

Proceedings

21st IEEE Conference on Business Informatics



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Volume Editors

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Preface

For the last time in 2010-2020 decade, the IEEE Conference on Business Informatics (CBI) was held to discuss today's challenges in the digital transformations of business, production and society. This time, the conference was hosted at the National Research University Higher School of Economics in Moscow on July 15-17th, 2019.

As a leading forum for research concerning Business Informatics, the aim of this event is to discuss and broaden our understanding of the field of Business Informatics which is characterized by investigating the theoretical and practical concerns of ubiquitous information flows in the company and its surrounding technological, economic or social entities.

By adopting a multi-disciplinary orientation from such fields as Computer Science, Information Systems, or Economics, many different facets are put forward. Accordingly, the CBI conferences use a format that enables in-depth discussions among researchers during the conference. By offering nine different tracks – in addition to a *General Topics* track – that were not confined to a specific research community, many perspectives on Business Informatics were covered at this 21st CBI. The tracks were:

- Enterprise Modelling, Engineering and Architecture
- Information Systems Engineering
- Business Process Management
- Artificial Intelligence for Business
- Information Management
- Industry 4.0 (Industry Applications)
- Business Analytics and Business Data Engineering
- Business Innovations and Digital Transformation
- Data-Driven Business Applications

IEEE CBI 2019 received 183 submissions, 60 of which have been selected as full presentations at the main conference, 10 of which as research-in-progress papers. Each submission was reviewed by at least two Program Committee members and received a recommendation from the corresponding Track Chairs. This review process allowed to select the most relevant and highest quality papers and to offer the audience an exciting program.

IEEE CBI 2019 hosted three co-located workshops and a doctoral consortium attracting participants from both industry and academia.

The First International Workshop on Business Informatics 4.0 (BI4) provided a forum to share research activities with a focus on the issue of the influence of the Industry 4.0 on current Business Informatics research and practice (organized by Judith Barrios Albornoz, System Engineering School, University of The Andes, Venezuela, Elena Kornyshova, CEDRIC, Conservatoire National des Arts et Métiers, France and Oscar Pastor, PROS Research Centre, Universitat Politècnica de Valencia, Spain).

The 7th International Workshop on the Internet of Things and Smart Services (ITSS 2019) discussed advances in theory, applications and different approaches to using IoT and Smart Services. Furthermore, it dealt with the business transformation in the digital economy and new types of services and innovative business models that were developed due to the high impact of IoT and data-based services. As the next step in globalization, this development surfaces new perspectives on strategy as well as recommendations

on the Collaborative Economy initiative by the European Commission (organized by Raisa Uskenbaeva, International University, Almaty, Kazakhstan, Dmitry M. Nazarov, Ural State University of Economics, Yekaterinburg, Russia, Olga A. Tsukanova, National Research University Higher School of Economics, Moscow, Russia).

The 1st SMART Mechanisms Workshop (WSM-2019) discussed development of control mechanisms for solving typical management problems (organized by Vladimir N. Burkov, Alexander V. Shchepkin, Vsevolod O. Korepanov and Denis N. Fedyanin, V.A. Trapeznikov Institute of Control Sciences, RAS).

The organization of a conference was only possible through the help and commitment of many people. We would like to thank the program committee and track chairs that guided us through the review process. Further, we would like to express our gratitude to the session chairs that enabled inspiring discussion throughout the conference. We thank Lisa O'Conner at IEEE for her constant support for the preparation of these proceedings. Lastly, we would like to give thanks to the local organizing team in Moscow. Their hospitality and the social events at the CBI 2019 made this conference an even more enjoyable event!

Dmitry Novikov, Corresponding Member of Russian Academy of Sciences, Director of V.A. Trapeznikov Institute of Control Sciences of Russian Academy of Sciences, Moscow, Russia

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Co-Chair

Mikhail M. Komarov, Deputy Head of School of Business Informatics, National Research University Higher School of Economics, Moscow, Russia

Chair of Organizing Committee

Welcome from the General Chair

As General Co-Chair of CBI 2019 I welcome you to Moscow!

This year the IEEE Conference on Business Informatics is being held in Moscow, Russia at the National Research University Higher School of Economics (HSE).

Over the past two decades, the conference has brought together researchers and practitioners from various fields of knowledge, primarily from such fields as computer science, economics and management. It is the leading international platform for the exchange of views, ideas and results contributing to a vision for the development of information technologies as the most important basis of the modern business and socio-economic sphere in general.

The impact of information and information technology on the world around us today is extremely large. Changes that are generated by new possibilities for obtaining and processing information affect all areas of life. The time has passed when doubts were expressed as to whether it was necessary or not to use IT in various areas. Now we are not only ready to actively try to introduce new technologies in various fields, but we are waiting for their appearance, because they provide new opportunities, open up new spaces of activity, create new lifestyles, generate new professions. For business, information technologies are today the undisputed driver of development, a condition for improving competitiveness, and for entering new markets.

Modern ideas and concepts such as cryptocurrency, distributed registries, big data, virtual reality, the Internet of things, artificial intelligence and machine learning are today generating an ever-growing list of cases. Ahead we can see quantum computing, smart spaces, serverless computing, immersive technologies, and much more that a business has to master.

Each year the IT spending of companies on analytics and forecasting is growing. In this context, research in the field of Information Systems, Management Science, and Organization Science is of particular importance in the search for new models, architectures, and solutions that ensure efficient and sustainable business development.

