Analysis of Areas of Financial and Economic Cooperation Between China and Russia

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Abstract— **The article reveals the relevance of the problem of studying the possible areas of financial and economic cooperation of such large countries as China and Russia, as well as the role of developed and developing countries, in the face of a decline in world trade growth and increased global competition.**

The study uses statistical, cluster and factor analysis of economic growth and financial solvency of China and Russia based on an assessment of the dynamics of the main indicators.

As a result of the analysis of the dynamics of economic growth, the following areas of cooperation between China and Russia are identified: "GDP per capital, PPP (current international $)" and" Gross capital formation (current US$)", due to the increase in hydrocarbon exports and equipment purchases.

The results of the analysis of the proximity matrix of indicators of financial solvency of China and Russia revealed the following priorities: China – "Inflation, GDP deflator (annual %)" and "Gross capital formation (% of GDP)"; Russia – "Broad money growth (annual %)" and "Inflation, GDP deflator (annual). The General direction of international cooperation between China and Russia to ensure financial solvency is "Inflation, GDP deflator (annual %)".

Keywords: hierarchical clustering, neural network, priority areas of cooperation, financial solvency, financial and economic cooperation, economic growth

I. Introduction

Increasing turbulence in the world economy requires the development of adequate methods and approaches to solving the problem of ensuring sustainable economic growth and financial solvency of countries.

Global problems caused by changes in the technological order and the change of the world order have led to the need to explore possible areas of financial and economic cooperation, including such large countries as China and Russia. The increasing mutual influence of China and Russia in the context of slowing world trade growth and increasing global competition leads to a reduction in the duration of the crisis in the world economy and an increase in the period of stable economic growth. The role of developed and developing countries, in the conditions of strengthening of mutually dependent cooperation of China and Russia on the world market becomes equivalent.

At the same time world rating agencies predict the continuation of the prolonged recession and a possible transition to a situation of global crisis, as a result of protective US duties against China and Russia. The international monetary Fund forecasts global economic growth of about 3.5 percent of GDP.

II. Literature review

The choice of areas of financial and economic cooperation of countries is determined by the adequacy of material capital, labor and technology. They depend on the spatial-temporal and economic characteristics of the territories, as well as the institutions on it. The manifestation of institutions is associated with the financial activities of multinationals, namely the potential for foreign investment. The assessment of the quality of institutions is determined by the dynamics of foreign direct investment. The income gap between rich and poor countries has worsened since 1950. There is a General consensus that weak institutions are to blame for this. [1] For

example, direct investment in land has a positive impact on food security through the expansion of land used for growing crops [2].

The promotion of development institutions over the period 2000-2015 has led all developing countries to improve their situation, and the differences between rich and poor countries have decreased [3].

Successful industrialization in developing countries is due not only to the presence of institutions, but also to their ability to combine the initial economic conditions of the country to promote macroeconomic and institutional stability [4]. This ability is realized through financial, fiscal, sector and trade reforms, which complement each other to increase the productivity of firms [5] and reduce wage inequality in the framework of the General equilibrium approach [6], when the utility functions for the period are either additive or satisfy the replacement condition.

Modern China meets three key conditions for further economic growth [7]:

1) stable government that supports a market economy;

2) high and growing quality of human capital;

3) openness to developed economies.

China's economy is more concentrated in manufacturing and less in services.

The macroeconomic model of the Russian economy is focused on the analysis of the consequences of changes in oil prices and strengthening of fiscal policy. Russia's economy is vulnerable to large fluctuations in oil prices, but also has significant opportunities for economic growth in the absence of rising oil prices. A higher oil price not only leads to higher economic growth and savings in the sovereign Wealth Fund, but also causes a structural gap in the national economy.

III. METHOD

Modern methods of assessment as a symbiosis of statistical, cluster and factor analysis are in demand to identify: key factors of economic growth and financial solvency [8]; research the need to take into account the behavior of cross-border banking flows [9]; trends in the level of tax burden and the degree of convergence of the tax burden between countries [10]; the relationship between accounting and the regulatory framework [11]; the effects of types of preferential agreements on economic integration [12]; the growth and fall of current account deficits in some countries of the Eurozone and the Baltic States [13], the consequences for various strategies to curb credit growth [14].

