeconomic sample includes the following data. Announcements of central banks (dummy variable, 1 – the national central bank made an announcement on the day, 0 – the national central bank did not make any announcement), and their decisions on interest rate adjustments. Official statistical bodies' publications on the inflation and employment, gross domestic product, industrial production, retail trade, etc. Publications of private agencies of economic information and private banks on the market perception indices, business activity indices. Similar techniques are used to obtain this information in line with international agreements. The information is available in most of respective countries (*Table 2* provides descriptive statistics of macroeconomic data).

Other macroeconomic indicators of countries are not so easily compared. Housing price dynamics is another important metric. Original techniques are used to assess the indices in each particular country. For example, Nationwide's House Price Index (UK), S&P Case – Shiller Home Price Indices (USA). However, they are comparable since they are intended to forecast a business cycle phase and inflation in an economy. In the given sample, those indices are available only for five countries.

Purchasing Managers' Index (PMI) also reflects business activities. PMI is measured by private agencies or banks, such as Markit (emerging markets, Eastern Europe), HSBC (emerging markets, BRICS²), Caixin (China). The indicator is interesting for market actors since it implies real procurement transactions and, subsequently, allows for reliable forecasts of production orders and demand for products.

² BRICS countries shall mean Brazil, Russia, India, China and South Africa.

Descriptive statistics of logarithmic returns of foreign exchange rates is presented in *Table 1*. Foreign exchange rates are constructed so that the increased indicator would flag the devaluation of local currencies against the U.S. dollar. If the U.S. dollar index grows, it means the devaluation of the U.S. dollar against major currencies. As seen in *Table 1*, China and Japan are cases when national currencies and their exchange rates are somewhat pegged to the U.S. dollar. They have the smallest standard skewness of returns but very high kurtosis coefficient due to one-time intentional devaluations against the U.S. dollar. The high kurtosis coefficient of Brazil, South Korea, Russia qualifies them as emerging economies, where drastic changes in foreign exchange rates are possible.

Risk metrics, such as Value-at-Risk and average expected loss, in particular, indicate that currencies in such countries as Brazil, Bulgaria, Poland, Russia and South Africa are exposed to significant and extraordinary devaluation (*Table 1*).

The Ljung–Box test proves the majority of currency pairs correlates, including the Ruble-based currency pairs, thus justifying the use of autoregression models. The Jarque–Bera test is significant at one-percent level, thus warning about an abnormal distribution of returns of all currency pairs. The unit roots tests (the augmented Dickey–Fuller test and Philips–Perron test) prove ($p < 0.05$) stationarity of the time series in question (*Table 1*), thus making them applicable to the regression analysis. Returns of stock indices were subject to the similar tests, with the same conclusions being made.

Descriptive statistics of macroeconomic data are given in *Table 2*. For panel analysis purposes, time series of indicators shall be available for the majority of panels (countries). If data on a certain country are missing, the country is excluded out of the observation. As seen in the Table, data on key interest rates, inflation, employment, business activity are available in relation to most countries. Standard deviation of indicators is much less than their averages, thus indicating the reliability and applicability of data in verifying statistical hypotheses.

The available macroeconomic data were processed in the following way. Inflation metrics are published

as monthly percentage points of movements in prices for consumer goods, production goods or real estate and can be construed as negative return on cash held. Although being negative in certain cases, the official interest rate is a benchmark of the return on risk-free assets. Hence, to compare the return and gain from foreign exchange or stock indices, inflation metrics and official interest rates were used as they are. Official announcements of central banks represent dummy variables, which shall not be transformed either. The remaining indicators are published as absolute values. I calculated their logarithmic return and included transformed data into the sample.

In addition to the formal verification of data, descriptive statistics analysis in *Table 2* reveals interesting facts. First, Sweden, China and South Korea demonstrate deflation of their costs (averages of the Producer Price Index are negative). As for Sweden, this may stem from its access to cheap oil in comparison with the rest of Europe. China and South Korea are presumed to increase their labor productivity or tend to cheap workforce from agriculture (*Table 2*). Second, there is inconsistency between intuitive perceptions and data on expected volatility of the market when economic news is released. The data is given in the bottom line of the right-hand column of the table per each economic indicator and national average. Considering the large scale of the U.S. economy and broad trading ties with other countries, U.S. data are expected to cause the highest volatility of the global financial market in comparison with other countries. However, the USA is a leader in terms of the average expected volatility caused by announcements. The reason is that numerous important news concerns the U.S. economy, thus averaging out (reducing) the market volatility in the long run (*Table 2*). If I focus on types of macroeconomic news, rather than countries, the average expected volatility of the market reaches its highest point at the moment of announcements. It is consistent with generally accepted views. Political events can cause dramatic changes in the market situation. They are more difficult to predict than economic developments (*Table 2*).

Methodology

Two general approaches are mainly used to observe the volatility of foreign exchange rates. The first one involves various types of models with conditional heteroskedasticity (GARCH). Such models are applied to evaluate and assess each country's indicators in particular. As per the second approach, assessments are made for all the sampled countries. It requires panel autoregression models.

Analyzing panel data, I may use hidden variables to consider and exclude individual distinctions of observable items. In the mean time, vector autoregressive models help examine several time series of economic variable and their correlation. For example, foreign exchange rate, stock index, inflation, etc. in a certain country. Therefore, if this research aims to find general economic patterns showing the reasons why the volatility of financial markets in different countries increases, the panel vector autoregressive model is a proper option. In previous researches, the panel vector autoregressive model was used to examine the mutual correlation of the foreign exchange rate in 29 countries (A. Grossmann, I. Love, A.G. Orlov [18]), European countries (M.A. Dąbrowski, M. Papież, S. Śmiech [19]), and Sub-Saharan countries of Africa (I.O. Oseni [20]). In Russia, panel models are applied by S.M. Guriev, A.D. Kolotilin, K.I. Sonin [21] to study the oil market volatility. E.A. Fedorova, A.E. Nikolaev, E.S. Mazalov³ resort to econometric methods to evaluate spillover effects (mutual influence) in Russia's defense industry.

The general expression of the panel vector autoregressive model can be presented like it is put in the research by A. Grossmann, I. Love, A. G. Orlov [19]:

$$Z_{it} = \Gamma_0 + \Gamma_1 Z_{it-1} + f_i + \varepsilon_{it}, \quad (1)$$

where Z_{it} is the vector of key variables;

f_i denotes fixed effects that reflect all concealed and time independent characteristics of a certain country (area, the number of population, international trade agreements, exchange rate regimes, etc.);

³Fedorova E.A., Nikolaev A.E., Mazalov E.S. [Spillover effects in the defense industry]. *Finansy i Kredit = Finance and Credit*, 2016, no. 1, pp. 2–11. (In Russ.)

i and t are indices signifying the country and time interval respectively.

The time lag of the model is chosen by minimizing the Akaike information criterion⁴ or Bayesian information criterion, which are determined for several models with identical sets of input variables and the different number of lags only. In most cases, it is enough to check lags, from one to four. Lag-one models, i.e. models based on previous-period data, happen to be the best option.

Based on equation (1), I review three models, which help assess an impact of macroeconomic shocks on the exchange rate of the local currency and stock index: the monetary policy modification model (2), the economic and business environment modification model (3) and the comprehensive model (4).

The monetary policy modification model (2) includes such variables as the exchange rate $ExchR_{it}$, stock index $StockI_{it}$, key rate $KeyR_{it}$, central bank's announcements CB_{it} , Consumer Price Index CPI_{it} , Producer Price Index PPI_{it} . The model traces the link between the financial market and monetary factors (cycles of interest rate increases and decreases as a response to the inflation).

$$Z_{it} = (ExchR_{it}, StockI_{it}, KeyR_{it}, CB_{it}, CPI_{it}, PPI_{it}). \quad (2)$$

The economic and business environment modification model (3) includes the exchange rate $ExchR_{it}$, stock index $StockI_{it}$, key rate $KeyR_{it}$, Industrial Production Index $Prod_{it}$, Purchasing Managers' Index PMI_{it} . The model detects the correlation between the financial market and a business cycle (recession or growth).

$$Z_{it} = (ExchR_{it}, StockI_{it}, KeyR_{it}, Prod_{it}, PMI_{it}). \quad (3)$$

The comprehensive model (4) includes the exchange rate $ExchR_{it}$, stock index $StockI_{it}$, key rate $KeyR_{it}$, Industrial Production Index $Prod_{it}$, unemployment rate J_{it} .

$$Z_{it} = (ExchR_{it}, StockI_{it}, KeyR_{it}, Prod_{it}, J_{it}). \quad (4)$$

⁴The Akaike information criterion shows how many errors the model with limited variables has in comparison with the complete or ideal model that includes all factors. The Akaike information criterion of the ideal model is zero, by its nature.

In this model, industrial production trends signify a business cycle phase, while the unemployment rate generalizes the outcome of the central bank's monetary policy for stimulating or hindering the business activity and inflation.

Results

The main results of panel vector autoregression are presented in *Table 3*. I use a one-period lag for all the three models. I choose this lag by comparing the quality of the models with different lags in line with the Akaike information criterion.

Please note that *Table 3* is divided into two sections – *Exchange Rate* and *Stock Index*. The sections contain regression model coefficients in relation to factors that influence the two resultant indicators. The variables are deemed to correlate, if the regression coefficient is statistically meaningful (such coefficients are marked with an asterisk in the table). As seen in the table, the exchange rate demonstrates the strongest response to news informing that central banks altered interest rates (-0.00511 , $p < 0.05$) and the stock market fluctuates (-0.0126 , $p < 0.05$). News about the inflation and real economy indices (industrial production, PMI) does not invoke an immediate response of the currency market.

The stock market and the national currency market are closely related. Fluctuations in the one echo through the other immediately. The transmission of volatility from the currency market to the stock one and the autocorrelation of the stock market have special statistical significance: 0.075 , $p < 0.001$ and -0.0434 , $p < 0.001$, respectively.

News about the industrial production induces a statistically significant response of the stock market (0.0014 , $p < 0.01$). The three models are based on 11 to 13 panels (countries) with more than 15 thousand observation being made in total. The sample is representative.

Impulse response functions give an illustrative view of the statistical significance of the regression coefficients. They are presented in *Table 1* for the monetary policy modification model and *Table 2* for the comprehensive model.

As displayed in the Figures, the market completely overwhelms a news shock in a four-day time, with record high indicators being registered on the following day. The Figures also indicate the bounds of a 95-percent confidence interval for impulse response functions, which help assess the statistical significance of regression coefficients. Given the dependence exists, the response function graph and confidence bounds are above or below zero in case of a positive or negative correlation, respectively. Sections *Key Rate and Exchange rate*, and *Exchange Rate and Stock* are noteworthy.

As per the first graph, if the local central bank raises an interest rate, the national currency immediately strengthens (in the graph, exchange rates are constructed so that a drop would mean a growth of the national currency against USD). As per the second graph, the local currency devaluation entails an immediate growth in the stock index denominated in the national currency. The correlation is rather evident, for the money devaluation does not necessarily mean a drop in the company value. As the section *CPI and Stock Index* shows, announcements on a growth in CPI leads to an immediate upward revaluation of stock assets. From economic perspectives, the correlation is quite justifiable, however, the statistical significance was not corroborated with the formal test, with its results reported in *Table 3*.

Fig. 2 depicts impulse response functions for the comprehensive model including monetary and economic factors. The sections *Industrial Production and Stock Index* display that positive announcements on industrial production makes the stock market grow on the following day.

The economic theory provides the convincing rationale for the correlation between inflation and employment metrics with the currency and stock markets. Nevertheless, I do identify the statistically significant correlation between such announcements and an immediate response of the financial market. It stems from monetary policies of contemporary central banks, especially, in the USA and Europe. The increased inflation is not considered as a prerequisite for the central bank to raise interest rates. Moreover, if the inflation rises once, it will not necessarily gain momentum in the future. Hence,

financial markets do not tend to actively respond to tentative data, awaiting official announcements of monetary authorities on changes in interest rates. As for employment metrics, the financial market seems to consider leading indicators, i.e. the Industrial Production Index, and foresees the changes. Thus, the market volatility will be moderate as labor market statistics are published.

Other sections in *Fig. 1* and *2* are given for reference. They are difficult to interpret from economic perspectives for purposes of this research. For example, it is not that easy to substantiate the psychological correlation between the publication of the Producer Price Index and Consumer Price Index.

I construct regressions in relation to other macroeconomic variables. Announcements on confidence of businesses and consumers, leading indicators (retail trade, Purchasing Managers' Index) do not have an immediate impact on the volatility of the currency and stock market. The reason is that local markets mostly react to the publication of such indicators in relation to the U.S. economy. While similar information on the other country's market is released, prices have already been adjusted for the information. The panel model is designated to reveal significant coefficients only if a certain phenomenon is typical of most panels, rather than one or two. In this research, I do not weight macroeconomic indicators by size of respective economies. Thus, each country has the same weight in the models.

Announcements on gross domestic product do not invoke the market volatility since the indicator, I presume, is published within a considerable time interval after the reporting period, thus allowing the market to embed this information in prices.

Conclusions

The research results in the following conclusions. The currency and stock markets are mutually related. If one of them experiences any changes, the other one reacts immediately. Considering macroeconomic factors that cause the volatility of the stock market, I should point out changes in the interest rate, and Consumer Price Index. In case of the stock market, these factors are announcements

on the interest rate and industrial production. The market can forecast the employment situation through leading indicators. Thus, the respective response to those announcements is mild. Announcements on the inflation also have a small impact on the market volatility since market actors prefer to know official authorities' decision on monetary policies and respective changes.

The findings can be applied by regulatory authorities to outline monetary and economic policies of

the State. Private investors should consider the market volatility on the days of relevant announcements, with their statistical significance for the currency and stock market being proved in this research.

Further studies might focus on the intraday volatility of the financial market upon the release of macroeconomic announcements.

Table 1
Descriptive statistics of exchange rate returns. Data for Q1 2008–Q4 2016

Country (a group of countries)	Moments			Risk			JB ⁷	BL ⁸	Unit roots ⁹	
	Mean ¹	sd ² , %	sk ³	krt ⁴	VaR ⁵ , %	ES ⁶ , %			ADF ¹⁰	PP ¹¹
Australia	0	0.89	0.89	16.14	-1.28	-1.96	0	7.62**	-37.51*	-2,803.31*
Eurozone	0	0.61	0.21	7.68	-0.91	-1.35	0	0.01	-37.42*	-2,776.24*
Brazil	0	0.95	1.59	29.05	-1.39	-2.08	0	0.04	-27.87*	-1,443.46*
Canada	0	0.63	-0.13	8.63	-1	-1.48	0	0.3	-38.03*	-2,730.27*
China	0	0.12	1.33	33.47	-0.17	-0.28	0	0.85	-36.47*	-2,802.64*
Czech Republic	0	0.79	-0.02	7.99	-1.23	-1.81	0	0.21	-37.04*	-2,747.52*
Denmark	0	0.61	-0.17	7.12	-0.98	-1.42	0	0.68	-37.13*	-2,726.8*
United Kingdom	0	0.62	0.89	18.83	-0.91	-1.34	0	2.92	-36.14*	-2,583.26*
Bulgaria	0	0.97	0.05	6.59	-1.52	-2.22	0	0.67	-37.25*	-2,675.51*
India	0	0.67	-0.45	12.51	-1.02	-1.57	0	0.24	-38.51*	-2,744.24*
Japan	0	0.65	-0.29	8.23	-1.03	-1.54	0	0.54	-38.55*	-2,701.69*
South Korea	0	0.77	-0.01	36.82	-0.93	-1.74	0	0.93	-37.75*	-2,459.54*
New Zealand	0	0.89	0.34	9.16	-1.35	-1.99	0	0.67	-37.16*	-2,657.41*
Norway	0	0.82	-0.01	8.02	-1.29	-1.84	0	1.27	-39.31*	-2,655.94*
Poland	0	0.94	0.12	7.72	-1.4	-2.14	0	0.74	-37.08*	-2,604.11*
Russia	0	0.95	0.06	49.03	-1.19	-2.11	0	1.21	-36.81*	-2,498.09*
Singapore	0	0.36	-0.04	8.19	-0.55	-0.85	0	6.83**	-39.04*	-2,844.48*
South Africa	0	1.04	0.45	9.17	-1.5	-2.21	0	1.52	-37.32*	-2,563.47*
Sweden	0	0.8	-0.22	7.17	-1.25	-1.84	0	2.85	-39.33*	-2,712.88*
Switzerland	0	0.7	-1.29	40.86	-1.07	-1.62	0	22.33***	-37.06*	-2,539.54*
Turkey	0	0.78	0.38	11.13	-1.11	-1.62	0	8.16**	-36.27*	-2,552.06*
USA	0	0.46	-0.45	8.49	-0.74	-1.09	0	0.34	-38.04*	-2, 813.01*

¹ Mean is the mean value.

² sd is standard deviation.

³ sk is the kurtosis coefficient.

⁴ krt is the asymmetry coefficient.

⁵ VaR is Value-at-Risk.

⁶ ES is the average expected losses.

⁷ JB is p -value of the Jarque–Bera test for normality.

⁸ BL is the Ljung–Box test for autocorrelation.

⁹ Unit roots test (stationarity test).

¹⁰ ADF is the augmented Dickey–Fuller test.

¹¹ PP is the Phillips–Perron test.

* $p < 0.05$.

** p < 0.01.

*** p < 0,001.

Source: Authoring, based on currency quotes retrieved from *Investing.com* financial portal. URL: <https://www.investing.com>; Trade Weighted U.S. Dollar Index: Major Currencies [DTWEXM] retrieved from FRED, Federal Reserve Bank of St. Louis. URL: <https://fred.stlouisfed.org/series/DTWEXM>

Table 2**Monetary, economic and business determinants of currency exchange movements. Descriptive statistics. Data for Q1 2008–Q4 2016**

Country (a group of countries)	% ¹			CPI ²			PPI ³		
	n ⁴	mn ⁵	sd ⁶	n	mn	sd	n	mn	sd
Europe									
Eurozone	109	1.3	1.4	375	1.3	1	116	0.9	4
Great Britain	115	1.3	1.8	117	2.4	1.4	117	2.5	3
Switzerland	45	0.5	1.1	116	0.1	1.1	0	0	0
Norway	55	2.2	1.5	71	2	0.9	71	0.7	10
Denmark	27	1.3	1.7	135	1.1	1.1	0	0	0
Russia	22	10.9	2.3	0	0	0	63	8.4	6
Czech Republic	55	0.7	1.1	72	1.3	1.1	69	0.3	3
Bulgaria	91	4.7	2.7	72	2	2.3	60	1	3
Poland	84	3.1	1.1	71	1.3	2.1	70	1	4
Sweden	51	1.3	1.5	70	0.8	1.2	71	-0.5	2
North America									
USA	79	0.8	1.3	117	1.8	1.5	116	2.3	3
Canada	77	1.2	1.1	117	1.7	0.9	0	0	0
Asia									
China	24	6.1	0.9	75	2.8	1.4	73	-0.9	4
Japan	126	0.2	0.2	117	0.3	1.3	0	0	0
India	55	7.3	1	70	4.3	4.2	0	0	0
Singapore	0	0	0	54	1.5	2.1	0	0	0
South Korea	76	2.5	1	60	1.7	1.2	65	-0.2	3
Turkey	178	8.1	3.3	130	8	1.4	130	6.6	3
Australia and Oceania									
Australia	105	3.7	1.6	39	2.4	1	38	2	2
New Zealand	77	3.6	2	19	0.8	0.5	0	0	0
South America									
Brazil	63	11.2	2.2	73	0.6	0.3	0	0	0
Africa									
South Africa	47	6.9	2.1	70	5.5	0.8	71	6.4	2
Total volatility	1.8			1.7			1.3		

¹ % is the interest rate set by the central bank.² CPI is the Consumer Price Index.³ PPI is the Producer Price Index.⁴ n is the number of observations.⁵ mn is the mean.⁶ sd is standard deviation.*Continued from the above table*

Country (a group of countries)	J ¹			PMI ²			CB ³	V.ty ⁴
	n	mn	sd	n	mn	sd		
Europe								
Eurozone	117	10.1	1.6	229	50.1	5.1	1,225	2.1
Great Britain	110	6.8	1.2	118	51.7	5.1	962	2.2
Switzerland	0	0	0	113	52.5	7.2	187	1.8

Norway	71	89.1	6.5	0	0	0	0	1
Denmark	68	4.2	0.4	0	0	0	0	1
Russia	66	5.6	0.6	67	50.4	1.8	0	1
Czech Republic	71	7.5	1.2	66	53.4	3.4	0	1
Bulgaria	68	8.9	2.1	71	52.7	2.7	0	1
Poland	0	0	0	59	51.4	2.4	0	1.1
Sweden	69	7.6	0.7	0	0	0	0	1
North America								
USA	117	7.1	1.8	109	53.6	1.9	2,462	1.7
Canada	114	7.1	0.7	65	55.4	5.4	344	2.2
Asia								
China	0	0	0	215	50.4	1.9	0	1.8
Japan	116	4.1	0.7	139	49.9	4.2	748	1.9
India	0	0	0	0	0	0	0	1
Singapore	33	2	0.1	52	50.1	0.9	0	1
South Korea	63	3.4	0.3	62	49.5	1.4	0	1
Turkey	0	0	0	0	0	0	0	0.9
Australia and Oceania								
Australia	116	5.3	0.6	86	48.7	4.1	842	2.1
New Zealand	38	5.7	1.1	95	53.6	3.3	260	1.9
South America								
Brazil	66	6.4	1.9	53	48.3	2.7	0	1
Africa								
South Africa	21	25.2	0.8	55	51	2.9	0	1
Total volatility	1.7			1.5			2	-

¹ J is the unemployment rate.

² PMI is Purchasing Managers' Index.

³ CB is the central bank's announcements on monetary policies.

⁴ V_{ty} is the average expected volatility.

Source: Authoring. Economic metrics and volatility data retrieved from FXStreet. URL: <https://www.fxstreet.com/economic-calendar>

Table 3

Exchange rate volatility assessment under Panel VAR method

Indicator	Monetary Policy (1)	Economic and Business Environment (2)	Comprehensive Model (3)
Exchange Rate			
Exchange rate	-0.00363 (-0.32) ¹	-0.00437 (-0.29)	-0.0217 (-1.45)
Stock index	0.00906 (1.86)	-0.00501 (-0.91)	-0.0126* (-2.02)
Key rate	-0.00511* (-2.42)	-0.00432 (-1.05)	-0.00868* (-2.13)
Central Bank's announcements	0.0000738 (0.38)	-	-
Consumer Price Index	0.000112 (0.16)	-	-
Producer Price Index	0.000375 (0.80)	-	-
Industrial production	-	0.000305 (0.73)	0.0000954 (0.27)
Purchasing Managers' Index	-	-0.00717 (-1.00)	-
Unemployment rate	-	-	-0.00858 (-1.09)
Stock Index			
Exchange rate	-0.075*** (-4.34)	0.0356 (1.72)	0.0375 (1.82)
Stock index	-0.0434*** (-3.93)	-0.0199 (-1.68)	-0.0388** (-3.2)
Key rate	0.00229 (0.76)	0.00456 (0.86)	0.00502 (1.06)
Central Bank's announcements	-0.00046 (-1.22)	-	-
Consumer Price Index	0.0027 (1.83)	-	-
Producer Price Index	0.00115 (1.36)	-	-

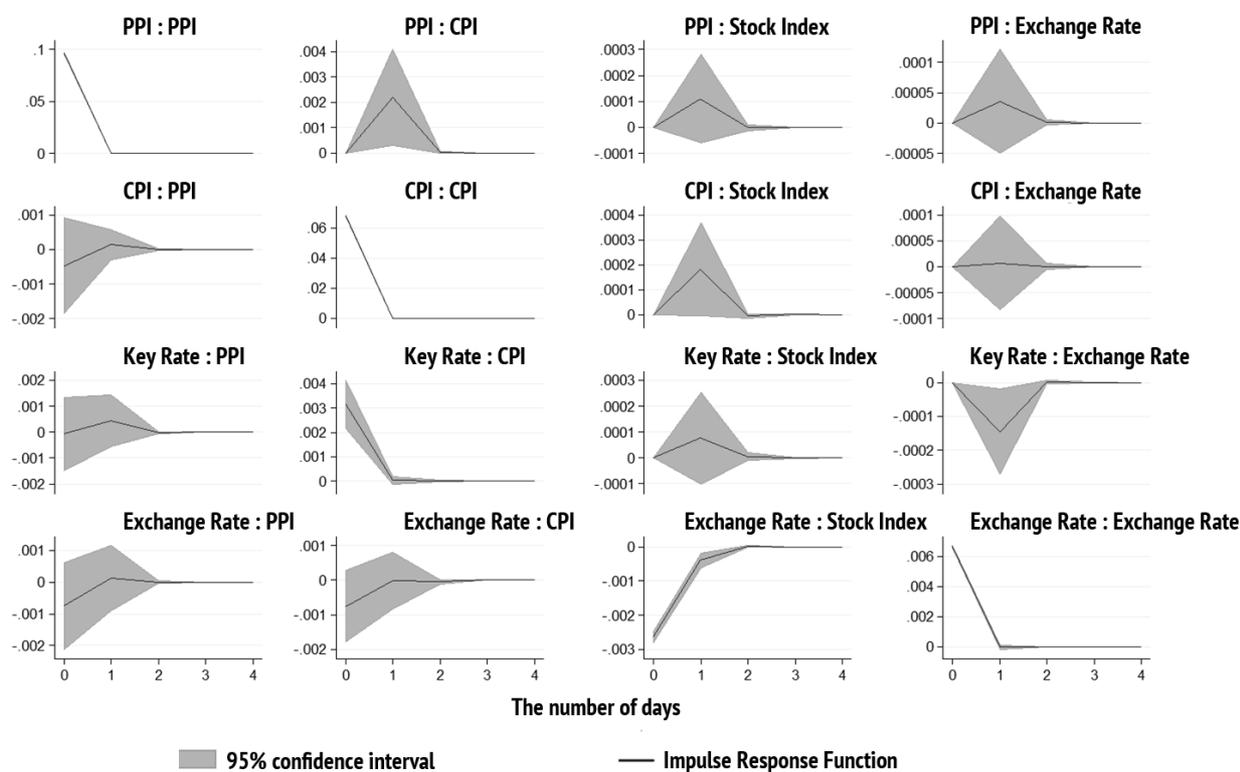
Industrial production	-	0.0014** (2.71)	0.00134** (2.71)
Purchasing Managers' Index	-	-0.00168 (-0.12)	-
Unemployment rate	-	-	0,000777 (0,07)
Total observations	18,812	16,444	15,253
The number of data panels (countries)	13	12	11
Chi-square Statistic	168.9 (108)	126.8 (75)	126.1 (75)

¹ *t*-statistics in brackets.

* $p < 0,05$, ** $p < 0,01$, *** $p < 0,001$.

Source: Authoring

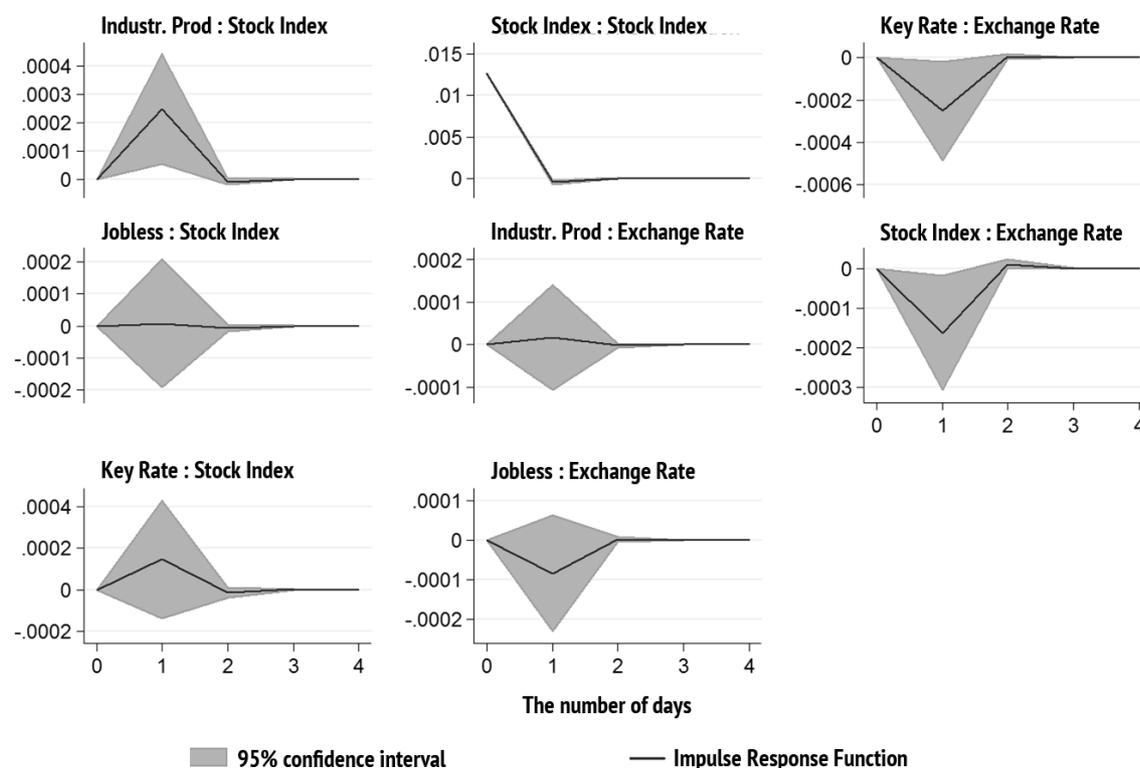
Figure 1
Impulse response function for the model with monetary metrics



* Exchange Rate is the exchange rate of the local currency against the U.S. dollar or the U.S. dollar index, Stock Index is the stock market index, Key Rate is the key rate set by the central bank, CPI is the Consumer Price Index, PPI is the Producer Price Index.

Source: Authoring

Figure 2
Impulse response function for the model with monetary and economic metrics



* Exchange Rate is the exchange rate of the local currency against the U.S. dollar or the U.S. dollar index, Stock Index is the stock market index, Key Rate is the key rate set by the central bank, Industr. Prod is industrial production, Jobless is the unemployment rate.

Source: Authoring

References

1. Chirkova E.V., Sukhanova M.S. [Impact of the earnings' guidance provided by public companies on their market capitalization and share price volatility in the Russian stock market]. *Korporativnye finansy = Journal of Corporate Finance Research*, 2013, no. 4, pp. 37–52. (In Russ.)
2. Kondratov D.I. [Formation of the Russian rubles as an international currency]. *Ekonomicheskii zhurnal VShE = The HSE Economic Journal*, 2012, vol. 16, no. 3, pp. 367–403. (In Russ.)
3. Kondratov D.I. [Recent approaches to reforming the global monetary system]. *Ekonomicheskii zhurnal VShE = The HSE Economic Journal*, 2015, vol. 19, no. 1, pp. 128–157. (In Russ.)
4. Reboredo J.C., Rivera-Castro M.A. Gold and Exchange Rates: Downside Risk and Hedging at Different Investment Horizons. *International Review of Economics & Finance*, 2014, vol. 34, pp. 267–279. URL: <https://doi.org/10.1016/j.iref.2014.07.005>
5. Nazlioglu S., Soytaş U., Gupta R. Oil Prices and Financial Stress: A Volatility Spillover Analysis. *Energy Policy*, 2015, vol. 82, pp. 278–288. URL: <https://doi.org/10.1016/j.enpol.2015.01.003>

6. Jawadi F., Louhichi W., Ameer H.B., Cheffou A.I. On Oil-US Exchange Rate Volatility Relationships: An Intraday Analysis. *Economic Modelling*, 2016, vol. 59, pp. 329–334.
URL: <https://doi.org/10.1016/j.econmod.2016.07.014>
7. Turhan I., Hacıhasanoglu E., Soytas U. Oil Prices and Emerging Market Exchange Rates. *Emerging Markets Finance and Trade*, 2013, vol. 49, iss. S1, pp. 21–36.
8. Agudelo D.A., Gutiérrez M., Cardona L. Volatility Transmission between US and Latin American Stock Markets: Testing the Decoupling Hypothesis. *Research in International Business and Finance*, 2017, vol. 39, part A, pp. 115–127. URL: <https://doi.org/10.1016/j.ribaf.2016.07.008>
9. Allen D.E., McAleer M., Powell R.J., Singh A.K. Volatility Spillovers from Australia's Major Trading Partners Across the GFC. *International Review of Economics & Finance*, 2017, vol. 47, pp. 159–175.
URL: <https://doi.org/10.1016/j.iref.2016.10.007>
10. Della Corte P., Ramadorai T., Sarno L. Volatility Risk Premia and Exchange Rate Predictability. *Journal of Financial Economics*, 2016, vol. 120, iss. 1, pp. 21–40. URL: <https://doi.org/10.1016/j.jfineco.2016.02.015>
11. Tunç C., Solakoğlu M.N. Does Exchange Rate Volatility Matter for International Sales? Evidence from US Firm Level Data. *Economics Letters*, 2016, vol. 149, pp. 152–156.
URL: <https://doi.org/10.1016/j.econlet.2016.08.008>
12. Rambaldi M., Pennesi P., Lillo F. Modeling Foreign Exchange Market Activity around Macroeconomic News: Hawkes-Process Approach. *Physical Review*, 2015, vol. 91, iss. 1.
13. Barunik J., Krehlik T., Vacha L. Modeling and Forecasting Exchange Rate Volatility in Time-Frequency Domain. *European Journal of Operational Research*, 2016, vol. 251, iss. 1, pp. 329–340.
URL: <https://doi.org/10.1016/j.ejor.2015.12.010>
14. Tian S., Hamori S. Time-Varying Price Shock Transmission and Volatility Spillover in Foreign Exchange, Bond, Equity, and Commodity Markets: Evidence from the United States. *The North American Journal of Economics and Finance*, 2016, vol. 38, iss. C, pp. 163–171. URL: <https://doi.org/10.1016/j.najef.2016.09.004>
15. Omrane W.B., Hafner C. Macroeconomic News Surprises and Volatility Spillover in Foreign Exchange Markets. *Empirical Economics*, 2015, vol. 48, iss. 2, pp. 577–607.
16. Redl C. Noisy News and Exchange Rates: A SVAR Approach. *Journal of International Money and Finance*, 2015, vol. 58, pp. 150–171. URL: <https://doi.org/10.1016/j.jimonfin.2015.08.002>
17. Kenourgios D., Papadamou S., Dimitriou D. Intraday Exchange Rate Volatility Transmissions across QE Announcements. *Finance Research Letters*, 2015, vol. 14, pp. 128–134.
URL: <https://doi.org/10.1016/j.frl.2015.05.007>
18. Grossmann A., Love I., Orlov A.G. The Dynamics of Exchange Rate Volatility: A Panel VAR Approach. *Journal of International Financial Markets, Institutions and Money*, 2014, vol. 33, pp. 1–27.
URL: <https://doi.org/10.1016/j.intfin.2014.07.008>
19. Dąbrowski M.A., Papiież M., Śmiech S. Exchange Rates and Monetary Fundamentals in CEE Countries: Evidence from a Panel Approach. *Journal of Macroeconomics*, 2014, vol. 41, pp. 148–159.
URL: <https://doi.org/10.1016/j.jmacro.2014.05.005>

20. Oseni I.O. Exchange Rate Volatility and Private Consumption in Sub-Saharan African Countries: A System-GMM Dynamic Panel Analysis. *Future Business Journal*, 2016, vol. 2, iss. 2, pp. 103–115.
URL: <https://doi.org/10.1016/j.fbj.2016.05.004>
21. Guriev S.M., Kolotilin A.D., Sonin K.I. [Determinants of expropriation of the oil sector: A theory and evidence from panel data]. *Ekonomicheskii zhurnal VShE = The HSE Economic Journal*, 2008, vol. 12, no. 2, pp. 151–175. (In Russ.)

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.

Translated Article[†]

MODERN INTEREST RATE POLICY AND THE PHENOMENON OF NEGATIVE INTEREST RATES



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Abstract

Importance The target interest rate is the main tool of the interest rate policy. Deflationary trends in leading economies undermined interest rates of central banks. It resulted in the phenomenon of negative interest rates on commercial banks' deposits.

Objectives The research focuses on the specifics of the modern interest rate policy of central banks in leading economies. I also identify what caused negative interest rates and outline a methodological framework for the interest rate policy in the Russian economy.

Methods The research is based on methods of logic and statistical analysis.

Results I unveil distinctions of central banks' interest rate policies, while the monetary mechanism of the modern economy evolves. I unfold the specifics of regulating interest rates with interest rate corridors. The article highlights distinctions in setting interest rates and the way they influence lending and liquidity. I also underpin the nexus between the formation of interest rates and leverage level of the economy. Interest rates were found to impact deflationary trends.

Conclusions and Relevance The specifics of the modern interest rate policies of central banks depends on the way the monetary mechanism evolves, i.e. the mechanism of the money supply. As central banks implemented payment systems, cash in correspondent accounts of commercial banks with central banks grew even more important. However, in targeting the rate on these reserves, central banks are constrained to influence interest rates on commercial bank's loans. That is why central banks are unable to effectively stimulate a growth in bank lending during the cyclical recession and have to apply an unconventional method to increase the money supply.

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Currently the financial and credit segments of leading countries demonstrate some common traits, such as a decline in deposit rates of central banks down to negative values, increase in public and private debts, higher leverage of the public sector and households.

The European Central Bank (ECB) set up the rate of negative 0.1 percent on overnight deposits of commercial banks and cut it down to negative 0.4 percent in March 2016. On January 29, 2016, the Bank of Japan pronounced its move to the policy of quantitative and qualitative easing and negative interest rates and imposed the rate of negative 0.1 percent on excess reserves of commercial banks. Central banks of Denmark and Sweden also introduced negative interest rates.

[†]For the source article, please refer to: Бурлачков В.К.