The IEEE Conference on Business Informatics is always a combination of in-depth studies of objects, systems and processes that traditionally determine the scope of business informatics, such as enterprise architecture, business processes, information systems, information management and business analytics, with research aimed at finding new areas, new facilities, new challenges for future research. Such topics are included in all tracks, but, first of all, they are devoted to the tracks of Artificial Intelligence for Business, Business Innovations and Digital Transformation, Industry 4.0.

An important role in this is played by the workshops and the doctoral school. So, one of the workshops this year has the name - First International Workshop on Business Informatics 4.0 and announces a new look at business informatics in the context of Industry 4.0. It is the concept of a control mechanism.

My education and my doctoral degree are related to computer science. For several years I have been working in the field of business informatics. My research activity, my experience in the industry and the consultancy sector are related to modeling, computer-aided design and analytics. As a researcher, I see a synergistic effect of combining the engineering approach with research in the socio-economic sphere, ensuring the relevance of the interdisciplinary field of business informatics.

HSE was founded in 1992. This is a young, rapidly developing university, which today is one of the leading Russian universities and research centers. HSE occupies a leading position in many areas of knowledge that form the field of business informatics - in economics, management, mathematics, computer science. As the head of the HSE School of Business Informatics, I am very pleased that our university will become a platform for communication of IEEE CBI 2019 participants during these three days in July.

I hope you enjoy the IEEE CBI 2019 and your stay in Moscow.

Moscow, July 15 2019
Svetlana Maltseva

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Foreword to the International Workshop on the Internet of Things and Smart Services

International Workshop on the Internet of Things and Smart Services (ITSS2019) was held in Moscow, Russia within the 21th IEEE Conference on Business Informatics (CBI 2019).

The goal of the workshop is to encourage activities in the field of Collaborative Economy (based on Smart Services and the Internet of Things) and to bring together worldwide researchers with an interest in digital economy as well.

The present workshop is concentrated on theoretical and practical problems raised by the participants in relation to advances in theory, applications and different approaches to using Internet of Things and Smart Services. The range of topics for discussion includes intelligent web applications, smart commerce, Web 3.0 services, web of things, internet of things, smart services, collaborative economy, big data and big data analytics, etc.

Workshop organizers hope that the International Workshop on the Internet of Things and Smart Services makes a good ground for discussion between the academic researchers and practitioners in Business Informatics area focusing on IoT and Smart Services research and implementation.

As the workshop organizers, we would like to thank authors for their contributions, members of the Program Committee and members of the Organizing Committee of the CBI 2019 for their help with the organization of the workshop.

Sincerely,

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Foreword to the 2019 SMART Mechanisms Workshop

This part contains the full papers presented at the 2019 SMART Mechanisms Workshop (WSM-2019) co-located with IEEE Conference of Business Informatics (CBI 2019). The tracks: planning, organizational, rating mechanisms and stimulation mechanisms.

Mechanism Design (MD) in general is a branch of game theory, which deals with conflict situations involving a principal and a set of active agents (usually in the presence of asymmetric information). Mechanism design theory delivers a solution to many management problems in the form of a control mechanism, (i.e., a formalized routine of decision-making). Formal results of MD can change the fundamentals of managerial practice by introducing decision-making mechanisms in organizations, which are efficient and robust with respect to employees' self-serving behavior.

SMART Mechanisms are formalized management decision-making procedures that take into account the active behavior of the organization's employees where active behavior includes (but is not limited to) cognitive biases.

Many thanks are due to the program committee members and additional reviewers who offered their expertise in evaluating the papers and provided very professional feedback to authors for improvement.

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Smart Mechanisms Workshop Organizing Committee

Foreword to First International Workshop on Business Informatics 4.0

Welcome to the proceedings of the First International Workshop on Business Informatics 4.0 (BI4.0) held at Moscow, Russia from 15 to 17 July 2019, as part of the international Conference on Business Informatics CBI 2019.

BI4.0 is related to two particular CBI tracks (Industry 4.0 (Industry Applications) and Business Innovations and Digital Transformation); at the same time BI4.0 complements CBI topics by focusing on the study of the influence of this new context on current Business Informatics research and practice.

The BI4.0 goal is to investigate how the theories and practices of Business Informatics should be adapted to fit the new context created by an Industry 4.0 evolution and its associated digital transformation. As the first workshop in this field, BI4.0 provided an academic space for present and discuss research and practice works related to the application of industry 4.0 concepts and tools as well as how to manage their impact in current business informatics practices.

Our half day workshop program has three accepted papers and a panel discussion. We want to express our gratitude to the members of the Program Committee for their work in reviewing submissions. We also thank all authors for their participation and contributions.

We hope that this first workshop will promote research work in how Business Informatics practices ought to advance thus to face the digital transformation caused by the new I4.0 organizational context.

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The Determinants of Credit Cycle and Its Forecast

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Abstract — In our research, we study what macroeconomic factors drive and influence the credit cycle. Also, our study contains four sections with theoretical and empirical parts, in which we describe how to measure credit cycles for developed and developing countries, and then we introduce an important indicator credit gap. Our results show the comparative analysis of credit cycles between different countries with various economic growth, and we built up an econometric model, which shows us the impact of macroeconomic factors according to credit cycles for developing and developed economies.

