

National Research University Higher School of Economics

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**THE CONSTRUCTION OF AN AGGREGATED RATING SYSTEM FOR
CREDIT RISK MANAGEMENT IN A COMMERCIAL BANK**

PhD DISSERTATION SUMMARY

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Relevance of the research. It is difficult to imagine the modern financial market without the daily use of credit ratings: they are widely used by commercial banks in assessing the creditworthiness of borrowers; in the world of developed financial relations, credit ratings play the role of indicators of the financial condition of potential borrowers. That is why the use of credit ratings in models for comparing and predicting financial risks based on aggregation contributes to an increase in the risk culture and the effectiveness of risk management.

The credit rating represents the opinion of the rating agency regarding the ability of the rated object to fulfill its financial obligations in full and within the specified period. Understanding the problem of comparability of ratings, both at the micro- and at the macroeconomic level, should help to improve the methods of financial risk management in commercial banks and in enterprises of the real sector of the economy: instead of analyzing all companies existing on the market, an investor can focus only on those companies that have acceptable credit ratings for it.

There are international and national rating agencies on the market that assign ratings to the same companies on different scales. Scales of rating agencies, differing from each other, do not allow direct comparison of symbolic-numeric ratings in simple ways. The lack of a quick and reliable way of correlating ratings is a scientific and practical problem. Its solution is difficult due to the impossibility of universal comparison of rating scales of various agencies due to the large number of factors affecting the reliability of the assessment.

The research is motivated by the following: to develop and implement modern methods of credit risk management for aggregating borrowers' credit ratings, using statistical mapping and clustering tools, and thereby for expanding the scope of application of comparable credit ratings in the financial sector by using them in credit risk models for creating a rating system based on internal ratings (IRB-approach) in accordance with the recommendations of the Basel II requirements in commercial banks.

The proposed approaches make it possible to eliminate the negative effects arising from the information asymmetry of the discrepancy in the ratings of various

agencies. Comparison and aggregation of ratings of both industrial companies and commercial banks is a topical issue for most foreign and Russian investors. Methods of quantitative aggregation of ratings make it possible to obtain an assessment of credit risks and financial stability of borrowing companies and banks.

The services of rating agencies are highly differentiated and strictly regulated according to the methodologies adopted by them and self-regulating quality standards. The self-regulatory process and management standards of rating agencies have come a long way from relatively simple agreements and regulations to rigid, statutory norms and requirements, such as IOSCO standards in the European Union (EU) or the Dodd-Frank Act in the United States.

Credit ratings from IRA* have been assigned to only about 25% of Russian banks**, since these services can be afforded mainly by large banks and companies focused on international capital markets. For other Russian banks - medium and small in terms of assets – such consulting and rating services are unlikely to be paid off.

Russian banks need to create their own methods for monitoring counterparties for various economic entities in order to ensure a timely and high-quality assessment of their financial condition and creditworthiness at the micro and macro levels. Changes in the procedure for calculating credit risk are also due to the introduction of Basel II and Basel III provisions when creating integrated risk management and assessment systems within Russian commercial banks. All this focuses on the aggregation of ratings and risk assessment of economic entities to form a credit risk management system in a commercial bank.

In financial econometrics, models are in demand that make it possible to use various information on issuers available in financial markets to predict the likelihood of their default. Discrepancies in ratings arise due to various qualitative and quantitative factors that rating agencies use in their methodologies.

* IRA – for international rating agencies known as – Moody’s, Standard & Poor’s, Fitch.

** Bank of Russia report “Creation of a system for comparing rating scales of credit rating agencies (mapping)”, December, 2016, Moscow, link URL: https://www.cbr.ru/Content/Document/File/50715/Consultation_Paper_171115.pdf.

Most empirical works deal with large industrial companies and banks, but despite this in developing countries, there are trends towards the growth and globalization of various economic entities. This trend leads to the need to improve the quality of risk assessment for management based on open, public information for a wider range of companies. At the same time, there is a growing interest in risk assessment from potential investors. At the same time, economic objects strive to obtain the highest credit rating, reflecting their current state and containing a forecast for a certain period.

One of the factors of underestimation in the financial market of a company or a bank is a low credit rating, its downgrade or complete absence. The opposite situation corresponds to a similar phenomenon in financial markets, when the company's revaluation is associated with a high credit rating and the absence of changes in the rating revision relative to the market. Consequently, a rating discrepancy appears in the financial market, which can be considered, in conditions of information asymmetry, as a negative relationship between the effectiveness of a credit rating and the probability of a company or bank default.