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These actions shall be viewed not only as an attempt to boost the economy, but also as a response to new trends in the formation of interest rates. As stated in proceedings by C. Borio [1], L. Rachel, T. Smith [2], G. Thwaites [3], developed countries have been experiencing a stable decline in yields on long-term government bonds and real policy rate, which is defined as the difference between the target short-term interest rate of the central bank and the inflation index.

The new trends left a trail in the way the monetary mechanism operates, i.e. the mechanism of money supply. As noted by the analysts of the Bank of England M. McLeay, M. Radia, R. Thomas, the money creation in fact differs from popular, though erroneous, concepts. That is, banks act as intermediaries and lend saving deposits, but, in the mean time, they do not multiply the central bank's money when they grant loans and accept deposits respectively. The amount of money created in the economy ultimately depends on the monetary policy of the central bank. Generally this policy is enforced through interest rates. The central bank can also influence the money supply by purchasing assets, i.e. quantitative easing [4].

According to the analysts of the U.S. Federal Reserve System S. Carpenter and S. Demiralp, the recent growth in bank reserves necessitates the revision of the nexus between banking reserves and money aggregates and bank lending. As they note, an analysis of the U.S. institutional structure and empirical data from the 1990s and onwards clearly shows that the transmission mechanism fails if based on the standard model of the money multiplier from reserves to money aggregates and bank loans [5].

As the contemporary practice of non-cash money creation proves, the mechanism of a money multiplier ceased to be actively used in the economic system, though being very current in the second half of the 20th century. The money multiplier concept is known to imply that money aggregates stem from the money base controlled by the central bank.

Issues of the money multiplier concept and its effect on interest rates were addressed in researches by U. Bindseil [6, 7], Z. Jakab and M. Kumhof [8]. R. Werner providing empirical evidence of the non-

cash money creation in the process of lending transactions and without reference to the money base [9, 10]. Distinctions of the monetary policy in the contemporary environment were studied by A. Kashyap, J. Stein [11, 12], M. Farag, D. Harland, D. Nixon [13], C. Bowdler, A. Radia [14], L. Christiano and M. Eichenbaum [15]. The specifics of quantitative easing, as an unconventional lever of the money supply, was examined by J. Bridges, R. Thomas [16], S. Fullwiler, L. Wray [17], M.S. Mohanty [18], P. Mishra, P. Montiel [19], B. Fawley, C. Neely [20].

In my opinion, it is important to remember that current trends that arise in monetary segments of leading countries and result in dropping real and nominal interest rates have been evolving for many years. They originated from changes in the monetary mechanism of the contemporary economy, i.e. the money supply mechanism. It is the money supply growth that ensured the downward movement of interest rates.

The monetary mechanism of leading countries transformed due to a number of reasons. First, the prudential supervision of commercial banks was developed. It particularly refers to the adoption of the Basel I Accord (1988) and subsequent Basel II Accord. Second, payment systems of central banks were designed to streamline commercial banks' settlements. Those events took place in the early 1990s and led to unexpected implications.

As for the first implication, in the existing circumstances, the Basel capital adequacy ratio minimum requirement appeared to be a natural constraint on bank lending, rather than an inflow of deposits to a commercial bank. It enabled commercial banks to lend more, notwithstanding balances of accounts and their trends.

Assignment of previous loans to special purpose vehicles (SPV), subsequent securitization of those loans and sale of bonds in the financial market became another option for increased lending.

Upon the advent of central banks' payment systems, money circulating in such systems, i.e. balances of correspondent accounts (reserves), acquired special properties that distinguished them from bank deposits. It appeared that money in correspondent

accounts (reserves) were not subject to a multiplicative effect and completely controlled by central banks. This is due to the fact that they are formed in the closed system, while money is debited from one correspondent account and credited to the other one simultaneously. Currently, the term *banking sector liquidity* is used denoting gross reserves of commercial banks at the central bank.

As the economists of the Bank of Norway T. Bernhardsen and A. Kloster point out, reserves of the central bank are the only generally accepted means of interbank settlements, with the central bank having the exclusive authority to create them. In the closed system, reserves of the central bank migrate throughout accounts of commercial banks at the central bank. Commercial banks cannot influence total reserves in the banking system, at their own discretion [21].

Thus, here we have a paradox. For purposes of lending transactions commercial banks got empowered to create the money supply limited only with the corporate sector and households' demand for loans. To create money, commercial banks may simply debit the *Loans Granted* account and credit the amount from the customer's account (borrower). Things get more complicated when the customer requests the bank to transfer money to the other bank. If there is not enough money in the correspondent account at the central bank, it shall be borrowed from the interbank market or central bank.

Currently, these features are common not only for the monetary mechanism of national economies, but also the mechanism for forming monetary liquidity in the global economy. Global currencies circulating in this sector are called *European currency*, according to the tradition dating back to the 1960s. The Eurodollar lays the basis for this. As S. Fowler emphasizes, Eurodollars, in a way, can be presented as *decisions*, rather than funds. Eurodollars are formed when a foreign banker assumes an obligation denominated in dollars as a deposit, notwithstanding that no cent will leave the U.S. Federal Reserve System [22].

Based on this example, the foreign (say, European) bank can place a dollar deposit, i.e. grant a loan to the customer, by making a banking entry through

accounts of the balance sheet. However, if the customer requests to transfer the money to an U.S. bank, the bank that grants the loan and places the dollar deposit respectively shall raise a respective amount from the interbank market. Currently, commercial banks need the central banks' money to transfer money they created from one bank into another upon the customers' requests (borrowers), rather than to grant loans.

The monetary mechanism transformation, which caused an increase in the money supply and a drop in interest rates respectively, could but make many corporations and households seek loan refinance. It shaped the downward trend in interest rates. Unsustainability of money and credit aggregates was the first thing monetary regulators noticed in the early 2000s when the situation changed. It derogated the targeting of monetary indicators and paved the way for the regulation of interest rates. It is noteworthy that various countries made attempts to manage interest rates. However, such regulatory attempts were not very efficient, impeding any prompt reaction to economic activities and price dynamics.

In the early 2000s, leading countries were setting up their practices for regulating interest rates, while the formation of the latter underwent significant changes. As the money mechanism evolved, the short-term interest rate, which central banks control, turned into a tariff for transporting money from one commercial bank into the other one through their correspondent accounts at the central bank.

As part of their interest rate policy, the U.S. Federal Reserve System sets the target rate on federal funds. This interest rate is overnight. Banks with excess statutory reserves grant loans to banks with insufficient statutory reserves. The target rate of the Federal Reserve System on federal funds is the critical metric of excess statutory reserves. The effective federal funds rate is the weighted average rate of market deals commercial banks make with federal funds, i.e. lending transactions based on federal funds.

In addition to the target rate on federal funds, the interest rate on required reserves – IORR and

the interest on excess reserves rate – IOER are used in the USA.

IORR is paid on statutory reserves, which the U.S. banks are bound to hold in the Federal Reserve System. IOER is charged on the amount of factual reserves (that is, commercial banks' funds in accounts at the Federal Reserve System) that exceeds statutory reserves. IOER and interests charged on excess reserves in particular are tools the Federal Reserve System resorts to absorb excess liquidity. They resemble the European Central Bank's practice of attracting excess resources into deposits.

As part of its interest rate policy, the ECB maintains an interest rate corridor. The ceiling of the interest rate corridor is the marginal lending facility rate. Using this rate, the ECB injects liquidity into the banking sector in case the overnight interest rate of the monetary market increases.

The floor of the interest rate corridor is the overnight deposit facility rate. Using this rate, the ECB shall raise excess liquidity for deposits in ordinary circumstances. Adhering to the quantitative easing policy, the ECB sets up a negative interest rate on deposits of 0.4 percent so as to urge commercial banks to utilize their reserves.

In addition to the above rates, the ECB applies the main refinancing rate. The ECB applies it when making weekly transactions for providing additional liquidity to the banking sector.

When implementing its interest rate policy, the Bank of England sets up the target overnight interest rate. The Bank of England absorbs excess liquidity attracting deposits at the deposit rate. If liquidity is insufficient and the short-term interest rate increases respectively, the Bank of England provides the banking system with additional reserves at the lending rate. Thus, the Bank of England maintains the bank rate within the corridor bounds. The lending rate is its ceiling, and the deposit rate is its floor. Central banks set up a symmetric corridor of its fluctuations. The identical model is run in Russia through the key rate.

When using the interest rate corridor, central banks of leading countries both ensure the supply of monetary liquidity (in case the target interest rate hits its ceiling) and absorb the excess liquidity by

streaming it to deposits (in case the target interest rate hits its floor). These measures draw the interbank interest rate into the middle of the corridor.

To forecast the trajectory of the target interest rate within the corridor, central banks shall consider how autonomous factors (the banking system's demand for cash and transactions of the governmental treasury) change. As part of these transactions, treasuries gain proceeds and incur expenses [6].

Initially, interest corridors were put in practice by the ECB and central banks of Australia, Canada, New Zealand [6]. It is worth mentioning that only one in four (ECB) central banks employs the system of statutory reserves. From their inception, interests rates are regarded as a versatile tool to regulate monetary liquidity central banks provide. In the USA the excess liquidity of the banking system is not pooled into deposits. Interests are paid on such liquidity. This practice led to an important consequence. Excess statutory reserves turned into a type of risk-free assets.

As the monetary mechanism evolves, the conversion of (1) bank deposits and (2) balances of correspondent accounts into two separate elements shaped the specifics of interests rates in the contemporary economy. They are involved in the regulation of the interest rate on reserves, i.e. the central bank's money. Commercial banks request this money for transferring customers' deposits, i.e. money they create when they lend. If commercial banks need more resources than the central bank can give, the latter has to create more money (reserves) in maintaining the interest rate within the given corridor. It means that the interest rate corridor is *de facto* a tool to correlate the central bank's money supply and the amount of money generated by commercial banks. However, this mechanism actually results in refinancing of the economy and a drop in interest rates.

As proved in practice, the interest rate corridor poses a substantial threat to countries, the currencies of which depend on resources. For example, Russia. If the global price for goods, which such countries export, drops, national currency markets become turbulent. Under these circumstances, commercial banks transfer their

funds through the central bank's payment system to a stock exchange. Those funds are money generated by commercial banks indeed. Maintaining the target interest rate within the given corridor, the central bank increases the volume of liquidity. That is, it issues reserves as a special element of the money supply. In this case, speculation against the national currency can be beaten if the target rate (the key rate in Russia) is increased so much as to make speculative transactions with currency less profitable for commercial banks. As seen in the market, a spiking increase in the key interest rate disrupts lending processes in the national economy.

Targeting the federal funds rate (FFR) is a distinction of the U.S. Federal Reserve System's interest rate policy. As federal funds needed to be raised on an interest-rate basis to settle customers' accounts, the U.S. commercial banks could but try diminishing the demand for such funds. To address the issue, commercial banks chose to transfer balances of customers' accounts from deposit account to the currency market since they are exempt from reserve requirements. Private netting offices became another option to reduce commercial banks' demand for federal funds. CHIPS (Clearing House and Interbank Payment System) processes multiple clearing transactions among the U.S. banks, and Fedwire finalizes the settlements. Smaller banks choose to make payments through local systems. Transactions with securities are settled via DTCC (Depository Trust and Clearing Corp.) and FICC (Fixed Income Clearing Corp.). To become less dependent on federal funds, the U.S. banks started to raise resources from the Eurodollar market and perform REPO transactions. Such operations had a tremendous effect. They intensified the effect of the federal funds rate on short-term interest rates, which are formed in other markets and the markets of Eurodollars and REPO in particular. Those markets started arbitrage trading.

As netting mechanisms evolve, the U.S. banking system needs much less federal funds, and banks attract fewer overnight loans for their payment purposes. However, as the amount of reserve funds decreased, FFR became more volatile. Insufficient funds for payments cause the volatility of this rate in certain periods of time.

As netting practices expand, federal funds will become less important for the monetary policy of the Federal Reserve System. Hence, it is noteworthy that some countries (Australia and Canada in particular) adopted legislative remedies for using solely central banks' money in order to finally settle payments in the banking system. As per laws of the countries, it is money of central banks that ensures the final settlement among commercial banks [23].

The monetary mechanism and its evolution dictated the way interest rates are formed in line with the special role of such elements of the money supply as bank deposits and reserves (balances of correspondent accounts). In the contemporary economy corporate and household lending is based on endogenous (internal) money generated by commercial banks. In this type of lending, interest rates depend on the demand for credit resources and banks' lending capabilities in accordance with principles of prudential supervision and credit risks of specific classes of borrowers. To transfer customers' funds, including those ones from a lending transaction, in the payment system of the central bank, commercial banks use exogenous (external) money generated by monetary authorities in ensuring the banking sector's liquidity. So, it is money that commercial banks hold at the central bank. The interest rate on respective loans is set by central banks.

Therefore, commercial banks grant loans to customers at the interest rate on endogenous money created by commercial banks. The interest rate which the central bank maintains within the corridor is the rate on exogenous money created by central banks. As I have already mentioned, this interest rate virtually constitutes the tariff for remitting money from one bank to the other.

The interest rate which central banks target at has no direct impact on the amount of loans commercial banks provide to the real economy and households. However, it determines whether commercial banks are capable of making timely remittances via the payment system upon customers' requests.

The rate on reserves can influence the situation in the financial market, being a kind of an anchor since the interest rate policy of central banks fails to

stipulate any quantitative benchmarks. For instance, this rate has an impact on yields on government bonds.

It is important to note, for purposes of maintaining the interest rate within the given corridor, deposit accounts of commercial banks at the central bank hold money that ensures the remittance from one bank to the other one during payments. That is why lending activity cannot be stimulated by imposing the negative interest rate on respective deposits.

The interest rate policy of central banks has become less influential in forming interest rates on bank loans issued to companies and households for the recent decades after the said changes in the monetary mechanism. The interest policy of monetary authorities became less effective. The problem is that the interest rate on reserves as set by central banks can exert a certain pressure on lending activities of commercial banks, which currently depend on the capital-to-asset ratio. It restricted the impact central banks could have on the aggregate demand and price dynamics. Thus, regulating the interest rate on reserves (the key rate in Russia), which is very common in the contemporary economy, cannot be considered as an effective tool of inflation targeting.

The low interest rate is often called *the liquidity trap*. The term originates in the Keynesian theory of the demand for money to describe distinguishing features of the situation that arises at the cyclical depression phase, i.e. when the aggregate demand and deflationary trends fall. However, this situation does not last for a long time. In the contemporary economy too low interest rates can have other roots. These are changes in the monetary mechanism after central banks introduce their payment systems and the Basel capital adequacy ratio is introduced, which actually blazed the money supply.

Hence, as a result of the monetary mechanism evolution, the short-term interest rate, which central

banks target at, has a limited effect on lending activities of commercial banks. This is due to the fact that commercial banks utilize reserves subject to the said interest rate to remit money within the closed payment system of the central bank upon customers' requests (borrowers), rather than to provide loan to companies and households.

Considering the existing monetary mechanism, the short-term interest rate on monetary liquidity, which circulates in the payment system of central banks, will not guarantee the efficiency of the monetary policy aimed to support the economic growth and ensure the relative stability of price indicators.

This is no coincidence resulting from the unconventional monetary policy, interest rates which monetary authorities of developed economies target at approximate zero and the rates on credit institutions' deposits at central banks become negative. They consistently stem from the monetary mechanism transformation, being influenced by the evolution of the governmental regulation and a *response* of market forces to regulatory measures. The monetary mechanism was modified so to emphasize the special role commercial banks' reserves (balances of correspondent accounts) play to finalize interbank settlements in the closed payment system of the central bank (the adoption of the Basel Accord). The changes also concerned lending activities of commercial banks in line with the capital-to-assets ratio.

The changes boosted the money supply in leading economies and made the corporate sector and households have their loans refinanced. Subsequent attempts to optimize the debt burden engendered deflationary trends. Longstanding deleveraging is the only way to overwhelm the trends. Besides, central banks should configure their policies so as to cease regulating interest rates and manage credit aggregates comprehensively.

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References

1. Borio C. Revisiting Three Intellectual Pillars of Monetary Policy Received Wisdom.
URL: <http://www.bis.org/speeches/sp151112.pdf>
2. Rachel L., Smith T. Secular Drivers of the Global Real Interest Rate. *Bank of England Staff Working Paper*, 2015, no. 571. URL: <http://www.centreformacroeconomics.ac.uk/Discussion-Papers/2016/CFMDP2016-05-Paper.pdf>
3. Thwaites G. Why are Real Interest Rates So Low? Secular Stagnation and the Relative Price of Investment Goods. *Bank of England Staff Working Paper*, 2015, no. 564.
URL: <http://www.bankofengland.co.uk/research/Documents/workingpapers/2015/swp564.pdf>
4. McLeay M., Radia A., Thomas R. Money Creation in the Modern Economy. *Bank of England Quarterly Bulletin*, 2014, Q1.
URL: <http://www.bankofengland.co.uk/publications/Documents/quarterlybulletin/2014/qb14q101.pdf>
5. Carpenter S., Demiralp S. Money, Reserves and the Transmission of Monetary Policy: Does the Money Multiplier Exist?
URL: <https://www.federalreserve.gov/pubs/feds/2010/201041/201041pap.pdf>
6. Bindseil U. Monetary Policy Operations and the Financial System. Oxford, Oxford University Press, 2014, 320 p.
7. Bindseil U. The Operational Target of Monetary Policy and the Rise and Fall of the Reserve Position Doctrine. *ECB Working Paper Series*, 2004, no. 372, 44 p.
URL: <https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp372.pdf?45b110aa94d14117d8ed98277c4d55a4>
8. Jakab Z., Kumhof M. Banks are not Intermediaries of Loanable Funds – and Why This Matters.
URL: <http://voxeu.org/article/banks-are-not-loanable-funds-intermediaries-macroeconomic-implications>
9. Werner R. Can Banks Individually Create Money Out of Nothing? – The Theories and the Empirical Evidence. *International Review of Financial Analysis*, 2014, vol. 36, pp. 1–19.
URL: <https://doi.org/10.1016/j.irfa.2014.07.015>
10. Werner R. How do Banks Create Money, and Why Can Other Firms not Do the Same? An Explanation for the Coexistence of Lending and Deposit-taking. *International Review of Financial Analysis*, 2014, vol. 36, pp. 71–77. URL: <https://doi.org/10.1016/j.irfa.2014.10.013>
11. Kashyap A., Stein J. The Impact of Monetary Policy on Bank Balance Sheets. *Carnegie-Rochester Conference Series on Public Policy*, 1995, no. 42, pp. 151–195.
12. Kashyap A., Stein J. What Do a Million Observations on Banks Say about the Transmission of Monetary Policy. *The American Economic Review*, 2000, vol. 90, no. 3, pp. 407–428.
13. Farag M., Harland D., Nixon D. Bank Capital and Liquidity. *Bank of England Quarterly Bulletin*, 2013, vol. 53, iss. 3, pp. 201–215.
14. Bowdler C., Radia A. Unconventional Monetary Policy: The Assessment. *Oxford Review of Economic Policy*, 2012, vol. 28, no. 4, pp. 603–621. URL: <https://doi.org/10.1093/oxrep/grs037>
15. Christiano L., Eichenbaum M., Evans C. Monetary Policy Shocks: What Have We Learned and to What End? *NBER Working Paper*, 1998, no. 6400, 95 p.
16. Bridges J., Thomas R. The Impact of QE on the UK Economy: Some Supportive Monetarist Arithmetic. *Bank of England Working Paper*, 2012, no. 442, 52 p.
URL: <http://www.bankofengland.co.uk/research/Documents/workingpapers/2012/wp442.pdf>

17. Fullwiler S., Wray L. Quantitative Easing and Proposals for Reform of Monetary Policy Operations. *Levy Economic Institute Working Paper*, 2010, no. 645, 35 p. URL: http://www.levyinstitute.org/pubs/wp_645.pdf
18. Mohanty M.S. The Transmission of Unconventional Monetary Policy to the Emerging Markets: An Overview. *BIS Papers*, 2014, no. 78, 24 p. URL: <http://www.bis.org/publ/bppdf/bispap78.htm>
19. Mishra P., Montiel P. How Effective is Monetary Transmission in Low-Income Countries? A Survey of the Empirical Evidence. *IMF Working Paper*, 2012, no. WP/12/143, 47 p. URL: <https://www.imf.org/external/pubs/ft/wp/2012/wp12143.pdf>
20. Fawley B., Neely C. Four Stories of Quantitative Easing. *Federal Reserve Bank of St. Louis Review*, 2013, vol. 95, iss. 1, pp. 51–88.
21. Bernhardsen T., Kloster A. Misunderstood Central Bank Reserves. *Norges Bank Economic Commentaries*, 2012, no. 1. URL: http://www.norges-bank.no/pages/87889/Economic_Commentaries_2012_1.pdf
22. Fowler S. The Monetary Fifth Column: The Eurodollar Threat to Financial Stability and Economic Sovereignty. *Vanderbilt Journal of Transnational Law*, 2014, vol. 47, pp. 825–860.
23. Fullwiler S. Setting Interest Rates in the Modern Money Area. *Journal of Post Keynesian Economics*, 2006, vol. 28, no. 3, pp. 496–525.

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.

Translated Article[†]

DATA MINING TECHNIQUES: MODERN APPROACHES TO APPLICATION IN CREDIT SCORING



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Abstract

Importance This article examines the current state of research in machine learning and data mining, which computational methods get combined with conventional lending models such as scoring, for instance.

Objectives The article aims to classify the modern methods of credit scoring and describe models for comparing the effectiveness of the various methods of credit scoring.

Methods To perform the tasks, we have studied relevant scientific publications on the article subject presented in Google Scholar.

Results The article presents a classification of modern data mining techniques used in credit scoring.

Conclusions and Relevance Credit scoring models using machine learning procedures and hybrid models using combined methods can provide the required level of efficiency in the modern environment.

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Introduction

Credit scoring can be defined as a technology that helps a credit organization decide on the granting of

credit to the applicant in the light of its characteristics, such as age, income, marital status, etc. Such technologies have emerged and been developed along with the emergence of trade and the need for credit. The ideas and methods of scoring, consistent with their modern understanding, were first formulated in the work by D. Durand [1].

[†]For the source article, please refer to: Волкова Е.С., Гисин В.Б., Соловьев В.И. Современные подходы к применению методов интеллектуального анализа данных в задаче кредитного скоринга. *Финансы и кредит*. 2017. Т. 23. Вып. 34. С. 2044–2060. URL: <https://doi.org/10.24891/df.23.34.2044>

Following the adoption of the Basel II and especially, Basel III Accords, it has become possible and necessary to apply internal ranking procedures to assess the basic risk parameters. This makes the role of credit scoring more significant and urges financial institutions to continually improve the quantitative models they use.

The article by D.J. Hand and W.E. Henley gives a fairly complete idea of the works on the classical methods of credit scoring [2]. The articles by V. García, A.I. Marqués, J.S. Sánchez [3] and S. Lessmann, H.-V. Seow, B. Baesens, and L.C. Thomas [4] provide reviews of later publications on the subject. Numerous reviews are devoted to selected technologies of credit scoring and comparative analysis of methods used.

The present review article focuses on the works which apply and describe the methods of credit scoring based on the data mining methodology.

In recent years, there has been a significant increase in the number of publications describing so-called hybrid methods.

Section 1 of the article provides a brief overview of the basic techniques of credit scoring.

Section 2 provides a brief description of common test data sets to compare the effectiveness of credit scoring techniques.

Sections 3 and *4* describe how different models and techniques of credit scoring can be compared.

Section 5 provides an analysis of the software implementation of machine learning algorithms.

1. Basic Machine-Learning Techniques in Credit Scoring

1.1. Linear Regression

Linear regression links the borrower's characteristics represented by the $x \in \mathbb{R}^n$ vector to the target variable $y \in \{-1; 1\}$:

$$y = \beta_0 + \langle \beta, x \rangle + \varepsilon,$$

where ε is a random error with zero mean. When deciding whether to assign y to a class, the $\beta_0 + \langle \beta, x \rangle$ value is interpreted as a conditional mathematical expectation $E(y|x)$. The work by D.J. Hand and M.G. Kelly [5] presents scorecards built

by means of linear regression. Note that in recent years, linear regression has not been used alone, although it is still used as an important tool in mixed models.

1.2. Logistic Regression

Logistic regression is one of the main tools of credit scoring. In publications, logistic regression is typically used to compare with other techniques, for instance, the works by B.W. Yap (et alias) [6], N.G. Pavlidis (et alias) [7], Z. Khemais (et alias) [8], or in combination with other techniques, for instance, the works by F. Louzada (et alias) [9], and Z. Li (et alias) [10].

The logistic regression technique is used in credit scoring to calculate the $P(y=1|x)$ probability of rejection of loan issue to a borrower with x characteristics. This probability can be presented as

$$P(y=1|x) = \frac{1}{1 + e^{-(\alpha + \beta^T x)}}.$$

The maximum-likelihood technique is used to estimate the α and β , coefficients (the coordinates of β vector). For estimation, a learning set is used.

1.3. Discriminant Analysis

Discriminant analysis is one of the most frequently used score techniques, in credit scoring in particular. Discriminant analysis goes back to the work by R.A. Fisher [11]. This was one of the first techniques used to build credit scoring systems. R.A. Eisenbeis' article [12] analyzes problems related to the application of discriminant analysis in credit scoring. Currently, the discriminant analysis continues to be used in credit scoring directly [13]. Discriminant analysis often serves as a benchmark against which other techniques are compared, as is done, for instance, in the article by S. Akkoç [14]. A number of studies are related to improving the accuracy of the discriminant analysis through applying the new procedures [15].

1.4. Decision Trees

This technique originates from the work by L. Breiman (et alias) [16]. W.-Y. Loh's work [17] gives an insight into the state of the art. In the case of credit scoring, decision trees are mainly used for classification [4].

We next briefly describe the techniques involved in building decision trees. Variable X is stated to be an order one if the numerical values it adopts are ordered as significant for the classification. Otherwise, the variable is called categorical.

The algorithm for *Automatic Interaction Detector Analysis* (AID), one of the first algorithms for building classification trees, sequentially breaks data in each node. In the case of an order variable, branching occurs according to the $X \leq c$, type conditions, in the case of a categorical variable, it occurs according to the $X \in A$. Assume that $S(t)$ is a set of data numbers in the learning sample that are related to t node. Let us denote the average (for $S(t)$) value of the interpretable variable Y by \bar{y}_t . The $imp(t) = \sum_{i \in S(t)} (y_i - \bar{y}_t)^2$ value is a measure of the contamination of t node. The AID algorithm chooses such a splitting, which minimizes the amount of contamination indices by direct successor node. The split process ends when the contamination level becomes less than the predetermined threshold.

The *THeta Automatic Interaction Detection* (THAID) algorithms extend the described technique to categorical variables. Here, entropy or the Gini coefficient are used as a contamination measure.

The newer algorithms, like *Classification and Regression Trees* (CART) algorithms replace the stopping rules used in the AID and THAID algorithms by the rules for creating and pruning new branches. *Chi-square Automatic Interaction Detection* (CHAID) and *C4.5* algorithms are used as well.

The article by S.M. Finlay [18] shows the comparative characteristics of the various algorithms of credit scoring, including the CART algorithms. It notes that the CART algorithms are less efficient than the other ones. However, some new ideas and improvements to the modeling of trees make it possible to significantly increase the algorithms' efficiency (See D. Zhang (et alias) [19] and Q. Hu (et alias) [20]).

Knowledge extraction algorithms, e.g. *Rule Extraction*, and *RX* big data-centric algorithms can be attributed to algorithms associated with decision trees (See Y. Hayashi (et alias) [21]).

1.5. Support Vector Machine

Support Vector Machine (SVM) as a model for statistical classification was proposed by Vladimir N. Vapnik [22]. The principle of the technique is as follows.

Assume a given learning set $\{(x^{(j)}, y^{(j)})\}_{j=1,2,\dots,l}$, where $x^{(j)} \in X \subset R^n$ is the attribute description of the object, and $y^{(j)} \in \{-1; 1\}$ is the binary classifier. The equation of $\langle w, x \rangle - w_0 = 0, w \in R^n$ type specifies a hyperplane with w normal vector that separates the classes of "good" $y^{(j)} = 1$ and "bad" $y^{(j)} = -1$ objects in R^n space.

The best separating hyperplane is defined as an optimization solution:

$$\|w\| \rightarrow \min;$$

$$y^{(j)}(\langle w, x^{(j)} \rangle - w_0) \geq 1, j = 1, 2, \dots, l.$$

If there is a separating hyperplane, the $\frac{2}{\|w\|}$ value is the width of the band between points of different classes. The problem of finding the best separating hyperplane can be solved by using the Karush-Kuhn-Tucker (KKT) Conditions. Assume that

$$L(w, w_0, \lambda) = \frac{1}{2} \langle w, w \rangle -$$

$$- \sum_{j=1}^l \lambda_j (y^{(j)} (\langle w, x^{(j)} \rangle - w_0) - 1)$$

is the corresponding Lagrange function.

Learning sample object $x^{(j)}$ is called a support vector if $\lambda_j > 0$ and $\langle w, x^{(j)} \rangle - w_0 = y^{(j)}$. Vector w is a linear combination of support vectors:

$$w = \sum_j \lambda_j y^{(j)} x^{(j)}.$$

Therefore, a relatively small number of learning sample objects are used to actually build the w vector. This sparseness property distinguishes the SVM technique from the classical linear separators of the Fischer's linear discriminant type.

If there is no separating hyperplane (the learning sample cannot be linearly separated), the optimization problem gets adjusted: the amount

of error penalties gets added to the objective function.

Switching to a non-linear separator using a kernel is possible as well. The kernel is the $K(x, x'), x, x' \in X$ function such that $K(x, x') = \langle \varphi(x), \varphi(x') \rangle$ is for some $\varphi: X \rightarrow R^m$ mapping. If the φ mapping is used, linear separator can be built in the R^m space [23].

The quadratic optimization problem through the SVM technique can be formulated in a dual form: we find

$$\max_{\lambda} \left(\sum_j \lambda_j + \frac{1}{2} \sum_{i,j} \lambda_i \lambda_j y^{(i)} y^{(j)} K(x^{(i)}, x^{(j)}) \right)$$

under the preceding conditions $0 \leq \lambda_j \leq C_j$ for all j and $\sum_j \lambda_j y_j = 0$.

The C_j parameters control the relative value of the indicators. The most common kernel functions are as follows:

$$K(x^{(i)}, x^{(j)}) = \langle x^{(i)}, x^{(j)} \rangle \quad \text{– a linear model;}$$

$K(x^{(i)}, x^{(j)}) = (\langle x^{(i)}, x^{(j)} \rangle + 1)^d$ – a polynomial degree d model;

$$K(x^{(i)}, x^{(j)}) = \exp\left(-\frac{\|x^{(i)} - x^{(j)}\|}{2\sigma^2}\right) \quad \text{– the Gaussian}$$

radial base function (RBF) with the σ parameter.

For a new object, the prediction is based on a formula $y = \text{sgn}\left(\sum_j \lambda_j y^{(j)} K(x^{(i)}, x) + b_j\right)$, where $b_j = \sum_j \lambda_j y^{(j)} K(x^{(i)}, x^{(j)})$.

The work by W. Chen (et alias) [24] is one of the first to use the SVM technique to solve the problem of credit scoring. For credit scoring, Y. Ling (et alias) [25] used the SVM system in respect to the class of kernels.

1.6. Bayesian Network

The work by N. Friedman (et alias) [26] was probably the starting point for the use of *Bayesian networks* (BN) in credit scoring. This work extends the so-called simple (naïve) Bayesian technique, according to which the decision with the highest *a posteriori*

information is chosen. The naïve Bayesian technique is used when a particular feature is independent.

As the authors point out, in credit scoring, this assumption is unrealistic: for instance, the correlation of parameters such as age, education, and income cannot be ignored. The authors have developed the ideas of J. Pearl [27].

In general terms, the Bayesian network is a *directed acyclic graph* (DAG). The training generates a conditional distribution of the probability of $P(Y|X_1, \dots, X_k)$, where Y is the vertex, and X_1, \dots, X_k is the *parents* on graph.

The Bayesian network defines the joint vertex distribution. For instance, the naïve Bayesian technique is obtained by taking a categorical variable as the root vertex and all attributes as its *children*.

Informal learning of the Bayesian network consists of maximizing its adaptation to the learning set. Optimization is performed relative to scoring function. Bayesian scoring function and the function based on the *minimum description length principle* (MDL) are the most used ones. These functions asymptotically lead to the same learning outcome, but the MDL function has proved to be better in the finite sets.

Assume that $B = (G, \Theta)$ is a Bayesian network (G is a graph, Θ is the appropriate probability distribution) and $D = \{u_1, \dots, u_n\}$ is a learning set (each u_i assigns values to all the vertices of the graph). In this case

$$MDL(B|D) = \frac{\log N}{2} |B| - LL(B|D), \quad \text{where } |B|$$

is the number of network settings and

$$LL(B|D) = \sum_{i=1}^N \log(P_B(u_i))$$

measures the amount of information required to describe D based on the P_B probability distribution.

The MDL scoring function is asymptotically correct.

We shall indicate several works in which the Bayesian networks were used for credit scoring: P. Giudici [28], J. Gemela [29], A.C. Antonakis (et alias) [30, 31], W.-W. Wu [32], and H. Zhu (et alias) [33].

1.7. (Artificial) Neural Network

(Artificial) neural networks (ANNs) convert a set of input variables into a set of output variables and model both linear and non-linear transformations. Transformations are carried out using neurons, which are a simplified model of animal/human brain neurons. Neurons are connected to the network by one-way channels of communication. Each neuron can be activated by incoming input signals and output signals will be issued in the active state. The neural network has a layer of input neurons, which are the neurons that receive input variables, and a layer of output neurons, the output signals of which form output variables and the hidden layers. Neural networks differ in structure, number of hidden layers, and activation function.

The work by D. West [34] analyzes the five models of neural network used in the credit scoring:

- Multilayer Perceptron (MLP);
- Mixture of Experts (MOE);
- Network of Radial Basis Function (RBF);
- Learning Vector Quantization (LVQ);
- Fuzzy Adaptive Resonance Theory (Fuzzy ART).

The efficiency of the neural networks of the listed types in credit scoring has been compared with the efficient use of classical parametric techniques (linear discriminant analysis and logistic regression), non-parametric methods (k -nearest neighbors algorithm (k -NN) and kernel density estimation (KDE), and the classification tree method (CTM).

The results obtained confirm that multilayer perceptrons show far less than the highest accuracy, the networks of mixture of experts and the network of radial basis function show satisfactory results in credit scoring. Logistic regression is the most accurate technique of the classical ones. Networks based on the fuzzy adaptive resonance theory fall within the least accurate. Being as efficient as the other nets to identify a bad borrower, the Fuzzy ART-based networks are essentially less efficient at recognizing a good borrower.

1.8. Genetic Algorithm

The specific application of *genetic algorithms* (GA) in credit scoring is that the population is formed by classification trees. Mutation and crossover algorithms are applied to trees. In other respects, the algorithm structure is standard. Once the initial population is created, the mutation and crossover processes get iterated and then evaluated. The relative number of classification errors is taken as an estimate. The work by C.-S. Ong (et alia) [35] shows that the results of genetic algorithms (with 1,000 generations) are among the best in the test suites.

1.9. Ensemble Methods

Hybrid and ensemble methods are those which use different techniques of credit scoring to improve efficiency. *Bootstrap Aggregating*, also called *Bagging*, *Boosting*, and *Stacking* are the most common three machine learning ensemble meta-algorithms.

Bagging (stands for **B**ootstrap **A**ggregating) was proposed and introduced by Leo Breiman [36]. The basic idea of this technique is to build a series of predictors, which, in aggregate (after a certain aggregation), produce a better predictor with improved predictive force.

Schematically, in the case of credit scoring, the bagging approach can be outlined like the following. Assume that there is a training algorithm that, by the learning set L , builds the predictor $\varphi(x, L)$, which gives y upon given x . Based on the learning set L , one can build a set of learning sets $\{L_k\}_{k=1,\dots,K}$ (usually, the same amount as L). These sets consist of the same objects selected randomly from L (possibly, with repetitions). Let K_+ is equal to the number of those k for which $\varphi(x, L_k)$ gives an affirmative answer. The aggregated predictor produces an affirmative answer if

$$K_+ > \frac{1}{2}.$$

Bagging is particularly effective where the basic training algorithm is instable, viz, strongly dependent on small changes in the learning set.

The basic idea of **Boosting** is to build a strong classification algorithm based on the weak (in terms of accuracy) algorithm. In the process of forming

a strong algorithm, the weak algorithm “improves itself” through a redistribution of sample weights from the training sample: in the case of correct recognition, the weight decreases. If recognition is wrong, the weight increases. The boosting approach can be illustrated with the following example.

Assume that X , the space $\{(x^{(j)}, y^{(j)})\}_{j=1,2,\dots,l}$ – is a training sample. The basic algorithm runs in a series of rounds $t = 1, \dots, T$. Let us denote the weight assigned to the object in round t by $D_t(j)$ (initial distribution of the weights $D_0(j)$ can be uniform). The learning task is to find in round t such a $h_t(x)$ mapping with values in $\{-1;1\}$ that minimizes the error probability $\varepsilon_t = \sum_{h_t(x^{(j)}) \neq y^{(j)}} D_t(j)$.

The weights are updated as follows: assume that

$$\alpha_t = \frac{1}{2} \ln \left(\frac{1 - \varepsilon_t}{\varepsilon_t} \right).$$

Then $D_{t+1}(j) = \frac{D_t(j) \exp(-\alpha_t y^j h_t(x^{(j)}))}{Z_t}$, where

Z_t is the normalizing factor (so that $D_{t+1}(j)$ is a distribution). The final recognition algorithm is

$$H(x) = \text{sign} \left(\sum_{t=1}^T \alpha_t h_t(x) \right).$$

This technique of boosting, based on the exponential loss function, is called *AdaBoost*. It provides an advantage for the algorithm to get improved when the noise use cases are abundant. To minimize this effect, the logistic loss function can be used (this algorithm is called *LogitBoost*).