Keywords – credit cycle, credit gap, credit market, credit rationing, monetary policy, bank loans

JEL-codes: E10, E40, E47, E50, E51, F34

I. INTRODUCTION

Financial crises appear all around the globe. All crises lead to damages of stability in a particular country. If the crisis was a local one, or in a group of countries, the scale of the crisis will tend to a world one. After a crisis appears, for some period there can be seen a process of restructuring of an economy, which is accompanied by development and economic increase, in other words, financial boom starts. However, the heyday cannot last forever, and a new crisis comes. Therefore, the main attention in this paper will be paid to credit cycles. The basic idea behind the credit cycle theory is the following: the more loans are provided, the higher the speed of development in real sector will be.

This paper is aimed to solving the problem of the decomposition of the credit cycle. The main aim of the paper is to try to expand the existing knowledge of determinants of credit cycles in the framework of developing countries such as BRICS.

There will be provided a new point of view to the problem, via dividing indicators of credit cycles to semantic groups, and finding out ones with the most explanatory and forecasting power. In addition, an alternative method of the credit gap calculation, will be proposed.

The paper is organized as follows: the first section is devoted to previous research, their main findings and

discussion of ways in which the results will be used in our research. In the second part, empirical analysis will be presented, as well as the data used. The third section is devoted to the methodology of the research the specification of the model. Finally, theoretical discussion of the main results of the research and the economical interpretation will be highlighted and there will be suggested some practical applications of the findings as well as outlook of future research.

II. THE HISTORY OF THE QUESTION

A. Types of financial cycles

The process of determining a specific credit cycle, inspired researchers to investigate the cyclical nature of a particular economy. During years of study, many different financial cycles were discovered.

Major types of financial cycles are: (1) Economic cycles: changes in economic activity. The changes are mostly described by productivity of the real sector (appearance of new technology, changes in price of materials, political situation, etc.); (2) Business cycles: changes in business activity. The changes are mostly related to production process, and employment; (3) Credit cycles: changes in real sector of economy, depend on the amount of loans provided by financial institutions.

Various analysts state that business and economic cycles are no more applicable to the contemporary world. The main reasoning behind the statement is that the manipulations of rates by Central Banks of developed and developing countries, is mostly aimed to encourage people to use borrowed funds, depending on the state of the economy. Therefore, the main attention in the paper will be paid to the credit cycles.

The basic idea behind the credit cycle theory is the following: the more loans are provided, the higher the speed of development in real sector will be. The development in the real sector will lead to improvement in the economy as a whole. However, the economic growth and, especially the speed of changes, cause overheating. In the overheated economy, even more credits are provided, so the risks are

rapidly increasing. In such cases, the probability of default of a borrower is rising; therefore, a crisis is likely to appear.

Therefore, the crucial part of the whole credit cycle story, is to find the most convenient and reliable ways to determine the point, where steady improvement and a healthy rising economy becomes an overheated one, which is likely to result in a crisis. The idea of implementation of a counter-cyclical buffer (proposed by Basel Committee) is relatively new, and is implemented worldwide for the first time. Correct measure of the size of the buffer, directly depends on an accurate determination of credit cycles.

B. Literature review

Financial crises are the events to which all countries in the world, especially with developed and developing economies, are susceptible. The world became highly globalized. Therefore, the emergence of instabilities, due to various crises in one country, usually influence the sustainability of neighboring countries. This process is known as financial contagion. According to [3], the concept refers to the spread of market disturbances, mostly on the downside, from one country to another, a process observed through co-movements in exchange rates, stock prices, sovereign spreads, and capital flows [3]. That highlights the necessity to have a possibility to predict the occurrence of crises events. In addition, various regulatory units are making attempts to find an instrument that would smooth out consequences of a crisis, and help the exposed economy to recover as soon as possible.

The Basel Committee in December 2010 published, new rules, stating that a capital buffer should have counter-cyclical nature. The amount of the buffer is calculated according to the state of economy, more precisely, to the phase of the credit cycle.

The process of credit cycles can be illustrated by the picture below (see Fig. 1).

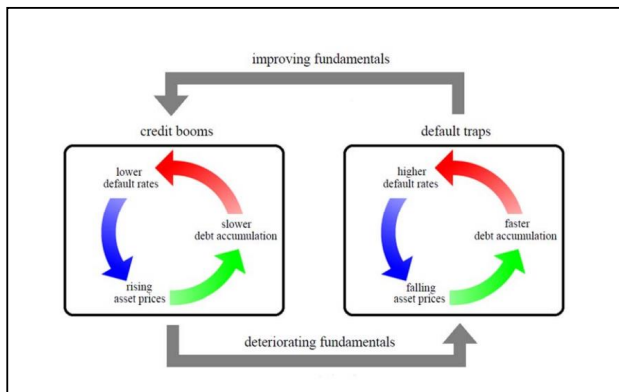


Figure 1. The credit cycle, from Greenwood, Hanson, Jin (2016)

If the theory is true, the probability of a crisis arising may be controlled by the regulation of the amount of loans provided by banks and other financial institutions, and also by government regulation of rates, for example the interbank lending rate. On the other hand, the regulation may

concern the amount of reserves held by banks. The ways are aimed to reduce the risks that arise with the lending process, especially the effects of the default of the borrowers.

The proposition of the Basel Committee, is that the amount of money reserved through creation of a counter-cyclical buffer, should increase in good time, when there is an upward trend, and lower amount of reserves are made during downturns. Such an approach will provide an opportunity to accumulate a reasonable buffer that will be used in case of emergency of or crises.

C. Fundamental research

The components of a financial structure, especially the network of payments, highly depend on financial intermediaries such as banks. Therefore, the efficiency, clarity and strategy of their policy, supremely defines such important parameters as amount of money in hand, relative volume of liquidity in the economy (which is considered as one of the main dimensions of stability of financial structure by P. H. Minsky), the riskiness of various financial relations (the function is provided not by regular banks, but Central Banks and governments) and others.