The degree of elaboration of the problem. The issues of aggregation and comparison of ratings raised in the research are considered in the works of foreign researchers: D. Aikman, E. Altman, D. Amato, C. Bannier, A. Barton, M. Blume, F. Cantor, J. Kiff, N. Kiyotaki, M. Kose, A. Livingston, E. Mendoza, F. Packer, J. Saurina, J. Wei, L. Zhou and others. The works of S.A. Ayvazyan, A.M. Karminsky, A.A. Peresetskiy, M.V. Pomazanova, V.M. Solodkov and others. A separate direction in the study of clustering methods is devoted to the work of F.T. Aleskerova, A.A. Peresetsky, N.I. Berzon. Works concerning the macroeconomic assessment of the relationship between credit cycles and ratings are reflected in the works of O.G. Solntsev and A.A. Ponomarenko.

The publications listed above are based on different approaches and form a rating aggregation toolkit for risk management purposes. The subject of differences in credit ratings, the reasons for these differences and the possibility of their comparison, as well as the degree of development of methods for aggregating

ratings, have been studied in the literature since the mid-1980s [Billingsley et al., 1985; Hsueh et al., 1988].

Some empirical studies [Banner et al., 2010, Cantor, 1997], devoted to the issue of differences in methodologies of rating agencies, reflect attempts to quantify and show the differences in ratings, but the results obtained by various authors are ambiguous in interpretation. In turn, discrepancies in credit ratings can be used to identify significant differences and variances in the credit ratings of one or another rating agency to assess credit risks. The empirical evidence for aggregate ratings estimates the importance of building multivariate models of differences when comparing rating scales and aggregating ratings in a financial risk management environment at a more advanced level.

Among the large number of works by foreign and domestic researchers, there is no generally accepted unified approach to the consideration of aggregation measures and comparison of ratings [Cantor, Packer, 1996; Kose et al., 2003; Cornaggia, 2013; Peresetsky, 2012; Karminsky, 2015; Buzdalin et al., 2017]. It is worth paying attention to a number of works devoted to the study of the activities of rating agencies, incentives for their behavior in the market and the problem of the bias of credit ratings in favor of both the issuer and the rating agency [Becker, Milbourn, 2010; Bolton et al., 2012; Feng et al., 2014; White, 2013].

The approach used by agencies is not always the same in terms of the timing of determining the issuer's creditworthiness [Bongaerts, 2012; Kiff et al., 2013]. In addition, in addition to the discrepancies themselves, it becomes difficult to compare the ratings of foreign and national agencies, the scales of which may differ significantly [Banner et al., 2010; Barton, 2006]. There are differences in the number of gradations in the scale [Peresetsky et al., 2011; Karminsky, Polozov, 2016].

Empirical results of modern works on the analysis of discrepancies (splits) in credit ratings of various issuers and their relationship with the level of the financial condition of the issuer [Alsaka et al., 2012; Barton A., 2006; Livingston et al., 2010; Shimizu et al., 2013] show that the answer to the question about the reasons for such

discrepancies and the acceptable level of rating discrepancies is not unambiguous. One of the explanations for the ambiguous results is the evidence of a number of authors [Molinero et al., 1996; Nickell et al., 2000; Shimizu et al., 2013] in favor of the fact that different rating agencies assign different types of ratings and a significant part of the discrepancies is based on differences in the methodologies for evaluating issuers. The expert component of ratings plays an important role [Cantor, 1996; Kimberly, 2011]: if for assessing financial performance it is possible to build a model that can determine the financial stability of a bank or company, then in assessing qualitative factors, the opinion of experts can be decisive [Cornaggia, 2013; Feng et al, 2014].

The methods for aggregation ratings and comparing rating scales to obtain reliably accurate estimates over a long time horizon can be based on data clustering and their economic assessment in relation to the credit cycle, as well as rating scale mapping [Hainsworth et al., 2013; Mukhopadhyay et al., 2006; Ayvazyan et al., 2011; Karminsky et al., 2011]. It should be noted separately that some of the authors in their works point to different motives for the behavior of the rating agencies themselves in the framework of assigning a remote (unpaid) rating and a custom (purchased) rating.