Stacking (sometimes called *Stacked Generalization*) is a technique which combines several learning algorithms by means of a combiner. A single-layer logistic regression model is often used as the combiner. The theoretical principles of stacking were provided in the work by D.H. Wolpert [37].

The ensemble methods are extensively applied in the credit scoring. The works by S. Akkoç [14], S. Vukovic (et alias) [38], A.I. Marqués (et alias) [39] are illustrative of that.

1.10. Fuzzy Logic Techniques

There are quite a few publications on the application of fuzzy logic techniques in credit scoring. We shall

mention some of them: F. Hoffmann (et alias) [40], J. Ignatius (et alias) [41], A. Lahsasna (et alias) [42], A. Kaur (et alias) [43], R. Malhotra, D. Malhotra [44].

However, given the enormous number of publications on credit scoring, the quantity of the above-mentioned publications is relatively small. The works using fuzzy logic for credit scoring can be roughly divided into two groups.

The first group includes the studies applying fuzzy logic within traditional techniques. Typically, these works are related to neural networks and SVM.

The second group includes the studies applying the technique derived from fuzzy set theory. Primarily, these are the works based on fuzzy logic systems, in particular the Mamdani and Takagi-Sugeno-Kang (TSK) type models.

The second part of the review deals with a detailed analysis of the fuzzy logic application in credit scoring.

2. Test Data Sets

The *German Credit* and *Australian Credit Approval* Data Sets are commonly used by developers of credit scoring algorithms.

The Australian Credit Approval Data Set contains a combined total of 690 borrowers (instances), 307 of which are solvent (paying towards a loan) and 383 are insolvent. The description of each particular borrower includes 14 attributes: six continuous and eight categorical ones.

The German Credit Data Set contains 1,000 records of borrowers (instances), 700 of which are solvent and 300 are insolvent. The description of each particular borrower contains 20 attributes.

Both the data sets are publicly available at UCI Repository of Machine Learning¹.

3. General Credit Scoring Model Concept and the Comparison of Credit Scoring Models

Let us agree to call the outcome *good* if $y = 0$ and *bad*, if $y = 1$. In the classical setting, the prediction

¹ Statlog (Australian Credit Approval) Data Set.

URL: [http://archive.ics.uci.edu/ml/datasets/Statlog+\(Australian+Credit+Approval\)](http://archive.ics.uci.edu/ml/datasets/Statlog+(Australian+Credit+Approval)); Statlog (German Credit Data) Data Set.
URL: [http://archive.ics.uci.edu/ml/datasets/Statlog+\(German+Credit+Data\)](http://archive.ics.uci.edu/ml/datasets/Statlog+(German+Credit+Data))

task is to define $E[Y|x]=E[y=1|x]$. by the set of objects under observation (x, y) . If the conditional probabilities were known, it would not be difficult to make optimal decisions on credit granting. Attribute space is usually too large to allow for empirical evaluation of the probabilities $P(Bad|x)$. The standard approach is to build a scoring function $s(x)$. The posterior probability $P(Bad|s)=P(Bad|s(x)=s)$ is used to build predictions, replacing $P(Bad|x)$.

Assume that A is a credit scoring model. The scoring function $s_A(x)$ value can be considered as realization of a random value s_A . Let us denote the probability density of the s_A conditional prediction upon given y by $f(s_A|y)$, and denote the probability that the scoring function value will be equal to s_A by $v(s_A)$.

The basic principles of comparing credit scoring models are found in the works by R.T. Clemen (et alias) [45], M. DeGroot (et alias) [46, 47], and H. Zhu (et alias) [33].

Assume that A and B are scoring models. It is stated that the A model is sufficient for the B model if there is an h function with the following properties:

- 1) $h(s_B|s_A) \geq 0$ for any s_A, s_B ;
- 2) $\sum_{s_B} h(s_B, s_A) = 1$ at any s_A ;
- 3) $\sum_{s_A} h(s_B|s_A) f_A(s_A|y) = f_B(s_B|y)$ for any s_B and y .

If A is sufficient for B , then B can be considered more undefined, since the h function gives additional randomness to the s_B values.

It is stated that the B model is not related to the A model, if y is independent of the s_B upon given s_A , that is $P(y|s_A, s_B) = P(y|s_A)$.

For the assumed A and B scoring models, we define a combined scoring model C , assuming that $s_C = P(Good|s_A, s_B)$. The combined model is sufficient for the A and B models. The model is sufficient for the C model when and only when the B model and A model are unrelated.

Now, let us briefly run through the scoring model in terms of utility value.

Suppose that credit granting to a good borrower yields an income of 1, and in the case of a bad borrower, it amounts to $-\alpha \leq 0$ (loss). Assume that $\pi(s) = P(Good|s)$. When a loan is granted to the borrower with s scoring, the expected income R is:

$$E[R|s] = \pi(s) - \alpha(1 - \pi(s)).$$

We also assume that the credit denial yields an income of 0 regardless of the type of borrower. The decision to grant a loan is made if $E[R|s] \geq 0$. Since the $\pi(s)$ function increases monotonically, there is a value of s^* , that $E[R|s^*] = 0$. If the scoring function value is greater than s^* , the loan granting is approved, if not, the borrower's credit application is rejected. Thus,

$$E[R] = \sum_{s \geq s^*} E[R|s] v(s).$$

Since s^* depends on α , the mathematical expectation value of $E[R]$ income also depends on α . This value can be used to compare credit scoring models: scoring model A is sufficient for scoring model B when and only when $E_A[R] \geq E_B[R]$ is for all α .

4. Evaluating the Quality of Credit Scoring Algorithms

One of the ways to determine the quality of a machine learning model is to split the sample into a *training dataset*, which is used to identify algorithm parameters, and a *validation dataset* for each object of which the algorithm-predicted and true classes are compared.

The most common techniques of credit scoring algorithm evaluation are based on the confusion matrix: all sample objects are divided into four categories, depending on the combination of the true y response and the $\alpha(x)$ response supplied by the algorithm:

	$\alpha(x)=1$	$\alpha(x)=0$
$y=1$	<i>TP</i>	<i>FN</i>
$y=0$	<i>FP</i>	<i>TN</i>

(*TP* is the abbreviation for *True Positive*, *FN* is the abbreviation for *False Negative*, and similarly in the two remaining cases).

Since the purpose of applying classification algorithms in credit scoring is to sort the scoring objects into *good* and *bad*, the algorithms efficiency is evaluated through matching of the algorithm-predicted class and true class of the object for each particular one from the validation dataset.

The credit scoring task has two features.

First, the classification of bad credit as a good one is more costly than the classification of good credit as a bad one.

Second, there are always more good customers than bad ones in a learning sample.

Due to the first feature, the following algorithm quality measures are used in the credit scoring task:

$Accuracy = \frac{TP+TN}{TP+TN+FP+FN}$ is the proportion of loans classified correctly;

$Precision = \frac{TP}{TP+FP}$ is the proportion of bad loans classified correctly among all observations and classified by the algorithm as bad loan;

$Recall = \frac{TP}{TP+FN}$ is the completeness, i.e. assessment of the ability of the algorithm to recognize bad loans;

$Negative Predictive Value = \frac{TN}{TN+FN}$ is the proportion of good loans classified correctly among all observations and classified by the algorithm as good loan;

$Specificity = \frac{TN}{TN+FP}$ is the assessment of the ability of the algorithm to recognize good loans;

$F1 Score = \frac{2(Precision \cdot Recall)}{Precision+Recall}$ is the harmonic mean of precision and recall;

$False Negative Rate = \frac{FN}{TP+FN}$ is the proportion of bad loans incorrectly classified as good loan;

$False Positive Rate = \frac{FP}{TN+FP}$ is the proportion of good loans incorrectly classified as bad loan.

A *Receiver Operating Characteristic Curve* (ROC curve) is a graphical plot that illustrates the change in the ratio of *Recall* correctly classified bad loans in their total number to the *False Positive Rate* of good loans incorrectly classified as bad loan, as the decision rule threshold is varied.

The ROC curve is obtained as follows:

Assume that the result of the $\alpha(x)$ algorithm depends on some parameter, for example, the threshold value, and the algorithm is as follows $\alpha(x) = Entier [s(x) > s^*]$.

If $s^* = \infty$ we get $SEN = 0$ and $FPR = 0$, if $s^* = -\infty$ $-SEN = 1$ and $FPR = 1$. When s^* changes from $-\infty$ to ∞ , the point (FPR, SEN) describes a curve called the ROC curve. The *Area Under the ROC Curve* (AUC) serves as a quality characteristic of the algorithm.

The equality of $AUC = 0.5$ means that the algorithm categorizes objects at random. The more AUC value, the better the algorithm. Another most commonly used measure is called the *Gini coefficient* (sometimes expressed as a *Gini ratio* or a normalized *Gini index*) that can be thought of as the ratio of the area that lies between the diagonal line and the curve: $Gini = 2 AUC - 1$.

An important problem in building scoring models is the fact that the proportion of bad loans in the sample is significantly lower than the proportion of good loans (typically, between 2 and 30 percent). In this situation, a model that offers to recognize all customers as the good ones can provide a minor error in the training and test samples.

Possible solutions to this problem are the introduction of different cost of Type I and Type II errors or the modification of the training sample to change the representativeness of the sample.

There are two main techniques used to change the representativeness of sample: *Oversampling* and *Undersampling*.

The limitation of the first technique is that a simple use case duplication may not affect some training methods in any way but may lead to the overfitting of others. If removing the instances that belong to a majority class, some information important for

the classification may be lost, which is also not desirable.

Synthetic Minority Oversampling Technique (SMOTE) is the most frequently used statistical technique for increasing the number of cases in the dataset in a balanced way:

- The difference $d = x_b - x_a$ between the x_a, x_b vectors of features of nearest neighbors a, b of minority class is calculated;
- A vector of features for the new instance is generated $x_{\bar{a}} = x_a + cd$, where $c \sim N(0,1)$.

There are different variations of the SMOTE technique, where the nearest neighbors from both the minority and majority classes are used to generate minority class cases, and the generated instances are closer to or away from the margin of class separation.

In practice, however, the SMOTE technique very often results in the overfitting of models. It is also a computationally expensive and time-consuming approach. Moreover, the problem of unbalanced classes in scoring samples is usually a separate challenge.

5. Software Implementation of Machine Learning Algorithms in Credit Scoring

The software that is used to automate the data mining and machine learning task handling can be divided into three classes:

- Commercial statistical package;
- Open-source framework;
- Cloud solution.

Generally, commercial software has been used in banks to address data analysis, particularly related to scoring. SAS software suite has been most frequently used, IBM SPSS Statistics and Statistica software packages have been used less frequently.

These three software product lines provide similar features. These capabilities include analytical data preparation tools, ready and custom machine learning algorithm templates, including linear and logistic regression models, decision trees and forests, gradient boosting, support vectors, neural networks, etc. In addition, these packages can set up

model parameters and use interactive quality assessment techniques.

In recent years, the banks, while not completely refusing to use the commercial SAS-type packages, have also used the free and open-source Python/R/Spark software framework.

The advantage of these software frameworks is that one can use many more algorithms than commercial software packages offer.

But if, for example public health and industry institutions and organizations have largely stopped using commercial software packages in favor of open-source libraries, the banks still use SAS-type packages more frequently than Python and R software.

The *open-source R programming language* was created as a special tool for statistical computing. It became the first open-source software environment to be used extensively for data analysis.

The most commonly used libraries for machine learning in R are as follows:

- **rpart** and **CARET** (classification and regression algorithms);
- **randomForest** (random forest algorithm);
- **nnet** (neural networks);
- **e1071** (one of the first machine learning libraries in R that contains the implementation of the support vector machine, naive Bayes classifier, and a number of other techniques);
- **kernlab** (support vector machine);
- **gbm** (gradient boosting);
- **ROCR** (visualization of the performance of scoring classifiers).

The *Python programming language* has become the most popular tool for analyzing data after a perfectly documented **scikit-learn** library was released that implements a large number of machine-based learning algorithms. In addition to the scikit-learn library, the **TensorFlow** and **Theano** open-source software libraries are also popular (these libraries also implement different data analysis techniques but outnumber scikit-learn only in techniques implemented with neural networks).

The **Pyinference** library is used for Bayesian and fuzzy reasoning in Python. The main advantage of Python over R is the faster script execution speed.

Apache Spark, an open-source cluster-computing scalable framework oriented to compute in RAM is an alternative solution for analyzing data when Python performance is not enough. The **MLib** Apache Spark's scalable machine learning library is still substantially inferior to the scikit-learn library by the number of algorithms, but is actively developing.

Cloud-based machine learning platforms have emerged in recent years.

The main advantage of these systems is flexible scalability, viz the allocation and release of computing resources occurs instantaneously according to the tasks to be performed.

The *Amazon Machine Learning* service implements only the basic algorithms for binary and multi-class classifications, as well as regression.

The *Google Cloud Machine Learning Engine* service provides the ability to run TensorFlow models in a cloud environment.

The *Microsoft Azure Machine Learning Studio* environment provides a powerful tool to build machine learning models through a simple graphical interface using a variety of standard classification, regression, cluster analysis, and anomaly detection algorithms, and embed native code in these models in SQL, Python, and R.

A similar solution, the *Watson Machine Learning* service is expected from IBM in the near future.

However, despite the benefits of the cloud-based data mining tools, they are not virtually used in banks because of security concerns about the transfer of confidential customer data to cloud storage.

References

1. Durand D. Risk Elements in Consumer Installment Financing. New York, National Bureau of Economic Research Books, 1941, 163 p.
2. Hand D.J., Henley W.E. Statistical Classification Methods in Consumer Credit Scoring: A Review. *Journal of the Royal Statistical Society: Series A (Statistics in Society)*, 1997, vol. 160, iss. 3, pp. 523–541. URL: <https://doi.org/10.1111/j.1467-985X.1997.00078.x>
3. García V., Marqués A.I., Sánchez J.S. An Insight into the Experimental Design for Credit Risk and Corporate Bankruptcy Prediction Systems. *Journal of Intelligent Information Systems*, 2015, vol. 44, iss. 1, pp. 159–189. URL: <https://doi.org/10.1007/s10844-014-0333-4>
4. Lessmann S., Seow H.-V., Baesens B., Thomas L.C. Benchmarking State-of-the-Art Classification Algorithms for Credit Scoring: An Update of Research. *European Journal of Operational Research*, 2015, vol. 247, iss. 1, pp. 124–136. URL: <https://doi.org/10.1016/j.ejor.2015.05.030>
5. Hand D.J., Kelly M.G. Superscorecards. *IMA Journal of Management Mathematics*, 2002, vol. 13, iss. 4, pp. 273–281.
6. Yap B.W., Ong S.H., Husain N.H.M. Using Data Mining to Improve Assessment of Credit Worthiness via Credit Scoring Models. *Expert Systems with Applications*, 2011, vol. 38, iss. 10, pp. 13274–13283. URL: <https://doi.org/10.1016/j.eswa.2011.04.147>
7. Pavlidis N.G., Tasoulis D.K., Adams N.M., Hand D.J. Adaptive Consumer Credit Classification. *Journal of the Operational Research Society*, 2012, vol. 63, iss. 12, pp. 1645–1654. URL: <https://doi.org/10.1057/jors.2012.15>
8. Khemais Z., Nesrine D., Mohamed M. Credit Scoring and Default Risk Prediction: A Comparative Study between Discriminant Analysis & Logistic Regression. *International Journal of Economics and Finance*, 2016, vol. 8, iss. 4, pp. 39–53. URL: <http://dx.doi.org/10.5539/ijef.v8n4p39>

9. Louzada F., Anacleto-Junior O., Candolo C., Mazucheli J. Poly-bagging Predictors for Classification Modelling for Credit Scoring. *Expert Systems with Applications*, 2011, vol. 38, iss. 10, pp. 12717–12720. URL: <https://doi.org/10.1016/j.eswa.2011.04.059>
10. Li Z., Tianb Y., Li K. et al. Reject Inference in Credit Scoring Using Semi-supervised Support Vector Machines. *Expert Systems with Applications*, 2017, vol. 74, pp. 105–114. URL: <https://doi.org/10.1016/j.eswa.2017.01.011>
11. Fisher R.A. The Use of Multiple Measurements in Taxonomic Problems. *Annals of Eugenics*, 1936, vol. 7, iss. 2, pp. 179–188. URL: <https://doi.org/10.1111/j.1469-1809.1936.tb02137.x>
12. Eisenbeis R.A. Problems in Applying Discriminant Analysis in Credit Scoring Models. *Journal of Banking & Finance*, 1978, vol. 2, iss. 3, pp. 205–219. URL: [https://doi.org/10.1016/0378-4266\(78\)90012-2](https://doi.org/10.1016/0378-4266(78)90012-2)
13. Mylonakis J., Diacogiannis G. Evaluating the Likelihood of Using Linear Discriminant Analysis as a Commercial Bank Card Owners Credit Scoring Model. *International Business Research*, 2010, vol. 3, no. 2, pp. 9–20. URL: <https://doi.org/10.5539/ibr.v3n2p9>
14. Akkoç S. An Empirical Comparison of Conventional Techniques, Neural Networks and the Three Stage Hybrid Adaptive Neuro Fuzzy Inference System (ANFIS) Model for Credit Scoring Analysis: The Case of Turkish Credit Card Data. *European Journal of Operational Research*, 2012, vol. 222, iss. 1, pp. 168–178. URL: <https://doi.org/10.1016/j.ejor.2012.04.009>
15. Falangis K., Glen J.J. Heuristics for Feature Selection in Mathematical Programming Discriminant Analysis Models. *Journal of the Operational Research Society*, 2010, vol. 61, no. 5, pp. 804–812. URL: <https://doi.org/10.1057/jors.2009.24>
16. Breiman L., Friedman J., Stone C.J., Olshen R.A. Classification and Regression Trees. Monterey, CA, Wadsworth & Brooks/Cole Advanced Books & Software, 1984, 368 p.
17. Loh W.-Y. Fifty Years of Classification and Regression Trees. *International Statistical Review*, 2014, vol. 82, iss. 3, pp. 329–348. URL: <https://doi.org/10.1111/insr.12016>
18. Finlay S. Multiple Classifier Architectures and Their Application to Credit Risk Assessment. *European Journal of Operational Research*, 2011, vol. 210, iss. 2, pp. 368–378. URL: <http://dx.doi.org/10.1016/j.ejor.2010.09.029>
19. Zhang D., Zhou X., Leung S.C.H., Zheng J. Vertical Bagging Decision Trees Model for Credit Scoring. *Expert Systems with Applications*, 2010, vol. 37, iss. 12, pp. 7838–7843. URL: <https://doi.org/10.1016/j.eswa.2010.04.054>
20. Hu Q., Che X., Zhang L. et al. Rank Entropy-Based Decision Trees for Monotonic Classification. *IEEE Transactions on Knowledge and Data Engineering*, 2012, vol. 24, iss. 11, pp. 2052–2064. URL: <https://doi.org/10.1109/TKDE.2011.149>
21. Hayashi Y., Tanaka Y., Takagi T. et al. Recursive-Rule Extraction Algorithm with J48graft and Applications to Generating Credit Scores. *Journal of Artificial Intelligence and Soft Computing Research*, 2016, vol. 6, iss. 1, pp. 35–44. URL: <https://doi.org/10.1515/jaiscr-2016-0004>
22. Vapnik V.N. Statistical Learning Theory. New York, John Wiley, 1998, 768 p.
23. Bellotti T., Crook J. Support Vector Machines for Credit Scoring and Discovery of Significant Features. *Expert Systems with Applications*, 2009, vol. 36, iss. 2-2, pp. 3302–3308. URL: <https://doi.org/10.1016/j.eswa.2008.01.005>

24. Chen W., Ma C., Ma L. Mining the Customer Credit Using Hybrid Support Vector Machine Technique. *Expert Systems with Applications*, 2009, vol. 36, iss. 4, pp. 7611–7616. URL: <https://doi.org/10.1016/j.eswa.2008.09.054>
25. Ling Y., Cao Q., Zhang H. Credit Scoring Using Multi-Kernel Support Vector Machine and Chaos Particle Swarm Optimization. *International Journal of Computational Intelligence and Applications*, 2012, vol. 11, iss. 3, pp. 12500198:1–12500198:13.
26. Friedman N., Geiger D., Goldszmidt M. Bayesian Network Classifiers. *Machine Learning*, 1997, vol. 29, iss. 2-3, pp. 131–163. URL: <https://doi.org/10.1023/A:1007465528199>
27. Pearl J. Probabilistic Reasoning in Intelligent Systems: Networks of Plausible Inference. Morgan Kaufmann, 1988, 552 p.
28. Giudici P. Bayesian Data Mining, with Application to Benchmarking and Credit Scoring. *Applied Stochastic Models in Business and Industry*, 2001, vol. 17, iss. 1, pp. 69–81. URL: <https://doi.org/10.1002/asmb.425>
29. Gemela J. Financial Analysis Using Bayesian Networks. *Applied Stochastic Models in Business and Industry*, 2001, vol. 17, iss. 1, pp. 57–67. URL: <https://doi.org/10.1002/asmb.422>
30. Antonakis A.C., Sfakianakis M.E. Naïve Bayes as a Means of Constructing Application Scorecards. In: L. Moutinho and K.-H. Huarng (eds), *Advances in Doctoral Research in Management*. Singapore, World Scientific Publishing Co. Pte. Ltd, 2008, vol. 2, pp. 47–62.
31. Antonakis A.C., Sfakianakis M.E. Assessing Naïve Bayes as a Method for Screening Credit Applicants. *Journal of Applied Statistics*, 2009, vol. 36, iss. 5-6, pp. 537–545. URL: <https://doi.org/10.1080/02664760802554263>
32. Wu W.-W. Improving Classification Accuracy and Causal Knowledge for Better Credit Decisions. *International Journal of Neural Systems*, 2011, vol. 21, iss. 4, pp. 297–309. URL: <https://doi.org/10.1142/S0129065711002845>
33. Zhu H., Beling P.A., Overstreet G.A. A Bayesian Framework for the Combination of Classifier Outputs. *Journal of the Operational Research Society*, 2002, vol. 53, iss. 7, pp. 719–727. URL: <https://doi.org/10.1057/palgrave.jors.2601262>
34. West D. Neural Network Credit Scoring Models. *Computers & Operations Research*, 2000, vol. 27, iss. 11-12, pp. 1131–1152. URL: [https://doi.org/10.1016/S0305-0548\(99\)00149-5](https://doi.org/10.1016/S0305-0548(99)00149-5)
35. Ong C.-S., Huang J.-J., Tzeng G.-H. Building Credit Scoring Models Using Genetic Programming. *Expert Systems with Applications*, 2005, vol. 29, iss. 1, pp. 41–47. URL: <https://doi.org/10.1016/j.eswa.2005.01.003>
36. Breiman L. Bagging Predictors. *Machine Learning*, 1996, vol. 24, iss. 2, pp. 123–140. URL: <https://doi.org/10.1007/BF00058655>
37. Wolpert D.H. Stacked Generalization. *Neural Networks*, 1992, vol. 5, no. 2, pp. 241–259.
38. Vukovic S., Delibašić B., Uzelac A., Suknovic M. A Case-Based Reasoning Model That Uses Preference Theory Functions for Credit Scoring. *Expert Systems with Applications*, 2012, vol. 39, iss. 9, pp. 8389–8395. URL: <https://doi.org/10.1016/j.eswa.2012.01.181>
39. Marqués A.I., García V., Sánchez J.S. Two-Level Classifier Ensembles for Credit Risk Assessment. *Expert Systems with Applications*, 2012, vol. 39, iss. 12, pp. 10916–10922. URL: <https://doi.org/10.1016/j.eswa.2012.03.033>
40. Hoffmann F., Baesens B., Mues C. et al. Inferring Descriptive and Approximate Fuzzy Rules for Credit Scoring Using Evolutionary Algorithms. *European Journal of Operational Research*, 2007, vol. 177, iss. 1, pp. 540–555. URL: <https://doi.org/10.1016/j.ejor.2005.09.044>

41. Ignatius J., Hatami-Marbini A., Rahman A. et al. A Fuzzy Decision Support System for Credit Scoring. *Neural Computing and Applications*, 2016, vol. 27, no. 1, pp. 1–17.
URL: <https://doi.org/10.1007/s00521-016-2592-1>
42. Lahsasna A., Ainon R.N., Wah T.Y. Credit Risk Evaluation Decision Modeling Through Optimized Fuzzy Classifier. Proc. International Symposium on Information Technology, 2008. *IEEE*, 2008, vol. 1, pp. 1–8.
43. Kaur A. et al. Fuzzy Rule-based Expert System for Evaluating Defaulter Risk in Banking Sector. *Indian Journal of Science and Technology*, 2016, vol. 9, iss. 28, pp. 1–6.
URL: <https://doi.org/10.17485/ijst/2016/v9i28/98395>
44. Malhotra R., Malhotra D.K. Differentiating Between Good Credits and Bad Credits Using Neuro-Fuzzy Systems. *European Journal of Operational Research*, 2002, vol. 136, iss. 1, pp. 190–211.
URL: [https://doi.org/10.1016/S0377-2217\(01\)00052-2](https://doi.org/10.1016/S0377-2217(01)00052-2)
45. Clemen R.T., Murphy A.H., Winkler R.L. Screening Probability Forecasts: Contrasts Between Choosing and Combining. *International Journal of Forecasting*, 1995, vol. 11, iss. 1, pp. 133–145.
URL: [https://doi.org/10.1016/0169-2070\(94\)02007-C](https://doi.org/10.1016/0169-2070(94)02007-C)
46. DeGroot M.H., Fienberg S.E. The Comparison and Evaluation of Forecasters. *Journal of the Royal Statistical Society. Series D (The Statistician)*, 1983, vol. 32, no. 1/2, pp. 12–22.
Stable URL: <http://www.jstor.org/stable/2987588>
47. DeGroot M.H., Eriksson E.A. Probability Forecasting, Stochastic Dominance, and the Lorenz Curve. J.M. Bernardo, M.H. DeGroot, D.V. Lindley and A.F.M. Smith (eds). Amsterdam, North-Holland, Bayesian Statistics, 1985, vol. 2, pp. 99–118.

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Translated Article[†]

PERSONAL INSOLVENCY AND IMPLICATIONS FOR CREDIT INSTITUTIONS



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Abstract

Importance Having been adopted in 2015, personal insolvency regulations significantly influenced the supply structure in the lending market, and dramatically changed banks' approaches to dealing with difficult customers, especially in consumer lending.

Objectives The research analyzes strengths and weaknesses credit institutions face as a result of the enforcement of personal insolvency regulations, nature of changes in banks and debtors' interaction models, and transforms principles of lending policies in line with existing economic realities.

Methods I apply methods of logic, economic analysis to study banking risks associated with insolvency of individual borrowers.

Results I fundamentally evaluate principles of personal bankruptcy laws so as to determine possible banking risks at each stage of bankruptcy proceedings. Having analyzed cause-and-effect perspectives, I identified procedural and economic difference of debt restructuring processes and sale of debtors' property that took place as part of bankruptcy proceedings.

Conclusions and Relevance The adoption of bankruptcy regulations will make banks be more tolerable to troubled borrowers seeking for debt restructuring. Banks seldom exercise their entitlement for suing bankrupt debtors, since this reduces interest, other income and the amount to be repaid. The analysis unravels the personal insolvency procedure in terms of vulnerable aspects and allows to understand advantages banks may enjoy if they deal with borrowers without initiating bankruptcy litigations.

Keywords: bankruptcy, citizen, bank risk, insolvency procedure in terms of vulnerable aspects and allows to understand advantages banks may enjoy if they deal with borrowers without initiating bankruptcy litigations.

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Introduction

Nowadays every economically active Russian owes about RUB 141.7 thousand to credit institutions, according to RBK Group. It noticeably differs from trends of the previous years. For instance, as of 2014, 2013, 2012 and 2011 outstanding loan balances amounted to RUB 120 thousand, 116.7 thousand, 85 thousand and 60.8 thousand respectively. Hence, the loan debt-to-income ratio of

the Russian population has almost tripled for the recent five years.

Statistically, one in four Russians has a nonperforming loan borrowed in cash. Credit card debts are common for one in six people, auto loan debts for one in ten people, and mortgage debts for one in 25 people. Furthermore, debt burden still remains high per debtor, i.e. 1.8 against 1.2 year-on-year. This indicator grows as debtors' financial position deteriorates due to the Ruble devaluation, increasing inflation and unemployment.

[†]For the source article, please refer to: Юсупова О.А. Банкротство граждан и его последствия для кредитных организаций. Финансовая аналитика: проблемы и решения. 2017. Т. 10. Вып. 4. С. 403–417. URL: <https://doi.org/10.24891/fa.10.4.403>

Indicators of overdue debts and loans as a whole also follow a pessimistic scenario, especially in retail lending (Fig. 1).

The above figures are very indicative of an outstripping growth in relative indicators of overdue debts of individuals as compared with identical indicators of deposited amounts. While as of October 1, 2013 overdue balances of retail loans in a certain loan portfolio exceed the identical indicator in the overall portfolio of deposited amounts by 0.89 percent (with the indicators are 3.6 and 4.49 percent respectively), this gap triples as of October 2016 up to 2.78 percent (5.76 and 8.54 percent respectively).

So, the market not only sees increasing overdue debts on all types of loans but also faces a bigger challenge of an outstripping growth in the relative amount of nonperforming loans in the retail lending portfolio. The collectibility of those debts raises concerns considering numerous unsecured loans.

Once any nonperforming signs emerge, they not only downgrade the quality of banks' loan portfolios, but also oblige the banks to make more provisions for possible losses. Such provisions have grown from 6.18 to 8.74 percent as part of loan portfolios for two years. That is, provisions cover lower percentage of nonperforming loans, with the growth being incommensurable to an increase in overdue amounts.

As I have already mentioned, there may be two causes. Banks may overstate the factual quality class of loans that is verified through credit monitoring, or actively manage overdue debts *inter alia* by selling them to debt collection agencies so as to improve the quality of their loan portfolio [1].

Personal bankruptcy proceedings became another method for handling nonperforming loans in October 2015 in accordance with the adopted principles of Federal Law *On Insolvency (Bankruptcy)* of October 26, 2002 № 127-ФЗ. Those proceedings invoked an ambiguous response of bankers and *mala fide* debtors. Bankers interpreted them as a more tolerant treatment of doubtful debtors who solicit debt restructuring. Banks used to restructure

debts with some reluctance since restructured or refinanced loans required banks to make bigger provisions for possible losses, more than ordinary ones. *Mala fide* debtors believed the new procedures would legitimately purify them from their financial sins.

What are strengths and weaknesses of the law for credit institutions that are seriously exposed to the risk? What behavioral models of banks and debtors shall be adjusted to new circumstances? What aspects of lending policies do banks modify in line with the current economic situation?

Before answering the above questions, I shall emphasize that the personal bankruptcy institution is a novelty as opposed to bankruptcy of legal entities and sole proprietors. The novelty came into being about a year ago raising multiple disputes before it entered into effect. Disputes and arguments still continue as seen in researches by such authors as V.I. Gladkikh [2], P.E. Gubin [3], K.B. Koraev [4], V.V. Sergeev [5], E.E. Uksusova [6, 7] et al.¹

In fact, the institution of personal bankruptcy proves to be quite complicated for both court-appointed administrators and its parties, i.e. creditors (banks) and debtors (individuals).

As court practices show, *mala fide* debtors were disappointed with the new law and its principles since they still blocked fraudulent bankruptcy schemes. Debtors intended to conceal factual information about their assets from court-appointed administrators and creditors (banks) assuming that the court was allowed to relieve individuals from

¹ Belyaeva O. [Personal bankruptcy]. *Yuridicheskaya gazeta = Legal Newspaper*, 2011, no. 18. (In Russ.); Butorin A.E. [Retail lending: Have expectations of banks and customers been met?]. *Yuridicheskaya rabota v kreditnoi organizatsii = Legal Work in the Credit Institution*, 2014, no. 3. (In Russ.); Zheleznyak A. [Personal bankruptcy. Genuine goals and the first enforcement experience]. *EZh-Yurist*, 2016, no. 22, p. 5. (In Russ.); Kirillovykh A.A. [Personal bankruptcy: the future of this legal institution]. *Zakonodatel'stvo i ekonomika = Legislation and Economy*, 2011, no. 3. (In Russ.); Lazareva N. [Personal bankruptcy: Directions for further development]. *EZh-Yurist*, 2014, no. 15, pp. 9–10. (In Russ.); Slesarev S. [A riot on board of a bankrupt ship]. *Administrativnoe pravo = Administrative Law*, 2016, no. 2, pp. 27–32. (In Russ.); Kharitonov G.A. [Challenging issues of personal bankruptcy proceedings]. *Arbitrazhnyi upravlyayushchii = Court-Appointed Administrator*, 2016, no. 3, pp. 35–38. (In Russ.)

debts and liabilities by assessing whether they were exposed to circumstances ruling out such relief.

Furthermore, the law sets out circumstances which survive bankruptcy proceedings. The principles are promulgated in Article 213.28 of the Federal Law *On Insolvency (Bankruptcy)*. For instance, the individual is not relieved from his/her obligations if:

- the individual is charged with criminal or administrative offense for unlawful activities during the bankruptcy proceedings, deliberate or fraudulent bankruptcy (there is a court ruling);
- the individual fails to submit necessary information or provides deliberate misrepresentation on his/her personality, property and this fact is established to satisfaction of the court;
- the court establishes that the individual acted in an unlawful manner upon origination or fulfillment of the liability underlying the debtor's claim. Such unlawful actions include fraud, fraudulent avoidance of taxes or repayment of debts, submission of deliberate misrepresentations to the creditor in order to obtain a loan, concealment or deliberate destruction of property.

The above circumstances will become issues in proof in court proceedings and underlay the respective court decision. T. Zhukova², A. Sorokin³, M.V. Telyukina [8], V.N. Tkachev [9] spotlight this aspect in their articles.

Nevertheless, *bona fide* individuals understand the strengths of the law. First of all, the debtor can be eligible to personal bankruptcy as enshrined in the law, i.e. debt restructuring, sale of property, out-of-court agreement.

For instance, the property sale procedure allows the debtor to fulfill obligations and subsequently solve all financial problems and settle up debts. The settlement of obligations will entail the sale of the entire property and fair distribution of proceeds among creditors, including banks. If the proceeds are

insufficient, the debtor's obligations shall be discharged upon the court decision.

Following this scenario, lending banks are trapped in a difficult situation as they lose the possibility of collecting the total debt. Furthermore, if the debtor's property is sold, the proceeds shall be distributed among the debtor's creditors on a pro-rata basis. Otherwise outstanding amounts are not covered completely.

Currently, the law is not very popular among debtors and creditors. According to non-profit partnership Avangard Association of Court-Appointed Administrators, commercial courts of the Omsk oblast received 1,047 bankruptcy applications (totally from legal entities, individuals, sole proprietors) within the effective period of the law. Novosibirsk commercial courts received 1,596 bankruptcy applications, i.e. 30 percent more.

During the first month of the law (October 2015), the Omsk commercial courts received 45 bankruptcy applications and 170 ones for the first quarter of 2016. Thus, about 50 bankruptcy applications are filed monthly. This shows an upward trend, though not being overwhelming in numbers since debtors have to pay for the court-appointed administrator's services the court engages to handle bankruptcy proceedings. Banks seldom exercise their legitimate right for filing bankruptcy claims against their debtors since it cuts banks' interest and other yields and has a strong likelihood of reducing the outstanding amount due from the principle.

Considering the above reason, the banking sector tends to deal with debtors independently and out of court. However, debtors more often than not resort to the court and claim their personal bankruptcy as envisaged in article 213.5 of the law. They understand advantages the procedure provides and try to get a *fresh start* after their debts are forgiven.

In some cases, the law obliges debtors to resort to the court and initiate bankruptcy proceedings (*Fig. 2*).

In this respect, if we differentiate the debtor's right and obligation to resort to the commercial court and initiate its personal bankruptcy proceedings, as the law sets forth, we can conclude that all large

² Zhukova T. [Financial sanctions in personal bankruptcy]. *EZh-Yurist*, 2015, no. 10, pp. 8–12. (In Russ.)

³ Sorokin A. [Personal bankruptcy]. *Zhilishchnoe pravo = Housing Law*, 2016, no. 1, pp. 47–52. (In Russ.)

loans exceeding RUB 500 thousand *de facto* fall within the scope of the personal bankruptcy institution. Thus, creditors' claims are satisfied partially, rather than totally, with available assets of the bankrupt. As a result, banks' losses may exceed those ones as though they deal with defaulting borrowers on their own.

Operating losses of a bank shall not include losses on secured loans, including mortgages, since civil laws on bankruptcy require to satisfy secured lenders' claims first using the pledged property. I omit certain details in this article since they generally coincide with ordinary foreclosure of pledged property as part of a civil lawsuit between the bank and the borrower concerning a secured loan, except for the need to cover balances of preferential creditors' loans using the property and pay for services of the court-appointed administrator and parties it involves.

If the commercial court accepts a bankruptcy claim, the debtor is subject to procedures stipulated in Article 213.2 of the law and intended for different purposes. It sets out an exhaustive list of the procedures, including:

- personal debt restructuring;
- sale of the individual's property;
- settlement.

I focus on the substance of each procedure so as to identify positive and negative effects they may have on banks and credit risk.

A settlement is a procedure in bankruptcy proceedings that may be initiated at any stage of a lawsuit. It is intended to put an end to litigation by ensuring the agreement of the creditor and debtor. The settlement has the equivalent effect as if the borrower approaches the bank, without prejudicing the bank's interests.

As proved with arbitration practices for the duration of the law, restructuring is the most frequent remedy the court imposes on the borrower. It is applied to the individual in order to recover his/her solvency and the ability to pay to creditors in accordance with a respective scheme.