In the research, H. P. Minsky found that the instability in an economy, is mainly caused by growth of contractual payment commitments, relative to both money holdings and specified money flows. The main indicators of financial stability are supposed to be asset prices, which are increasing during the good times, and ultimate liquidity. The higher the ratio of ultimately liquid assets, the more stable the economy is.

One of the first researches of credit cycles was conducted in 1997 by N. Kiyotaki and J. Moore. There are two ways to consider the cycles: from the side of the demand for credit (borrower side), and of the supply of credit (lender side). The research is made with regard to the demand side. There are determined factors that influence the amount that borrowers need [6].

The main idea of the research is that the durable assets can be viewed, on the one hand, as factors of production, and, on the other hand, as collateral for loans. Therefore, the demand for loans from borrowers is highly connected to the changes in the prices of the assets that are used as collateral [6]. At the same time, the demand for loans influences the prices. As with changes in the demand for loans, the net worth of the companies / borrowers changes.

In the paper there are several types of models, including different assumptions about borrowers conditions and their opportunities. Here, the focus will be paid to the conclusions made by the authors, that are applicable to our further research. According to Kiyotaki and Moore [6], the length of credit cycles is, on average, around 10 years. Moreover, shocks arise when prices for land and property (some assets that are assumed to be the base of production, and at the same time, the most secure collateral), are at their peak value.

Therefore, the major causative agent of shocks is the net worth of the borrower, or in other words, the value of assets and liabilities of the borrower, as well as the value of collateral provided.

III. THE METHODOLOGY AND DATA

A. *Dependent variables*

One of the most significant questions of the whole topic of credit cycles is how to estimate it? The Basel Committee on Banking Supervision (BSBC), proposes to use Credit-to-GDP gap figure, as the representation of a credit cycle. According to BSBC (2010), financial and business cycles are tightly connected with each other. However, financial cycles are longer and more turbulent than the business cycles.

Partly because of the relation between the cycles, the Credit-to-GDP ratio starts to rise in advance, before the actual peak point is attained. According to the findings of BSBC, the Credit-to-GDP ratio tends to rise smoothly, well above trend before the most serious episodes [1]. This fact provides an opportunity to use the parameter to predict a crisis situation beforehand and to have enough time to undertake appropriate preventive actions. As the whole story of credit cycles nowadays is built around the necessity to provide a tool for ensuring the safety and stability of the financial sector in distinct countries and global community, the predicting feature becomes essential.

The vast majority of research that use credit-to-GDP ratio as the dependent variable, try to implement some technique to remove non-stationarity in data under research. For the sake of research, a number of de-trending instruments can be applied. One of the most prevalent is the Hodrick-Prescott filter.

In one of the most recent researches conducted within the framework of the Central Bank of Russia [4], emphasis is based on the application of Hodrick-Prescott filter, to the figure of credit gap. Credit gap is calculated according to findings [2], as the deviation of Credit-to-GDP ratio from its long-term trend. The filter is aimed at removing long-term trends from the time series. The results attained in the research point out that the method is quite valid in the framework of data used in the research (quarterly data of 5 developing economies).

B. *Independent variables*

As the dependent variable has been discussed previously the next thing to be determined is the approach to the essence of independent variables. Each and every paper checks the validity of different groups of parameters, trying to find the most reliable and applicable in a real life model.

There are two most common ways to split independent variables into groups:

- Variables that determine supply and demand [4] which compared the explanatory power of demand variables and supply variables; or the research made by N. Kiyotaki and J. Moore who estimated only the demand side of the question);
- Microeconomic and macroeconomic variables [7] who estimated a model using both micro and macro data).

However, some research goes further and add such groups as:

- (1) Bank variables (bank lending conditions);
- (2) Global variables;
- (3) Financial market variables;
- (4) Variables concerning markets, connected to the banking sector.

For the purposes of our further research, the most convenient way to discuss the main outcomes of a number of researches is to hold the most relevant independent variables in semantic groups. As in the framework of my research, the main attention will be paid to the supply side of the topic: banks and control units (such as Central Banks and governments). The variables will be split into groups.

Starting from the most comprehensive variables let us look at macro ones on a global level.

The class of variables is not very thoroughly researched, as such variables are not very often added into models under consideration. To the group, there may be added such variables as EMBIG spread, volatility of SP500 returns and default spread of a certain type of company (BBB rated corporate bonds). Therefore, these are the variables that characterize the financial market as a whole - its riskiness and overall condition. Mostly, such variables appear to be highly significant in models, and their signs fulfill expectations. However, after some robustness checks were conducted, some variables lose their significance, for example, volatility of SP500 returns.

C. *Methods applied*

In the vast majority of research of the topic, there are so many approaches for estimation a model: OLS (Ordinary Least Squares), probit and logit regressions. During the research analysis the most convenient and reliable models that can be assumed: from probit regressions with binary dependent variables to OLS linear regressions. Both types of models are especially useful for regression method of analysis. If the main aim of a research is to construct a model that will detect significantly high points of the credit cycle, as it is mentioned in the papers [5], the construction of a probit or a linear regression model is justified. On the other hand, if the purpose of an investigation is determining the credit cycle and finding linear relations between the independent and explanatory variables, a simple OLS regression may provide more reliable and significant results.