The strategies of such behavior of rating agencies affect the development of the company: for example, before the start of the financial crisis in 2008, many rating agencies overestimated the assigned ratings, which subsequently led to a conflict between participants and users of ratings and the state, as a result of which the Dodd-Frank law was adopted [Altman et al., 2005; Behr et al., 2008; Dimitrov et al., 2015; Kose et al., 2003]. Such conflict situations, affecting many private interests of investors, and not only, lead to high financial costs and a disproportionate distribution of the influence of rating agencies on financial market participants [Bannier et al., 2010; Claessens et al., 2018; Kisgen et al., 2010; Mulder et al., 2001].

As a result of the literature review, the author of the thesis formed areas of research on the relationship between the credit cycle and ratings, the reasons for discrepancies and the effectiveness of ratings, as well as their application for credit

risk management. Research methods are based on modern empirical works [Ahn et al., 2016; Danėnas et al., 2011; Gentle J., 2012; Griffiths et al., 2005; Hainsworth et al., 2013; Hajek et al., 2011; Masiak et al., 2017; Parnes D 2007; Timmermans et al., 2017; Yin et al., 2011], systematized and statistically improved taking into account data from commercial banks and industrial companies, as well as by aggregating ratings. The results obtained by the author show an increased degree of reliability and accuracy of credit risk assessment.

Object and main goal of the study. The object of the research is the credit ratings of economic entities - industrial companies, which are large producers from various sectors of the real sector of the economy, and commercial banks. The subject of the research is the formation of an aggregated rating system for assessing the credit risks of economic objects in the risk management system of a commercial bank.

The objectives of the study. The aim of the work is to build a system of aggregated ratings using the methods of econometric analysis and the apparatus of applied statistics. It provides for an assessment of the relationship between the methodologies of various rating agencies, as well as the financial and non-financial characteristics of objects with credit ratings of issuers (both industrial companies and commercial banks). In addition, the tasks include identifying the relationship with macroeconomic indicators of the change in the phase of the credit cycle at the intercountry level.

The result of the work is shown in the construction of a system of aggregated ratings of various issuers to improve the assessment of their credit risks. The results of aggregated ratings are proposed for use in the risk management system of a commercial bank within the IRB approach.

To achieve the set goals, the following main tasks were solved in the work:

- 1) considered and classified the methods of aggregation and comparison of ratings based on modern empirical methods;

2) formed a voluminous database of financial and non-financial indicators on credit ratings of various economic entities for a number of developed and developing countries, including Russia;

3) algorithms for aggregation have been developed by comparing rating scales of various agencies, including using structural clustering based on financial patterns;

4) a comparative analysis of the aggregated ratings was carried out and an increase in the accuracy of the comparison of ratings for managing credit risks within the framework of the approach based on internal ratings was assessed;

5) the relationship between credit ratings and the phases of the credit cycle was revealed and the nature of their changes was determined.

To solve the set goals, a number of research problems were formulated regarding a quantitative increase in the accuracy of rating assessments based on methods of statistical aggregation and clustering of sets of financial and non-financial economic objects:

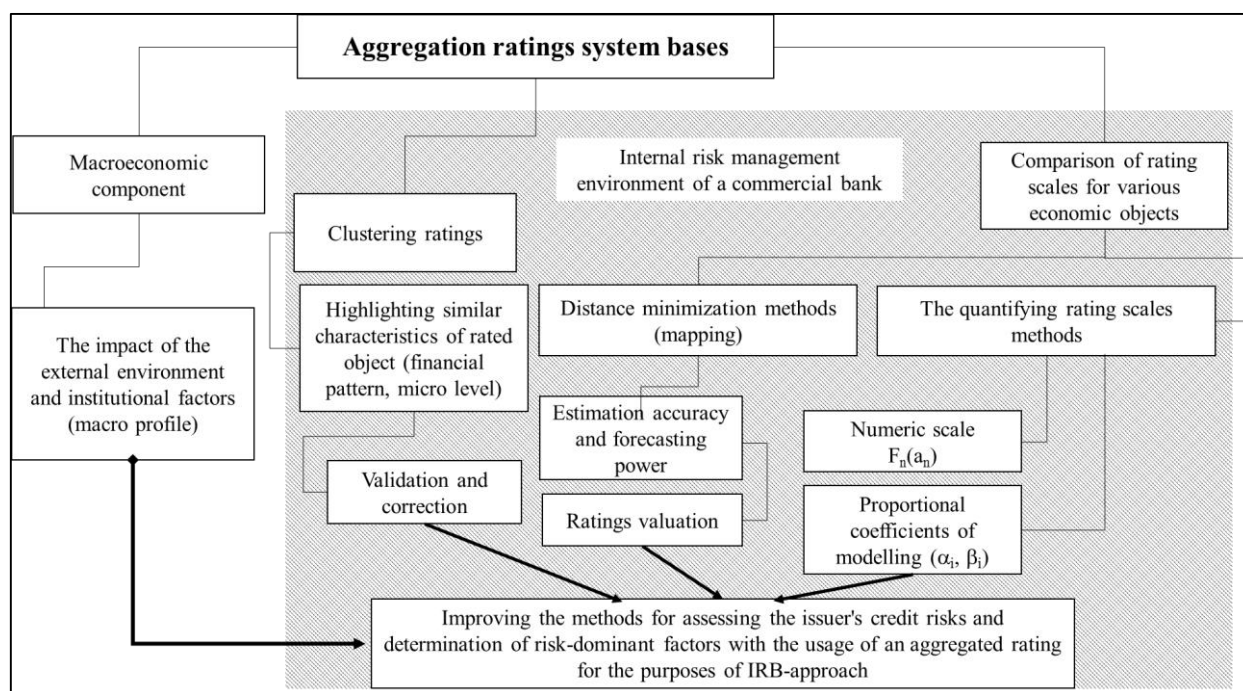
1. Evaluate the increase in the accuracy of assessing the issuer's ratings due to mapping as part of the aggregation procedure, including in the presence of two or more credit ratings from different agencies.