It is noteworthy that bankruptcy procedures impose the other approach to debt restructuring in comparison with that the bank carries out internally once the borrower approaches the bank (creditor) on a pre-trial basis. What differentiates a trial and pre-trial approval of debt restructuring decision? What implications may arise for the bank and the borrower?

In both cases debt restructuring is applicable only to those borrowers who retain sources of income but their loan burden hinders their repayment of the loan balance. Debt restructuring helps the individual solicit a practicable and feasible repayment schedule.

Banks may be exposed to the risk that court-based debt restructuring will apply to those debts involved into bankruptcy proceedings with the creditors. To be entered into the register of preferential creditors' claims and participate in the first meeting of creditors, creditors in bankruptcy proceedings, including banks, with their claims being secured with the individual's property, are entitled to lodge a claim against the individual within two months from the date when the personal bankruptcy application is satisfied as per Article 213.7 of the law. It is unlikely but still probable that the bank may violate the period the law prescribes for its involvement into the proceedings, thus not being listed as one of the creditors.

As for positive effects on banks, law-makers introduce a limited grace period of three years (two years in exceptional cases). It prevents too protracted proceedings. In the mean time, when the borrower approaches the bank out of court and solicit debt restructuring as proved in my research, the procedure may take less than three years to cover the real credit risk of the bank⁴. In this case, once the court rules that the debt shall be restructured, the credit risk of the bank increases, and the established period of debt restructuring becomes inadequate to the real risk exposure.

⁴Yusupova O.A. [Managing nonperforming loans in the commercial bank's portfolio]. *Innovatsionnaya ekonomika i obshchestvo = Innovative Economy and Society*, 2016, no. 2, pp. 81–88. (In Russ.)

It is difficult to unambiguously interpret the legal requirement that all creditors shall agree upon the debt restructuring plan. This is not a guarantee that the bank's needs will be satisfied under the adopted repayment schedule. The fact is that decisions are made by voting at meetings of creditors. The number of votes depends on the amount due to a certain creditor on the list.

The debtor may have several unequal loans with different banks, concurrently owing money to other parties, other than credit institutions. In this case, there is a strong likelihood that terms of the court-appointed and equitable debt restructuring plan will come short of the one if the borrower approaches the bank out of court.

It is also worth mentioning that the list of creditors may include decision-making parties (the bankrupt owes the biggest amounts to them) and their receivables are formalistic. It happens in case of fraudulent or deliberate bankruptcy, which cannot be established or proved in court. Nevertheless, the law empowers the court-appointed administrator and actively involved creditors to gather information about the debtor.

In the course of its performance, the court-appointed administrator shall analyze previous deals of the debtor (at least three or more years retrospectively) and test them for validity (repayment).

If transacting parties are suspected in any malpractice, the deals shall be challenged in court as principles of Article 10 of the Civil Code of the Russian Federation forbid exercising civil rights with the intention of damaging the other person, any unlawful activities and deliberate misuse of civil rights (abuse).

The law promulgates what conditions shall be met to approve a debt restructuring plan. However, it is evident that the statutory list of such conditions may appear much shorter in practice in comparison with those conditions the lending department of the bank takes into consideration in agreeing and approving the plan (*Fig. 3*).

According to available data, an approval of a debt restructuring plan in trial requires numerous conditions to be met concurrently. They are common for all debtors involved in bankruptcy proceedings, while the debt restructuring procedure in banks sets up more stringent and extensive requirements to borrowers, being specific in each case and consistent with the bank's strategy for lending.

It is noteworthy that the commercial court makes the final decision in bankruptcy lawsuits, while the bank determines whether it is possible and reasonable to restructure debts in case of no bankruptcy proceedings. In the latter case the bank makes a decision and sets up conditions after it reasonably assesses the credit risk by analyzing quantitative and qualitative indicators, borrower's creditworthiness and financial scenarios considered by underwriting specialists having professional knowledge of lending practices. In case of litigation, it is the debtor who outlines the plan and subsequently coordinates it with creditors, with the court giving the final resolution.

Banks may possibly suffer from the court-based debt restructuring as the law does not foresee an option when the court is to approve the plan in case creditors fail to reach an agreement. This option is practicable if debtors propose the debt repayment schedule but creditors refuse to accept it. The court is empowered to approve the debtor's schedule and set up a limited period for its enforcement in line with available evidence. This extension period may take two years if the court is sure that the option will be more lucrative for the creditors than the immediate sale of the debtor's property.

It should be kept in mind that the court and banks may assess the credit risk in a different way. However, after the debt repayment plan is approved, creditors' claims may be lodged only as the plan provides for this. As per the law, creditors may not require the reimbursement of their losses incurred to the plan approbation.

After the commercial court rules to satisfy the individual's bankruptcy application and restructure the respective debt, forfeitures (penalties, charges) and other financial sanctions

shall cease. This scenario is impossible if the individual addresses the bank.

In case of bankruptcy, interests on claims of the creditor in bankruptcy are charged at the refinance rate, being significantly lower than interests under a loan agreement if the bank deals with nonperforming loans on its own.

As for positive effects of court-based debt restructuring on banks, individuals are bound to handle their property and manage their money in other accounts or deposits upon written consent of the court-appointed administrator, thus mitigating risks creditors in bankruptcy are exposed to if debtors attempt to conceal property.

The individual is also bound to report on considerable changes in his/her property and send a written notice to creditors in bankruptcy within 15 days such changes occur. Relevant criteria are set forth in the debt restructuring plan and approved by the respective credit institution.

Another advantage for banks is that the law permits creditors in bankruptcy to apply to commercial courts for amending the individual's debt restructuring plan if his/her financial position gets better, i.e. the debt restructuring plan is not constant.

If the court-appointed administrator does not receive any debt restructuring plan of the individual or the meeting of creditors declines the plan and the court dismisses the plan on its own (as I mentioned above), the court qualifies the individual as bankrupt.

In such circumstances, the law prescribes the individual property sale procedure, which may initially last for six months and rightfully extended.

The property sale is a recovery procedure intended to satisfy creditors' claims proportionately.

During this rather protracted period, the court can rule to temporarily forbid the individual's exit from the Russian Federation as long as the procedure are in progress, provided the court has an appropriate application and reasons. The bank is not authorized to do so dealing with its debtors.

During the sale procedure, the individual's property is aggregated in a pool of bankruptcy assets. It enables the bank to cover amounts due from unsecured and most risky loans, which account for a greater portion of nonperforming debts, using the individual's sole or marital property (including property shared with the former spouse).

Bankruptcy assets may also include the individual's property, which comprises his/her share of marital property. The lending bank is empowered to request the individual's share in the marital property for foreclosure.

Property exempt from foreclosure makes the only exception. It is excluded out of bankruptcy assets, being corroborated with the court order. As per Article 446 of the Civil Code of the Russian Federation, such foreclosure exempt property includes:

- household items, possessions for non-shared use (clothing, shoes and so on), other than jewelry and other luxury items;
- food;
- fuel the debtor's family needs to prepare everyday meal and generate heating for their house;
- motor vehicles and other possessions the debtor needs due to his/her disability;
- prizes, State awards, honorable and commemorative distinctions bestowed to the debtor.

Upon a reasoned application of a concerned party, the court is entitled to exclude property, which is not listed in the Article and subject to foreclosure, out of bankruptcy assets. It is important that proceeds from the sale of the property will not cover the bank's claims. Total value of the individual's property out of bankruptcy assets shall not exceed RUB 10 thousand.

Hence, the bank benefits from the debtor's property sale in two cases:

- if the property outvalues the bank's claims;
- if the bank deals with the debtor less effectively, i.e. the bank has no right to initiate foreclosure in

relation to the debtor's property (including shared property) so as to repay unsecured loans; the bank has no right to prevent the debtor from leaving the country, disposal of deposits and current accounts, etc.

In other cases, the bank's financial interests are infringed if bankruptcy assets are used to cover the debtor's payables since the funds shall be distributed among all creditors proportionately.

The enforcement of the law raises many questions and disputes among parties to bankruptcy proceedings – debtors, creditors, court-appointed administrators:

- how shall parties avoid violating timelines when entries to the Uniform Federal Register of Bankruptcy are released, if there is no taxpayer's identification number (*INN* in Russian) and individual insurance account number (*SNILS* in Russian)?;
- may foreclosure be initiated and imposed on the accumulated savings of the insured?;
- is the bankrupt's property search procedure properly established outside Russia?;
- how is a property share put on auction if the property is owned by the debtor's relatives and so on?

These and other questions caused that Chapter 10, as introduced by the Federal Law on June 29, 2015 and effective from October 1, 2015, was amended many times within a year time.

Three months after the law had come into effect, on December 29, 2015, another law was adopted to supplement the Chapter. On June 23, 2016, law makers passed another Federal Law that came into effect in December 2016 and set up a rule implying that, if the court accepts the debt restructuring plan, the individual is entitled to open a special bank account and use monetary funds without the court-appointed administrator's consent within RUB 50 thousand a month and the court may increase it upon the debtor's request. It mirrors law-makers' more tolerant and loyal attitude to *mala*

fide payers than it was as of the effective date of the law.

The personal bankruptcy legislation is being developed, with its principles being adjusted and specified on an ongoing basis:

- Federal Law of July 3, 2006 edits bankruptcy principles concerning secured creditors;
- fundamental principles of the Russian laws on notaries were supplemented with principles on notaries' authority in bankruptcy proceedings in relation of a deceased person or person declared to be deceased;
- some amendments were made to the Code of Administrative Offenses of the Russian Federation;
- on October 13, 2015 (several weeks after the effective date of the law), Resolution of the Plenum of the Supreme Court of the Russian Federation of October 1, 2015 № 45, *On Some Issues of Enforcement of Personal Insolvency (Bankruptcy) Procedures*.

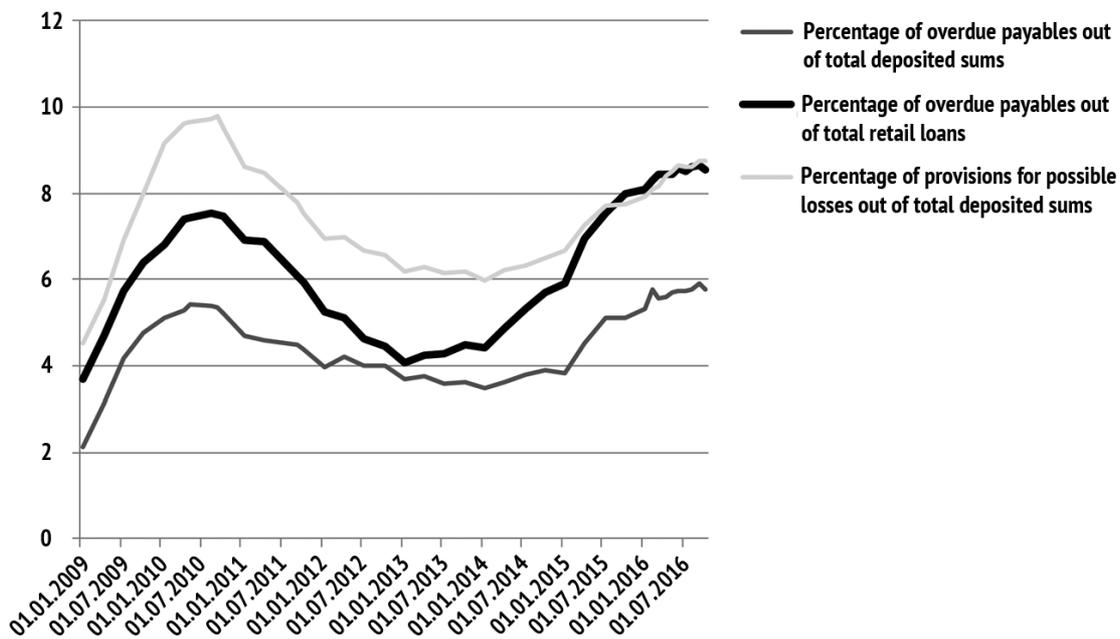
Factors below prevent many individuals from applying to commercial courts:

- a vast array of documents to support the application, which individuals are unable to collect on their own. In addition to documents prescribed by the procedural laws, debtors should submit the following ones:
 - documents supporting the existing indebtedness, basis for its origination, individual's inability to satisfy creditors' claims entirely;
 - lists of creditors and debtors of the individual;
 - property inventory;
 - copies of documents corroborating the individual's title for the property;
 - copies of documents on the individual's transactions with real estate, securities, interest in share capital, motor vehicles, and transactions worth more than RUB 300 thousand, within three years up to the application date;

- extracts from the register of the entity's shareholders (members), if any, and other documents;
- upon the completion of the bankruptcy procedure, payment for the court-appointed administrator services as the fixed amount of RUB 25 thousand (as per paragraph 3, Article 20.6 of the law), which can be increased in line with the scope and complexity of the procedure, compensation to other parties involved by the court-appointed administrator as per paragraph 6, Article 213 to exercise its authority [10]. Monetary funds for compensation are deposited with the commercial court (paragraph 4, Article 213 of the law). It is necessary to add expenses for information coverage of the bankruptcy procedure (paragraph 4, Article 123.7 of the law);
- payment of the State duty. Prior to 2017, the State duty for bankruptcy applications to commercial courts amounted to RUB 6,000, without being differentiated by applicant – an individual or legal entity. Nowadays it costs RUB 300 for individuals and RUB 6,000 for legal entities.

According to the Central Bank of the Russian Federation, as of December 1, 2016, retail loans with overdue balances exceeding 90 days account for 9.7 percent out of total loans. In a portfolio of retail loans, unsecured retail loans have the highest specific weight of about 79 percent. The relative value of overdue loan balances is higher than the average one in the portfolio – 15 percent. Thus, loans in the portfolio are likely to be involved into bankruptcy proceedings. A 20-fold decrease in the State duty for bankruptcy proceedings is another trigger.

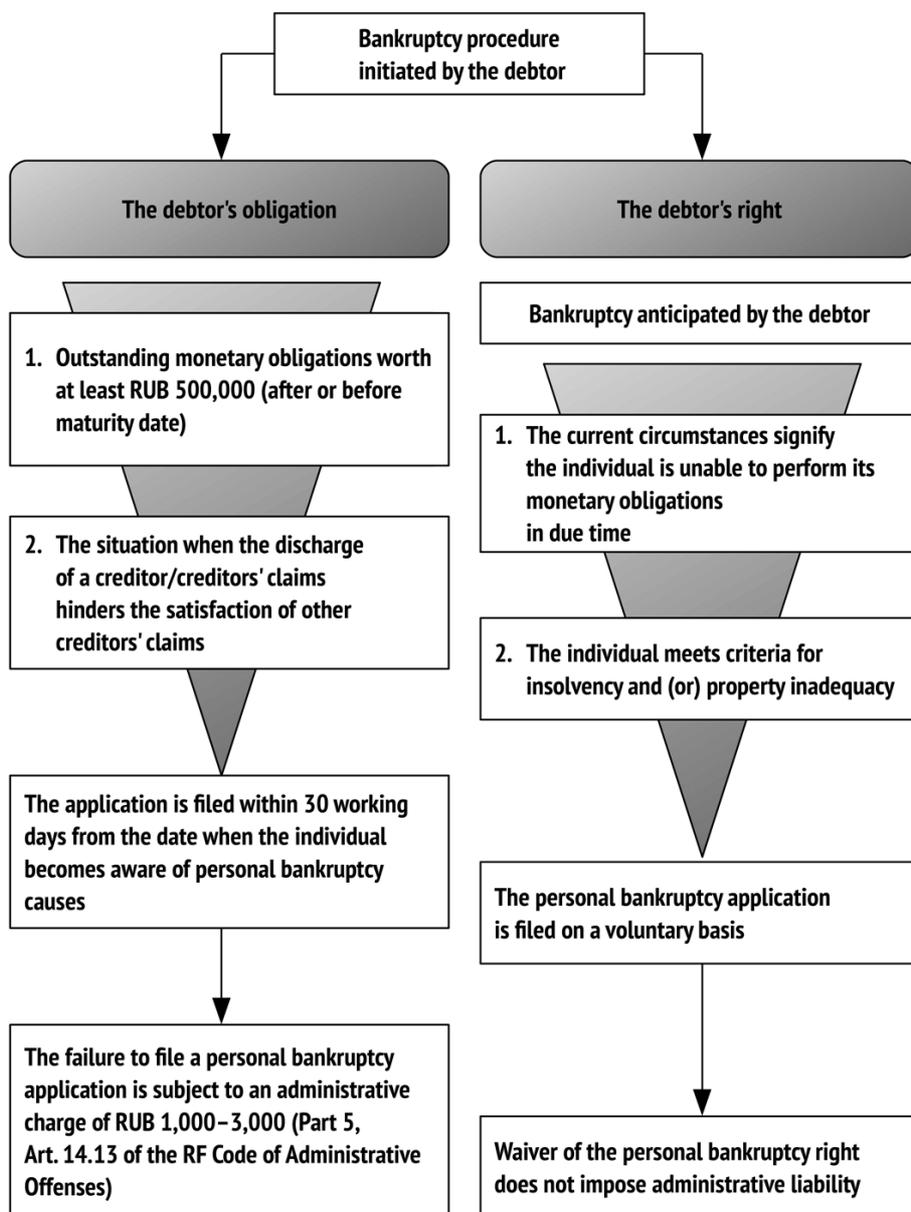
Figure 1
Trends in overdue payables, percentage points



Source: Central Bank of the Russian Federation

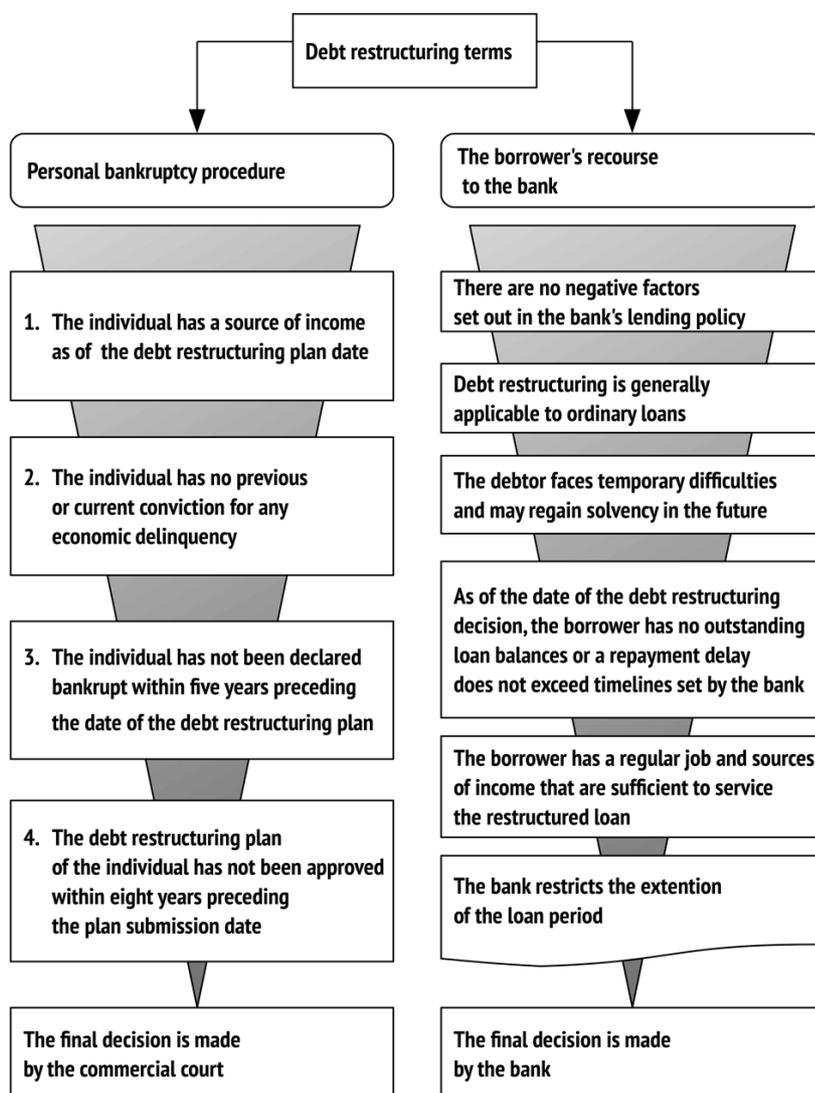
Figure 2

Debtor's rights and obligations in case of the bankruptcy proceedings initiated by the debtor



Source: Authoring

Figure 3
Comparative analysis of debt restructuring terms



Source. Authoring

Acknowledgments

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References

1. Yusupova O.A. [Transformation of monitoring in bank lending]. *Innovatsionnaya ekonomika i obshchestvo = Innovative Economy and Society*, 2014, no. 3, pp. 87–95. (In Russ.)
2. Gladkikh V.I., Sukharenko A.N. [Countering illegal bankruptcy of individuals]. *Bezopasnost' biznesa = Business Security*, 2016, no. 2, pp. 42–46. (In Russ.)

3. Gubin P.E., Smirnykh A.G. [Personal insolvency: balancing the debtor and lender's interests]. *Predprinimatel'skoe pravo = Entrepreneurial Law*, 2010, no. 4. (In Russ.)
4. Koraev K.B. [The principal idea of personal bankruptcy law]. *Rossiiskaya yustitsiya = Russian Justitia*, 2014, no. 7, pp. 54–61. (In Russ.)
5. Sergeev V.V. [Issues of legislative regulation of the personal bankruptcy procedure]. *Bankovskoe pravo = Banking Law*, 2012, no. 5, pp. 14–19. (In Russ.)
6. Uksusova E.E. [Cases of public interests protection]. *Rossiiskaya yustitsiya = Russian Justitia*, 1997, no. 11, pp. 42–44. (In Russ.)
7. Uksusova E.E. [Determining the appropriate court procedure for civil cases]. *Zhurnal rossiiskogo prava = Journal of Russian Law*, 2009, no. 6, pp. 77–92. (In Russ.)
8. Telyukina M.V. [Personal insolvency]. *Zakonodatel'stvo = Legislation*, 2001, no. 1, pp. 16–21. (In Russ.)
9. Tkachev V.N. [Specifics of legislative regulation of the individual debtor's receivership]. *Predprinimatel'skoe pravo = Entrepreneurial Law*, 2008, no. 1, pp. 23–29. (In Russ.)
10. Karelina S.A., Frolov I.V. [Can the citizen be qualified as bankrupt without a court-appointed financial administrator?]. *Sud'ya = Judge*, 2016, no. 7, pp. 10–15. (In Russ.)

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.

Translated Article[†]

SUSTAINABLE CORPORATE GROWTH: RELATIONSHIP BETWEEN LIFE CYCLE CONCEPTS AND FINANCIAL AND ECONOMIC FACTORS, PROBABILISTIC MODELING

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Moscow, Russian FederationKrasilnikova_lena@list.ru**Article history:**Received 7 July 2017
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Available online 14 December 2017**JEL classification:** C5, G32, O12**Keywords:** life cycle, development,
sustainable growth, probability**Abstract****Importance** The article considers the issue of the company's transition to sustainable growth and investigates the trade-off of its performance and life cycle phases.**Objectives** The research aims to substantiate the hypothesis stating that a system integration concept of sustainable growth should be developed in line with changes in financial and economic characteristics at different phases of life cycle. I also identify an impact on the probability of transition to a new phase and determine significant drivers of instability.**Methods** I construct logistic regression models based on panel data of public companies to assess the impact of financial and economic factors on corporate growth and model the probability of unsustainable growth. I apply graphical analysis methods. The probability is assessed by calculating partial derivatives of a composite function.**Results** The research states the need to take into consideration the organization's life cycle concept while examining its condition, underpins the expediency of developing a system integration concept to study company's growth. Using the economic and mathematical methods of analysis, I evaluate and quantify an impact on life cycle phases, calculate the probability of unsustainable growth depending on financial leverage and slow growth phase.**Conclusions and Relevance** It is important to consider life cycle phases when studying the company's operations. Management should adhere to probabilistic modeling results in order to create forecasts and scenarios of development, potential threats, and motivating factors.

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*The editor-in-charge of this article was Irina M. Vechkanova
Authorized translation by Irina M. Vechkanova*

Introduction

Contemporary models subject to testing often imply such concepts as corporate sustainability and unsustainability. It directly alludes to financial and business results of corporate operations. Revenue, profitability, indirect indicator of corporate value measured through the ratio of the company

capitalization to its carrying amount usually become those factors that attract researchers.

Findings, more often than not, hinder conclusions to be made on the way corporate performance correlates with endogenous and exogenous factors by including independent variables.

Researchers generally choose large and mature companies to study the way the factors influence corporate sustainability.

Entities are not static. Characteristics of mature entities differ from the specifics and factors of growing entities.

[†]For the source article, please refer to: Красильникова Е.В. Устойчивый рост компании: связь концепций жизненного цикла и финансово-экономических факторов, моделирование вероятности. Экономический анализ: теория и практика, 2017. Т. 16. Вып. 8. С. 1400–1419. URL: <https://doi.org/10.24891/ea.16.8.1400>

If analyzable entities are divided by phase of their life cycle, it will streamline the modification of models, specify empirical results of researches.

Identifying the entity's life cycle phase helps analyze its growth pace, determine its trends at different development stages and factors which influence the corporate sustainability at certain phases of the life cycle.

Research Methods

Controversial results of researches into financial and economic indicators often stem from different samples of companies operating in advanced or emerging markets, and different ownership structure.

If certain groups of owners prevail, it has a distinct impact of the decision making process, strategy and performance.

The specifics of the ownership structure and corporate relationship are one of the key metrics reflecting a qualitative growth of any company.

The high ownership concentration is conventionally regarded as a negative factor that influences the corporate performance, since the high concentration of ownership presumably affects minority shareholders.

As for the Russian companies, this corporate culture quality has been as a shield protecting them from hostile takeovers.

Corporate relationship becomes more harmonized and stable if there is a large shareholder interested in the long-term operations of the company.

Hence, the ownership structure can be viewed as an advantage and a motivation for a corporate growth as well as its sustainability threat.

Methods for measuring the ownership structure relations and critical metrics of the company's financial and economic health are designated to scientifically assess an impact the factors have on performance results and development opportunities.

Generally, financial and economic efficiency indicators are independent variables in models, indicating the ratio of benefits, returns and costs.

Profitability is a crucial indicator that reflects the entity's efficiency in line with its financial and economic policies.

Trends in the market price, more or less, describe the way the corporate performance and potential change. However, the indicator is not always a good metric of the company's investing and innovative activities since it is significantly exposed to external factors and environment.

Individual indicators of efficiency are also applied, i.e. the return on certain types of resources, labor productivity, return on equity, etc.

Based on the empirical analysis, some hypotheses were outlined and approved. The hypotheses state that types of owners and their ownership size influence the business and financial performance [1–3]:

- entities have the best performance indicators if their share capital is held by a great deal of managers and, to a lesser extent, employees;
- the higher ownership concentration is, the higher the corporate performance is;
- the earlier the entity goes private, the more efficient it is;
- privatization processes turn even more efficient, if the percentage of outsiders increases in the share capital;
- if the percentage of foreign investors increases, such owners start to have a more positive impact on performance results.

High concentration of capital is proved to have a positive effect on efficiency indicators (performance rate measured as the ratio of sales volume and the number of employees). However, the difference is immaterial in case of medians.

Labor productivity increased in 61 percent of joint stock companies with the medium concentration of capital, 55 percent with high concentration and 44 percent with the low concentration [4].

The Russian and foreign authors mostly examine corporate performance factors using large companies' data, though neglecting the corporate development phase, which may have an absolutely different impact on sustainability.

Risk premium associated with the life cycle phase can range from 0–10 percent¹.

Studies into development phase issues, in fact, simply modify the corporate life cycle concept from descriptive organizational characteristics to a methodology.

The existing scientific proceedings on corporate development basically rely upon principles of L.E. Greiner and I. Adizes who paved the way for the life cycle theory [5–8].

Greiner's life cycle model [5] outlines several development phases that diverge by distinction in corporate relations. Corporate performance issues have been examined to a lesser extent.

The initial phase of the life cycle is called a *growth through creativity*. At this phase, initiating shareholders undertake business activities and implement their ideas. The phase reveals whether the activities are coordinated or not. Initiators may be trapped in leadership crises, thus posing a threat to the entity.

The following phase aims to formalize and centralize the decision-making process, being called a *growth through direction*. Corporate growth is driven through the corporate management enhancement.

As corporate relationships are built up, professional managers are involved and may fuel the leadership crisis among the owners. The company grows afterwards by making its activities more complicated and comprehensive, consolidating and merging with other businesses.

At the *delegation* phase, the governance system is decentralized, with the immediate responsibility and benefits of departments' leaders being raised. However, the decentralization induces the crisis of control.

The *co-ordination* phase multiplies the number of independent projects by setting up planning centers, thus igniting the crisis of boundaries.

At the *cooperation* phase, coordinated activities emerge. Team members are pondering the way they

should steer the development. Shall they orient at an inward or outward growth? Later on, the *alliances* phase comes as an additional stage of the outward growth.

The Adizes life cycle model [7, 8] points out a lot of phases. The *courtship* phase engenders a business idea, though the business is not yet set up. However, it is regarded as the initial phase of development.

This life cycle phase is accompanied with intrinsic issues of corporate relationships, such as uncertainty and doubts. At this phase unforeseen problems also arise, such as profit-making motivation, zero doubts. The corporate growth is driven by the entrepreneur's confidence in his/her idea.

The *courtship* phase may not come into being, if the founder's idea fades away. At the *birth* phase, the company is set up. This phase requires an active increment in current assets and persisting confidence in the business idea.

The company has an account of the difference among cash flows from operating, financing and investing activities, when the negative cash flow is a rule.

Deviations are supposed to include excessive control, zero feedback from the management, misuse of corporate funds for personal needs. At this life cycle phase, the crisis stems from insufficient investment and the founder's lost interest in the business idea.

The *go-go* phase sees a rapid growth in sales, cash flows and faces issues of frail corporate relationships and the founder's trap.

Hired leadership shall be involved. The *adolescence* implies the stewardship of hired managers. At this point, conflicts become possible at the corporate level, with prices for products still continuing to grow. The company grows and attains a new development phase by implementing the project mission and reinforcing confidence.

During the *prime*, possible risks and profit are balanced provided that the crisis does not invoke any changes and renovation investment. The *stability* rests on a reduction and zero increase in profit, short-term planning horizon.

¹ Goryunov E.V., Babicheva N.E., Kozlova L.V. [The influence of life cycle on business value evaluation]. *Ekonomicheskii analiz: teoriya i praktika* = *Economic Analysis: Theory and Practice*, 2010, no. 30, pp. 35–42. (In Russ.)

If the company makes investments for retrofitting its processes, it will prevent the continuous *decline* phase, i.e. *aristocracy*, meaning that the company mostly focuses on administrative expenses.

The early *bureaucracy* witnesses plunging sales and a revelation of causes. Restructuring becomes the sole option for growth. Otherwise the entity makes a step to the *bureaucracy* that is followed by the *death*.

Before the *adolescence* phase, the company is committed to sales, being constrained with profit and policies.

During the *prime*, the objective changes. Profit becomes important for the company, though its policies still remain a constraining objective.

After the *aristocracy* phase, the company abruptly shifts to constraining objectives of sales and profit, being guided by political aspects. The tendency gains momentum during the *bureaucracy* phase. Afterwards the business *dies* (Fig. 1).

Basic researches into corporate life cycles frame new concepts, which not only provide qualitative and descriptive characteristics of corporate challenges, but also assess key performance indicators. For example, the volatility of sales volume, retained earnings, return on assets [9–11].

Such researches usually deal with quantitative indicators and leave out the dynamics and variability of corporate relationships.

It is reasonable to mention a profound research by G.V. Shirokova concerning phase criteria and the specifics [12–14].

Development phases are marked with the company's age, corporate structure (evolving from simple one without functional subdivisions to functional, divisional and matrix-based structure) with numbers assigned. Passing through its development phases, the company formalizes its decision-making system, number of hierarchical levels (links in the longest chain of commands between the executive and working teams).

Descriptive variables include centralization, which is accounted as the extent to which the CEO is involved into decision-making processes, and the specialization level of the company.

I make a hypothesis assuming that agents' conflicts and ownership concentration have a non-linear impact on the way the company implements its strategy.

For purposes of the panel sample of the Russian companies, I determine the positive relation between the concentration and the occurrence of agents' controversies. The dependence is linear, since the sample includes large companies with the increased concentration of ownership.

I find the inverse dependence of the financial leverage level on the ownership concentration (Fig. 2, 3).

Based on data released by the largest public non-financial entities, I determine how the ownership concentration at various life cycles and performance indicators (the return on assets, in particular) correlate.

The U-shaped curve for age dependence and the inverse one are detected at the growth phase. During the decline, the concentration has a positive effect on indicators [15].

General principles for describing the life cycle of any system are promulgated in GOST R ISO/MEK 15288-2005 – *Information Technology. System Engineering. Processes of Systems' Life Cycle*.

Sales volume, resources, return on investment and relevant trends allow to assess the development type.

When the deviation (variance interval) exceeds 66.6 percent, it means the company is growing and using resources intensively. The interval of 33.3 through 66.6 percent signifies the *maturity* phase, when resources are used intensively and extensively. The interval of 14 percent through 33 percent is considered as the *adolescence* with the intensive and extensive use of resources. The interval under 14 percent is typical of the *birth* or *death* phases².

Providing the more robust explanatory basis for conclusions, cognitive modeling is one of the methods for examining complex systems when the mathematical analysis is difficult to use.

² Lyubushin N.P., Babicheva N.E. [The life-cycle concept: From qualitative change description to quantitative assessment]. *Ekonomicheskii analiz: teoriya i praktika = Economic Analysis: Theory and Practice*, 2010, no. 23, pp. 2–9. (In Russ.)

Cognitive mapping, or cognitive structuring, constitutes the methodology involving, analyzing and structuring the information.

Cognitive maps comprise base factors (the company's growth rate) and relationships. The weakness of the modeling method is that it fails to comprehensively evaluate the performance of projects³.

Problem Formulation

Studying the relationship of financial and economic factors, corporate sustainability relies upon regression analysis models, which disregard the phase-related details and respective adjustments, thus having a dramatic impact on conclusions.

Life cycle concepts are examined with an emphasis on organizational changes, when corporate growth is driven by descriptive variables.

Models are modified in line with the phase of corporate development. Specifying the samples by including factors of the life cycle phases, I improve an empirical evaluation.

Efficiency, profitability and absolute values of income are explicit and conventional indicators of corporate performance.

The factors are static facts as of a certain date, rather than being cash flows.

Constructing a regression model that evaluates the effect of independent variables on corporate revenue or the return on assets by the method of least squares, it is possible to determine which factors make the indicators grow or stall.

However, prospects and opportunities of corporate growth are not easy to forecast. The conclusion stating that such relationships will remain permanent in the future is erroneous.

Therefore, the understanding of corporate development prospects requires a more ample evaluation of performance indicators based on the consistency principles, rather than as variables estimated in line with financial statements.

³ Khrustalev E.Yu., Khrustalev O.E. [Cognitive modelling of knowledge-based industries development (on example of the military-industrial complex)]. *Ekonomicheskii analiz: teoriya i praktika = Economic Analysis: Theory and Practice*, 2013, no. 10, pp. 2–11. (In Russ.)

Future development and sustainability can be predicted with the integrative approach that aligns details of life cycle phases and model-based inference revealing how financial and economic indicators are influenced.

To modify the concept theoretically, corporate sustainable growth should be viewed as a system. Owners' preferences, specifics of corporate relationships constitute one of the crucial sub-systems of sustainable growth.

If economic processes are stable, internal driver of considerable development of a company are of crucial importance.

As one of its objectives, the research aims to trace the relationship among sub-systems and examine how the relationship variability change. Following the other objectives, I model key sustainability parameters and factors fueling the corporate unsustainability.

Hence, corporate sustainable growth is a complex, structural and protracted process that significantly differs at various phases of the life cycle.

Growth Drivers and Corporate Sustainability in Scientific Concepts

Financial sustainability shall mean the company is able to remain stable in a long run by analyzing its financial statements and financial ratios, in particular, such as liquidity, turnover of assets, debt management, profitability, market value⁴.

The company demonstrates financial and economic sustainability, if the allocation and use of its resources drive its development as profit and capital grow as well, while remaining solvent even under a tolerable risk. So, it requires a certain ratio of equity and borrowings, possibility to find additional resources through the issue of securities, development and market positioning capabilities [16].

Hence, it requires a flexible structure of financial resources, solvency and investment attractiveness.

Financial sustainability is a central component of the overall economic sustainability of the company,

⁴ Brigham E.F., Ehrhardt M.C. *Finansovyi menedzhment* [Financial Management]. Saint Petersburg, Piter Publ., 2009, 960 p.

i.e. the special state and trends in the structures of available resources and value, which relentlessly ensure high performance indicators and result from short-term productive and business processes and strategic managerial decisions.

The sustainability of economic systems depends on changes in results, consumable resources, while sustainability types correlate with the type of economic development⁵.

In the 1960s, management consulting studies focused on the issue and concept of corporate sustainable growth rates, with the main development pertaining to Boston Consulting Group.

Sustainable growth rate is considered as a possible and attainable pace of an increase in revenue from sales, while operating and financial policies remain unchanged. It is also defined as growth given net assets are profitable and borrowings can be used under the restricted debt-to-equity ratio and shareholders' policies for equity distribution.

As envisaged by corporate finance principles, the growth rate is a reinvested portion of earnings times the return on equity:

$$g = \text{reinv} \cdot ROE = \left(1 - \frac{\text{declare_div}}{NI}\right) ROE,$$

where *reinv* is a reinvested portion of earnings;

declare_div are declared dividends;

NI is net income.

The return on equity is broken down into distinct elements using the DuPont equation:

$$ROE = \frac{NI}{E} = \frac{NI}{TR} \frac{TR}{A} \frac{A}{E} = \frac{NI}{EBT} \frac{EBT}{EBIT} \frac{EBIT}{TR} \frac{TR}{A} \frac{A}{E},$$

where *NI / TR* is the return on sales;

TR / A is asset turnover;

A / E is financial leverage;

NI / EBT is tax burden;

EBT / EBIT is interest burden;

EBIT / TR is operating income margin.