The study uses statistical, cluster and factor analysis of economic growth and financial solvency of China and Russia on the basis of assessing the dynamics of the following indicators:

1) economic growth – "Expense (% of GDP) "; "GDP per capita, PPP (current international $)"; "Gross domestic savings (% of GDP) "; "Gross capital formation (current US$)"; "Manufacturing. value added (% of GDP) "; "Gross savings (% of GDP) "; "GDP growth (annual %)";

2) financial solvency – "Broad money growth (annual %)", "Inflation, GDP deflator (annual %)", "Gross capital formation (% of GDP) ", "Gross savings (% of GNI) ", "Bank capital to assets ratio (%)","Gross capital formation (annual % growth) ", "Broad money (% of GDP) ", "Gross fixed capital formation (% of GDP) ", "Bank liquid reserves to bank assets ratio (%)" and "Bank nonperforming loans to total gross loans (%)".

The process of statistical analysis is implemented in the environment "MS EXEL", cluster and factor analysis – "SPSS Statistics". Factor analysis-neural network ("Multilayer perceptron", definition of hierarchy of importance), cluster analysis-hierarchical clustering By K-means. The source of the estimated statistical indicators is the World Bank Group, All Rights Reserved. Data from database: World Development Indicators".

IV. ANALYSIS

A. *Analysis of economic growth*

An analysis of the dynamics of economic growth indicators in China and Russia is based on an assessment of their growth rate (Rate of Growth, RG) using the method of statistical analysis [15, 16, 17]. The analysis revealed (table I):

1) positive average growth rates:

- China: "Expense (% of GDP)" – 23.9%; "Gross capital formation (current US$)" – 17.4%; "GDP per capita, PPP (current international $) – 11.2%; Gross savings (% of GDP) – 1.9%; Gross domestic savings (% of GDP) – 1.7%; GDP growth (annual %) – 1.2%;

- Russia: Gross capital formation (current US$) – 23.3%; GDP per capita, PPP (current international $) – 10.3%; Expense (% of GDP) – 3.1%;

2) negative asymmetry of the growth rate:

- China: Expense (% of GDP) – -1.5%; GDP growth (annual %) – -1.4%; Gross capital formation (current US$) USA) – -0.3%;

- Russia: GDP growth (annual %) – -2.6%; Manufacturing, value added (% of GDP) – -1.2%; Gross capital formation (current US$) – -1.0%; GDP per capita, PPP (current international $) – -0.2%.

TABLE I. RG OF INDICATORS OF THE DEVELOPMENT OF CHINA AND RUSSIA, 2000-2020, %.

Series Name	Expense (% of GDP)	GDP per capita. PPP (current international $)	Gross domestic savings (% of GDP)	Gross capital formation (current US$)	Manufacturing. value added (% of GDP)	Gross savings (% of GDP)	GDP growth (annual %)
China							
2000		10.1	-3.0	9.0	1.6	-2.5	10.7
2001		10.0	5.1	17.0	-1.5	4.9	-1.8
2002		10.1	2.4	11.8	-0.7	4.1	9.5
2003		11.5	9.1	23.7	4.5	10.5	9.9
2004		12.5	6.1	24.3	-1.5	7.1	0.8
2005		14.3	2.8	12.8	0.4	1.5	12.7
2006		15.5	4.5	19.1	1.1	5.5	11.6
2007		16.7	2.1	30.7	-0.3	2.9	11.9
2008		11.2	-0.7	35.1	-0.8	-0.1	-32.2
2009		9.7	0.6	19.3	-1.7	-1.6	-2.6
2010		11.4	1.2	22.4	0.0	0.8	13.2
2011		11.3	-2.3	24.3	1.4	-3.9	-10.3
2012		9.3	-0.3	12.0	-1.7	0.6	-17.6
2013		9.0	-0.2	12.6	-2.8	-1.6	-1.3
2014	34.9	8.7	-0.6	8.2	-0.6	1.5	-5.9
2015	1.2	7.5	-1.3	1.9	-3.3	-2.5	-5.4
2016	34.9	7.5	-4.8	-1.2	1.1	-4.8	-3.1
2017	23.7	12.8	4.6	22.2	0.8	5.3	8.6
2018	23.8	12.5	3.9	21.1	0.6	4.5	6.9
2019	24.2	12.2	3.4	20.3	0.4	3.9	5.7
2020	24.7	12.0	3.1	19.8	0.3	3.5	4.8
Russia							
2000	4.3	15.4	21.5	67.1		28.0	56.2
2001	7.5	7.9	-10.6	38.6		-8.8	-49.1
2002	-0.9	9.0	-10.9	2.8		-12.9	-6.8
2003	2.2	15.3	4.5	29.7	-4.4	1.3	53.8
2004	-6.4	10.6	2.9	37.6	6.8	6.0	-1.6
2005	-7.5	15.5	1.9	24.2	4.9	1.0	-11.1
2006	-2.2	26.2	0.4	36.6	-2.1	-1.3	27.9
2007	18.0	11.6	-3.3	49.9	-1.5	-1.9	4.7
2008	-6.4	21.1	6.0	34.9	-0.7	4.7	-38.5
2009	49.1	-3.9	-24.1	-45.4	-15.6	-28.1	-249.0
2010	-14.7	5.7	16.4	49.0	0.2	19.9	-157.6
2011	-14.9	18.6	5.9	45.4	-9.6	7.7	17.3
2012	3.8	6.1	-4.0	8.2	1.7	-4.9	-30.8
2013	1.6	1.8	-8.6	-2.1	-4.9	-11.4	-51.2
2014	7.5	-1.7	0.4	-13.6	2.8	1.4	-58.6
2015	15.9	-4.3	6.2	-33.4	3.3	9.3	-482.9
2016	0.9	0.4	-6.2	-1.8	-0.3	-7.1	-92.0
2017	1.4	17.0	2.0	47.5	-1.1	2.9	49.1
2018	1.8	15.5	1.5	41.9	-1.2	2.3	26.9
2019	2.1	14.3	1.3	37.9	-1.2	2.0	11.0
2020	2.3	13.5	1.0	35.0	-1.2	1.7	-0.4