After the regression analysis, the obtained results should be conducted. As it was mentioned in subsection above, the threshold method may be used here. This method provides a tool to determine periods of significant increase or decrease of the variables, which are under considerably significant for illustration and description purposes.

D. *Most important indicators and variables*

For the finding process of the dependent variable, we will be guided by the propositions of Basel Committee. As the dependent variable, we used the change of Credit-to-GDP gap (the credit gap).

All calculations were conducted stating to the recommendations of Basel Committee (Basel Committee on Banking Supervision, 2010). The dependent variable was evaluated in two steps:

1st step is the calculation of the Credit-to-GDP ratio (R). Formula (1) shows the calculation:

$$R = (\text{Banking Loans}_i / \text{GDP}_i) * 100 \% \quad (1)$$

where banking loans – is the total amount of funds provided to private sector by banks.

Under the condition of the perfect information, the all-statistical figures include all types of banking loans provided by commercial banks to private households and firms from BRICS countries.

According to the BIS (2010) [2], the definition of the credit gap and its significance in the forecasting of instabilities in the banking sector, we clean up the real figures from “noisy” effects. This approach ensures the accountability of potential stress. After this, we did the 2nd step of our iterations of the collected data and calculate the credit gap with trend:

$$G = R - \text{Trend} \quad (2)$$

where trend – is the figure of long-term noise from the Credit-to-GDP ratio. Trend (G) is calculated as an average of historical values of R.

The Hodrick-Prescott filter was used to improve the reliance of the figures as it assigns higher weights for our observations. However, pros and cons of the filter are largely discussed in literature (the discussion was highlighted in [2, 3]).

The other method that we implemented to assign the weights of the credit gap to our calculations – was based on the method of weighted historical simulation. This method in general is used for evaluation of Value-at-Risk. However, the approach for determining most relevant weights may be used in the calculation of trend of the actual figures of credit gap. This approach helps us to assign more weights and to obtain recent observations, and does not crucially depend on the size of our sample used, there were no problems with the periodicity of data. The weights are estimated according to the following formula (3):

Calculation of weights for the Hodrick-Prescott filter:

$$w_j = (1 - q) / (1 - q^T), j = 1, \dots, T, 0 < q \leq 1 \quad (3)$$

where T is the sample size and q is the subsidiary parameter.

Although there is no proper guidance of estimation of parameter q, usually the parameter takes values from 0.95 to 0.99. In our research, the value of q is assumed to be 0.95. Therefore, according to the applied methods of different weights, we found that the figures are exponentially declining with observations that are more distant.

E. Database

For the research, there were used quarterly data from BRICS countries. The time period was determined by the availability of data. For the Brazil this period contains data from 2002 - 2015, for Russia: 2004-2015 and for the rest

countries – from 2000 - 2015. The data for dependent variable (the credit gap) was calculated according to the recommendations of the BIS.

The following figures (the graphs from 2 to 6***) show the dynamics of credit cycles in BRICS countries. This can be explained by the distinct patterns of economic, political and social development of the countries. The most interesting example is the case of China. For the last several years, China is holding title of a country with the fastest development. For the last 5-8 years the growth of GDP in this country varied from 7% to more than 9% per year. Today it is the second largest economy in the world (after the USA). Also, China is one of the biggest investment centers in the world. Near 10% of all global investments concentrate in China.

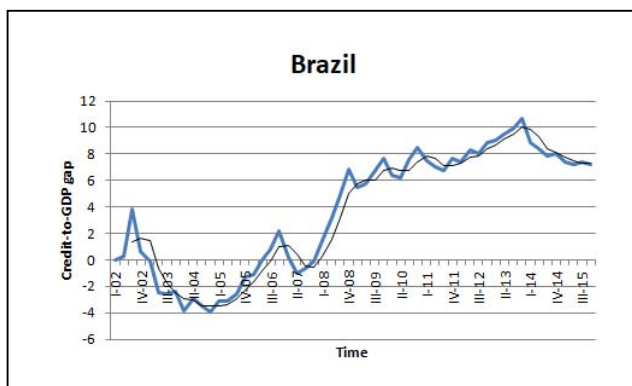


Figure 2. Credit gap for Brazil, 2002-2015.



Figure 3. Credit gap for Russia, 2002-2015.

IV. EMPIRICAL RESULTS

A. General trends

The obtained results during panel analysis of Brazil, Russia and India show the following dependence of the credit gap from explanatory variables (see table 1).

TABLE I. RESULTS FOR BRICS COUNTRIES

Cluster	Variable	Coefficient	Cluster coefficient
Banking	ROA	-0.04	-0.04
Macro country	Inflation	0.25	0.1
	GDP per capita	-0.15	
Macro world	Oil price	-0.07	-0.5
	USDX	-0.4	
	FRS rate	-0.03	

Source: Author's calculations

Only significant variables at level of 1,5 and 10 % are presented in the table above.

All three clusters of variables are significant for countries with emerging economy. However, not all the variables were approved by their signs. There are also some contradictions with the expectations of signs.

Firstly, ROA was the only significant banking variable for the all countries with emerging economy. The change of Return-on-Assets coefficient reflects the efficiency of usage of assets by the company/ borrower. In our research, the ROA coefficient shows the influence of the banking sector of the BRICS countries. Therefore, this variable state for the inefficiency of the banking sector and has a negative impact on the economy.

Secondly, we have to note that the development of the banking sector in emerging economies is a very challenging problem. According to the IMF analytics, there are three groups of problems. First problem is the problem of the banking regulation. In developing countries, the banking system is highly regulated and controlled by various government units. Besides that, there also appear the Basel standard and its requirements which are also needed to be implemented for the banks. This gives an opportunity for the banks from BRICS countries to operate not only on a country level but also on the global market.