The return on sales and assets turnover denote the company's operating policies. The return on sales describes the products, company's position in the market and performance of production management.

The reinvestment rate and financial leverage reflect the financing activity. The reinvestment rate depends on the use of internal finance and dividend policy.

Financial leverage dictates fund raising policies and measures total net assets per unit of equity.

Hence, sustainable growth gains momentum when sales increase, with the return on sales, asset turnover, savings rate and financial leverage remaining unchanged. The balanced scorecard on growth management is created likewise it is done under the value concept.

There is a broad and narrow interpretation of corporate growth, i.e. the company's extension, establishment of new departments, increased revenue, comparison of revenue growth rates with the market growth, as a whole, corporate value growth.

Some researchers evaluate corporate growth through sales growth [17, 18], while the other rely upon trends in the number of employees.

Are such indicators, however, applicable depending on a type of economic activities and the company's development phase?

As some scholars define, growth is the ratio of the company's turnover trends to the average indicator registered in the type of economic activity the company is engaged in.

Corporate growth can be perceived through a growth in revenue, which can be decomposed into multiple factors. I should also mention the ratio of revenue growth to the average indicator assessed for competitors, market ratio (comparison with the market index, say, S&P 500), GDP growth in case the company's activities are compared by segment and country. Thus, it is necessary to differentiate the absolute and relative growth of the company in comparison with the market.

⁵ Lyubushin N.P., Babicheva N.E., Usachev D.G., Shustova M.N. [Genesis of the concept of sustainable development of economic systems of various hierarchical levels]. *Regional'naya ekonomika: teoriya i praktika = Regional Economics: Theory and Practice*, 2015, no. 48, pp. 2–14. (In Russ.)

Empirical Research, Probabilistic Modeling

Drawing upon the panel sample of large public companies as provided in the Bloomberg data base from 2010 through 2015 and adjusted for a certain phase of the life cycle, I start a modeling process so as to substantiate and identify the way financial and economic results correlate with the corporate development phase. As I find out, current indicators have a positive effect, i.e. current ratio (*CR*) and market capitalization of the company (*MC*), and the number of employees (*NE*) on a growing company (*Table 1*).

Rapidly growing companies do have the highest market value of their equity:

$$p = \frac{1}{(1 + e^{-Z})}$$

where p is the probability for being at the growth phase.

$$Z = a_{it} + b_1 CR_{it} + b_2 MC_{it} + b_3 NE_{it} + \varepsilon_{it},$$

where *CR* is the current liquidity ratio, i.e. the ratio of current assets to current liabilities;

MC is the market capitalization of the company;

NE is the number of employees.

Pursuing the other objective of the research, I evaluate the future development, i.e. the probability of the company's transition to a new phase of its life cycle.

As stated in fundamental researches into the life cycle concept development, the potential growth does depend on internal corporate distinctions relating to the majority owners' preferences and other characteristics of agency relations.

However, conventional researches omitted an external impact, under other equal circumstances, and hypothesized the macroeconomic stability. It may lead to ambiguous results.

Macroeconomic factors are also reviewed through another key sub-system that influences the corporate growth. The issue is contemplated for further researches.

For purposes of the same panel sample, I model the corporate growth probability, when the financial leverage factors influence growth opportunities.

If the independent variable rises, the company is more likely to quit the slow growth phase and assume the rapid growth phase (*Fig. 4*).

The third objective of the research is to determine key parameters aggravating the unsustainable growth of the company (*Fig. 5*).

I devise an economic and mathematical model tracing the dependence of unsustainable growth (downward trend) on financial factors, management quality factors.

To detect the unsustainable growth, I find the factors that decrease the operating income margin and revenue by over 15 percent in comparison with the average. If the indicators fall more than by 15 percent, I assign 1 to the criteria and 0 in the other cases. I build logit models to evaluate whether factors of revenue and operating income margin are likely to decrease:

$$p = \frac{1}{(1 + e^{-Z})}$$

$$Z = a_{it} + b_1 MC_{it} + b_2 NE_{it} + b_3 CR_{it} +$$

$$+ b_4 \text{finlev}_{it} + b_5 \frac{D}{E} + b_6 \text{growth} +$$

$$+ b_7 \text{boost} + b_8 \text{mature} + b_9 \text{decline} + \varepsilon_{it},$$

where *finlev* is financial leverage, the ratio of the company's debt to its assets;

D/E is the ratio of the company's debt to equity;

growth is a dummy variable of slow growth. It becomes 1, if the company is at the slow growth phase, and 0 in the other cases;

boost is a dummy variable of rapid growth. It becomes 1, if the company undergoes a rapid growth, and 0 in the other cases;

mature is a dummy variable of maturity. It becomes 1, if the company reaches its maturity, and 0 in the other cases;

decline is a dummy variable of decline. It becomes 1, if the company's activities are declining, and 0 in the other cases.

The modeling led to the following outcome:

- in case of a 1-percent error in the deviation of an incorrect hypothesis, the company's decline phase increases the probability of unsustainable growth and drop in the operating income margin (growth criteria). It results from a decrease in sales and increase in the cost;
- in case of a 10-percent error, an increase in the debt-to-total asset ratio fuels an unsustainable growth, probable downward deviation from the average value;
- in case of a 5-percent error, the slow growth phase decreases the probability of the operating income margin reduction;
- unsustainable growth becomes more probable by 4.6 percent if the debt-to-total asset ratio increases;
- unsustainable growth decreases by 12 percent if the company undergoes the slow growth phase.

Thus, the corporate growth is proved to be a complex and multifaceted process.

If a growth is traditionally considered as a pace, at which revenue and profitability factors grow, it gives ambiguous results, which overlook possible development scenarios, present static data and cause a significant reduction in profit and value in the future.

Most economic models focus on the dependence of financial and economic results on internal corporate qualities and figures.

Those models do not imply any adjustments for a life cycle phase. The life cycle concepts mostly provide a description of changes in organizational characteristics. They have been modified recently through financial and economic parameters.

Sustainable growth studies are carried out in dynamics, requiring a consistency of the analysis (Fig. 6).

Identifying and studying sub-systems, their relationship and trends help refine the findings and conclusions on a sustainable growth of the company in line with possible changes.

Table 1

Modeling the impact on the company's being at the growth stage

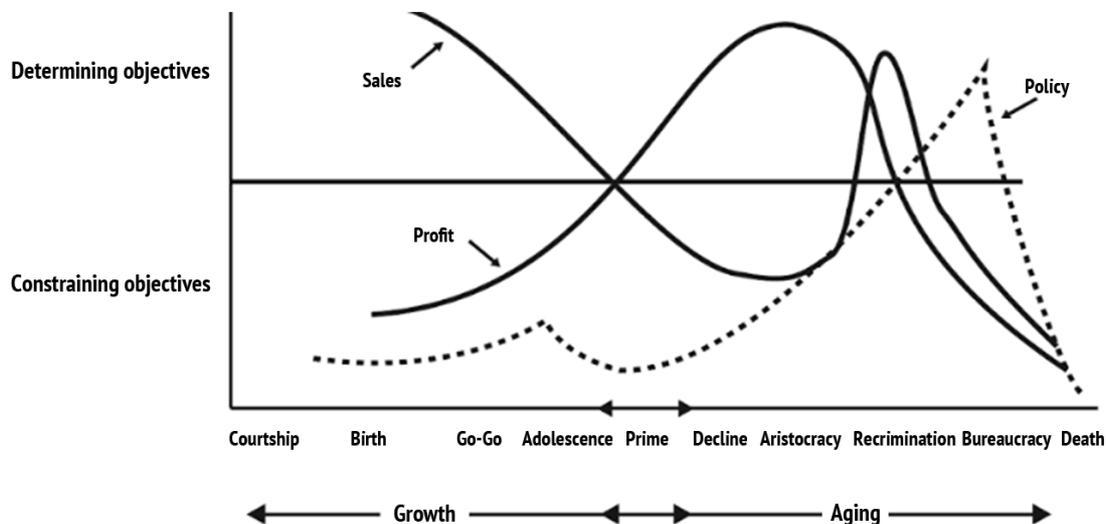
Factor	Interpretation of revealed relationships
Current ratio – the current assets-to-current liabilities ratio CR^*	Positive effect on the growth-phase position
The number of employees NE^*	Positive effect on the growth-phase position
Market capitalization of the company MC^*	Positive effect on the growth-phase position

* Significance of the independent factor at a 1-percent level.

** Significance at a 5-percent level.

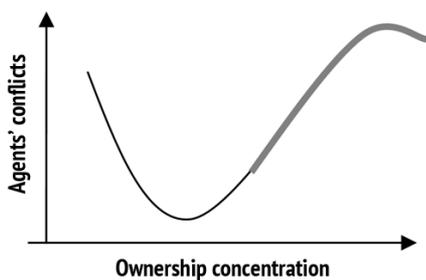
Source: Authoring

Figure 1
Determinants and constraints at different stages of life cycle



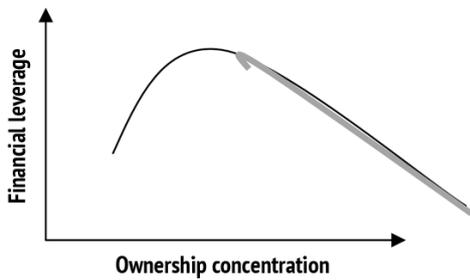
Source: [8]

Figure 2
Influence of concentration on agency conflicts



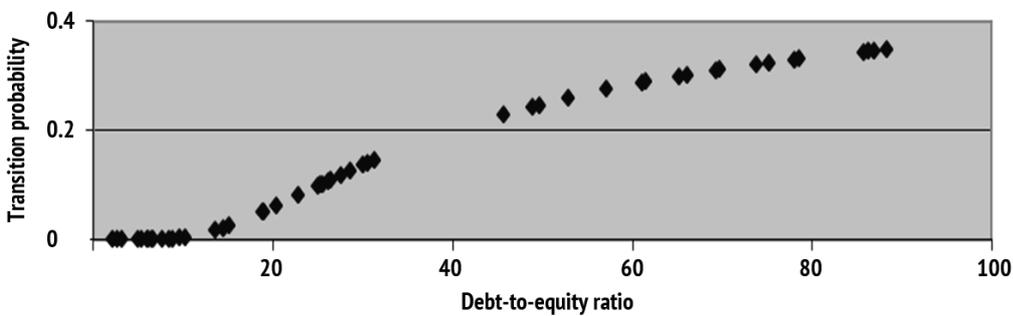
Source: Authoring

Figure 3
Influence of concentration on financial leverage



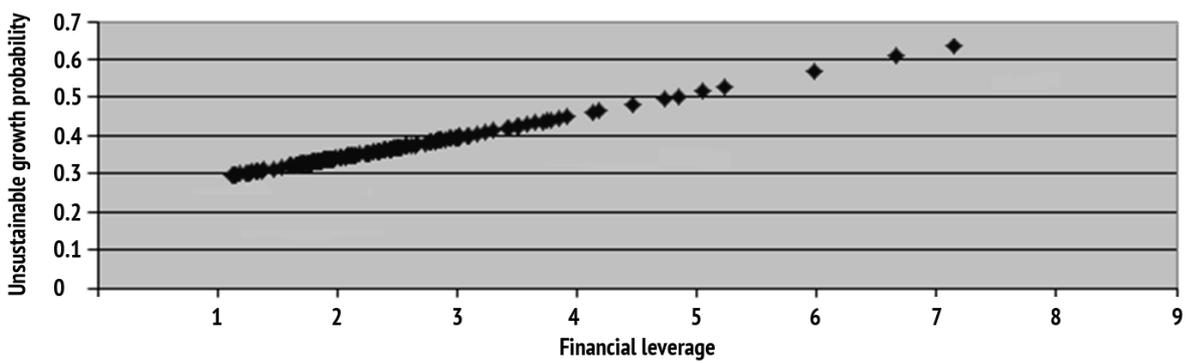
Source: Authoring

Figure 4
Simulating the probability of transition from slow growth to rapid growth stage



Source: Authoring

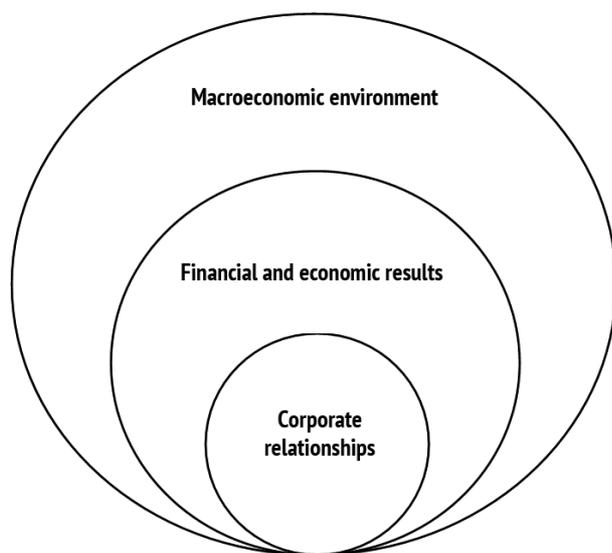
Figure 5
Simulating the probability of unsustainable growth



Source: Authoring

Figure 6

Systemic description of impact factors on company's sustainable growth



Source: Authoring

Acknowledgments

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References

1. Entov R.M., Radygin A.D. *Struktura sobstvennosti i problemy korporativnogo kontrolya v rossiiskoi ekonomike* [Ownership structure and corporate control problems in the Russian economy]. Moscow, Gaidar Institute Publ., 1999, 67 p.
2. Mal'ginov G.N., Radygin A.D. *Smeshannaya sobstvennost' v korporativnom sektore: evolyutsiya, upravlenie, regulirovanie* [Mixed ownership in the corporate sector: Evolution, management, regulation]. Moscow, Gaidar Institute Publ., 2007, 636 p.
3. Radygin A.D., Entov R.M. *Korporativnoe upravlenie i zashchita prav sobstvennosti: empiricheskii analiz i aktual'nye napravleniya reform* [Corporate governance and property rights protection: An empirical analysis of current trends and reforms]. Moscow, Gaidar Institute Publ., 2001, 294 p.
4. *Rossiiskaya korporatsiya: vnutrennyaya organizatsiya, vneshnie vzaimodeistviya, perspektivy razvitiya* [A Russian corporation: Internal organization, external cooperation and development prospects]. Moscow, Yustitsinform Publ., 2009, 542 p.
5. Greiner L.E. Evolution and Revolution as Organizations Grow. In: *Readings in Strategic Management*. David Asch, Cliff Bowman (eds). Macmillan Education, 1989, pp. 373–387.
URL: <https://doi.org/10.1007/978-1-349-20317-8>
6. Adizes I. *Corporate Lifecycles: How and Why Corporations Grow and Die and What to Do About It*. Englewood Cliffs, N.J., Prentice Hall, 1988.
7. Adizes I. Organizational Passages: Diagnosing and Treating Life Cycle Problems in Organization. *Organizational Dynamics*, 1979, vol. 8, no. 1, pp. 3–25.

8. Adizes I.K. *Upravlenie zhiznennym tsiklom korporatsii* [Managing Corporate Lifecycles: How Organizations Grow, Age, and Die]. Moscow, Eksmo Publ., 2016, 512 p.
9. Miller D., Friesen P.H. A Longitudinal Study of the Corporate Life Cycle. *Management Science*, 1984, vol. 30, iss. 10, pp. 1161–1183. URL: <https://doi.org/10.1287/mnsc.30.10.1161>
10. DeAngelo H., DeAngelo L., Stulz R.M. Dividend Policy and the Earned/Contributed Capital Mix: A Test of the Life-Cycle Theory. *Journal of Financial Economics*, 2006, vol. 81, iss. 2, pp. 227–254. URL: <https://doi.org/10.1016/j.jfineco.2005.07.005>
11. Lester D.L., Parnell J.A., Carraher A. Organizational Life Cycle: A Five Stage Empirical Scale. *The International Journal of Organizational Analysis*, 2003, vol. 11, iss. 4, pp. 339–354. URL: <https://doi.org/10.1108/eb028979>
12. Shirokova G.V. *Zhiznennyi tsikl organizatsii: kontseptsii i rossiiskaya praktika* [The life cycle of the organization: Concepts and Russian practice]. St. Petersburg, Saint Petersburg State University Publ., 2007, 480 p.
13. Shirokova G.V. [Organization's life cycle theory: Analysis of major models]. *Menedzhment v Rossii i za rubezhom = Management in Russia and Abroad*, 2007, no. 2, pp. 15–22. (In Russ.)
14. Shirokova G.V., Merkur'eva I.S., Serova O.Yu. [Specifics of life cycle formation of Russian companies (an empirical analysis)]. *Rossiiskii zhurnal menedzhmenta = Russian Management Journal*, 2006, vol. 4, no. 3, pp. 3–26. (In Russ.)
15. Stepanova A.N., Balkina E.A. [Corporate Financial Architecture at different lifecycle stages: Performance Effect in Russia]. *Korporativnye finansy*, 2013, vol. 7, no. 3. (In Russ.) URL: <https://cfjournal.hse.ru/article/view/1505>
16. Rodionova V.M., Fedotova M.A. *Finansovaya ustoichivost' predpriyatiya v usloviyakh inflyatsii* [Financial sustainability of an enterprise under inflation]. Moscow, Perspektiva Publ., 1995, 98 p.
17. Weinzimmer L.G., Nystron P.C., Freeman S.J. Measuring Organizational Growth: Issues, Consequences and Guidelines. *Journal of Management*, 1998, vol. 24, iss. 2, pp. 235–262.
18. Wiklund J. The Sustainability of the Entrepreneurial Orientation-Performance Relationship. *Entrepreneurship Theory and Practice*, 1999, vol. 24, iss. 1, pp. 37–48.

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.

Translated Article[†]

ON TAX IMPLICATIONS OF THE ROBOTIFICATION



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Abstract

Importance This article focuses on the robotification process and its impact on the budgetary system of the Russian Federation.

Objectives We scrutinize the situation in Russia in terms of the robotification extent in comparison with other countries, and determine taxes, which will be most impacted by robotification, and subsequent fiscal effects. We also analyze to what extent robotification threatens to social extrabudgetary funds, and estimate sales of robots in Russia, tax income loss, surplus tax revenue and losses of social extra-budgetary funds.

Methods Using the description and generalization, we identify strengths and weaknesses of global robotification processes. Based on extrapolation methods, analysis of statistical data, graphic method of data presentation, we obtain and report estimated sales of robots in Russia, income loss and surplus revenue of the budget, losses of social extrabudgetary funds as a result of the industrial robotification.

Results We quantify the robotification implications for the fiscal system of the Russian Federation and consider the possibility of introducing the robot tax.

Conclusions and Relevance The income loss will be offset by surplus income as a result of a growth in the corporate profit tax. We believe the Russian budget will soon have a significant burden as a result of the manpower substitution with robots. It will reduce fiscal revenue significantly due to transfers to extrabudgetary funds.

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Nowadays the robotification definitely turns into a natural process continuing worldwide within the span of several decades.

If viewed in the context of human development, the robotification opens up plenty of opportunities. The robotification automates the entire production process reducing the human factor as much as possible. Furthermore, robots ensure the uninterrupted production process. In other words, robots are free from any time constraints by work cycle [1]. It is worth mentioning that robotics gave a significant impetus to the development of medical knowledge. Currently, robots are involved in a great deal of complicated operations, and robotic prostheses help handicapped people live without routine physical challenges.

However, numerous benefits are accompanied with some implicit threats [2]. Manpower displacement appears to be the main negative implication triggering an unemployment growth. Moreover, market saturation and replacing humans with robots may make humans helpless, reluctant in their further development [3]. It is noteworthy that robots are not guided with any moral principles and responsibility, being incapable of substituting human beings but rather acting in a human-like manner¹.

If viewed from perspectives of the State, the robotification is more negative than positive. After robots substitute people in productive and manufacturing processes, the budget will lose some portion of the withholding tax, VAT, social security charges, etc. [4] This fact unleashes multiple and recurring ideas of adopting a special tax on robots.

The legislative initiative of the robot tax was first presented in 2016 by Mady Delvaux, a member of the European Parliament from Luxembourg. According to Mady Delvaux, robots, bots, androids and other forms of artificial intelligence (AI) can invoke a new industrial revolution in the world [5].

Her bill sets out the following measures to assume control over the robotics development:

- registration of robots with migration authorities;
- legally imposed liability of machines for damage arising from the loss of *live workplaces*²;
- special taxes or social security charges to be paid by owners of robots;
- robot's subordination to its creator and incapability of inflicting any injury to people.

In February 2017, Bill Gates sounded a similar idea³. The founder of Microsoft Inc. suggested slowing down the speed of automation and replacing humans with robots through tax policies. As he sees it, robots and their labor should be subject to the withholding tax and social security charges. *'Right now, the human worker who does, say, \$50,000 worth of work in a factory, that income is taxed and you get income tax, social security tax, all those things. If a robot comes in to do the same thing, you'd think that we'd tax the robot at a similar level'*, Mr Gates opines. He also argues that income from the robot tax shall be used not only to offset the loss of tax revenue, but also support laid-up workers with lower income and retrain them. Therefore, money should be redirected from automated industries to socially important ones, where people cannot be substituted with robots (care about elderly people, children, etc.) [6].

However, neither Europe, nor the USA have any legislative regulation imposing the robot tax.

As for the adoption of the robot tax in Russia, this idea grows more and more popular amid the mushrooming robotification of production processes. The main reason is that robots replace people in manufacturing⁴ but avoid an equivalent tax burden. It is believed to influence revenues of

¹For the source article, please refer to: Камараева Е.Я., Максимов Н.А., Пьянова М.В. О налоговых последствиях роботизации. Национальные интересы: приоритеты и безопасность. 2017. Т. 13. Вып. 9. С. 1608–1622. URL: <https://doi.org/10.24891/ni.13.9.1608>

¹ Sinitsyna Yu.V. [Problems of artificial intelligence and political challenges]. *Molodezhnyi nauchno-tekhnicheskii vestnik*, 2013, no. 5, p. 50. (In Russ.) URL: <http://sntbul.bmstu.ru/doc/569262.html>

²Nazarova A.A., Gubaidullina R.R. [Socio-economic aspects of robotification and information economy]. *Matritsa nauchnogo poznaniya*, 2017, no. 5, pp. 85–88. (In Russ.) URL: <http://os-russia.com/SBORNIKI/MNP-2017-5.pdf>

³The Robot That Takes Your Job Should Pay Taxes, says Bill Gates. URL: <https://qz.com/911968/bill-gates-the-robot-that-takes-your-job-should-pay-taxes/>

⁴Ladanova E.O. [Will the robot's mind be able to substitute a human one completely?]. *APRIORI. Seriya Estestvennye i tekhnicheskie nauki*, 2015, no. 5, p. 15. (In Russ.) URL: <http://apriori-journal.ru/seria2/5-2015/Ladanova.pdf>

the budgetary system of Russia that already undergoes hard times⁵. Anticipating the introduction of the robot tax, it seems reasonable to understand to what extent the robotification can influence the revenue from the existing taxes. Navigating through the tax system of the Russian Federation, we determine which taxes will be most affected by the robotification. It is worth mentioning that the robotification can have both a positive and negative effect on any tax⁶.

The automation of production processes frees up manpower, thus reducing the amount of social security charges. Furthermore, payroll funds also decrease since robots earn no wages. Remittances of the personal income tax fall as well.

The robotification may have an impact on indirect taxes. As the unemployment rises, personal income drops. It will undermine aggregate demand and subsequently retrench revenue from VAT and excise taxes.

However, the robotification can yet be favorable for the tax system⁷. Whereas entities cut their spending by introducing robots, their corporate profit increases alongside with income taxes they pay to the budget.

It cannot be overlooked that sales of robots will rise as more and more entities get interested in their use. So, it implies a growth in VAT remittances⁸. Moreover, value added of robots is much higher than those products redundant workers buy.

We build a model that primarily purports to show the robotification effect on tax revenue in Russia. We choose two taxes for analysis purposes, i.e.

corporate income tax and personal income tax. The idea is that the robotification enables entities to hire fewer workers, thus reducing the total withholding tax remitted to the budget due to the lower payroll fund. On the other hand, a possible reduction in payroll expenses significantly lowers the cost. So, with other factors being equal, the taxable base for the income tax will grow. Drawing upon forecasts and estimates of such organizations and agencies as International Federation of Robotics (IFR), ABI Research, Russian Association of Robotics (RAR) and Russian State Statistics Service (Rosstat) (*Table 1*), we made our own estimates.

Figures in *Table 1* are based on the following statistics. According to IFR (World Robotics 2015), in 2015, 340 robots were sold in Russia, with the total robot sales being 2,892⁹. For data extrapolation purposes, we use RAR's researches. As RAR reports, industrial robot sales in Russia incremented by 27 percent per annum from 2005 through 2015, while the growth was expected to accelerate up to 50 percent per annum, for the State got more focused on the industrial robotification and retrofitting of industrial processes at large enterprises¹⁰. Notwithstanding such tremendous pace, Russia has rather humdrum robotics in comparison with other countries¹¹. According to IFR, for example, China's annual sales of industrial robots amount to 60,000 units (Japan: 30,000 units; USA: 27,000 units). According to ABI Research, global sales of industrial robots are forecasted to triple by 2024¹².

Afterwards we assess how the industrial robotification influences the tax revenue from withholding taxes (*Table 2*). As reported by the UN,

⁵ *Roboty mogut zamenit' 50% rabochei sily v Rossii* [Robots may substitute 50 percent of human workforce in Russia]. URL: <https://hightech.fm/2017/01/18/replacement> (In Russ.)

⁶ Lukashin Yu.P. [A man in the economics of the future]. *MIRBIS Research Review*, 2016, no. 1, pp. 17–33. (In Russ.)

⁷ Bunto E.A. [Issues of robotifying the sectors of Russia's economy. Current situation and prospects]. *Aktual'nye problemy i perspektivy razvitiya ekonomiki: rossiiskii i zarubezhnyi opyt = Current Issues and Prospects of Economic Development: Russian and Foreign Practices*, 2016, no. 6, pp. 101–105. (In Russ.)

⁸ If we consider the fact that the major part of the two taxes is paid to budgets of the constituent entities of the Russian Federation, then the robotification will mainly influence regional budgets. For the clarity of our idea, we use the expression *the robotification effect/impact on the budget*, without referring specifically to any *constituent entity's budget, region's budget*.

⁹ Report, *World Robotics 2015 Industrial Robots*. URL: http://www.diag.uniroma1.it/~deluca/rob1_en/2015_WorldRobotics_ExecSummary.pdf

World Robotics 2015 mentions that the robot density in Russia is two robots per 10,000 industrial workers. According to Rosstat, 14,460 thousand people are employed in the Russian manufacturing sector. Thus, we assess the total number of industrial robots – 2,892 units.

¹⁰ World Robotics Report 2016. URL: <https://ifr.org/ifr-press-releases/news/world-robotics-report-2016>

¹¹ Tolkachev S.A., Kulakov A.D. [Neoindustrialization as the new technotronic economy (by example of introducing robots to the US industry)]. *Mir novoi ekonomiki = The World of New Economy*, 2015, no. 4, pp. 69–76. (In Russ.)

¹² According to IFR, as of 2015 sales of industrial robots amounted to 300,000 units.

about 25 percent of working people may lose their jobs by 2024 due to the robotification in Russia. The main reason is that robots are more industrious, sturdier and foolproof [7]. However, the indicator (25%) is too overstated, as RAR believes¹³, since Russia's robot density level¹⁴ is almost 70 times as low as the average level worldwide. Hence, international organizations' estimates of the robotification intensity are not sufficiently corroborated with the real situation in Russia. Thus, we decide to use the lowered indicator of 10 percent instead of 20 percent reflecting the loss of workplaces.

Based on Rosstat's data stating that, in 2015, 14,460,000 people were employed in the manufacturing sector of Russia and forecasting that $41,084 - 2,892 = 38,192$ new industrial robots will have been put into operation by 2024, we figure out that one industrial robot is capable of substituting 37 workers in the manufacturing sector ($[14,460,000 \times 0.1] / 38,192$). Considering the information on the number of robots involved in the manufacturing sector by year, we computed the number of displaced workers on an accrual basis and the number of industrial workers in each year within the 2017–2024 span. Rosstat also reports the average monthly pay in the manufacturing sector, being equal to RUB 34,748. Based on that, we assessed the accrued salary of an industrial worker for the year and the fiscal revenue loss as a product of the accrued wage and withholding tax rate (13%).

At the following step of this mathematical model, we assess how the robotification influences the corporate income tax.

We shall concentrate on savings from human labor displacement. Considering the number of industrial workers (*Table 2*), we calculate to what extent their quantity will change year after year and determine how many workers will be made redundant. The resultant figures shall be multiplied by the annual accrued wage of an industrial worker, thus showing how much entities will save per year as a result of human labor displacement. Considering that depreciation and wages are attributed to

the cost of products, entities will get displacement savings net of depreciation charges, rather than the gross amount.

The taxable base of the income tax will increase since the cost will drop, thus generating marginal income to the budget as much as the product of the decreased cost and the income tax rate (20%) (*Table 3*).

As the analysis shows, the robotification may affect the tax revenue in 2017 only. In subsequent periods, marginal income from the increased taxable base of the income tax will exceed the income loss from decreased remittances of the withholding tax (*Table 4*).

Based on average estimates, RUB 4.6 million in marginal income will presumably be remitted to the budget as a result of the robotification between 2017–2024. Furthermore, we shall mention positive trends in marginal income to the budget (*Fig. 1*).

This positive forecast of the robotification impact becomes more obscure in the light of the fact that the employer assesses social security charges to be paid in line with the accrued amount of wages. So, if the robotification cuts the total wages accrued in the nearest future, total social security charges fall as well (*Table 5*).

As we prove, the robotification does not have a direct adverse effect on the budget since an increase in the income tax base offsets lower tax revenue from a decrease in the withholding tax. However, the robotification may seriously affect budgets of the Pension Funds, Compulsory Medical Insurance Fund and Social Security Fund. The stability of the Pension Fund of the Russian Federation is at primary peril. Even now, when the robotification implications are not palpable so far, the Pension Fund balance remains questionable, with the budget deficit of 3.5 percent in 2016, being presumably caused by transfers to the Pension Fund. Under the circumstances, marginal income of the budget (*Table 5*) is not sufficient to offset such implications and cover increased transfers.

That is why, entities may be compelled to cease making social security charges on employees' wages and opt for, say, would-be income, which can be

¹³Analytical researches of the Russian Association of Robotics. Global Robotics Market. URL: <http://robotunion.ru/ru/analitika> (In Russ.)

¹⁴The number of robots per 10,000 workers.

yielded on the introduction of a robot¹⁵, or depreciation charges on robots, so to alleviate the pressure on the budget of the Pension Fund¹⁶.

It raises the question whether the above automation processes are common for Russia?¹⁷ Shall Russia slow down the robotification speed and introduce the robot tax?

Let us refer to statistical data. According to International Federation of Robotics (IFR), about 2,900 industrial robots were totally installed in Russia by 2015. *Fig. 2* showcases the way sales of industrial robots change over the period from 2005 through 2014. As seen in the graph, sales of industrial robots demonstrated a stable growth by about 20 percent a year within the 2010–2013 span. In 2013, sales hit their record high of 615 robots (a 34-percent increase as compared with 2012), but the indicator slumped by 52 percent down to 300 robots in 2014. Drastic changes in the foreign exchange rate triggered the situation.

It is reasonable to compare this indicator in Russia and other countries (*Fig. 3*)¹⁸.

As stated in IFR's analytical research, in 2015, only 340 industrial robots were sold in Russia, i.e. much less than in other countries. Hence, the robotics has just started to gain momentum in Russia [8]. Many authors reckon an additional tax may inhibit the process.

Aleksei Kudrin, a renowned public official from Russia, believes that the withholding tax on robots would mean the tax on the technological progress. Russia should move in the opposite direction and

streamline the technological progress. The robotification makes profits of rapidly growing companies rise. Such profits should be used to support the displaced workers¹⁹.

Robot-driven unemployment is another topical issue. However, as seen in *Fig. 4*, Russia significantly lags behind other countries by a robot density level per 10,000 industrial workers. Therefore, we emphasize that rapid unemployment growth rates are not so probable in Russia [9].

We can conclude Russia makes the first steps in installing robots in production²⁰. Thus, if the robot tax is adopted at the current stage, it will inhibit the robotification process and lead to undesired results.

In this article we evaluate how robotics influences tax remittances to the budget. As proved by the research, adverse effects of the robotification on the tax revenue will be seen in 2017 only. Marginal income from the increased income tax base will exceed the income loss from decreased remittances of the withholding tax later on. According to preliminary estimates, the robotification may yield RUB 4.6 billion in marginal income between 2017 and 2024 [10, 11].

Nevertheless, there is a risk that the robotification will exert serious pressure on budgets of the Pension Fund, Compulsory Medical Insurance Fund and Social Security Fund. Hence, there exists a broad array of issues to be resolved and subsequently mitigate possible risks and avoiding underpayments to extra-budgetary funds.

¹⁵The substance of the taxable base for this tax is a controversial issue. The global community has not reached any single and unanimous opinion on the matter yet.

¹⁶This option, by its nature, is similar to payroll expenses since it is also posted to the cost and can be qualified as a payment for using a robot in some production process.

¹⁷Askarov D.T., Bakytzhan D.A. [Economic aspects of the introduction of the concept of unmanned production]. *Nauka bez granits = Science without Borders*, 2017, no. 3, pp. 16–21. (In Russ.)

¹⁸Fedoseeva O.N. [Influence of the process production robotics unemployment]. *Master's Journal*, 2016, no. 2, pp. 612–617. (In Russ.)

¹⁹*Kudrin vystupil protiv nalogooblozheniya robotov* [Kudrin expressed his objections to the robot tax]. URL: <http://interfax.ru/Rusinvestforum/551471> (In Russ.)

²⁰Komkov N.I., Bondareva N.N. [The perspectives and the conditions of the robotics development in Russia]. *MIR (Modernizatsiya. Innovatsii. Razvitiye = MIR (Modernization. Innovation. Research)*, 2016, vol. 7, no. 2, pp. 8–22. (In Russ.)

Table 1**Sales of industrial robots and their number in Russia (forecast), pcs**

Year	Sales of robots, units	The number of robots on an accrual basis, units
2015	340	2,892
2016	510	3,402
2017	765	4,167
2018	1,149	5,315
2019	1,721	7,036
2020	2,582	9,618
2021	3,873	13,490
2022	5,809	19,300
2023	8,714	28,014
2024	13,071	41,084

Source: Authoring based on International Federation of Robotics (IFR) data

Table 2**Robotification effects in the industrial sector on the withholding tax remitted to the budget (forecast)**

Period	The number of robots on an accrual basis, units	The number of displaced workers on an accrual basis, units	The number of industrial workers, people	Industrial worker's wage accrued for the year*, RUB	Income loss, RUB
2017	4,167	157,767	14,302,233	450,334	-1,695,637,126
2018	5,315	201,213	14,258,787	486,361	-2,746,932,144
2019	7,036	266,381	14,193,619	525,270	-4,450,030,073
2020	9,618	364,134	14,095,866	567,291	-7,209,048,718
2021	13,490	510,763	13,949,237	612,675	-11,678,658,923
2022	19,300	730,706	13,729,294	661,689	-18,919,427,455
2023	28,013	1,060,622	13,399,378	714,624	-30,649,472,478
2024	41,084	1,555,494	12,904,506	771,793	-49,652,145,414

Note. *Wages were indexed by the average annual inflation rate of 8 percent every year for the period between 2008 and 2016.

Source: Authoring

Table 3**Robotification effects in the industrial sector on the corporate income tax remitted to the budget (forecast)**

Year	The number of robots on an accrual basis, units	Monetary value of robots, million RUB	Depreciation per year ^{**} , million RUB	Savings from labor displacement per year, million RUB	Cost reduction, million RUB	Marginal income, million RUB
2017	4,167	41,670	5,208.75	13,043.362	7,834.612	1,566.922
2018	5,315	53,145	6,643.125	21,130.247	14,487.122	2,897.424
2019	7,036	70,357.5	8,794.687	34,231	25,436.313	5,087.262
2020	9,618	96,176.25	12,022.031	55,454.22	43,432.189	8,686.437
2021	13,490	134,904.375	16,863.046	89,835.837	72,972.791	14,594.558
2022	19,300	192,996.562	24,124.57	145,534.057	121,409.487	24,281.897
2023	28,013	280,134.844	35,016.855	235,765.173	200,748.317	40,149.663
2024	41,084	410,842.266	51,355.283	381,939.580	330,584.296	66,116.859

Note. * Estimated as if one industrial robot costs RUB 10 million; ** Estimated with a straight-line method and based on the assumption that industrial robots pertain to the fifth depreciation group with the useful life of seven to ten years.