[a.] *Source:* calculated on the basis of data "World Bank Group, All Rights Reserved". URL: http://databank.worldbank.org (Accessed on 28 September 2019).

The results of the analysis show that China is the leader in RG with indicators – "GDP per capita, PPP (current international $)", "Gross domestic savings (% of GDP)". Russia is the leader in reducing RG asymmetry – "Gross capital formation (current US$)".

RG analysis of the dynamics of Russia's development indicators revealed increased activity in "GDP per capital, PPP (current international $)" and " Gross capital formation (current US$)", due to an increase in hydrocarbon exports and equipment purchases due to an increase in hydrocarbon

exports and equipment purchases (including state programs for the development of defense industry, etc.).

For China the priorities are:

- increase of labour productivity in "Manufacturing, value added (% of GDP)";

- enhancing returns from a combination of factors (according to Pearson pair correlation of table 1 results " "Gross domestic savings (%of GDP)", "GDP per capital, PPP (current international$)", "Gross domestic savings (% of GDP)" "" Gross savings (%of GDP" " and " GDP growth (annual %)";

- increase in gross investment expenditures and net exports associated with technological renewal of enterprises and increase in productivity of firms [18].

For Russia, the priority is "Expense (%of GDP)"," GDP per capital, PPP (current international$)" and " GDP growth (annual %)". The priority of inter-country cooperation is associated with high labor productivity in China and low-in Russia [19]. This provision promotes the spread of technology [20], increases productivity and net exports [21].

We will assess the effectiveness of intercountry cooperation using correlation coefficients to the dynamics of economic growth indicators (table II).

TABLE II. THE EFFECTIVENESS OF CROSS-NATIONAL COOPERATION OF CHINA AND RUSSIA, 2000-2020

Indicator	Correlation coefficient
Expense (% of GDP)	-0.7
GDP per capita, PPP (current international $)	0.7
Gross domestic savings (% of GDP)	-0.1
Gross capital formation (current US$)	0.5
Manufacturing, value added (% of GDP)	-0.2
Gross savings (% of GDP)	-0.1
GDP growth (annual %)	-0.6

[b.] *Source:* calculated on the basis of data "World Bank Group, All Rights Reserved". URL: http://databank.worldbank.org (Accessed on 28 September 2019).

The resulting values of the correlation coefficient on the dynamics of indicators show the direction of international cooperation between China and Russia – "GDP per capita, PPP (current international $)" and "Gross capital formation (current US$)".

B. Analysis of financial solvency of China

The result of hierarchical clustering using the method of intergroup communication (Pearson correlation), is determined by the proximity matrix (table III).