2. Determine the possibilities of increasing the accuracy of rating assessments by clustering a set of economic objects.

3. To study the relationship between the dynamics of changes in credit ratings with the change in the phases of the credit cycle, as well as the impact of the change in the phases of the cycle on the ratings of issuers.

The methodological basis of the study was based on the methods of multiple mapping and integral (remote) convergence when comparing rating scales and obtaining aggregated ratings, the individual components of which are shown in Fig. 1: The accuracy of the estimates is improved through structural clustering, mapping, and the use of regression analysis to assess the impact of the credit cycle on the ratings of economic objects.

Figure 1. The main elements of building an aggregated rating system with integration into the risk management system



Source: drawn by the author.

The research informational base includes empirical data on financial and non-financial indicators and credit ratings of various objects. The observation period is 1985-2016, annual and quarterly data for 19 countries (developed - the main EU countries, the USA, Japan - and developing ones, represented by the BRICS countries). The main sources were: macroeconomic data of the International Monetary Fund (IMF) and the World Bank; data from information and analytical agencies Bloomberg and Thomson Reuters; data on the dynamics of changes, assignment and revision of credit ratings, as well as reports, analytical materials and methodologies of rating agencies for various economic entities; analytical reviews and reference materials of the Bank of Russia.

In the study, the statistical estimation of the parameters of models and aggregation of ratings of economic objects, as well as the construction of graphs and visualization of data using the following programs and applications of applied mathematical and regression analysis, were carried out: STATA v.14.2, Matlab - PanelData & ScoreGroup, Python - NumPy & Matplotlib packages ...

The resulting database for the empirical part of the work and computational experiment using the tools of applied statistical analysis was divided into two main

categories of economic objects - for industrial companies in the real sector and for commercial banks. The industrial data base, compiled from Bloomberg and Eikon Thomson Reuters, is an unbalanced dashboard for 1985-2016. The database for commercial banks was formed in the course of research and development work (R&D) in the interests of the Bank of Russia and is an unbalanced panel for the largest commercial banks in 2000-2016.

Many non-financial characteristics and messages about changes and revisions of ratings of economic entities, as well as reports of rating agencies were collected by the author from open sources manually, due to the limited number of automatic uploads.

The main goals, which are set for the defense. A number of original results were obtained in the work, characterized by the following provisions:

1. A classification of reasons for discrepancies in ratings of economic entities, as well as methods for determining discrepancies in assessing the creditworthiness of issuers, has been developed. Various methods for comparing rating scales are systematized, and the quantitative effects of comparing rating scales are estimated.

2. Comparison of international and Russian rating scales based on well-known developed and developed by the author methods of aggregation of ratings of various economic entities (commercial banks, industrial companies) from developed and developing countries on the basis of comparison in the basic scale. Ratings aggregated in the base scale increase the accuracy of the integrated assessment of credit risks. The factors of differences and the reasons for the discrepancies between the assigned ratings are assessed.