Thirdly, the increase in the banking competition was taken place. The commercial banks in emerging economies have to compete not only with each other, but also with the foreign-owned banks [9, 10]. The foreign-owned banks are primarily the leaders in the banking and lending sector in the BRICS countries (for example, Citigroup (USA), HSBC (UK), BNP Paribas (France), UniCredit (Italy).

However, for the Chinese banks this effect is not so evident, and the Chinese banking sector is highly developed among the BRICS countries. For example, such global banks as Industrial and Commercial Bank of China (ICBC), China Construction Bank Corporation and Agricultural Bank of China are the top three banks in the world by the amount of assets for the last decade [14, 15].

The fourth group of problems is proposed by the increasing of the operational costs. The banking operational

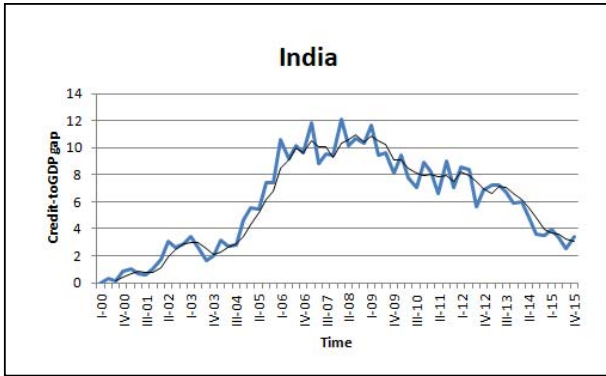


Figure 4. Credit gap for India, 2002-2015.

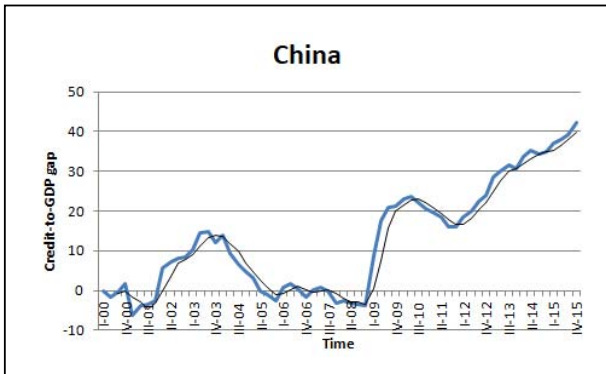


Figure 5. Credit gap for China, 2002-2015.

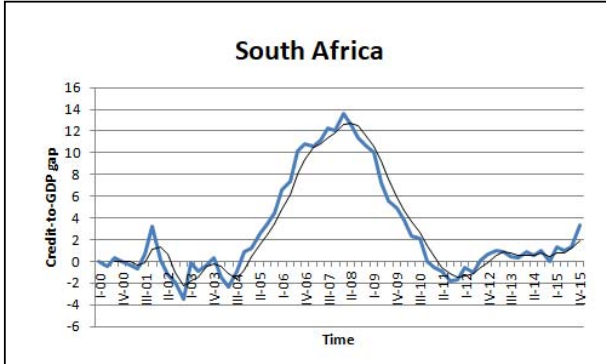


Figure 6. Credit gap for South Africa, 2002-2015.

*** Note: graphs based on authors' calculations.

costs are highly influenced by inflation (which is found to be also significant in our research). That can be illustrated by the indexing of wages of the banking employers and others. Therefore, as the emerging economies are highly susceptible to inflation, the wages are also noticeably increasing.

Because of these problems, which banks facing in emerging countries, the most efficient and largest banks in the BRICS countries are often government-owned banks and the foreign banks. For the fact, in Brazil – the second largest bank by the amount of assets, is a government-owned bank and in top-10 banks there are three foreign banks: Santander (Spain), HSBC (UK) and Citibank (USA). In Russia – the top four banks have government participation, and in top-10 banks there is a bank with foreign participation – UniCredit bank (Italy). In India – the largest bank is mixed: with government-owned and foreign (initially British) participation, and at least the 33 foreign banks are operating in India and they own 8.6% of all investments in the country.

Macro-country cluster variables: (1) The inflation problem: this parameter is very interesting and fully meets our expectations. It is significant and the sign of the coefficient is positive. The obtained results fully support the findings of previous research [4], which found out the significance of the inflation parameter, the unemployment rate and others;

(2) The GDP per capita is found to be significant, however, despite our expectations, the coefficient is negative. We consider that the increasing of the GDP per capita shows the uprising trend of the economic cycle. The economic cycle, as it was mentioned in the beginning of this paper, relates to changes in business activity and it is determined by the productivity and its output. That depends on production process, costs and also on the employment rate. However, we found that the credit gap and GDP per capita, from the statistical point of view, correlates with one another. The smallest increase in GDP per capita leads to the decrease of the credit gap, and shows the downshifting of the credit cycle. Therefore, the negative relationship between these two variables is fully confirmed;

Macro-world cluster variables: (1) The oil price, as well as the rest variables of this cluster is found to be significant. However, the dependence is negative, while the expected sign is positive. The reasoning for the negative coefficient is the same as for the negative coefficient of the GDP per capita factor. Two countries, Russia and Brazil are in the top-10 countries extracting oil (according to the statistical information provided by IMF) and the export of oil is one of the largest part of GDP for both countries. The higher the oil price leads to the higher volume (in money equivalent) of the exports. In other words, the oil price and GDP growth of a country are positively correlated. However, the higher GDP negatively influences the credit gap. We also find an exception for this, for example – the India itself is not a substantial exporter of oil, has a positive coefficient of oil price changes. However, as the countries under consideration are mostly large exporters of oil and the significance of this parameter differs.