Source: Authoring

Table 4**Income loss/surplus income of the budget as a result of the industrial robotification (forecast)**

Year	Income loss/marginal income of the budget, million RUB
2017	-128.715
2018	150.492
2019	637.233
2020	1,477.389
2021	2,915.899
2022	5,362.47
2023	9,500.191
2024	16,464.714

Source: Authoring

Table 5**Robotification effects on social security charges (forecast)**

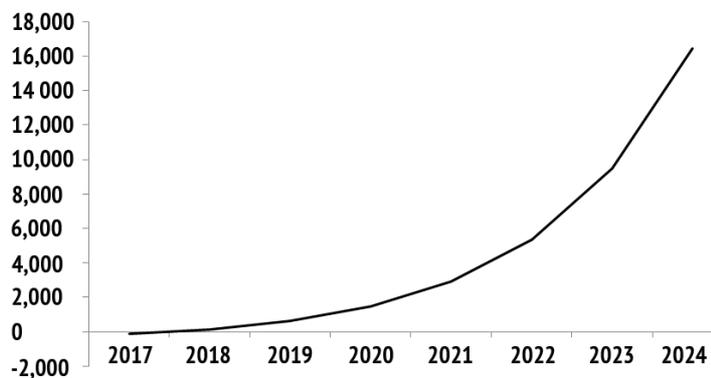
Year	The number of employees replaced with robots, people	Industrial worker's wages accrued for the year, RUB	Reduction in social security charges [*] , million RUB	Marginal income from corporate income tax ^{**} , million RUB
2017	28,964	450,334	-3,913.008	782.602
2018	43,446	486,361	-6,339.074	1,267.815
2019	65,168	525,270	-10,269.3	2,053.86
2020	97,753	567,291	-18,854.435	3,770.887
2021	146,629	612,675	-30,544.185	6,108.837
2022	219,943	661,689	-49,481.579	9,896.316
2023	329,915	714,624	-80,160.159	16,032.032
2024	494,873	771,793	-129,618.449	25,923.69

Note. * Calculated as if the rate of compulsory pension contributions for the 2017–2019 period was 22 percent and 26 percent in subsequent period; ** due to a reduction in expenses for the social security charges.

Source: Authoring

Figure 1

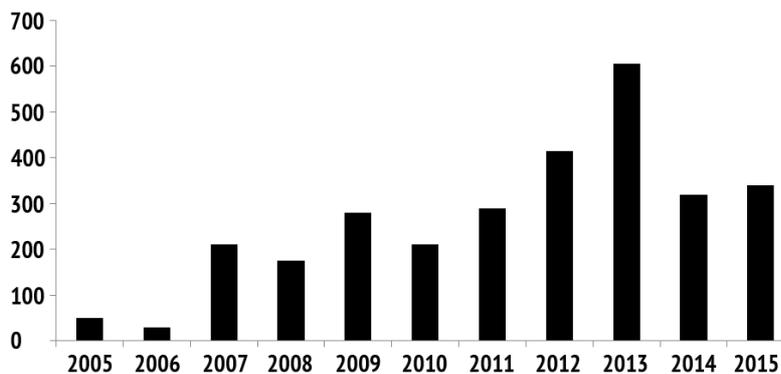
Income loss/surplus income of the budget as a result of robotification (forecast), million RUB



Source: Authoring

Figure 2

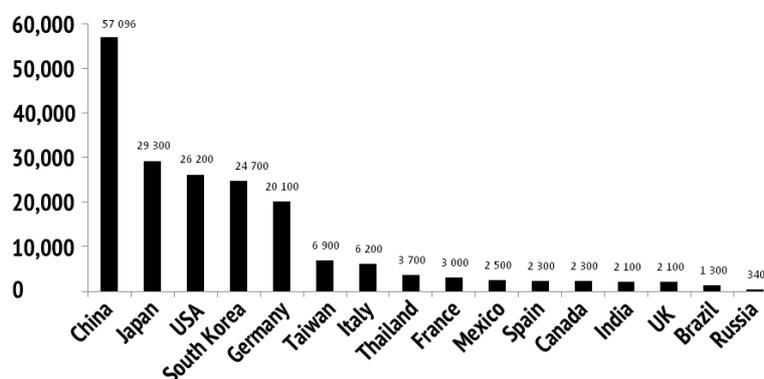
Trends in sales of industrial robots in the Russian Federation, 2005–2015, pcs



Source: Authoring based on International Federation of Robotics (IFR) data

Figure 3

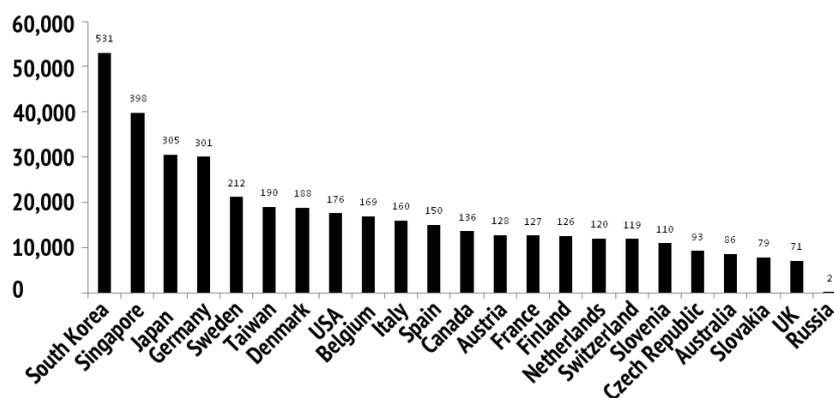
Sales of industrial robots in certain countries, 2015, pcs



Source : Fedoseeva O.N. [Influence of the process production robotics unemployment]. *Master's Journal*, 2016, no. 2, pp. 612–617. (In Russ.)

Figure 4

The number of industrial robots per 10,000 industrial workers, 2015, pcs



Source : [9]

References

- Gadzhieva K.A., Zakharova M.A. Tax on Robots. In: Science and Education: Research and Development in the Era of Globalization. Materials of the I European International Research and Practice Conference. Vienna, Scientific Publishing Center Open Knowledge, 2017, pp. 59–65.
- Kozlova O.A. [The socio-economic consequences of the robotization process or whether humanity will ever compete with robots]. *Ekonomika i predprinimatel'stvo = Journal of Economy and Entrepreneurship*, 2017, no. 3-1, pp. 1025–1028. (In Russ.)
- P'yanova M.V., Lavnik R.V. [Investment in human capital development: tax issue]. *Nalogi i finansy = Taxes and Finance*, 2016, no. 3, pp. 20–34. (In Russ.)
- Pankov V.G. [Tax policy and its impact on the labor market]. *Finansy = Finance*, 2017, no. 4, pp. 26–30. (In Russ.)
- Yudina M.A. [Industry 4.0: Opportunities and Challenges]. *Gosudarstvennoe upravlenie. Elektronnyi vestnik*, 2017, no. 60, pp. 197–215. (In Russ.)

URL: [http://e-](http://e-journal.spa.msu.ru/uploads/vestnik/2017/vipusk__60._fevral_2017_g./problemi_upravlenija_teorija_i_praktika/yudina.pdf)

[journal.spa.msu.ru/uploads/vestnik/2017/vipusk__60._fevral_2017_g./problemi_upravlenija_teorija_i_praktika/yudina.pdf](http://e-journal.spa.msu.ru/uploads/vestnik/2017/vipusk__60._fevral_2017_g./problemi_upravlenija_teorija_i_praktika/yudina.pdf)

6. Maksyutina E.V. [The changing world of work: challenges of globalization]. *V mire nauchnykh otkrytii = In the World of Scientific Discoveries*, 2014, no. 3-6, pp. 2345–2356. (In Russ.)
7. Kil'chukova A.L. [The labor market: Trends and prospects]. *Izvestiya Kabardino-Balkarskogo nauchnogo tsentra RAN = Bulletin of the Kabardino-Balkar Scientific Center of the Russian Academy of Sciences*, 2016, no. 6, pp. 160–165. (In Russ.)
8. Kolesnikov N.E., Kosheleva T.N. [Industrial robots and robotic complexes: Important components of high-performance workplaces in the Russian Federation]. *Ekonomika i upravlenie = Economics and Management*, 2014, no. 10, pp. 29–32. (In Russ.)
9. Kokhanov S.V. [Robotification of enterprises as a current trend in Russia's economy]. *Molodye ekonomisty – budushchemu Rossii: materialy VIII mezhdunarodnoi nauchno-prakticheskoi konferentsii studentov i molodykh uchenykh* [Proc. 8th Int. Sci. Conf. Young Economists to the Future of Russia]. Stavropol, North Caucasus Federal University Publ., 2016, pp. 236–238.
10. P'yanova M.V., Lavnik R.V. [Tax instruments for encouraging investments into developing human capital]. *Nalogi i nalogooblozhenie = Taxes and Taxation*, 2016, no. 10, pp. 768–778.
URL: <https://doi.org/10.7256/1812-8688.2016.10.19607> (In Russ.)
11. Nagibina N.I., Shchukina A.A. [HR-Digital: Digital technologies in human resource management]. *Internet-zhurnal Naukovedenie*, 2017, vol. 9, no. 1, p. 24. URL: <http://naukovedenie.ru/PDF/24EVN117.pdf> (In Russ.)

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.

Translated Article[†]**WORKING CAPITAL OF THE RUSSIAN ECONOMY****Diana A. ERMILINA**

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Available online 14 December 2017**JEL classification:** E43, G21, G31**Keywords:** working capital, financial condition, equity, borrowed resources**Abstract****Importance** The article discusses the state of working capital of the Russian economy.**Objectives** The article aims to study various aspects of working capital of the Russian economy and its sources, and develop recommendations to address the problem of insufficient working capital and optimize the structure of the sources.**Methods** For the study, I used methods of systems, logical and statistical analyses, classification and synthesis.**Results** I assess some indicators of working capital by major economic activity and industry, showing an unsatisfactory structure of working capital. The paper contains certain recommendations and proposals to address the problem.**Conclusions and Relevance** Most Russian enterprises lack their own sources of working capital. Bank loans constitute the principal source of borrowings, which hinders the production and economic activity due to high interest rates.

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The priority goal of any enterprise is to ensure the sufficient working capital for its smooth and continuing operations. In most industries enterprises dramatically lack working capital after economic relationships in Russia have transformed for the recent two decades.

To avoid any confusion of terminology, I should note that during the Soviet period the word combination *working capital** (*'oborotnyi kapital'* in Russian, or circulating capital) was inconsistent with the socialist

economy and substituted with the term *circulating resources* (*'oborotnye sredstva'* in Russian).

Most Russian scholars equate both notions, though they do have distinctions. The issue remains disputable and controversial due to a variety of definitions *working capital* (*circulating capital*), *working assets* and *circulating resources*. As the most current meaning, *circulating resources* are interpreted as *means of production* (raw materials, inventories, fuel), which are completely consumed in each production cycle, losing and modifying their natural form¹.

Working capital (circulating capital) is viewed as interpreted by Karl Marx, i.e. it is a part of productive capital, the value of which is totally carried to goods [1].

[†]For the source article, please refer to: Ермилина Д.А. Оборотные средства российской экономики. Финансовая аналитика: проблемы и решения. 2017. Т. 10. Вып. 7. С. 755–766.
URL: <https://doi.org/10.24891/fa.10.7.755>

*Translator's Note: The author hereinafter intends to define the terms given in italics from perspectives of the Russian language and illustrates how they are understood in Russia. Some of the Russian wordings do not have matching equivalents in English. The translator has to render the non-matching wordings as distinctively as possible, though keeping their differentiation and understanding their overlapping use.

¹ *Bol'shaya sovetskaya entsiklopediya. Pod. red. B.A. Vvedenskogo. 2 izd* [Unabridged Soviet Encyclopedia. Edited by B.A. Vvedenskii. Second Edition]. Moscow, Grand Soviet Encyclopedia, 1954, vol. 30, p. 370. (In Russ.)

There is a subtle difference between the economic concepts *working capital* and *circulating resources*.

The term *working assets* is more common for accounting². They mean standardized and non-standardized circulating resources of the enterprise, which are carried in the balance sheet as assets³.

Unfortunately, contemporary economists insufficiently study and analyze working capital. The Soviet economist V.L. Perlamutrov performed the most in-depth analysis of this concept [2].

I should point out that the Soviet and contemporary statistical reports interpret working capital in a different way. As formulated in the Soviet statistical books, working capital means circulating resources, the structure of which includes commodities and materials, goods shipped and services delivered, cash, receivables and other circulating resources⁴.

In contemporary literature on statistics, working capital is equated with working assets, with inventories, short-term financial investment and cash being principal items.

In this article, the above economic categories are used as synonyms. I examine their common and different traits in my previous research [3, pp. 214–223].

Non-borrowed and raised resources are known to make up circulating resources. If the equity prevails among the total sources of working capital, the entity is stable and financially independent. However, it requires a certain level of financial sustainability.

According to official statistics, the Russian economy faces the financial crisis. Principal financial ratios corroborate the statement (*Table 1*). Hence, it is not sensible to talk about the financial independence of the Russian entities.

² Order of the Russian Ministry of Finance *On Approval of the Accounting Regulation – Financial Statements of the Entity (PBU 4/99)* of July 6, 1999 № 43H.

³ *Bol'shoi ekonomicheskii slovar'. Pod red. A.N. Azrieliyana. 6 izd* [Unabridged Dictionary of Economics. Edited by A.N. Azrieliyan. Sixth Edition]. Moscow, Institute of New Economics Publ., 2004, p. 27. (In Russ.)

⁴ *Narodnoe khozyaistvo SSSR 1922–1972 gg.: statisticheskii sbornik* [National Economy of the USSR 1922–1972: A Statistical Book]. Moscow, Statistika Publ., 1972, p. 470. (In Russ.)

Throughout the entire analyzable period, the ratios remained within the range of regulatory values. Financial sustainability metrics of manufacturing enterprises lag behind the same metrics of mineral production enterprises.

The analyzable indicators worsen. The Russian laws set up 2 as the regulatory value of the current ratio, but it actually equals 1.28 and 1.27 in 2012 and 2015 respectively.

Globally, optimal values of the current ratio range from 1.5 to 2.5 [4, 5]. But the Russian economy has not reached the optimal lower bound for more than 20 years (in 1995 and 2005 the current ratio was 1.15 and 1.22 respectively)⁵.

Downward changes in the equity-to-assets ratio signify the growing dependence of the Russian economy on external sources of finance. It is mainly typical of manufacturing enterprises. In 2012, the equity-to-assets ratio of manufacturing industries was twice as low as the same indicator of the mineral production sector.

For purposes of the research, it is valuable to analyze the ratio of net working capital to working assets. Throughout the entire contemporary history, the ratio becomes negative in the economy as a whole and by type of economic activities (*Table 2*), meaning that the formation of working assets is distorted.

I should mention that the shortage of circulating resources and subsequent crisis phenomena deteriorated over time. Economically, the negative ratio of net working capital to working assets means that entities do not have net working capital at all. Multiplying this ratio and working assets (the transformation of the initial formula), I arrive at the value that can be construed as the company's outstanding bank interests to be capitalized and subject to interests [6, p. 19].

In 2015, working capital deficit severely affected such segments as Hotels and Restaurants, Transport and Communications, Manufacturing Sector. Furthermore, in 2015, the ratio demonstrated

⁵ *Rossiiskii statisticheskii ezhegodnik. 2000: statisticheskii sbornik* [Russian Statistical Yearbook. 2000]. Moscow, Goskomstat Rossii Publ., 2000, p. 532 (In Russ.); *Rossiiskii statisticheskii ezhegodnik. 2007: statisticheskii sbornik* [Russian Statistical Yearbook. 2007]. Moscow, Goskomstat Rossii Publ., 2007, p. 683. (In Russ.)

a slump in all the segments as compared with 2010, thus proving an increase in the debt burden of enterprises.

It is reasonable to analyze circulating resources in the manufacturing sector. The manufacturing sector is traditionally considered as the innovative platform for the economy. For reference: innovation expenses account for 4.6 percent in the mineral production sector, 24.6 percent in the manufacturing sector, 4.7 percent in the electric power engineering, and 15 percent in communications out of total investment⁶.

That is why the priority goal is to provide manufacturing enterprises with sufficient circulating resources so as to implement the principal objectives of the Industrial Policy Program of the Russian Federation⁷.

The ratio of net working capital to working assets of manufacturing sector is below than its overall value in the economy. In 2015, the chemical and petrochemical sector, ferrous and non-ferrous metallurgy experience the most severe working capital deficit. The light industry is less exposed to this process.

It is noteworthy that all industries and types of economic activities have their own technological distinctions that influence flows of working capital and performance.

In 2015, the cycle of working assets took 157 days, whereas it did 212 and 136 days in the manufacturing sector and trade respectively⁸.

Considering the retail trade separately, this indicator takes from one to two months. A longer turnover period basically aggravates business and financial risks. The more turnover cycles take place within a year, the higher revenue trading entities have in comparison with industrial enterprises. Thus, trade

intermediaries have better profit and profitability metrics.

Please refer to *Table 3* for more details on the formation of working assets in manufacturing, mineral production and trading enterprises.

As I calculate, interests payable of companies significantly exceed a growth rate of working assets. The manufacturing sector faces the toughest situation, with respective interests payable being 13 times as high as their working assets. Mineral production enterprises have the best indicators. Their capitalized debt rises 1.28 times as fast as working assets. Total borrowings increase 1.25 times as fast as working assets in the economy as a whole, and 1.05, 1.4 and 1.01 times as fast as working assets in mining, manufacturing and trading sectors respectively.

Whereas a substantial growth in the debt burden is offset with a slight increase in working assets, manufacturing enterprises have no capabilities for adequate production and operations since they lack monetary resources. There is no decision concerning the way their competitiveness can be improved. Under the current circumstances, it is impossible to count on the prevalence of equity to form working capital.

It is worth mentioning that it is impossible to determine the ratio of equity and borrowed funds needed to construct working capital of the Russian economy as a whole and per type of principal economic activities and industry. Such data are simply unavailable in the contemporary official statistics.

The Soviet economy tended to have an equal proportion of equity and borrowed funds, which still remains the best condition for forming circulating resources in industrially developed countries.

In the USSR official statistics for 1960 and 1970, equity and other sources regarded as equity accounted for 47.7 and 38.8 percent respectively, with 39.2 and 43.6 percent of bank loans⁹.

Although the equity and borrowed sources of circulating resources were in the approximate

⁶ *Rossiiskii statisticheskii ezhegodnik. 2016: statisticheskii sbornik* [Russian Statistical Yearbook. 2016]. Moscow, Rosstat Publ., 2016, p. 572, p. 578. (In Russ.)

⁷ Resolution of the Russian Government *On Approval of the State Program of the Russian Federation – The Development of the Industry and Increase in its Competitiveness* of April 15, 2014 № 328.

⁸ *Finansy Rossii. 2016: statisticheskii sbornik* [Finance of Russia. 2016. Statistical Yearbook]. Moscow, Rosstat Publ., 2016, pp. 198–199. (In Russ.)

⁹ *Narodnoe khozyaistvo SSSR 1922 – 1972 gg.: statisticheskii sbornik* [National Economy of the USSR 1922–1972: A Statistical Book]. Moscow, Statistika Publ., 1972, p. 471. (In Russ.)

balance, the borrowed sources included not only bank loans but also other receivables and sources, being gratuitous contributions.

Despite high inflation rates and expensive loans, the equity is being substituted with borrowed sources of circulating resources in Russia. While the profitability of most domestic enterprises' products is below the interest rate (*Table 4*), the banking system exerts pressure on corporate finance.

The weighted average interest rate on loans has not changed for the entire period in question. As for the profitability, it demonstrates a stable decline in all enterprises, other than agricultural ones.

The affordability of loan facilities is out of question, assuming that the key interest rate is less than the profit margin. Nevertheless, many entities still use loans as the main source for replenishing their working capital, despite its expensiveness.

I should mention that borrowing costs are not the same for various groups of entities. On the one hand, free pricing (tariffs) enables enterprises in trading, mineral production and electrical power engineering to compensate their expenses for raising loans with customers' payments, thus alleviating their debt burden. On the other hand, this distinction triggers a growth in the lending rate without having any special detrimental effect on them.

However, short-term loans account for a more and more considerable share in total loan facilities granted to entities, thus indirectly pointing to the problem of the effective formation of the Russian entities' working capital (*Table 5*).

It is evidence that short-term loans are utilized to ensure continuous operations, including the replenishment of circulating resources. Whereas would-be borrowers (entities) have no other sources of finance, they agree upon enslaving terms credit institutions offer, thus plunging into an even deeper crisis and dependence.

The fact that the Russian entities replenish their circulating resources with accrued depreciation reflects the severe distortion of the way circulating resources are formed. It is the only method for most entities to solve urgent matters and ensure their

uninterrupted operations. These assertions are supported in *Tables 6* and *7*.

In case of an inexhaustible pool of resources, depreciation charges constitute an amount to be included into the cost of finished goods in line with the opening value of fixed assets. According to *Table 6*, factual and statutory depreciation charge diverge.

As shown in *Table 7*, RUB 7,417.17, or 60.85 percent of standard-compliant capabilities, are idle in the economy. Furthermore, the Russian entities tend to raise the share of depreciation charges used for purposes other than core activities, including the replenishment of working capital. For reference: in 2007, depreciation, which was not included into the cost, accounted for 56 percent of total depreciation charges¹⁰.

Treating profit as a source for financing circulating resources, it is important to remember that a *healthy* company uses profit to finance an increase in circulating resources only.

Profit contributes to the production expansion. If the entity finances its circulating resources using its profit during crises and stagnation, it means it consumes its net working capital. Accounting for 32.6 percent of the overall economy as of 2015, unprofitable entities do not have this source of finance¹¹.

When this happens, many Russian entities were caught in a trap of maintaining the required amount of circulating resources. Although there are two areas of traditional investment – long-term and short-term investment, the second one really works only since the major part of net profit (sometimes the entire profit) is often earmarked for servicing the production, rather than its retrofitting.

Thus entities are trapped in a vicious circle. Higher profitability and renewal of fixed assets can turn the situation for the better, thus expanding the depreciation basis and increasing non-borrowed sources of finance for current operations.

¹⁰ Indicators for 2007 were measured by the authors referred to in point [7]

¹¹ *Finansy Rossii. 2016: statisticheskii sbornik* [Finance of Russia. 2016. Statistical Yearbook]. Moscow, Rosstat Publ., 2016, p. 98.

However, it is difficult to realize since many production and business agents owe significant amounts to credit institutions. Net profit is utilized to settle those debts and provide the entity with circulating resources (short-term lending). Hence, the entity no longer can allocate its profit for the core activity needs, i.e. the expanded production. Here we return to the starting point.

Summing up the above conclusions, I can say that the contemporary economy of Russia vastly lacks circulating resources. This matter causes not only a production decline and all respective consequences, but also destabilizes the banking sector (the existence of a critical pool of uncollectible or bad debts. Refer to *Table 3*, line 4).

I can point out several solutions to the problem.

1. Special-purpose support to the real economy with funds earmarked as gratuitous aid to the banking system (2015: RUB 1 trillion) at the bearable lending rate.

According to S. Andryushin and V. Kuznetsova [8, p. 12], the crisis is impossible to overcome without a reform. As they believe, the Russian Government should, first of all, tackle bad loans by creating the appropriate infrastructure under the auspices of the Central Bank of Russia so as to effectively purge toxic assets from bank account balances.

2. If credit institutions finance technological retrofitting projects, on the one hand, it will enable the banking system to cease the primitive practice of immediate profiteering and opt for the *long-term money* strategy. On the other hand, entities will be able to expand their depreciation base and ample their non-borrowed sources of finance for the working capital. As S.V. Solov'eva expresses in her article, the policy of monetary regulators shall pursue the creation of favorable conditions for sustainable economic growth. The affordability of loans (*inter alia* long-term loans through the effective refinance system) and the mechanism for converting savings into investments are of paramount importance in this context [9, p. 5].

3. V. Daskovskii and V. Kiselev suggest setting up trading and industrial groups as a remedy for

recovering both the production and banking sectors in Russia. In their opinion, uncollectible debts should not, by no means, be borne by the State [6, p. 25].

If industrial enterprises, which lack circulating resources and hold substantial debt liabilities, and credit institutions unite their efforts, they will mend the financial position of many entities. In this case, bad debts will cease to rise since banks will hold shares in pledged property, rather than debts. Therefore, all parties to such an association will benefit from trouble-free operations of entities.

4. According to the other suggestion for entities to raise additional working capital, the effective regulatory and legislative framework for financial and industrial groups should be created. Nowadays the relevant law was abolished¹². Therefore, the law shall be re-enacted so that it would integrate all the best practices of such associations.

¹²Based on Federal Law *On the Abolition of the Federal Law – On Financial and Industrial Groups* of June 22, 2007 № 115-ФЗ

Table 1**Individual indicators of financial stability and liquidity of companies in the Russian economy in 2012–2015**

Indicator	Regulatory value [*]	2012	2013	2014	2015
Current ratio, total	> 2	1.28	1.25	1.21	1.27
Mineral production	–	1.7	1.51	1.52	1.41
Manufacturing enterprises	–	1.42	1.31	1.31	1.43
The net working capital to working assets ratio, total	> 0.1	–0.26	–0.31	–0.41	–0.42
Mineral production	–	–0.09	–0.23	–0.33	–0.44
Manufacturing enterprises	–	–0.16	–0.35	–0.46	–0.44
The equity-to-assets ratio, total	> 0.5	0.48	0.45	0.4	0.4
Mineral production	–	0.67	0.56	0.53	0.53
Manufacturing enterprises	–	0.41	0.37	0.29	0.27

* Regulatory values are prescribed by Resolution of the Russian Government of May 20, 1994 № 498, *On Some Measures for Enforcement of the Insolvency (Bankruptcy) Laws*.

Source: *Finansy Rossii. 2016* [Finance of Russia. 2016]. Moscow, Rosstat Publ., 2016, pp. 109–114. (In Russ.)

Table 2**The net working capital to working assets ratio in 1995–2015, percentage**

Sector	1995	2000	2005	2010	2015
Overall economy	14.2	–7.4	–12.5	–14.1	–42.6
Industries, total	15.5	–4.5	–16.6	–4.8	–53.2
Mineral production	1.2	1.5	–34.6	–13.1	–43.9
Manufacturing enterprises, total, including	12.3	–14.7	–3.4	–8.2	–44
– ferrous and non-ferrous metallurgy	11.7	7.6	16.8	–6.8	–42.6
– chemical and petrochemical industry [*]	18.6	–6.3	–8.7	–19.1	–53.7
– mechanical engineering and metal working	12.7	–14	2.5	–2.3	–9.3
– light industry	11.5	–31.5	–12.1	–9.4	–7.8
– food industry	13.6	–29.3	–14.1	–19.1	–17.2
Production and distribution of electrical power (gas, water)	36.8	5	–11.9	6.9	–71.6
Wholesale and retail trade	8.5	–9.9	–4.7	3.7	–6.3
Transport and communications	9.6	–27.7	–39.1	–57.8	–131.2
Agriculture	36.7	–10.5	–3.2	–36	–33.7
Construction	5.7	–9.2	–10	–26	–28.4
Financing activity	–	–	–7.7	–17.4	–45.4
Hotels and restaurants	–	–	–57	–34.8	–359.8
Public administration	–	–	–102.2	–27.5	30.4

Note. Matching of codes as a result of the abolition of the Soviet Union Classifier of Industries of the National Economy and adoption of the Russian Classifier of Types of Economic Activity as set forth in Resolution of the Russian Government of February 2, 2003 № 108 [5, pp. 40–46].

* The net working capital to working assets ratio was assessed as the weighted average value per type of economic activities, which are represented with several industries (for example, chemical and petrochemical sectors).

Source: Authoring

Table 3
The structure of, and change in loans vs. working assets in 2005–2015

Indicator	Overall economy			Mineral production			Manufacturing industries			Wholesale and retail trade		
	2005	2010	2015	2005	2010	2015	2005	2010	2015	2005	2010	2015
1. Net working capital to working assets ratio, %	-12.5	-14.1	-42.6	-34.6	-13.1	-43.9	-3.4	-8.2	-44	-4.7	3.7	-6.3
2. Working assets, billion RUB	14,316	39,384	85,129	1,945	3,294	6,790	4,344	10,879	23,588	2,713	9,347	19,534
3. Capitalized amount payable for interests, billion RUB (point 1 × point 2)	1,790	5,553	36,265	673	432	2,981	148	892	10,379	128	-346	1,231
4. Loan, billion RUB (point 2 + point 3)	16,106	44,937	121,394	2,618	3,726	9,771	4,492	11,681	33,967	2,841	9,001	20,765
5. Growth in working assets (2015 vs. 2005), %	594			349			543			720		
6. Growth in entities' interests payable (2015 vs. 2005), %	202			443			701			962		
7. Loan growth (2015 vs. 2005), %	754			373			756			731		

Source: Authoring, based on [6]

Table 4
Product profitability at basic prices in comparison with the average interest rate on loans, percentage

Type of activity, parameter	Product profitability at basic prices		
	2005	2010	2015
Overall economy	13.5	10	8.1
Mineral production	35.6	31.9	24.9
Manufacturing sectors	15.3	14.8	11.9
Production and distribution of electric power, gas and water	5.3	7.1	5
Wholesale and retail trade	9.7	8.3	6.1
Transport and communications	14.4	13.5	9.4
Agriculture	6.7	9.1	20.7
Construction	3.9	4.5	3.8
Weighted average interest rate on loans	11.6	12	11.7

Note. The interest rate is calculated on the basis of statistical data on the average interest rates on loans issued to non-financial organizations.

Source: *Rossiiskii statisticheskii ezhegodnik. 2016* [Russian Statistical Yearbook. 2016]. Moscow, Goskomstat Rossii Publ., 2016, p. 564; *Rossiiskii statisticheskii ezhegodnik. 2006* [Russian Statistical Yearbook. 2006]. Moscow, Goskomstat Rossii Publ., 2006, p. 657; *Rossiiskii statisticheskii ezhegodnik. 2011* [Russian Statistical Yearbook. 2011]. Moscow, Goskomstat Rossii Publ., 2011, p. 627; *Byulleten' bankovskoi statistiki = Bulletin of Banking Statistics*, 2006, no. 10, p. 123; *Byulleten' bankovskoi statistiki = Bulletin of Banking Statistics*, 2011, no. 8, p. 126; *Statisticheskii byulleten' Banka Rossii = Statistical Bulletin of the Bank of Russia*, 2016, no. 2, p. 120 (In Russ.)

Table 5
Lending to the Russian economy

Indicator	2005	2010	2015	2015 vs. 2005, factor
The amount of loans issued to entities, other than governmental and local authorities, governmental and extra-budgetary funds, billion RUB	30,768,322	38,107,176	249,650,725	8.11
Short-term loans (with the maturity date within a year inclusive), billion RUB	10,285,959	11,687,814	165,999,644	16.1
Specific weight of short-term loans out of total loans, percent	33.4	30.7	66.5	2

Source: Authoring, based on: *Byulleten' bankovskoi statistiki = Bulletin of Banking Statistics*, 2006, no. 10, p. 104; *Byulleten' bankovskoi statistiki = Bulletin of Banking Statistics*, 2011, no. 8, p. 116; *Statisticheskii byulleten' Banka Rossii = Statistical Bulletin of the Bank of Russia*, 2016, no. 2, p. 125

Table 6
The depreciation base of the Russian economy and depreciation charges in 2015

Indicator	Fixed assets					Total
	Buildings	Facilities	Machinery and equipment	Vehicles	Other	
Types of fixed assets, depreciation base:						
– percentage						
– billion RUB	14.7	49.6	28.2	5.4	2.1	100
	23,625.5	79,719.6	45,324.5	8,679.15	3,375.25	160,725
Depreciation rate, %	3.33	7	10	10	12.5	–
Depreciation charges in case of the complete base per all types of fixed assets, billion RUB	786.76	5,580.33	4,532.45	867.92	421.91	12,189.37
Depreciation that is actually included into the cost of products, billion RUB	–	–	–	–	–	4,772.2

* As per the classification of fixed assets included into depreciation groups.

Source: Authoring, based on: *Finansy Rossii. 2016* [Finance of Russia. 2016]. Moscow, Rosstat Publ., 2016, p. 103; *Rossiiskii statisticheskii ezhegodnik. 2006* [Russian statistical Yearbook. 2006]. Moscow, Goskomstat Rossii Publ., 2006, p. 31; [7, pp. 20–21]; *Investitsionnaya deyatel'nost' v Rossii: usloviya, tendentsii, faktory* [Investment activity in Russia: conditions, trends, factors]. Moscow, Rosstat Publ., 2016, p. 67

Table 7
The capacity, use and areas for depreciation in 2015

Indicator	Billion RUB	%
Depreciation charges in case of the complete base	12,189.37	100
Depreciation not included into the cost	7,417.17	60.85
Depreciation included into the cost	4,772.2	39.15

Source: Authoring

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References

1. Marx K., Engels F. *Sochineniya. V 50 t* [Selected works. In 50 volumes]. Moscow, Politizdat Publ., 1961, vol. 24, p. 188.
2. Perlamutrov V.L. *Problemy ispol'zovaniya oborotnykh sredstv v promyshlennosti* [Issues of the use of circulating assets in industry]. Moscow, Nauka Publ., 1973, 213 p.
3. Ermilina D.A. [The category of 'floating capital' in economic science]. *Zhurnal ekonomicheskoi teorii = Journal of Economic Theory*, 2016, no. 4, pp. 214–223. (In Russ.)
URL: <http://www.uiec.ru/content/zhurnal2015/22iErmilina.pdf>
4. Lushenkova N.I. [Issues of methodology analysis of financial condition]. *Mir nauki i obrazovaniya = World of Science and Education*, 2016, no. 1(5), p. 6. (In Russ.)
URL: [http://www.mgirm.ru/World_of_science_and_education/2016/1\(5\)/Lushenkova.pdf](http://www.mgirm.ru/World_of_science_and_education/2016/1(5)/Lushenkova.pdf)
5. Saifieva S.N. [A method of calculation and the efficiency of industry tax burden in 2000–2008]. *Finansy = Finance*, 2010, no. 12, pp. 40–46. (In Russ.) URL: <http://www.ipr-ras.ru/articles/sajf11-01.pdf>
6. Daskovskii V., Kiselev V. [The relationships of the real and banking sectors of economy]. *Ekonomist*, 2016, no. 1, pp. 15–29. (In Russ.)
7. Daskovskii V., Kiselev V. [Degradation and phenomena of the investment activities in Russia]. *Investitsii v Rossii = Investments in Russia*, 2009, no. 5, pp. 20–32. (In Russ.)
8. Andryushin S., Kuznetsova V. [The banking sector of Russia and its reform]. *Voprosy Ekonomiki*, 2009, no. 7, pp. 15–30. (In Russ.)
9. Solov'eva S.V. [Problems of investment and lending in the Russian economy in modern conditions]. *Segodnya i zavtra rossiiskoi ekonomiki = Today and Tomorrow of Russian Economy*, 2016, no. 77, pp. 5–12. (In Russ.)

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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.

Translated Article[†]

ENERGY INTENSITY OF DEVELOPMENT AND THE PRECONDITIONS FOR ITS ABATEMENT: AN ECONOMETRIC ANALYSIS, WITH EMPHASIS ON THE CIS COUNTRIES



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Abstract

Importance The article focuses on the issues of development of the macroeconomic and institutional environment necessary to reduce energy intensity in the CIS countries.

Objectives The paper aims to develop a methodological approach based on econometric analysis of a sample of global statistical reports to justify the energy intensity abatement.

Methods I use methods of comparative analysis, linear and non-linear regressions, equations with threshold values, and the methods of index numbers.

Results The article proves that existing statistics can be used to justify factors influencing the energy intensity of the economy in the context of both demand and supply. As the comparative analysis shows, the regulatory quality is a key factor in reducing energy intensity in the CIS countries.

Conclusions and Relevance The CIS countries have the potential for improving the energy efficiency. This requires building the potential of State institutions and focusing on the development of competitive markets for energy products, energy auditing, adoption of power-saving standards, limitation of shadow economy, and more intensive counteraction to corruption.

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Introduction

As confirmed by the World Bank data, high energy intensity or low energy efficiency in the CIS countries remain a topical issue. For instance, as seen in the selected countries of the world¹, in 2000–2016,

[†]For the source article, please refer to: Чепель С.В. Энергоемкость развития и предпосылки ее ограничения: эконометрический анализ с акцентом на страны СНГ. *Финансы и кредит*. 2017. Т. 23. Вып. 40. С. 2420–2436. URL: <https://doi.org/10.24891/fc.23.40.2420>

¹ The analysis is based on the sample of 50 developing countries (eight CIS countries among them) that have identical parameters as the leading CIS countries. Selection criteria are as follows: GDP per capita within USD 3–25 thousand by PPP; population of at least five million people; manufacturing sector accounting for at least 20 percent of GDP. It ensured the comparability of the sampled and CIS countries

the energy efficiency index (GDP per unit of primary energy consumed, i.e. the inverse indicator of energy intensity²) ranged between USD 8–10, demonstrating

and relative homogeneity of international statistics used for purposes of the analysis.

² I present energy efficiency in this simplified form (as the inverse value of energy intensity: Energy Efficiency = 1 / Energy Intensity) due to the specifics of the subject of research (entire economy) and unavailability of other preciser indicators for the 50 sampled developing countries involved into the econometric and comparative analysis. The existing approaches to measuring energy efficiency require identifying industrial and sectoral indicators of energy efficiency (I. Bashmakov et al. [1], M. Boiko [2]), attention to environmental and social consequences for the share of renewable energy sources and dependence on external factors (V. Tsi bilina [3]), construction of relevant integral indices.

a sustainable growth, though this indicator was significantly lower, i.e. USD 5 as shown in *Fig. 1*, in the leading CIS countries (Russia, Ukraine, Kazakhstan, Uzbekistan). Furthermore, while Uzbekistan and Ukraine managed to narrow the gap, albeit insubstantially, it widened in Kazakhstan.

It means that low energy efficiency lies deep in economies in transit as compared with other emerging economies since the former USSR and dominated States were developing under the command and administration system for many decades. The command and administration system is known to imply the wasteful use of resources for growth.

There was a prevalence of State-financed enterprises in those countries, which had no incentives for growth and implementation of new resource-saving technologies, efficiency energy policy institutions and any competition among them. Therefore, CIS countries should prioritize resource- and energy-saving policies for tackling the issue. It is evidenced with respective program documents on energy saving those countries adopt and implement³.

Why is Energy Intensity Abatement Important?

High energy and resource consumption implies resources, materials, energy supplies prevail in the amount of costs for production of finished goods. It undermines the competitiveness and marketability of the finished goods in the external market. Energy- and resource-rich countries usually have excessive demand for natural capital, thus causing its quick depletion and subsequent negative effects on development sustainability [1–4].