3. An aggregated rating system was formed on the basis of consolidated assessments for implementation into the general risk management system in a commercial bank. The stability of the obtained aggregate estimates is confirmed by comparable quantitative results obtained on the basis of mapping and structural clustering methods.

4. The indicator of the credit gap for the largest developed and developing economies of the world has been quantified and proposed for assessing the credit

cycle. Using the proposed indicator, the effects of changing the phases of the credit cycle and their influence on changes in the ratings of economic objects are revealed. It is shown that aggregate assessments of banks' ratings are lagging behind macroeconomic changes and the credit cycle in financial markets.

The scientific novelty of the study lies in the formation and development of an aggregated rating system for building on their basis a single rating space in order to improve the assessment and level of forecasting credit risks for different types of economic entities. The paper has developed methods for comparing rating scales, as well as a method for clustering rating assessments of economic objects based on financial patterns. The study of the relationship between credit ratings and the stages of the credit cycle revealed inconsistencies in time between changes in credit cycles and ratings.

This work is one of the first to solve the problem of aggregating and comparing ratings of various agencies and displaying these ratings in a single scale using micro- and macroeconomic indicators based on modern methods of econometric modeling.

The most important scientific results obtained by the author in this study:

1. Improved methods of comparison and aggregation of issuer ratings are proposed. The novelty of these methods lies in the use of microeconomic financial indicators, disclosing the level of credit risks of issuers at the micro level through aggregating the rating and building financial patterns obtained as a result of clustering economic objects. The author's classification of the reasons for the discrepancy and degradation in time of the ratings of the issuers is given.

2. A system of aggregated rating assessments has been formed, which is proposed for inclusion in the risk management system in a commercial bank. The stability of the rating aggregation algorithms developed by the author is investigated and shown when comparing rating scales.

3. An econometric model has been developed for assessing the relationship between credit ratings and the credit cycle. For the model, a new method for calculating the credit gap indicator is proposed, with the help of which the sequence

of the change in the phases of the credit cycle for the 19 largest developed and developing countries is quantitatively estimated.

4. Revealed a countercyclical change in ratings depending on the change in the phases of the credit cycle at the macro level. The article considers and provides a quantitative assessment of the credit cycle based on the credit gap.

At the same time, the empirical results on the comparison and aggregation of ratings are evaluated in comparison with other works on this topic by two different methods, and both micro and macro indicators are used in the analysis. The author's work contributes to the scientific literature on the role of credit ratings in the financial economy, as they demonstrate not only the differences in ratings, but also their evolutionary variability depending on the behavior of credit cycles.

The theoretical significance of the study is as follows:

- systematization of methods for comparing rating scales and aggregating rating assessments;
- expanding the possibilities of using aggregated rating estimates and, on their basis, increasing the accuracy of the level of assessing credit risks for various economic entities;
- development of quantitative methods for clustering rating assessments of various types of economic entities to obtain assessments of the level of credit risks;
- comparative analysis of opportunities and identification of the relationship between credit ratings and the credit cycle through quantitative instrumental variables; in forecasting changes in the level of credit ratings based on the change in the phases of the credit cycle.

The validity of the scientific provisions and results, conclusions and scientific-theoretical and practical recommendations obtained in the research work follows from the practical use of the methods and econometric models developed by the author in the research work "Long-term targets for the development of the financial sector", prepared by order of the Bank of Russia in The Center for Macroeconomic and Short-Term Forecasting (CMASF), as well as on discussions of the results of work at international conferences and in the author's articles.

During the preparation of the study, the methods of fundamental and applied research, the work of leading foreign and Russian scientists and experts in the field of modeling and comparison of ratings were used. The empirical research results obtained by the author correspond to the goals and objectives set in the study. It also developed a system for obtaining aggregate ratings for implementation in the risk management system of a commercial bank.

The conclusions of the study for Chapter 1 are based on theoretical work in the field of comparison of rating scales and the search for the reasons for the discrepancy between ratings among various agencies. The conclusions of the research work on chapters 2, 3 and 4 are substantiated by factual data and supported by reasoned use of modern financial-analytical, statistical and econometric methods, which made it possible to confirm the purpose and objectives of the study, as well as show the result of forming a system for aggregating credit ratings and their assessments over time.

The contribution of scientific work on the research topic to the scientific literature. The work covers the issues of constructing and aggregating rating assessments, reducing them to a single basis to obtain the most accurate assessments of credit risks. The assessment methods considered by the author form a unified system for aggregating rating estimates for risk management tasks in a commercial bank. The article presents and describes the possibility of using credit ratings as a risk management tool, as well as their relationship with the indicator of the credit gap, which determines the change in the stages of the credit cycle.