B. Country specific trends

BRAZIL

TABLE II. RESULTS FOR BRAZIL

Cluster	Variable	Coefficient	Cluster coefficient
<i>Banking</i>	Capital to Assets ratio	-1.755	-1.755
<i>Macro country</i>	GDP per capita	-0.703	-0.944
	Unemployment	-0.241	

Source: Author's calculations

In our analysis of Brazil, the best explanatory power had a model including only Banking and Macro country clusters of variables. Macro-world cluster of variables did not add significance and explanatory power to the model.

In the table 2 above, there are presented variables which are significant in the country-specific panel model and mostly explain the dependence of the credit gap.

(1) *Banking cluster variables*: In the model the CAP (Capital-to-Assets ratio) has more explanatory power than the ROA-coefficient, which is significant for all emerging countries. This dependence is negative, as it is was initially expected. In Brazil, unlike most countries with emerging economies, exists one of the healthiest form of the banking competition. The two banks of the top are not government-owned unlike, for example, Russia.

(2) *Macro-country cluster variables*: The GDP per capita: is significant for Brazil model, however the sign coefficient does not correspond with our expectations of the signs. As it was discussed in previous part, the coefficient may be negative due to non-economic reasons.

The level of unemployment is the second significant parameter from Macro-country cluster variables for Brazil. The impact of the variable is comparatively large and its negative.

The negative sign of the coefficient corresponds our expectations. In Brazil, the social support is not well-developed, therefore, people are not so confident in their nearest future. The smallest increase in the unemployment rate aggravates the uncertainty of people's living conditions. Therefore, the impact of the factor to credit cycle is crucial.

RUSSIA

TABLE III. RESULTS FOR RUSSIA

Cluster	Variable	Coefficient	Cluster coefficient
<i>Banking</i>	ROA	-0.069	0.609
	Capital to Assets ratio	-0.678	
<i>Macro country</i>	Inflation	0.295	0.295

Source: Author's calculations

According to the analytical research conducted in the part 2, the best explanatory and forecasting power has a model including variables of Banking and Macro-country clusters. In the table 3 above, there are factors that are country significant.

(1) *Banking cluster variables:* The ROA and CAP coefficients negatively influences the credit gap. Additionally to the discussion, presented in subsection A, where we consider these variables to be negative because of economic reasons.

The sign of the ROA coefficient may reflect the additional country risk bearing by Russian banks. There is supposed to be an additional return to compensate the country risk and high counter-cyclical buffer. Therefore, the higher return on assets in the Russian banking sector reflects higher risks and leads to increasing the financial instability of the system. Therefore, this negatively influences the credit gap.

The CAP shows the stability of the Russian banking system. The negative relationship states for the unidirectional changes in the independent and dependent variables. The increase in the CAP reflects to the more stable situation in the Russian lending market. Therefore, the supply side of the market for borrowers becomes more solid and resistant to external stresses.

According to the obtained data and regression results, the effect of the CAP change is stronger than the effect of change in the ROA. The overall banking cluster effect was expected to be positive rather than negative [15].

(2) *Macro-country cluster variables:* The sign of the inflation variable corresponds with our expectations. Therefore, according to the historical data, the effect of the inflation is mostly positive. The uprising inflation leads to the expansion of the Russian economy. However, this monetary effect is limited in time as in case of too high inflation rate, the Russian economy will become overheated and this effect will impact from the increasing process of the devaluation of national currency and can lead to the new economic and production crises events.

INDIA

TABLE IV. RESULTS FOR INDIA

Cluster	Variable	Coefficient	Cluster coefficient
<i>Banking</i>	ROA	-0.129	0.791
	Capital to Assets ratio	0.92	
<i>Macro country</i>	Inflation	0.186	-1.877
	Unemployment	-2.063	

Source: Author's calculations

The case of India is very similar to the results of Russia. For India, also the best explanatory power has a country-specific panel model including only two clusters of variables: Banking and Macro-country clusters. The only difference from Russia is the significance of unemployment variable.

(1) *Banking cluster variables:* Concerning such variables as ROA, CAP and inflation, the reasoning behind their significance and the expected sign of the corresponding coefficients is the same as for Russia. However, the unemployment variable is described in more details below.

(2) *Macro-country cluster variables:* Unemployment seems to be a crucial variable for India case it has a great impact on the credit cycle. As the country has the second largest population in the world, social and demographic variables are expected to influence all spheres of life a lot and the economic sphere is not an exception.

The social support in India is quite low, so the life expectations about future is expected to be comparatively low. Therefore, the additional social instability and stress rapidly increases the uncertainty of the population of this country, which is shown in the uprising of unemployment rate. Consequently, in India people and companies are not willing to take any banking loans. The effect on credit cycle is negative.

CHINA

The obtained results for China in our research demand a special approach for discussion. None of the combinations of clusters proposed a country-specific model that would be significant enough and have a good explanatory and forecast power. We find that the only way to get a significant model is to separate data for two periods: before 2009 and after 2009. In this case, only a country-specific model including all three clusters shows an adjusted R2 higher than 0.45 level. However, still in the model there is only one variable, which arises to be significant, is the CAP. The variable has a positive coefficient of + 1.42.