As for other distinctions, such economies often significantly depend on external factors and have high unemployment and poverty rates, underdeveloped small business, with their economic growth longing for considerable financial injections. The economies concurrently face a shortage of energy and resources, ineffective structure

³ I refer to the State Program, *Energy Saving and Enhancement of Energy Efficiency up to 2020*, in Russia and Presidential Directive, *The Program of Measures for Reducing Energy Intensity, Implementing Energy Saving Technologies in Commercial and Social Sectors for 2015–2019* of May 5, 2015 № ПП-2343, etc.

dominated by industries that intensively consume interim products per unit of value added⁴.

If the energy saving strategy is adopted, it will give a strong impetus to the innovative economy development (K. Ermolaev [5]) because an innovative activity boost in power engineering is an important driver for modernizing national economies.

Energy efficiency is one of the crucial components of the potential inflation level (S. Chepel' [6]). That is, the higher energy efficiency, the lower the inflation rate, thus providing more opportunities for economic growth funding at minimum inflation risks.

Unless factors and conditions for the energy intensity abatement are not comprehended at the macroeconomic level, it is difficult to make long-term forecasts of GDP (V.A. Volkonskii et al. [7], A.I. Kuzovkin [8]), assess risks and formulate a long-term development strategy (K. Kaygusuz [9]). In this respect, it is reasonable to conduct a factor analysis of conditions, premises and sources of energy efficiency growth at the macroeconomic level, laying the basis for this article.

Existing Possibilities for Energy Intensity Abatement: A Cross-Country Comparison

Comparing energy efficiency and its changes throughout a 15 year time in the sample of developing countries worldwide (*Fig. 2*), it is noticeable that developing countries, with the CIS among them, have a substantial opportunity for an energy efficiency breakthrough.

This conclusion stems from the fact that Top-10 countries with the highest growth in energy efficiency include four economies in transit (Azerbaijan, Romania, Tajikistan and Belarus).

At this point, a logic question arises. Why have some countries managed to increase their energy efficiency by USD 5.4 and more, while the others still have same or worse indicators (Thailand, Guatemala, Egypt, etc.)? What macroeconomic, institutional, financial and other solutions are needed? Do they exist in Russia and other CIS countries?

⁴ The respective analysis of Russia's economy is performed in proceedings by I. Bashmakov [1, 4], N. Gukasova [5] and some others.

Having analyzed existing researches on this issue worldwide, I found out the majority of them focus on industry-specific and technological aspects, overlooking macroeconomic and institutional conditions, especially for emerging economies and CIS countries.

Viewing the issue systemically, factors are entirely divided into two streams, i.e. factors driving energy efficiency trends in terms of demand and supply. For example, Cambridge Econometrics report⁵ attributes prices for energy resources, governmental policy for energy efficiency promotion (*inter alia* anti-trust policy and development of competitive markets) and consumer preferences to factors influencing demand (incentives for energy efficiency growth).

Factors influencing supply include the production of energy efficient equipment, R&D (innovative impact of technologies, including renewable energy sources), energy efficient utilities and power supply, energy conserving buildings and cost-effective transport.

The research justifies the assumption that energy efficiency investment is more lucrative than investment in new generating capacities. Furthermore, it is worth mentioning those manufacturing industries, which manufacture energy conserving equipment and materials and create more jobs per investment unit than throughout the economy on average.

Other proceedings state energy efficiency impediments shall be overcome to identify its factors and conditions. Most of such researches qualify the following factors as the main barriers hindering energy efficiency, i.e. no access to capital and investment resources, no incentives for energy conservation (low prices for energy resources, low competition in the domestic market), regulatory and administrative obstacles (nonexistent standards, laws, mechanisms for energy accounting (A.K. Reddy [10] J. Sutherland [11])), technological barriers (unavailability of energy efficient equipment, focus on efficiency of certain components instead of overall energy efficiency, lack of technical personnel

⁵ Assessing the Employment and Social Impact of Energy Efficiency. Final Report. Volume 1: Main Report. Cambridge, Cambridge Econometrics, 2015, 139 p.

(W.H. Golove et al. [12]), institutional barriers (weak contractual institutions, nonexistent policy on energy, etc.), market failures (shortage or dearth of information, information asymmetry, etc.), lack of knowledge and qualification (N. Eyre [13], UNDP⁶, S. Sorrell⁷).

Some studies focus on correlations between energy efficiency and institutional environment (regulatory quality) through an empirical econometric analysis. For instance, in his research N.I. Suslov [14] evaluated how the regulatory quality influenced energy efficiency, figuring out that the Russian economy demonstrated low energy efficiency due to frail incentives for energy conservation and drawbacks of the existing institutional mechanism.

Robust governmental institutions are the cornerstone for creating incentives (motivation) for energy saving. They may include factors of competition and tariffs. The ratio of gas/electricity/heat tariffs plays an important role in energy conservation. In many developing countries, power rates do not reflect their real value, being lower than their marginal cost for power generation. In the context, subsidies shall also be pointed out (no cost-based tariffs). As a result, subsidies for energy make energy efficiency measures less lucrative (A.K. Reddy [10], J. Sutherland [11], W.H. Golove et al. [12], S. Meyers [15], D. Farrell et al. [16]).

Are These Hypotheses and Assumptions Immanent in CIS Countries and Other Developing Countries?

Answering the above question, I performed a cross-country econometric analysis by making a sample of 50 developing countries. Analyzable factors were selected in accordance with theoretical views and information resources of international organizations (first of all, World Bank indicators).

Finally, the analyzable factors comprise 16 indicators describing the initial development level of

⁶ World Energy Assessment: Energy and the Challenge of Sustainability. New York, United Nations Development Programme, 2000, 508 p.

⁷ Sorrell S., Schleich J., Scott S. et al. Barriers to Energy Efficiency in Public and Private Organizations: Final Report to the European Commission. Project JOS3CT970022, Environment and Energy Programme, September 2000, 9 p.

an economy and its structure (manufacturing industries as percentage of GDP), liberalization and openness (for evaluating the development of competitive markets), investing activity, contributions to human capital and new technologies (investment, expenses for education, R&D as percentage of GDP), parameters of energy tariff policies (diesel price per liter in USD), regulatory quality (Control of Corruption Index, Rule of Law index, Government Effectiveness, ranging from 1 to 5) and labor potential (percentage of qualified manpower out of total employed). Moreover, the analysis involved a conditional variable for well-resourced countries (1 for well-resourced countries, such as Russia, Kazakhstan, Uzbekistan, etc. and 0 for the others), and the annual mean temperature in degrees centigrade. For comparability of time, all value-based indicators were used as constant prices as of 2000.

When choosing analysis methods, I consider structural distinctions of matrices in line with the analyzable indicator. First of all, the structure consists of, to various extents, reporting statistics of separate lines and columns of initial matrices (indicators) on certain countries in the sample. It can be illustrated with missing trend data on such indicators as expenses for education, science and technologies, employed population with higher education, prices for energy supplies and some others.

It substantially hinders the use of classical methods for panel analysis (RE, FE, etc.). The cross-section analysis method turns out to be the only alternative in this case with respect to the fifty developing countries in the sample.

However, the question arises concerning the form such indicators are used in the analysis, i.e. their values as of the last year of the reporting period (the 2013 level), average annual values for the entire reporting period, changes in the indicator for the reporting period (the 2013 value less the 2000 value).

As proved through the correlation analysis of the resulting statistical basis, the third form of variables (their changes) prevails. If variables are used as their 2013 level, energy efficiency and its factors reveal only two statistically significant coefficients of correlation with logically consistent

signs (economic freedom with the coefficient of +0.4002 and control of corruption of +0.2689*), a choice of average annual values results in four factors, while a choice of changes in indicators for the period leads to seven factors (initial development level, investment factors, prices for energy carriers, regulatory became significant).

The econometric analysis involves a number of steps. At the first step, I search for traditional linear regressions with as many statistically significant factors as possible that would meet theoretically consistent signs of their coefficients relating to a certain factor (model L). At the second step when the results are used, I test nonlinear dependence of those factors to be included into equations as per the existing theory but appeared statistically insignificant (model NL). At the final step, I evaluate regressions with thresholds for the regulatory quality (Model TH). The respective results are presented in *Table 1* and hereinafter.

As the analysis reveals, *investment*⁸ and *diesel tariffs* prove, in the absolute majority of combinations, to be the most sustainable and statistically significant⁹ among traditional linear multivariate regressions for this sample of countries. For the analyzable group of countries the first factor verifies the assumption that investing activity should be boosted for raising energy efficiency (factor of supply). Increased investing activity is believed to arise *inter alia* from replacement of obsolete, energy-consuming equipment, production of energy-saving devices and machines, and release of cost-effective cars, retrofitting of thermal power grids and construction of energy efficient buildings and facilities, improved structure of an economy, rapid growth in new industries and services with moderate energy demand.

The second factor¹⁰ generates demand for energy-saving technologies and fuel-efficient vehicles. As

⁸The result of the investment factor is tentative and subject to further specification, since a growth in investment can influence not only energy efficiency, but also GDP (the relevance of endogeneity studies).

⁹The factors marked with asterisks:
*** – 1-percent significance, ** – 5-percent significance, * – 10-percent significance.

the result shows, effective tariff regulation, development of commodity markets, conditions for industrial small business, other mentioned premises constitute one of the principal requirements for abating the energy intensity of an economy as a whole in the majority of emerging countries and CIS countries.

Government effectiveness and initial level of annual mean temperature proved to be other factors that demonstrated their statistical significance if included into a linear regression (Models L1–L3). Being combined with the first two factors, they explained from 33 to 44 percent of fluctuations in energy efficiency trends within the analyzable group of countries.

Whereas the government effectiveness factor is statistically significant, it proves the importance of increasing the quality of public services, i.e. the efficiency of public administration, efficacy of reforms, securing guarantees for property rights and other contemporary requirements to the State. This factor turns to be especially influential on resource-rich developing countries (conditional variable *inresr*), including *inter alia* some CIS countries (Russia, Kazakhstan, Uzbekistan). This is evident from the fact that the coefficient of the *goveff* factor significantly rises (from +2.75 up to +5.68) when model L2 is substituted with model L3, where the factor is integrated into the regression as the product of *goveff*inresr*. The possible reason is that the effective government ensures more reasonable use of revenue from export of natural resources by setting pools of development funds, adhering to fiscal rules and other mechanisms for reinforcing technological, S&T and human capital. It also exerts more stringent control over the reasonable use of energy resources and reduce their loss.

As for a positive correlation between energy efficiency and average mean temperature in the country, it could be possibly explained by the prevalence of obsolete and worn-out systems of heat and hot water supply in cities of the CIS

countries with cold climate. Such systems require ongoing technical maintenance and cause substantial energy losses¹¹ [17]. In the mean time, energy efficiency elasticity is low for this factor (from +0.053 to +0.083). It may reflect other correlations with the opposite sign. For example, higher electricity consumption in hot countries due to air conditioning and irrigation.

As for other possible areas and conditions for energy efficiency growth (increased openness of economy, improvement of the economy structure, increased expenses for education, R&D, etc.), expected results were not attained with respective indicators introduced into linear regression factors (statistical insignificance of respective coefficients or illogical signs. Refer to model L3 with the manufacturing sector becoming a new factor). Hence, I test the hypothesis on the nonlinear correlation between those factors and energy efficiency.

The hypothesis was verified concerning two factors, i.e. the share of manufacturing industries as of the beginning of the period and the degree of economy openness (as of the beginning of the period, please refer to models L4, L5). They were included into the regression as a second degree polynomial. This form implies an inflection point and changes in the factor effect on energy efficiency provided that the factor takes on a certain value. Relying upon calculations for the initial development level of manufacturing industries *inmanuf*, I conclude that the industry expansion (percentage of GDP), in the given sample of emerging economies, has an adverse effect on energy intensity initially. The industry expansion has a positive effect if only the industry accounts for 35 to 40 percent of GDP.

This may be due to the fact that traditional types of production prevail in the industry structure at the initial development phase (fabrics, food, construction materials, conventional chemical products, etc.). They have relatively high energy intensity of output. When the industry reaches a certain technological level, modern manufacturing types take a lead (electronics, components). They

¹⁰ I have chosen the *diesel tariff* indicators in line with available information in the World Bank database since there are not other indicators reflecting prices for secondary energy resources (prices for petrol, electricity, etc.).

¹¹ This conclusion is consistent with findings made in the research by R.R. Khabibrakhmanov and others, stating that energy intensity of economy has a negative correlation with annual mean temperature.

have high value added and relatively low specific energy intensity.

At the final step of the analysis, I examine whether the hypothesis of threshold values in regulatory quality indicators is applicable to the sample. Threshold overrun provides for a positive and statistically significant effect of the remaining factors, which are not included into models L1–NL2 (*Table 1*). For this purposes, I use a linear regression with the following threshold values:

$$eneff = c + a_1 \cdot CV_1 + a_2 \cdot CV_2 \dots + \varepsilon_1 \cdot (th_1 - QI) \cdot R_1 + b_2 \cdot (th_2 - QI) \cdot R_2 + \dots (\text{Model TH}),$$

where *eneff* is energy efficiency;

QI is regulatory quality (Control of Corruption Index *corrup*, Government Effectiveness *goveff*, etc.);

$R_{1,2,\dots,n}$ stands for potential drivers of energy efficiency growth, with their effect on energy intensity of an economy depending on the regulatory quality (increased expenses for education, growing fuel tariffs, greater extent of economic openness, etc.);

$CV_{1,2,\dots,n}$ stands for control variables, such as investment, conditional variable for countries with large natural resource endowments, input conditions, etc.;

c is a constant;

$a_{1,2,\dots,n}$, $b_{1,2,\dots,n}$ are regression coefficients.

If the regression estimation reveals negative results and significance of the coefficient *b*, as well as a positive and significant value of the parameter *th*, the *R*-factor growth will invoke an increase in energy efficiency only in case the regulatory quality *QI* of a certain country exceeds the threshold value *th*.

Having tested this correlation form, I obtain two models for such factors as *education expenses* and *S&T costs*. The first one is expressed as follows:

$$\begin{aligned} Eneff = & -1,56 + 0,067 \cdot \underset{0,1}{intemp} + 0,188 \cdot \underset{0,01}{invest} + \\ & + 5,11 \cdot \underset{0,02}{goveff} \cdot \underset{0}{inres} + 2,8 \cdot \underset{0}{diesel} + \\ & + 0,29 \cdot \underset{0,15}{(1,95 - incorrupt)} \cdot \\ & \cdot edbudlagv \quad (\text{Model TH 1}) \\ R^2 = & 0,42 \quad SE = 1,97 \quad num. \text{ of obs.} = 43 \end{aligned}$$

In this case, the education expenses factor is used as education expenses as percentage of total budgetary spending with a certain lag (ranging from three to five years). It verifies the hypothesis stating that increased education expenses influence energy efficiency in a certain period of time, rather than immediately.

The model's coefficients are of statistical significance as proved with the *pval* value indicated in brackets under the coefficients. The coefficient of the *edbudlagv* factor (–0.29) is the only exception, but its *pval* value of 0.15 approximates the 10-percent level of significance.

The threshold value of the Corruption of Control Index (initial value, *incorrupt*) is 1.95 implying that increased education expenses will have a positive effect on energy efficiency provided that the index is above 1.95. The more the index in a certain country exceeds this value, the greater effect increased expenses have on energy efficiency.

The result can be interpreted as follows. The low Control of Corruption Index signifies the possibility of deriving big income that has no relation to labor productivity or qualification. It suppresses motivation for good education, making it formalistic and affecting the quality of teaching. This situation causes an outflow of the most promising and creative students and streams them to foreign universities. It reduces the share of qualified talent needed to address energy saving issues. In such circumstances, increased education expenses will not substantially solve the problem of energy efficiency.

In the majority of the sampled countries, this index exceeds its threshold value. The average and median values were 2.09 and 2.01 respectively. It means increased education expenses are one of the factors improving energy efficiency in those countries.

In the mean time, regulatory quality in relation to the *edbud* factor is not enough for the leading CIS countries to solve the problem of energy efficiency. As of the beginning of the reporting period, this index was 1.6 in Russia and Uzbekistan, while it was 1.42 in Kazakhstan and Ukraine, being significantly lower than the required threshold value (1.95).

S&T expenses became the second factor. The resultant model is expressed as follows:

$$\begin{aligned} E_{\text{eff}} = & -1,81 + 0,07 \cdot \text{intemp} + 0,17 \cdot \text{invest} + \\ & + 7,11 \cdot \text{goveff} \cdot \text{inresr} + 2,94 \cdot \text{diesel} - \\ & - 3,61 \cdot (3,01 - \text{incorrupt}) \cdot \text{rnd01} \quad (\text{Model TH 2}) \\ R^2 = & 0,47 \quad SE = 1,76 \quad \text{num. of obs.} = 42 \end{aligned}$$

Six countries in the sample meet the criterion. These are South Africa (3.1), Poland (3.05), Hungary (3.2), Costa Rica (3.26), Chile (4.04), Botswana (3.17). Hence, in the absolute majority of emerging countries, increased S&T expenses will not approximate the resource-saving model of development, unless regulatory quality and potential grow exponentially, thus ensuring positive and sustainable trends in the Control of Corruption Index and regulatory quality.

I obtain the similar result from the sample of average annual estimates of the indicators concerning the *diesel tariff* factor. The respective regression equation is expressed as follows:

$$\begin{aligned} E_{\text{eff}} = & 8,77 + 0,08 \cdot \text{temp} - 1,54 \cdot \text{inresr} - \\ & - 1,98 \cdot (3,11 - \text{rol}) \cdot \text{diesel}; \\ R^2 = & 0,13 \quad SE = 3,2 \quad \text{num. of obs.} = 49. \\ & (\text{Model TH 3}) \end{aligned}$$

Although the first two factors (temperature and resource endowments of a country) are formally incompliant with statistical significance criteria, coefficients for threshold estimation meet them.

The outcome means that diesel tariffs will grow without improving energy efficiency of an economy as a whole unless regulatory quality (by regulatory compliance indicator *rol*) does not match the threshold of 3.11, being seen in Malaysia (3), Costa Rica (3), etc.

What Message Do the Results Convey for Economic Policy?

Boosting investing activities shall become a cornerstone for raising energy efficiency nationwide. It is proved with the persistence of the *investment* factor and its presence in all the models obtained from the econometric analysis.

Uzbekistan and other CIS countries, especially ones with sufficient resource endowments (Kazakhstan, Russia, Azerbaijan), really need to undertake relevant measures so as to improve the investment environment, grant tax and other benefits to actively investing enterprises, increase monetization levels by making lending resources more accessible and affordable. While the average annual estimate of gross investment in Uzbekistan was 22 percent of GDP in the reporting period, it exceeded 30 percent for some developing countries in the analyzable sample, i.e. China (42 percent), Iraq (37 percent), India (34 percent), Botswana (33 percent), Morocco (32 percent), etc.

Energy saving priorities of an investment policy should not be neglected. The investment policy should pursue retrofitting the most energy intensive production, adopting new energy- and resource-saving standards in construction, utilities, transport, creating modern enterprises and industries manufacturing new household devices, more energy efficient industrial and technical equipment.

Uzbekistan may benefit from retrofitting and refurbishment of electric power engineering, chemical industry, production of industrial construction materials. According to the existing estimates¹², the wear and tear level of principal generating capacities (thermal power station) accounts for 62 percent, with the average energy conversion efficiency being just 33.5 percent, that is 1.5 times as low as the identical indicator of modern thermal power stations in Southeast Asia. If six major power plants have combined cycle gas turbine units installed to generate electricity, they will cut their gas consumption down to 270–300 tonne of gas equivalent per 1 kilowatt hour of electricity as compared with the current consumption of 375 tonnes of gas equivalent. The measure will substantially save fuel and gas, in particular.

Similar reserves are made to produce fertilizers and industrial construction materials. If the Haldor Topsoe installation is used, 900 m³, instead of 1,870 m³, will be used to produce one tonne of

¹² Based on the Report, *Energy Efficient Model of Growth*, by the Center of Economic Research.

ammonium. Thus, there will be a 1.5 to 2-fold reduction in operating and maintenance costs of the equipment.

Instead of the wet process, the dry process for manufacturing of cement cuts the specific consumption of gas from 230–250 kg of coal equivalent to 100–120 kg (as seen in cement manufacturing plants of Japan, Korea, China, Turkey).

A reasonable increase in tariffs for motor and other fuel is the second significant factor of energy efficiency, as the econometric analysis reveals. Average annual prices for diesel and petrol in Uzbekistan were significantly lower than the average in the sample of developing countries.

Furthermore, rapidly growing prices and tariffs for energy supplies may have a detrimental effect due to insufficiently developed institutions (please refer to Model TH3). The analysis validates this conclusions macroeconomically¹³. The consumption of energy resources accounts for 64 percent of the selling price of goods, say, at chemical enterprises of Uzbekistan (against 25–30 percent of identical foreign enterprises). In such circumstances, rapid growth in gas and electricity prices will instigate a commensurable rise in selling prices of fertilizers and other chemical products, undermine their competitiveness and affect enterprises' financial position, unless production facilities are fundamentally retrofitted and the quality of governance and State aid is enhanced (*Fig. 3*).

Raising education and R&D expenses constitutes another tool of an economic policy to improve

energy efficiency of the national economy. However, this approach and its efficacy strongly depends on the regulatory quality that should be supported with the high Control of Corruption Index. This approach is not productive in Uzbekistan since the Control of Corruption Index has been ranging from 1.2 to 1.4 for recent years, according to the World Bank data, meanwhile it shall be 1.9 for education (Model TH1) and 3 for R&D (Model TH2). The average Control of Corruption Index is slightly higher than 2 in the given sample, being quite sufficient for *increased education expenses*, but inadequate for increased R&D expenses.

Therefore, an elaborate methodological approach to the problem of high energy intensity of economy spotlights promising areas and measures for solving the issue and underpin them. The comparison of factual values of the resultant factors and conditions of Uzbekistan with threshold values and global benchmarks shows that the regulatory quality shall be improved¹⁴ as the first remedy in this case. Hence, the regulatory reform should be the top priority in the energy efficiency race. The regulatory reform is indented to expand the potential of governmental institutions in combatting corruption¹⁵ (primarily, distribution and control of energy resources), ensuring fair competition, developing competitive markets, creating the favorable investment climate and energy saving incentives, protecting investors' rights, coordinating activities of the public and private sectors for addressing this issue.

A similar analysis can be conducted for other CIS countries.

¹³ Report on energy efficient model of Uzbekistan's growth by the Center for Economic Research.

¹⁴ This is a general definition used by the World Bank and other international organizations, which quantify the regulatory quality. The principal indices include Corruption Perceptions Index (CPI) (the ability of the State to design and implement anti-corruption measures); Rule of Law (RoL), Government Effectiveness (GE). You may refer to articles by I.A. Nikolaeva and E.Sh. Gontmakher concerning these and other indices of regulatory quality.

¹⁵ In early 2017, the Republic of Uzbekistan adopted the Law *On Combatting Corruption* so as to enhance the efficacy of anti-corruption measures.

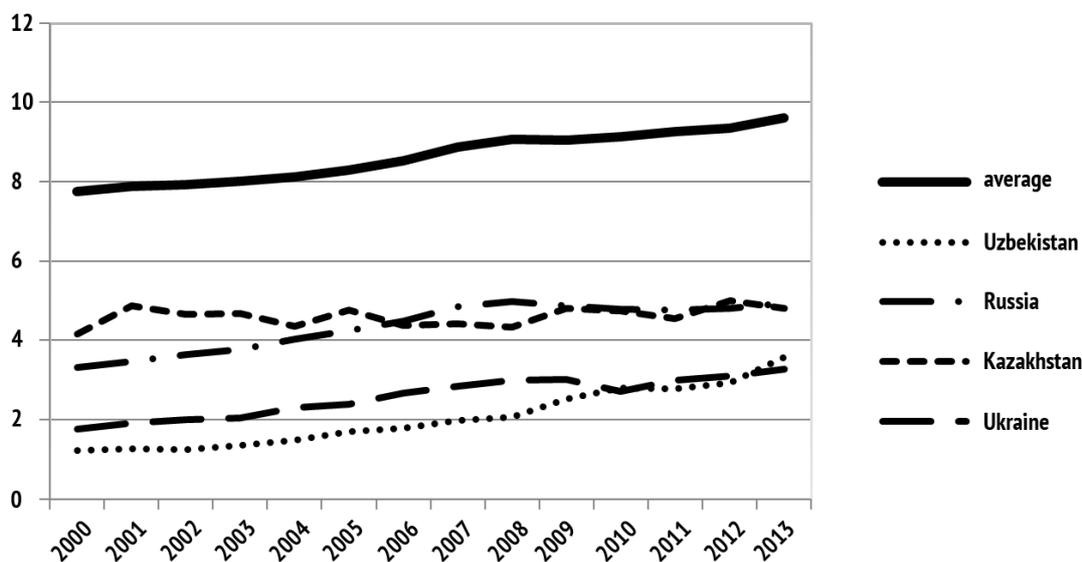
Table 1**The results of econometric analysis of macroeconomic conditions and preconditions for growth of the energy efficiency of economy, in general**

Factors and conditions	Dependent variable – increase in energy efficiency (<i>eneff</i>)				
	Model L1	Model L2	Model L3	Model NL1	Model NL2
1. Investment (<i>invest</i>)	0.14**	0.14	0.13**	0.13**	0.12*
2. Government effectiveness (<i>goveff</i>)	2.75**	–	–	–	–
3. Diesel tariffs (<i>diesel</i>)	2*	2.49***	2.69**	2.56***	2.57***
4. Temperature level (<i>intemp</i>)	0.053	0.069*	0.083**	0.077**	0.066*
5. Conditional variable for resource-rich countries and government effectiveness (<i>inresr*goveff</i>)	–	5.68***	6.01***	5.86***	4.7**
6. Share of manufacturing sector (<i>manuf</i>)	–	–	–0.11	–	–
7. Initial share of manufacturing sector (<i>inmanuf</i>)	–	–	–	–0.286	–0.608*
8. (<i>inmanuf</i>) ²	–	–	–	+0.0074	0.016***
9. Initial openness of economy (<i>inecopen</i>)	–	–	–	–	5.98*
10. (<i>inecopen</i>) ²	–	–	–	–	–4.34**
R2	0.33	0.38	0.41	0.41	0.49
Number of countries	48	48	47	47	44
SE Regression	1.97	1.91	1.9	1.92	1.81

Source: Authoring, based on the World Bank statistics for 50 developing countries comparable with Uzbekistan

Figure 1

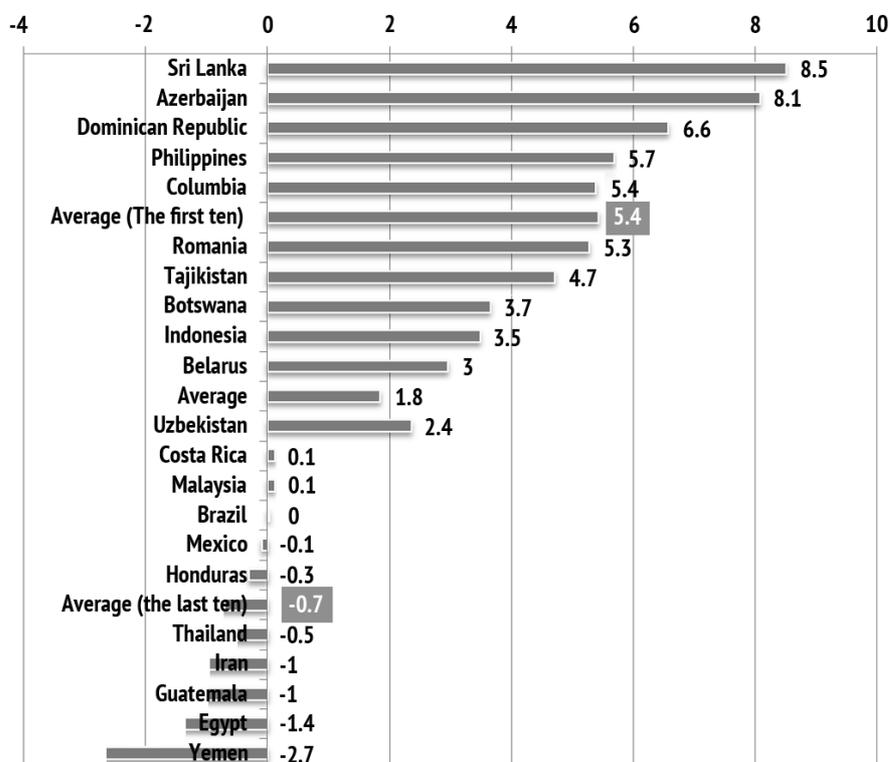
Dynamics of energy efficiency (EE) of the CIS in 2000–2013 in comparison with the average rates for developing countries (GDP at PPP in USD in constant prices, 2011, per 1 kg of oil equivalent of natural energy)



Source: Authoring, based on the World Bank WDI

Figure 2

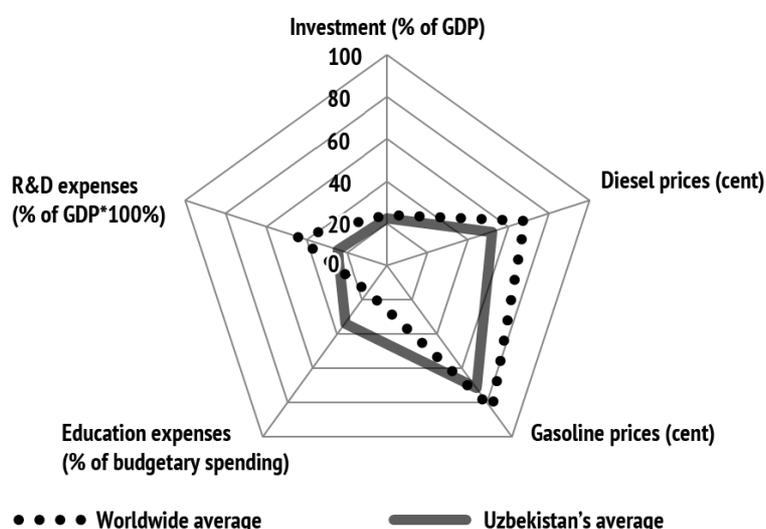
The first and last tens of developing countries according to the criterion of energy efficiency increase in 2000–2013



Source: Authoring, based on the World Bank WDI

Figure 3

The gap between Uzbekistan (mid-year estimates for the reporting period) and the average level (average for sample of 50 developing countries) by economic policy indicator



Source: The World Bank data

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References

1. Bashmakov I.A., Myshak A.D. [Factor Analysis of Evolution of Russian Energy Efficiency: Methodology and Outcomes]. *Voprosy Ekonomiki*, 2012, no. 10, pp. 117–131. (In Russ.)
2. Boiko M.S. [Energy saving as a key factor of Russian economic and national safety]. *Upravlenie ekonomicheskimi sistemami*, 2017, no. 2. (In Russ.)
URL: <http://uecs.ru/demografiya/item/4289-2017-02-15-06-52-40?pop=1&tmpl=component&print=1>
3. Bashmakov I.A. [What reduces the energy intensity of Russia's GDP]. *Energoberezheniye*, 2014, no. 1, pp. 12–17. URL: https://www.abok.ru/for_spec/articles.php?nid=5718 (In Russ.)
4. Gukasova N.R. [Instruments to increase an energy efficiency of the Russian industry]. *Statistika i ekonomika = Statistics and Economics*, 2015, no. 1, pp. 144–148.
URL: <https://cyberleninka.ru/article/n/instrumenty-povysheniya-energoeffektivnosti-rossiyskoy-promyshlennosti> (In Russ.)
5. Ermolaev K.A. [The impact of energy saving and energy efficiency enhancement on national economies' innovative development]. *Ekonomicheskii analiz: teoriya i praktika = Economic Analysis: Theory and Practice*, 2017, vol. 16, iss. 1, pp. 82–92. (In Russ.) URL: <https://doi.org/10.24891/ea.16.1.82>
6. Chepel' S. [How to raise the efficiency of economic policy: The empirical analysis of State institutions]. *Voprosy Ekonomiki*, 2009, no. 7, pp. 62–74. (In Russ.)

7. Volkonskii V.A., Kuzovkin A.I. [Analysis and assumptions of energy consumption and energy saving of Russian economy]. *Problemy prognozirovaniya = Problems of Forecasting*, 2006, no. 1, pp. 53–61.
URL: <https://ecfor.ru/publication/analiz-i-prognoz-energoemkosti-i-energoeffektivnosti/> (In Russ.)
8. Kuzovkin A.I. [Forecast of energy consumption of GDP of Russia and developed countries as at 2020]. *Problemy prognozirovaniya = Problems of Forecasting*, 2010, no. 3, pp. 144–148.
URL: <https://ecfor.ru/publication/prognoz-energoemkosti-vvp-rossii-i-razvityh-stran-na-2020-g/> (In Russ.)
9. Kaygusuz K. Energy for Sustainable Development: A Case of Developing Countries. *Renewable and Sustainable Energy Reviews*, 2012, vol. 16, iss. 2, pp. 1116–1126.
URL: <https://doi.org/10.1016/j.rser.2011.11.013>
10. Reddy A.K.N. Barriers to Improvements in Energy Efficiency. *Energy Policy*, 1991, vol. 19, iss. 10, pp. 953–961. URL: [http://dx.doi.org/10.1016/0301-4215\(91\)90115-5](http://dx.doi.org/10.1016/0301-4215(91)90115-5)
11. Sutherland R.J. Market Barriers to Energy-Efficiency Investments. *The Energy Journal*, 1991, vol. 12, no. 3, pp. 15–34. URL: <https://doi.org/10.5547/ISSN0195-6574-EJ-Vol12-No3-3>
12. Golove W.H., Eto J.H. Market Barriers to Energy Efficiency: A Critical Reappraisal of the Rationale for Public Policies to Promote Energy Efficiency. Berkeley, Energy & Environment Division, Lawrence Berkeley National Laboratory, University of California, 1996, 66 p.
13. Eyre N. Barriers to Energy Efficiency: More Than Just Market Failure. *Energy & Environment*, 1997, vol. 8, iss. 1, pp. 25–43.
14. Suslov N.I. Energy Saving Incentives and Institutional Environment: A Cross Country Analysis. Part 1. *Mir ekonomiki i upravleniya = World of Economics and Management*, 2014, vol. 14, iss. 2, pp. 61–70.
URL: <https://cyberleninka.ru/article/n/energy-saving-incentives-and-institutional-environment-a-cross-country-analysis-part-1>
15. Meyers S. Improving Energy Efficiency: Strategies for Supporting Sustained Market Evolution in Developing and Transitioning Countries. Berkeley, Lawrence Berkeley National Laboratory, 1998, 79 p.
16. Farrell D., Remes J.K. How the World Should Invest in Energy Efficiency. *The McKinsey Quarterly*, July 2008.
17. Khabibrakhmanov R.R., Ryzhkova L.V. [Factors determining the energy consumption of the domestic economy]. *Upravlenie ekonomicheskimi sistemami: elektronnyi nauchnyi zhurnal*, 2012, no. 12. (In Russ.)
URL: <http://uecs.ru/marketing/item/1802-2012-12-14-08-08-27?pop=1&tmpl=component&print=1>

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.

Translated Article[†]

INCORPORATION OF RATING PARAMETERS INTO THE PERPETUITY LIMIT OF THE BRUSOV–FILATOVA–OREKHOVA MODERN THEORY OF CAPITAL STRUCTURE



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Abstract

Importance The research focuses on the existing systems of rating, respective methodologies and weaknesses of these methods.

Objectives We modify the methodology embedded into the existing rating systems and devise a brand new approach based on the appropriate application of discounting to cash flows, use of rating ratios while discounting, correct assessment of discount rates in line with financial ratios.

Methods The research deals with the perpetuity limit of the Brusov–Filatova–Orekhova modern theory of capital cost and capital structure. We also rely upon the modified theory for rating purposes and ratios.

Results We modify the methodology of the existing rating systems and devise an absolutely new approach to it.

Conclusions and Relevance Modifying the rating methodology, we make our own assessments more accurate and unbiased. Using the toolkit of the developed theories, we reach new horizons of the rating practice since it enables the rating segment to predominantly use quantitative methods. The proposed approach should be applied by all rating agencies in assessing the creditworthiness of issuers.

*The editor-in-charge of this article was Irina M. Vechkanova
Authorized translation by Irina M. Vechkanova*

Introduction

In 2015, the leading rating agencies (RA) (Big Three – Standard & Poor's, Fitch and Moody's) downgraded the sovereign credit rating of Russia to non-investable, or junk status (BB+).

The sovereign credit rating decline has severe repercussions for the country, apart from tangible moral damage, and dramatically adverse effects. Foreign investors cannot make financial injections into non-investable economies, thus decreasing or even curbing foreign investment in the economy.

Are the credit ratings objective or politically biased, as the Russian Ministry of Finance reckons?

Can the Big Three ratings be essentially objective as well as ones provided by the other agencies (existing or newly established rating agencies, including European, Russian–Chinese, national, BRICS ones, etc.)? To answer this question, we should be cognizant of the methods rating agencies use to compute, assess, and analyze. However, this is a closely guarded secret. Rating agencies are extremely persistent in keeping their secrets even if they are threatened by multi-billion sanctions. For example, in August 2011, having downgraded the U.S. sovereign credit rating, Standard & Poor's caused the collapse of markets. Threatening with serious sanctions, a representative of the U.S. Department of the Treasury required S&P to disclose their methods of analysis but even this pressure did not make them do it. Thus, rating agencies are in fact a kind of *black boxes*, with the information about their methods being almost unavailable.