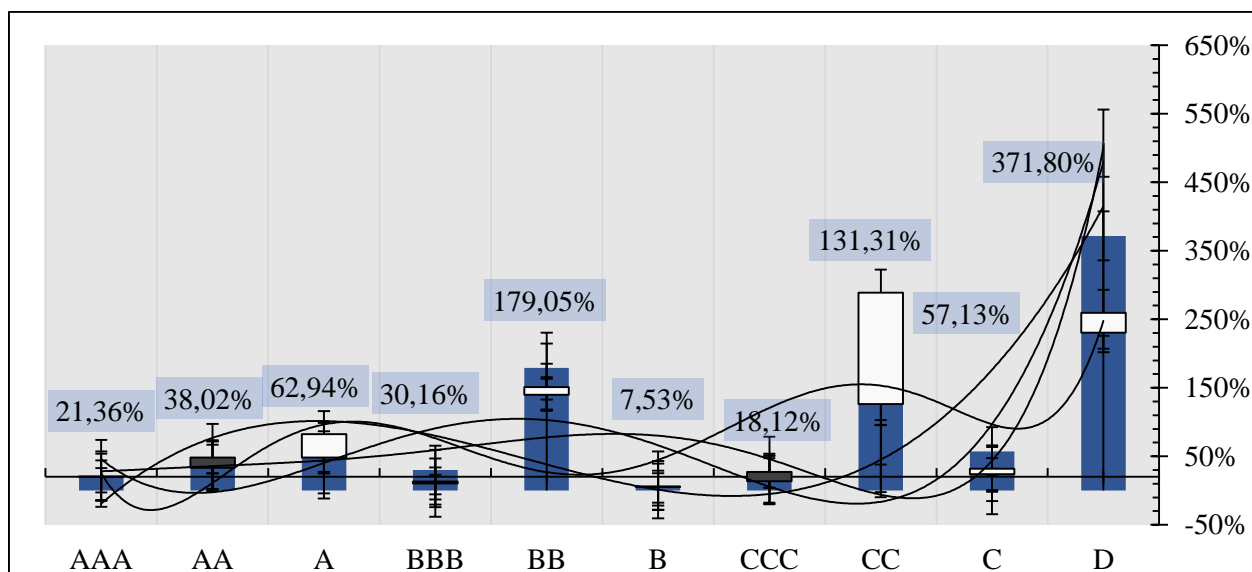
Scientific and practical significance of the work. The study systematized a set of methods for comparing and aggregating ratings. The obtained results of aggregation are confirmed empirically using a large statistical database. Methods for clustering and patterning credit ratings for various economic entities are described in terms of their components. The results of clustering in the form of financial patterns are presented, with the help of which the accuracy of obtaining predictive estimates of credit risks was improved.

Contents of the thesis. The first chapter provides an overview of theoretical and empirical works on the comparison of ratings and the reasons for the appearance of their discrepancies, the possibilities of comparison and evaluation. Methods for comparison and aggregation of credit ratings, as well as their quantitative assessment, are described and systematized. Considered are modern works on the assessment of credit cycles, their separation from existing macrocycles.

In the second chapter of the study, a comparative analysis of the rating scales of various agencies is carried out and, using multiple mapping methods, comparison estimates are obtained, and the type of economic entities is carried out on the basis of aggregate estimates. Various ratings are classified by observation groups for industrial companies and commercial banks. The table of correlation of scales for international rating agencies was formed. It is noted that Russian national rating agencies have methodological imperfections in comparison with foreign agencies. Individual aggregated ratings of issuers for each class of ratings were obtained on the basis of converting the scales into numerical categories and comparing rating pairs based on historical data.

The charts in the second chapter show the scheme of discrepancies (ratings splits, in %) of credit ratings with designations of categories for their conversion to the basic scale. Based on the collected data, it is shown (Fig. 2) that the largest number of discrepancies in the assigned credit ratings is observed in the Moody's agency, while most of the ratings of this agency are concentrated in completely different classes - both in speculative and in investment. Regarding the ratings assigned by the Standard & Poor's agency, the number of ratings is evenly distributed in different classes. The third agency, Fitch, mainly assigns its credit ratings in the investment range and at a lower volume than the other two international rating agencies.