This country needs a deeper research to get true arguments to explain the obtained results and to make any conclusions according the main subject matter of our study.

There can be presumed several reasons for the obtained observations. Firstly, China differs from other BRICS countries in political structure. Chinese People's Republic is a socialist state. Since 1949 the ruling party is the Communist Party of China.

The political structure straightly influences the economic sector in China. Officially, the economical structure of China is called "socialism with Chinese characteristics". The structure is based on scientific socialism and economic theory. This undermines a significant participation of government in economic sector, however, at the same time, there are some characteristics of market economy.

The determination of future development of economics is performed by the Communist Party on the base of five-year plans. Nevertheless there exist some special economic zones with free market trading.

All the reasoning leads to a supposition that the factors that can be applied for explanation of interdependences in market economies cannot be employed to the Chinese economic structure. In the country there are expected to be highly significant political effects in line with the economical ones.

The other supposition of a reason that could lead to the insignificance of models in the conducted empirical research is the data used. According to several sources, the economic statistics provided may not reflect the true statistical figures. The article provided by Federal Reserve Bank of St. Louis states that "due to the country's complex economy and

challenges posed by the transition from a command economy to a market economy, China's economic statistics remain unreliable" [13]. As the FRED databases were one of the main resources of data, it can be assumed that the data is biased. Therefore, the results from Chinese model are expected to be unreliable and inaccurate.

SOUTH AFRICA

TABLE V. RESULTS FOR SOUTH AFRICA

Cluster	Variable	Coefficient	Cluster coefficient
<i>Banking</i>	ROA	-0.364	-0.955
	Capital to Assets ratio	-0.591	
<i>Macro country</i>	Inflation	-0.162	-0.162
<i>Macro world</i>	FRS rate	-0.087	-0.087

Source: Author's calculations

South Africa also needs to be considered in more details, so we could be able to provide results that are more reliable. However, according to the data, later the middle of 2008, there can be proposed a significant model. The model includes all three clusters of variables. The variables that are significant are presented in the table 5 above. There should be noticed the fact that after mid-2008 there were not observed any crucial economic crises except the 2009. Therefore, there is a large downturn trend during the whole sample of the country panel data.

According to the fig. 6, during the whole period of the sample there can be sighted only one crisis, and therefore, for the reliable results the sample should be widened to include more types of these events.

However, the variables presented in the table 5 are appeared to be significant for the bigger sample. The empirical research showed that in various combinations of clusters they mostly stay significant (especially CAP, inflation rate and FRS rate). Despite that, the coefficients are expected to change their signs on the longer periods of observations.

C. Practical recommendations and future research

In countries such as Russia and other developing economies the application of Basel recommendations plays, among other factors, a significant role. As the countries bear their country risk, they overcome problems of asymmetric information and implement the Basel requirements.

According to the resent Basel rules and recommendations, there should be implemented a counter-cyclical buffer relatively to the credit cycle. Therefore, the credit cycle needs to be accurately defined.

In this research, the weighted historical simulation method was applied to determine the credit gap. According to the fig. 2 – 6, that illustrates the obtained values, there can be seen that this variable is sensitive not only to economical events, but also to political and social ones.

The financial recessions caused by mixed political, social and/or economical events are mostly much milder than the

ones caused solely by economical events. Also, the political events cannot be predicted by economic factors.

On the other hand, the financial strength to overcome a great recession initiated by economic events are expected to be large. The constant lack of banking loans would stop the financial activity of the banking system. Therefore, the counter-cyclical buffer should be mostly calculated for the case of appearance of economic crises.

The first step is to calculate accurately the credit cycle, and then – to determine the specification of significant factors. From our authors' point of view, our research based on the three aspects, which were determined as follow: the banking system, the macroeconomic conditions of a country and the global economy of the world. As it is shown for emerging economies, the most crucial variables come from the banking system and economic conditions of a country. However, this is not enough to provide a proper forecast for the financial crisis events and, accordingly, for the necessary calculation of counter-cyclical buffer.

The second step of our research undermines the determination of the credit cycle and when to determine the economic conditions which may show the overheating and, therefore, to find the closest point of arising economic crisis events.

V. CONCLUSION

For the stability of banking system in a country and to minimize the losses incurred by financial institutions during crises, Basel Committee proposes to use a counter-cyclical buffer with its correspondence to the phases of the credit cycle. This research is aimed to provide a contribution into the understanding of the nature of the credit cycle in BRICS countries with emerging economy. The novelty that was introduced in our research affects both the dependent variable and the explanatory variables. There was proposed an alternative method of evaluation of the credit gap. The method of weighted historical simulation provides calculations of the credit gap. This method provides explicit results; however, it is simpler for practical application than the classic approach of using the Hodrick-Prescott filter.

Finally, we imposed a new view on explanatory variables, which was presented in section 3. There was proposed a cluster analysis and three clusters were evaluated: Banking, Macro-country and Macro-world. For the BRICS countries and their country-specific models include mostly Banking and Macro-country clusters, which have the best explanatory and forecasting power.

According to the obtained results in our research, the BRICS countries have different sets of factors appearing to be significant for determination of credit cycles. Therefore, in future research the results may be improved by the investigation of the countries separately and by the enlargement of sample observations in time.

This research provides a view on the determination and calculation of the credit cycle. However, for the proper forecasts of future changes of the credit cycle and occurrence of the financial crises there should be conducted further research. The unobserved values of the parameters and their impact on the credit cycle needs to be evaluated.

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