The Closed Nature of Rating Agencies

Rating agencies are so closed systems due to several reasons:

[†]For the source article, please refer to: Брусов П.Н., Филатова Т.В., Орехова Н.П., Кулик В.Л. Инкорпорирование параметров, используемых в рейтинговании, в перпетуитетный предел современной теории структуры капитала Брусова–Филатовой–Ореховой. *Финансы и кредит*. 2017. Т. 23. Вып. 40. С. 2378–2397.
URL: <https://doi.org/10.24891/fc.23.40.2378>

- 1) they preserve their *know how*. Rating agencies gain rather high earnings from ratings they release (mostly from issuers). That is why they are reluctant to disseminate their methodologies;
- 2) they avoid public speculations on their ratings, including the ranked entity (issuer). It is very convenient behavior since rating agencies *a priori* protect themselves from any criticism;
- 3) as their methodologies are not controlled and analyzed externally, their drawbacks are not subject to critical analysis, thus existing for a very long time.

Playing upon democratic principles, some newly established rating agencies arrange public arguments about draft methodologies and publish only some principles and outlines of a methodology, that is the *tip of an iceberg*, thus preventing specialists from reviewing its *underwater body*.

As an illustration of the closed nature of rating agencies, we refer to the way S&P's CEO behaved after the U.S. sovereign credit rating was downgraded. He left his office but refused to disclose the methodology used. Moreover, S&P paid USD 1.5 billion to the U.S. Department of the Treasury.

However, even in such a situation of *closedness*, relying on knowledge and understanding of the existing evaluation methods, it is still possible to analyze, in some way or another, operations and conclusions of rating agencies. Rating agencies cannot use methods that are different from those ones leading economists and financiers have elaborated by the time.

The cost of corporate capital and capitalization assessed respectively are the most critical values used to make ratings. Assessments of the indicators are used to rank both particular companies and States. After S&P decreased the sovereign credit rating of the USA, the U.S. Department of the Treasury blamed them for a mistake worth USD

2 trillion, while the Security and Exchange Commission intended to scrutinize the S&P's rating model. Where is the truth?

The Use of Discounting in Rating

Despite their extensiveness and detailed approach, the existing methodologies have a lot of drawbacks. As for one of the considerable drawbacks of all the existing rating methodologies, they fail to use discounting or use it in a limited way. Even in those rare cases when discounting is applied, it is not quite properly done because the discount rate is chosen incorrectly.

In discounting, the timing factor shall be obviously used since it relates to the time value of money. Financial aspects of rating are based on the comparison of proceeds and the debt and interests. Whereas the time of yields and repayment of the principal and interests differs, the comparison of yields with the principal and interests absolutely necessitates the use of discounting to assign credit ratings to issuers.

In this respect, the question of the discount rate rises. This issue has always been dominant and challenging in finance [1–28], i.e. corporate finance, investment, especially business valuation, where even a slight change in the discount rate substantially modifies the company's capitalization (*mala fide* appraisers make use of it to artificially declare companies as bankrupt). The discount rate is especially important for purposes of ranking, assigning ratings to issuers and forecasting.

Incorporating Parameters Used in Ratings into Modern Theories of Capital Structure

In this article we propose a brand new approach to the rating methodology, the key aspect of which is adequate usage of cash flow discounting that the existing rating methodologies almost omit. It is the first time the discounting involves rating ratios.

For this purpose, rating ratios (financial ratios) were incorporated for the first time into the Brusov–Filatova–Orekhova modern theory of capital structure (BFO theory) (first of all, into its perpetuity limit) [1].

Constituting various ratios (direct or inverse) of generated income to the principal and interests, financial ratios play a significant role in determining the creditworthiness of issuers. We mean such ratios, as *DCF/Debt*, *FFO/Debt*, *CFO/Debt*, *FOCF/Debt*, *FFO/cash interest*, *EBITDA/interest*, *Interests/EBITDA*, *Debt/EBITDA* and so on.

It is important to introduce rating ratios into the BFO modern theory of capital structure and its perpetuity limits – the Modigliani–Miller theory so that it could be used as a robust tool to discount cash flows at correct discount rates. The BFO theory contributes to adequate assessment of the Weighted Average Cost of Capital (WACC) and its equity cost k_e applied to discount cash flows.

Tools of the well developed theories open up new horizons for the rating practice. The tools enable the rating practice to move from qualitative methods to the prevalence of quantitative ones in rating, thus definitely enhancing the quality and accuracy of ratings.

Currently, rating agencies apply financial ratios only directly, while the new methodology helps determine the correct values of discount rates (WACC and k_e) used to discount cash flows in line with the payment schedule and forecasting purposes, provided that the values of those ratios are known (and the parameter k_D).

It entailed the modification of the BFO theory and its perpetuity limit – the Modigliani–Miller theory since the concept of leverage in financial management as the debt-to-equity ratio differs from leverage in rating, that is, the ratio of a loan, loan interests to earnings. Inverse ratios (various earnings-to-loan/loan interests) are also used, the so called coverage ratios (principal, interests).

We introduce additional ratios that contribute to a more thorough description of the issuer's ability to repay debts and loan interests.

Hence, we build a bridge between discount rates used to discount various cash flows and ratios used in rating. We devise an algorithm for determining discount rates with rating ratios being given.

We afterwards propose two models (one-period and multi-period ones) designed to evaluate the issuers' creditworthiness through discounting.

Models for Evaluating the Issuers' Creditworthiness Through Discounting

One-Period Model

The one-period model is expressed with the following formula (Fig. 1):

$$CF(1+i)^{t_2-t_1} \geq D + k_d D(1+i)^{t_2-t_1};$$

$$CF(1+i)^{t_2-t_1} \geq D[1 + k_d D(1+i)^{t_2-t_1}],$$

where CF is the amount of income for the period;

D is the amount of a loan;

t , t_1 , t_2 are moments of yields, repayment of the principal and interests respectively;

i is the discount rate;

k_d is the interest rate on a loan;

$k_d D$ are interests on a loan in kind (monetary value).

Multi-Period Model

The one-period model for the issuer's creditworthiness evaluation, which implies the discounting of cash flows, can be generalized and adjusted for a more interesting multi-period case.

The multi-period model is expressed with the following inequality:

$$CF_j(1+i)^{t_{2j}-t_{1j}} \geq D_j[1 + k_{dj}(1+i)^{t_{2j}-t_{1j}}],$$

where $j=1,2,\dots,n$ (n is the number of periods);

CF_j is the amount of income for the j -period;

D_j is the amount of a loan in the j -period;

t_j , t_{1j} , t_{2j} are moments of yields, repayment of the principal and interests in the j -period respectively;

i is the common discount rate for all the periods (though, if needed, the special discount rate i_j for the j -period can be introduced);

k_{dj} is the interest rate on a loan in the j -period;

$k_{dj}D_j$ are interests on a loan in kind (monetary value) in the j -period.

The same inequality is also present:

$$\sum_j CF_j(1+i)^{t_{2j}-t_{1j}} \geq \sum_j D_j[1 + k_{dj}(1+i)^{t_{2j}-t_{1j}}].$$

There may be several options to deal with the models.

1. The issuer's creditworthiness can be verified if CF_j , D_j , t_j , t_{1j} , t_{2j} , k_{dj} are available and the discount rate i is assessed with the method given further.
2. If D_j , t_j , t_{1j} , t_{2j} , k_{dj} are given, it is possible to determine which income CF_j the issuer will need to ensure its creditworthiness.
3. If CF_j , t_j , t_{1j} , t_{2j} are given, it is possible to determine the tolerable level of debt financing (including the amount of the loan D_j and the interest rate on loans k_{dj}) that preserves the issuer's creditworthiness.

The Theory of Incorporating Rating Parameters into Modern Theories of Capital Structure

We introduce parameters used in rating into the perpetuity limit of the BFO modern theory of capital structure [1] – the Modigliani–Miller theorem [4–6] for the first time.

We suggest reviewing two types of rating ratios, i.e. coverage and leverage ones.

We begin with the coverage ratios in relation to the principal and respective interests.

Coverage Ratios

Debt-Service Coverage Ratio

We are going to focus on three types of coverage ratios: debt-service coverage, interest coverage and debt-and-interest coverage ratio. It is worth mentioning that we present the latter type for the first time in order to provide a more comprehensive description of the issuer's ability to repay its debts and interests on them.

Hereinafter we put it as $i_1 = CF/D$.

According to the Modigliani–Miller theorem in case of corporate taxes [4–6], the capitalization of the levered company (using debt financing) V_L equals that of the unlevered company (abstaining from debt

financing) V_0 times the value of tax shield for an infinite period of time Dt .

$$V_L = V_0 + Dt.$$

Inserting the capitalization expressions through earnings per period CF , we arrive at the following system:

$$\frac{CF}{WACC} = \frac{CF}{k_0} + Dt;$$

$$\frac{i_1}{WACC} = \frac{i_1}{k_0} + t;$$

$$WACC = i_1 \frac{k_0}{i_1 + tk_0}.$$

This ratio may be used to evaluate such rating parameters as $DCF/Debt$, $FFO/Debt$, $CFO/Debt$, $FOCF/Debt$, etc.

Hereinafter we apply the following denotations:

$EBITDA$ 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.

Interest Coverage Ratio

$$V_L = V_0 + Dt.$$

$$\frac{CF}{WACC} = \frac{CF}{k_0} + Dt;$$

$$\frac{i_2}{WACC} = \frac{i_2}{k_0} + \frac{t}{k_d};$$

$$WACC = \frac{i_2 k_0 k_d}{i_2 k_d + tk_0}.$$

It is given here as $i_2 = CF / k_d D$.

This ratio can be used to evaluate such rating parameters as $FFO/cash\ interests$, $EBITDA/interest$, etc.

Debt-and-Interest Coverage Ratio (A New Parameter)

$$V_L = V_0 + Dt.$$

$$\frac{CF}{WACC} = \frac{CF}{k_0} + Dt;$$

$$\frac{i_3}{WACC} = \frac{i_3}{k_0} + \frac{t}{1+k_d};$$

$$WACC = \frac{i_3 k_0 (1+k_d)}{i_3 (1+k_d) + tk_0}.$$

Here it is expressed as $i_3 = \frac{CF}{D(1+k_d)}$.

This ratio can be applied to evaluate such rating parameters as $FFO/Debt+interest$, $EBITDA/Debt+interest$, etc.

Leverage Ratios

The Leverage Ratio of the Loan (Debt)

$$l_1 = D / CF.$$

$$\frac{CF}{WACC} = \frac{CF}{k_0} + Dt;$$

$$\frac{1}{WACC} = \frac{1}{k_0} + l_1 t;$$

$$WACC = \frac{k_0}{1 + tl_1 k_0}.$$

This ratio can be applied to evaluate such rating parameters as $Debt/EBITDA$, etc.

The Leverage Ratio of Loan Interests

Here it is $l_2 = k_d D / CF$.

$$\frac{CF}{WACC} = \frac{CF}{k_0} + Dt;$$

$$\frac{1}{WACC} = \frac{1}{k_0} + \frac{l_2 t}{k_d};$$

$$WACC = \frac{k_0 k_d}{k_d + tl_2 k_0}.$$

This ratio can be applied to evaluate such rating parameters as $Interests/EBITDA$, etc.

The Leverage Ratio of the Debt and Interests

Assume that $I_2 = D(1+k_d)/CF$.

$$\frac{CF}{WACC} = \frac{CF}{k_0} + Dt;$$

$$\frac{1}{WACC} = \frac{1}{k_0} + \frac{I_2 t}{1+k_d};$$

$$WACC = \frac{k_0(1+k_d)}{1+k_d + I_2 t k_0}.$$

This ratio can be applied to evaluate such rating parameters as *Debt + interest/FFO*, *Debt + interest/EBITDA*, etc.

Studying the Dependence of the WACC on Rating Parameters

We examine how the WACC depends on rating parameters. Assume that $k_0 = 12\%$, $k_d = 6\%$, $t = 20\%$. The study concerned really different values of k_0 and k_d . Results are essentially similar.

The dependence of the WACC on the parameter i_2 , i.e. the dependence of the Weighted Average Cost of Capital on the interest coverage ratio is given in *Table 1* and *Fig. 2*.

The dependence of the WACC on the parameter i_3 , i.e. the Weighted Average Cost of Capital on the debt-and-interest coverage ratio, is given in *Table 2* and *Fig. 3*.

The dependence of the cost of capital on the debt-service coverage ratio, interest coverage ratio and debt-and-interest coverage ratio is presented in *Table 3* and *Fig. 4*.

A more thorough examination results in the following conclusions.

1. In case of the debt-and-interest ratio in relation to the loan i_3 , the WACC increases and gets saturated quite quickly: with a 20-percent precision if $i_3 = 0.15$, and a 5-percent precision if $i_3 = 0.5$.
2. In case of the debt-service coverage ratio i_1 , the WACC grows almost linearly alongside with an increase in the ratio i_1 , and gets saturated if $i_1 = 0.1$.
3. In case of the interest coverage ratio i_2 , the WACC rises at much slower pace, alongside with the ratio

i_2 , and gets saturated if i_2 has higher values: with a 10-percent precision if $i_2 = 4$.

4. We shall note that, as shown in *Table 1* and *3*, the dependencies of the WACC (i_1) and the WACC (i_3) approximate one another and almost converge in *Fig. 4*. It results from the low loan interest rate (6 percent). In case of considerable borrowings, the dependencies will differ more noticeably, including graphs.

The Dependence of the Weighted Average Cost of Capital on Leverage Levels l

We analyze the way the Weighted Average Cost of Capital (WACC) depends on the level of leverage l if the following parameters are given:

$k_0 = 12\%$; $k_d = 6\%$; $t = 20\%$; l ranges from 0 to 10.

Table 4 and *Fig. 5* showcase the dependence of the WACC on the leverage ratio of the loan l_1 .

The dependence of the WACC on the leverage ratio of interests on the loan l_2 is presented in *Table 5* and *Fig. 6*.

The dependence of the WACC on the leverage ratio of interests and principal on the loan l_3 is presented in *Table 6* and *Fig. 7*.

The dependence of the cost of capital on the leverage ratio of the principal, interest and combination of the principal and interests is presented in *Fig. 8*.

Having analyzed the dependence of the WACC on the leverage ratio of the principal l_1 , interests on the loan l_2 and combination of the principal and interests l_3 , we made the following conclusions. In case of all the three ratios l_1 , l_2 , l_3 , the WACC decreases as the leverage increases. In case of the leverage ratios l_1 and l_3 , the WACC drops in a similar way. It declines almost linearly from $k_0 = 12\%$ if $l_{1,3} = 0$, and down to 9.7% if $l_{1,3} = 10$. In case of the leverage ratio of interests on the loan l_2 , the WACC decreases not in a linear way and much faster, shifting from $k_0 = 12\%$ if $l_2 = 0$ down to 2.4% if $l_2 = 10$. Thus, the WACC decline point ($k_0 = 12\%$ if $l_{1,2,3} = 0$) and monotonous nature of this decline are common for all the three dependencies of the WACC on the leverage level, while the WACC decreases

much faster in case of the leverage ratio of interests on the loan l_2 than it does in cases of l_1 and l_3 . As seen in *Tables 4* and *6*, note that the dependencies $WACC(l_1)$ and $WACC(l_3)$ approximate one another and almost coincide in *Fig. 8*. It results from the low interest rate on the loan (6%). In case of the expensive borrowing costs, the difference between the dependencies will be more noticeable, including graphs.

How is the Discount Rate Measured?

In paragraphs below we discuss the algorithm for computing the discount rate, provided that one or several financial ratios are given (coverage ratios or leverage ratios).

The devised method helps measure the discount rate as precisely as possible in the BFO theory of capital structure or its perpetuity limit.

The Use of One Ratio

If one financial ratio (coverage ratio or leverage ratio) is known, the discount rate measurement algorithm implies the following steps in order to discount cash flows as part of the issuer's creditworthiness evaluation:

- 1) we determine the parameter k_0 . Please note that A.P. Brusova's methods for determining the parameter k_0 (WACC under zero leverage) [2] become one of the cornerstones in this part of the rating methodology;
- 2) having the values of k_0 , k_d and t and applying the devised methods, we construct a curve reflecting the dependence of the WACC on financial ratios (coverage ratio or leverage ratio), i.e. $WACC(i)$ or $WACC(l)$;
- 3) having the coverage ratio (i_0) or leverage ratio (l_0), we use the curves $WACC(i)$ or $WACC(l)$ to gauge the $WACC(i_0)$ or $WACC(l_0)$, which constitute the discount rate.

In our further researches, we will forge a similar method based on the BFO theory for arbitrary lifetime companies.

The Use of Several Ratios

If several financial ratios (say, m coverage ratios (i_j) and n leverage ratios (l_k)) are in place, the algorithm

for measuring the discount rate is modified in the following way so as to discount cash flows as part of the issuer's creditworthiness evaluation:

- 1) based on the given algorithm, we find m values of the $WACC(i_{0j})$ and n values of $WACC(l_{0k})$;
- 2) we compute the mean WACC using the following formula:

$$WACC_{av} = \frac{1}{m+n} \left[\sum_{j=1}^m WACC(i_{0j}) + \sum_{k=1}^n WACC(l_{0k}) \right].$$

It is the mean $WACC_{av}$ that represents the required discount rate used to discount cash flows in rating.

Conclusions

The article proposes a new approach to the rating methodology, the key factor of which is the appropriate use of cash flow discounting. The existing rating methodologies almost neglect it. It is the first time when the discounting is performed in line with rating ratios.

For this purpose, we incorporated the rating ratios (financial ratios) into the modern theory of capital structure by Brusov – Filatova – Orekhova (initially into its perpetuity limit). On the one hand, it helps involve a robust toolkit of the theory into the rating practice, but, on the other hand, it ensures the use of correct discount rates to discount cash flows.

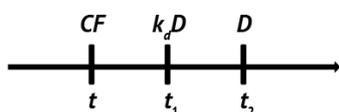
We proposed two models for the issuer's creditworthiness evaluation: one-period and multi-period ones. They help 1) verify the issuer's creditworthiness if CF_j , D_j , t_j , t_{1j} , t_{2j} , k_{dj} are known, and determine the discount rate $WACC_{av}$ with the devised method; 2) based on D_j , t_j , t_{1j} , t_{2j} , k_{dj} , determine which income CF_j the issuer will need to remain solvent; 3) based on CF_j , t_j , t_{1j} , t_{2j} , assess the tolerable level of the issuer's debt financing level (including values of the principal D_j and the interest rate on loans k_{dj}) so as to preserve its solvency.

The article sets out our method for determining the discount rate in line with the found rating ratios.

Thus, the above findings enable us to build a bridge between fundamental theories of corporate capital structure and rating methodologies.

The toolkit of the well developed theories opens new horizons for the rating practice, which can subsequently move from the prevalence of qualitative methods for creditworthiness evaluation to quantitative ones in rating, thus enhancing the quality and accuracy of ratings.

Figure 1
The one-period model



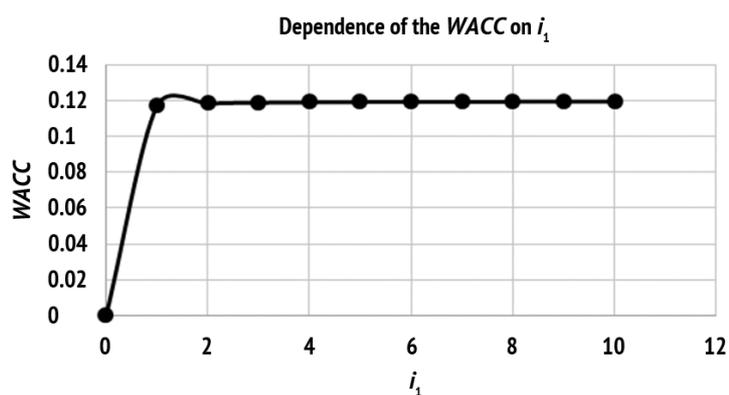
Source: Authoring

Table 1
Dependence of the WACC on the parameter i_1

t	i_1	k_0	K	WACC
0.2	0	0.12	0.06	0
0.2	1	0.12	0.06	0.1171875
0.2	2	0.12	0.06	0.1185771
0.2	3	0.12	0.06	0.1190476
0.2	4	0.12	0.06	0.1192843
0.2	5	0.12	0.06	0.1194268
0.2	6	0.12	0.06	0.1195219
0.2	7	0.12	0.06	0.11959
0.2	8	0.12	0.06	0.1196411
0.2	9	0.12	0.06	0.1196809
0.2	10	0.12	0.06	0.1197127

Source: Authoring

Figure 2
Dependence of the WACC on the Debt Service Coverage Ratio i_1

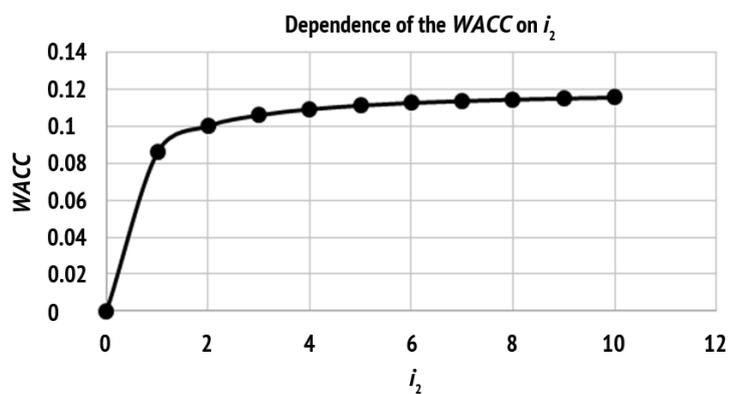


Source: Authoring

Table 2Dependence of the WACC on the parameter i_2

t	i_2	k_0	kd	WACC
0.2	0	0.12	0.06	0
0.2	1	0.12	0.06	0.085714
0.2	2	0.12	0.06	0.1
0.2	3	0.12	0.06	0.105882
0.2	4	0.12	0.06	0.109091
0.2	5	0.12	0.06	0.111111
0.2	6	0.12	0.06	0.1125
0.2	7	0.12	0.06	0.113514
0.2	8	0.12	0.06	0.114286
0.2	9	0.12	0.06	0.114894
0.2	10	0.12	0.06	0.115385

Source: Authoring

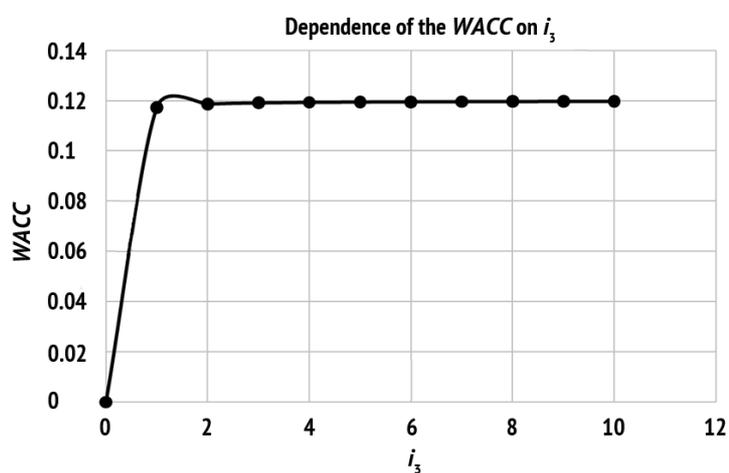
Figure 3Dependence of the WACC on the interest coverage ratio i_2 

Source: Authoring

Table 3Dependence of the WACC on the parameter i_3

t	i_3	k_0	kd	WACC
0.2	0	0.12	0.06	0
0.2	1	0.12	0.06	0.1173432
0.2	2	0.12	0.06	0.1186567
0.2	3	0.12	0.06	0.1191011
0.2	4	0.12	0.06	0.1193246
0.2	5	0.12	0.06	0.1194591
0.2	6	0.12	0.06	0.1195489
0.2	7	0.12	0.06	0.1196131
0.2	8	0.12	0.06	0.1196613
0.2	9	0.12	0.06	0.1196989
0.2	10	0.12	0.06	0.1197289

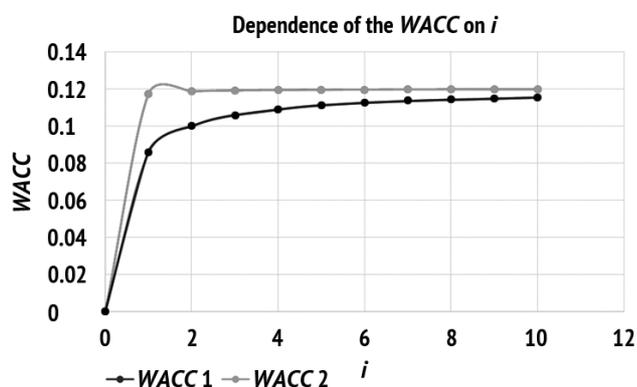
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Figure 4Dependence of the WACC on the debt-and-interests coverage ratio i_3 

Source. Authoring

Figure 5

Dependence of the WACC on the debt coverage ratio, interest coverage ratio and debt-and-interest ratio



Source: Authoring

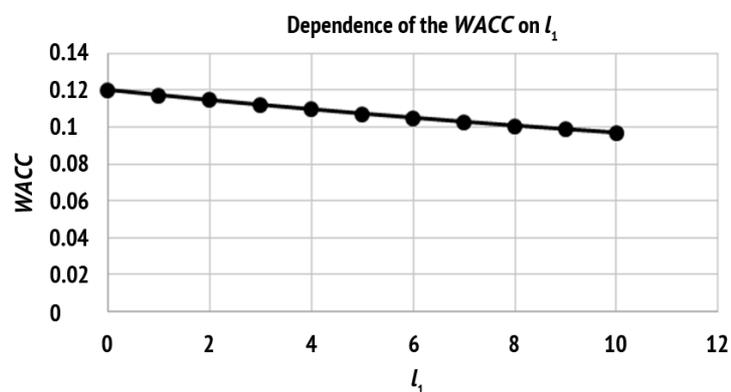
Table 4

Dependence of the WACC on the parameter l_1

t	l_1	k_0	kd	WACC
0.2	0	0.12	0.06	0.12
0.2	1	0.12	0.06	0.117188
0.2	2	0.12	0.06	0.114504
0.2	3	0.12	0.06	0.11194
0.2	4	0.12	0.06	0.109489
0.2	5	0.12	0.06	0.107143
0.2	6	0.12	0.06	0.104895
0.2	7	0.12	0.06	0.10274
0.2	8	0.12	0.06	0.100671
0.2	9	0.12	0.06	0.098684
0.2	10	0.12	0.06	0.096774

Source: Authoring

Figure 6
Dependence of the WACC on the leverage ratio of the debt l_1



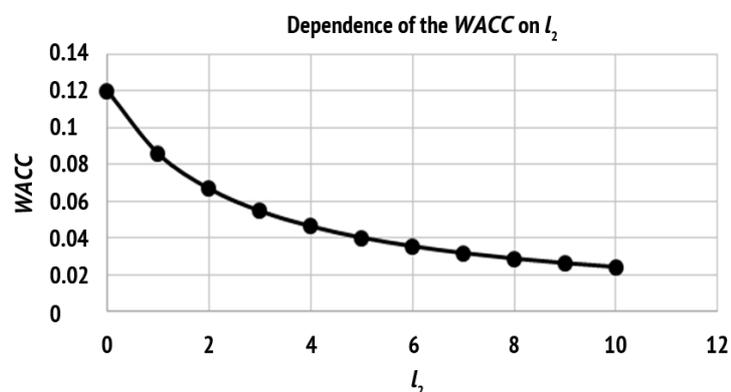
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Table 5
Dependence of the WACC on the parameter l_2

t	l_2	k_0	kd	WACC
0.2	0	0.12	0.06	0.12
0.2	1	0.12	0.06	0.085714
0.2	2	0.12	0.06	0.066667
0.2	3	0.12	0.06	0.054545
0.2	4	0.12	0.06	0.046154
0.2	5	0.12	0.06	0.04
0.2	6	0.12	0.06	0.035294
0.2	7	0.12	0.06	0.031579
0.2	8	0.12	0.06	0.028571
0.2	9	0.12	0.06	0.026087
0.2	10	0.12	0.06	0.024

Source: Authoring

Figure 7
Dependence of the WACC on the leverage ratio of interests on the loan l_2



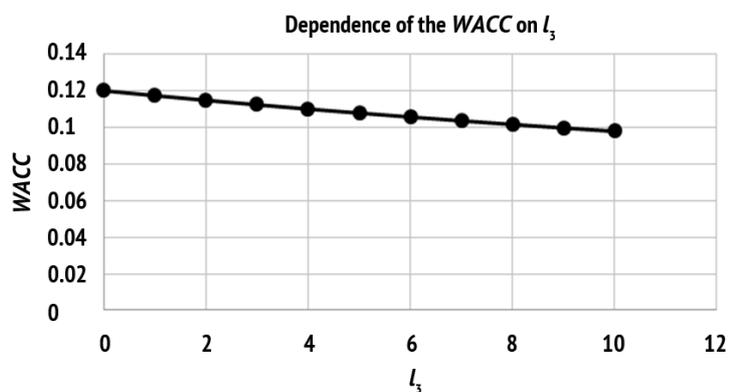
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Table 6
Dependence of the WACC on the parameter l_3

t	l_3	k_0	kd	WACC
0.2	0	0.12	0.06	0.12
0.2	1	0.12	0.06	0.117353
0.2	2	0.12	0.06	0.114819
0.2	3	0.12	0.06	0.112393
0.2	4	0.12	0.06	0.110068
0.2	5	0.12	0.06	0.107836
0.2	6	0.12	0.06	0.105693
0.2	7	0.12	0.06	0.103634
0.2	8	0.12	0.06	0.101654
0.2	9	0.12	0.06	0.099747
0.2	10	0.12	0.06	0.097911

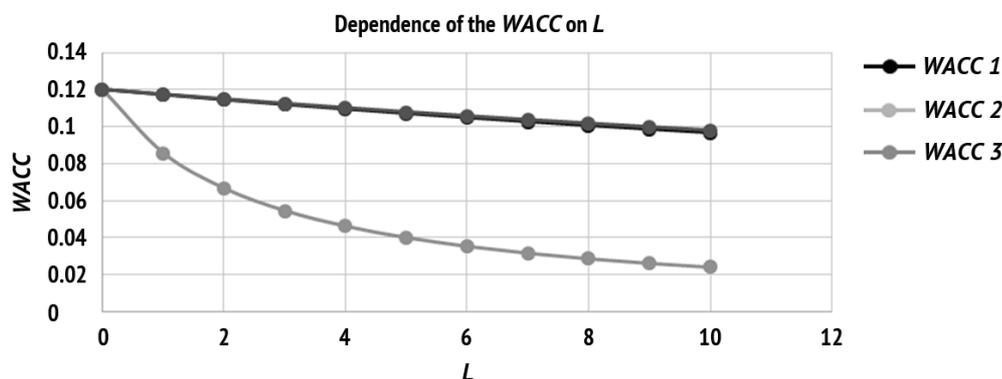
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Figure 8
Dependence of the WACC on the leverage ratio of the principal and interests on the loan l_3



Source: Authoring

Figure 9
Dependence of the WACC on the leverage level of the principle, interests and their combination



Source: Authoring

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References

1. Brusov P.N., Filatova T.V., Orekhova N.P., Eskindarov M.A. *Modern Corporate Finance, Investment and Taxation*. Springer International Publishing, 2015, 368 p.
2. Brusova A.P. [Comparison of the methods for assessment of weighted average cost of capital and the value of its equity]. *Finansovaya analitika: problemy i resheniya = Financial Analytics: Problems and Solutions*, 2011, no. 34, pp. 36–42. URL: <https://cyberleninka.ru/article/v/sravnenie-metodov-otsenki-srednevzveshennoy-stoimosti-kapitala-kompanii-i-stoimosti-ee-sobstvennogo-kapita> (In Russ.)
3. Myers S.C. Capital Structure. *Journal of Economic Perspectives*, 2001, vol. 15, iss. 2, pp. 81–102. URL: <https://doi.org/10.1257/jep.15.2.81>
4. Modigliani F., Miller M.H. The Cost of Capital, Corporate Finance and the Theory of Investment. *The American Economic Review*, 1958, vol. 48, no. 3, pp. 261–297.
5. Modigliani F., Miller M.H. Corporate Income Taxes and the Cost of Capital: A Correction. *The American Economic Review*, 1963, vol. 53, no. 3, pp. 433–443.
6. Modigliani F., Miller M.H. Some Estimates of the Cost of Capital to the Electric Utility Industry 1954–1957. *The American Economic Review*, 1966, vol. 56, no. 3, pp. 333–391.
7. Baker M., Wurgler J. Market Timing and Capital Structure. *The Journal of Finance*, 2002, vol. 57, iss. 1, pp. 1–32. URL: <https://doi.org/10.1111/1540-6261.00414>
8. Beattie V., Goodacre A., Thomson S.J. Corporate Financing Decisions: UK Survey Evidence. *Journal of Business Finance & Accounting*, 2006, vol. 33, iss. 9-10, pp. 1402–1434. URL: <https://doi.org/10.1111/j.1468-5957.2006.00640.x>
9. Bikhchandani S., Hirshleifer D., Welch I. Learning from the Behavior of Others: Conformity, Fads, and Informational Cascades. *The Journal of Economic Perspectives*, 1998, vol. 12, no. 3, pp. 151–170. URL: <https://doi.org/10.1257/jep.12.3.151>
10. Brennan M., Schwartz E.S. Corporate Income Taxes, Valuation, and the Problem of Optimal Capital Structure. *The Journal of Business*, 1978, vol. 51, iss. 1, pp. 103–114.
11. Brennan M.J., Schwartz E.S. Optimal Financial Policy and Firm Valuation. *The Journal of Finance*, 1984, vol. 39, iss. 3, pp. 593–607. URL: <https://doi.org/10.1111/j.1540-6261.1984.tb03647.x>
12. Dittmar A., Thakor A. Why Do Firms Issue Equity? *The Journal of Finance*, 2007, vol. 62, iss. 1, pp. 1–54. URL: <https://doi.org/10.1111/j.1540-6261.2007.01200.x>
13. Drobetz W., Pensa P., Wanzenried G. Firm Characteristics and Dynamic Capital Structure Adjustment. URL: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=952268
14. Fama E.F., French K.F. Financing Decisions: Who Issues Stock? *Journal of Financial Economics*, 2005, vol. 76, iss. 3, pp. 549–582. URL: <https://doi.org/10.1016/j.jfineco.2004.10.003>
15. Fischer E., Heinkel R., Zechner J. Dynamic Capital Structure Choice: Theory and Tests. *The Journal of Finance*, 1989, vol. 44, iss. 1, pp. 19–40. URL: <https://doi.org/10.2307/2328273>

16. Graham J.R., Harvey C.R. The Theory and Practice of Corporate Finance: Evidence from the Field. *Journal of Financial Economics*, 2001, vol. 60, iss. 2-3, pp. 187–243.
URL: [https://doi.org/10.1016/S0304-405X\(01\)00044-7](https://doi.org/10.1016/S0304-405X(01)00044-7)
17. Hamada R. Portfolio Analysis, Market Equilibrium, and Corporate Finance. *The Journal of Finance*, 1969, vol. 24, iss. 1, pp. 13–31. URL: <https://doi.org/10.1111/j.1540-6261.1969.tb00339.x>
18. Harris M., Raviv A. The Theory of Capital Structure. *The Journal of Finance*, 1991, vol. 46, iss. 1, pp. 297–355. URL: <https://doi.org/10.1111/j.1540-6261.1991.tb03753.x>
19. Hovakimian A., Opler T., Titman S. The Debt-Equity Choice. *Journal of Financial and Quantitative Analysis*, 2001, vol. 36, iss. 1, pp. 1–24. URL: <https://doi.org/10.2307/2676195>
20. Hsia C. Coherence of the Modern Theories of Finance. *The Financial Review*, 1981, vol. 16, iss. 1, pp. 27–42. URL: <https://doi.org/10.1111/j.1540-6288.1981.tb01617.x>
21. Jalilvand A., Harris R.S. Corporate Behavior in Adjusting to Capital Structure and Dividend Targets: An Econometric Study. *The Journal of Finance*, 1984, vol. 39, iss. 1, pp. 127–145. URL: <https://doi.org/10.1111/j.1540-6261.1984.tb03864.x>
22. Jensen M.C., Meckling W.H. Theory of the Firm: Managerial Behavior, Agency Costs, and Ownership Structure. *Journal of Financial Economics*, 1976, vol. 3, iss. 4, pp. 305–360. URL: [https://doi.org/10.1016/0304-405X\(76\)90026-X](https://doi.org/10.1016/0304-405X(76)90026-X)
23. Jenter D. Market Timing and Managerial Portfolio Decisions. *The Journal of Finance*, 2005, vol. 60, iss. 4, pp. 1903–1949. URL: <https://doi.org/10.1111/j.1540-6261.2005.00783.x>
24. Korajczyk R.A., Levy A. Capital Structure Choice: Macroeconomic Conditions and Financial Constraints. *Journal of Financial Economics*, 2003, vol. 68, iss. 1, pp. 75–109. URL: [https://doi.org/10.1016/S0304-405X\(02\)00249-0](https://doi.org/10.1016/S0304-405X(02)00249-0)
25. Kane A., Marcus A.J., McDonald R.L. How Big is the Tax Advantage to Debt? *The Journal of Finance*, 1984, vol. 39, iss. 3, pp. 841–853. URL: <https://doi.org/10.1111/j.1540-6261.1984.tb03678.x>
26. Leland H.E. Corporate Debt Value, Bond Covenants, and Optimal Capital Structure. *The Journal of Finance*, 1994, vol. 49, iss. 4, pp. 1213–1252. URL: <https://doi.org/10.1111/j.1540-6261.1994.tb02452.x>
27. Post J., Preston L., Sachs S. *Redefining the Corporation: Stakeholder Management and Organizational Wealth*. Stanford, Stanford University Press, 2002, 376 p.
28. Myers S.C., Majluf N.S. Corporate Financing and Investment Decisions When Firms Have Information That Investors Do Not Have. *Journal of Financial Economics*, 1984, vol. 13, iss. 2, pp. 187–221. URL: [https://doi.org/10.1016/0304-405X\(84\)90023-0](https://doi.org/10.1016/0304-405X(84)90023-0)

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