Figure 2. Credit ratings splits



Source: author's calculations.

On the other hand, given the time difference for the three rating agencies, the following is observed: since 2005, international rating agencies have often downgraded the credit ratings of many banks, and vice versa, raised the credit ratings of industrial companies. Differences in rating discrepancies for companies and banks are significant and are based on the use of not only financial indicators, but also expert assessments.

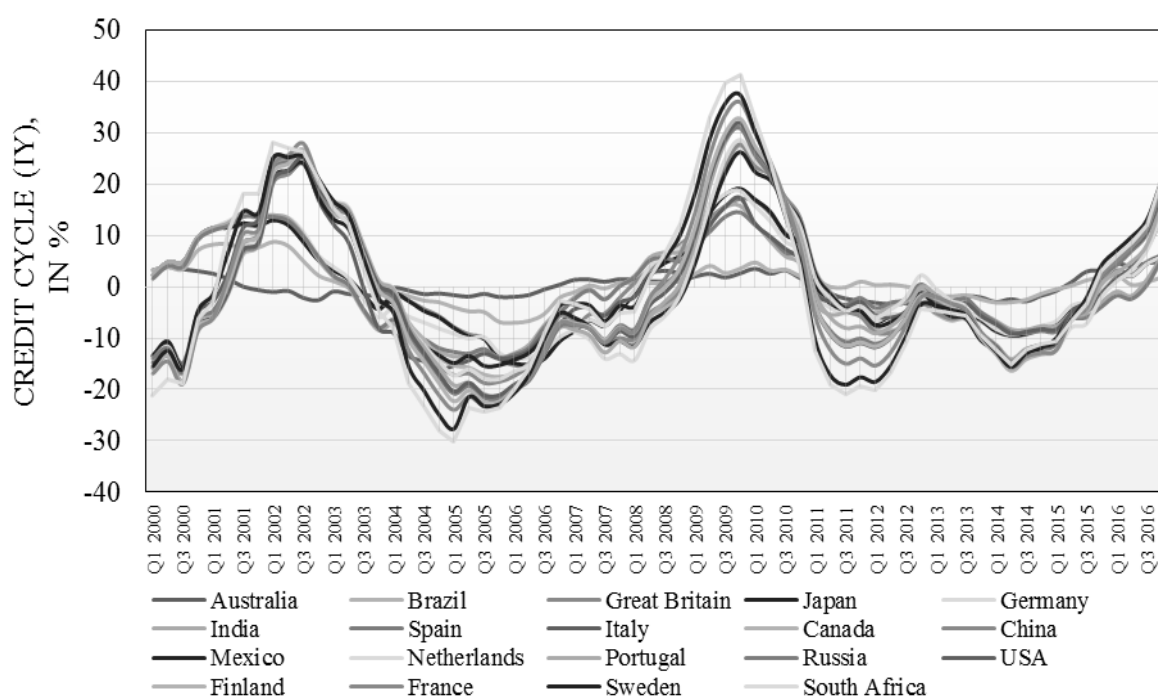
The third chapter of the study describes the method of patterning and the estimates of the level of credit risks for economic agents obtained with its help. The aggregated results of comparing and evaluating econometric rating models based on the method of multiple mapping and clustering show that the tendency for discrepancies over different periods of time relative to bank ratings is quite high and average for companies.

The fourth chapter presents a method for calculating the credit cycle indicator - credit gap, as well as estimates of the probit model and describes the impact of the credit cycle on the level of changes in credit ratings. Also presented is a visual analysis of the credit cycle for 19 countries (Fig. 3), calculated using the credit gap using a two-sided Hodrick-Prescott filter (HP-filter, twoway-sided). The credit cycle tracks the potential for expansion and contraction of access to credit in an economy

over time. This, in turn, indirectly affects the business cycle of various companies, as access to credit affects a company's ability to invest.

According to empirical observations, over the passing time, the performance of credit-oriented sectors with a fixed income from their own activities, including large corporations focused on the continuous maintenance of their credit ratings and, possibly, the investment grade ratings of their securities – is directly related to the credit cycle. The best tool to identify the beginning of a credit cycle is the credit gap. Its fluctuations below one or another certain level allow us to mark the beginning of the development of periods of recession and indicate conditional transition points between different stages of the credit cycle. Over time, at different phases of the credit cycle, the ratings assigned by the rating agencies undergo significant changes. Analysis of data over a ten-year period of time, both for developed and developing countries, makes it possible to single out several natural reactions of credit ratings received from international rating agencies. Their changes are out of sync during the credit cycle and are lagging behind macroeconomic changes.

Figure 3. Credit cycles for 19 countries



Source: authors' calculations based on IMF data.

Conclusion of the thesis. The main result of the presented work is to build a system of comparison and aggregation of credit ratings in order to increase the determination of the level of credit risks of issuers, and in the development of methods for assessing the relationship between the level of credit ratings and the credit cycle, which makes it possible to comprehensively track changes in ratings at different phases of the credit cycle and correctly compare them. for risk management purposes.

Implementation of research results. The results of the research were used in terms of assessing changes in credit ratings and their interaction with the credit cycle in the research work "Long-term targets for the development of the financial sector" to analyze the relationship of financial market indicators in the CMASF (Center for Macroeconomics and Short-term Forecasting).

The results of the research have also found practical application in teaching activities within the framework of the research seminar of the Master's program "Financial Markets and Financial Institutions" (FRFI) of the Higher School of Economics.

Approbation of research results. The results of the thesis research presented at the following conferences:

- Analytics for Management and Economics Conference / AMEC, report "The Determinants of Credit Cycle" (28.09.2019, School of Economics and Management, HSE University, St. Petersburg, Russia);
- Finance Risk and Accounting Perspectives Conference / 17th FRAP, report "The Determinants of Credit Cycle, Its Forecast and Impact on the Credit Ratings" (25.09.2019, Helsinki, Finland);
- 21st IEEE Conference on Business Informatics / 21st CBI, report "The Determinants of Credit Cycle and Its Forecast", (15.07.2019, NRU HSE, Moscow, Russia);
- XXVI International Conference of Students, Postgraduates and Young Scientists, report "Patterns of Credit Ratings of Industrial Companies in the BRICS Countries" (11.04.2019, Moscow State University, Moscow, Russia);

- The International Workshop of Systemic Risks in the Financial Sector, report “The credit cycles and its impact on credit ratings changes” (16.11.2018, NRU HSE, Moscow, Russia);
- IX Moscow International Conference on Operations Research, ORM 2018 - Germeyer-100, report "Patterns of Credit Ratings of Industrial Companies in the BRICS Countries" (22.10.2018, Moscow State University, Moscow, Russia);
- 25th Eurasian Business Economic Society conference - EBES, report "The Comparison of Statistical Methods for Modeling of Credit Ratings of Industrial Companies from BRICS Countries" (24.05.2018, the FOM University of Applied Sciences, Berlin, Germany);
- Second World Congress of Comparative Economics - 2nd WCCE, report "Rating scales mapping for different economic entities: an empirical study" (June 17, 2017, HSE University, St. Petersburg, Russia);
- XVIII April International Scientific Conference on Economic and Social Development, report "Comparison of rating scales for financial institutions" (13.04.2017, NRU HSE, Moscow, Russia).

List of author’s original articles. The main results of the research are published in 6 (six) papers with a total volume of 5.9 pp; the personal contribution of the author is 4.1 pp.

1. Dyachkova N.F. Comparison of rating scales of Russian and foreign agencies: industrial and financial companies // Corporate finance. 2018. PP. 35-50.
2. Dyachkova N.F., Karminsky A.M. Empirical study of the relationship between credit cycles and changes in credit ratings // Journal of the New Economic Association. 2020. N 4. (48). PP. 138–159.
3. Dyatchkova N., Karminsky A., Grishunin S., Bisenov M. The comparison of empirical methods for modeling credit ratings of industrial companies from BRICS countries // Eurasian Economic Review, 2019. Volume 9. PP. 1-16.
4. Dyatchkova N., Karminsky A. Credit rating patterns: a financial approach for industrial companies, Chapter 10, in: Recent Advances of the Russian Operations Research Society, 2020. PP. 163-177.

5. Dyatchkova N., Grishunin S., Karminsky A. Credit ratings patterns for BRICS industrial companies // *Procedia Computer Science* Volume 139, 2018. T. 634. PP. 17-25.
6. Dyachkova N., Karminsky A., Kareva Y. The Determinants of Credit Cycle and Its Forecast, in: *CBI Proceedings*, Volume 1, 2019. PP. 320-329.

The structure of the thesis. The research study consists of an introduction, four chapters, a conclusion, a list of references and four appendices. The material is presented on 239 pages, including 31 tables, 40 figures, and four appendices on 13 pages. The list of sources used contains 231 items.