TABLE III.   MATRIX OF PROXIMITY INDICATORS OF FINANCIAL SOLVENCY OF CHINA

Indicator	Correlation between value vectors								
	1. Broad money (% of GDP)	2. Gross savings (% of GNI)	3. Gross capital formation (% of	4. Gross fixed capital formation	5. Broad money growth (annual	6. Gross capital formation	7. Bank capital to assets ratio (%)	8. Inflation, GDP deflator (annual	9. Bank nonperforming
1. Broad money (% of GDP)	1.0	-0.9	-0.7	-0.6	-0.9	-1.0	0.5	-0.7	0.9
2. Gross savings (% of GNI)	-0.9	1.0	0.9	0.8	0.9	0.9	-0.7	0.5	-0.9
3. Gross capital formation (% of GDP)	-0.7	0.9	1.0	1.0	0.6	0.6	-0.8	0.4	-0.9
4. Gross fixed capital formation (% of GDP)	-0.6	0.8	1.0	1.0	0.5	0.5	-0.8	0.2	-0.8
5. Broad money growth (annual %)	-0.9	0.9	0.6	0.5	1.0	1.0	-0.4	0.6	-0.8
6. Gross capital formation (annual % growth)	-1.0	0.9	0.6	0.5	1.0	1.0	-0.5	0.7	-0.9
7. Bank capital to assets ratio (%)	0.5	-0.7	-0.8	-0.8	-0.4	-0.5	1.0	-0.2	0.8
8. Inflation, GDP deflator (annual %)	-0.7	0.5	0.4	0.2	0.6	0.7	-0.2	1.0	-0.7
9. Bank nonperforming loans to total gross loans (%)	0.9	-0.9	-0.9	-0.8	-0.8	-0.9	0.8	-0.7	1.0

[c.] *Note:* Hierarchical cluster analysis. The average distance between clusters, the square of the Euclidean distance.

[d.] *Source: Source:* calculated on the basis of data "World Bank Group, All Rights Reserved". URL: http://databank.worldbank.org (Accessed on 28 September 2019).

The agglomeration order indicates the priority of "Gross capital formation (% of GDP)" and "Gross fixed capital formation (% of GDP)" for the development of China's economy. Clustering with K-means revealed the clusters:

1) "Gross savings (% of GNI)", "Gross capital formation (% of GDP)" and "Gross fixed capital formation (% of GDP)";

2) "Broad money growth (annual %)", "Gross capital formation (annual % growth)" and "Inflation, GDP deflator (annual %)".

It should be noted that in retrospect, reliable data from China on the "Bank capital to assets ratio (%)" and "Bank nonperforming loans to total gross loans (%)" are absent due to strict state supervision of banking activities [22], including Providing information in the public domain.

The high importance of China's financial solvency indicators (table IV) is associated with "Inflation, GDP deflator (annual %)" and "Gross capital formation (% of GDP)," which is natural for the world leader in RG GDP and value added.

TABLE IV.   IMPORTANCE OF CHINA'S SOLVENCY INDICATORS

Indicator	Importance
Inflation, GDP deflator (annual %)	100.0%
Gross capital formation (% of GDP)	63.4%
Gross savings (% of GNI)	36.0%
Broad money (% of GDP)	26.9%
Bank capital to assets ratio (%)	21.3%
Gross fixed capital formation (% of GDP)	18.0%
Bank nonperforming loans to total gross loans (%)	14.4%
Broad money growth (annual %)	12.9%

[e.] *Note:* Multilayer perceptron, batch training.

[f.] *Source:* calculated on the basis of data "World Bank Group, All Rights Reserved". URL: http://databank.worldbank.org (Accessed on 28 September 2019).

C. Russia

The result of hierarchical clustering, using the intergroup communication method (Pearson correlation), determines the proximity matrix (table V).

TABLE V.   THE PROXIMITY MATRIX OF INDICATORS OF RUSSIA'S FINANCIAL SOLVENCY

Indicator	Correlation between value vectors									
	1. Broad money (% of GDP)	2. Gross savings (% of GNI)	3. Gross capital formation (% of GDP)	4. Gross fixed capital formation	5. Broad money growth (annual)	6. Bank capital to assets ratio (%)	7. Inflation, GDP deflator (annual)	8. Bank liquid reserves to bank	9. Bank nonperforming	10. Gross capital formation
1. Broad money (% of GDP)	1.0	-0.6	-0.3	-0.7	-0.6	-0.8	-0.8	0.0	0.8	-0.4
2. Gross savings (% of GNI)	-0.6	1.0	0.2	0.1	0.7	0.5	0.9	-0.2	-0.3	0.4
3. Gross capital formation (% of GDP)	-0.3	0.2	1.0	0.7	-0.2	0.7	0.1	0.7	0.1	0.8
4. Gross fixed capital formation (% of GDP)	-0.7	0.1	0.7	1.0	-0.1	0.8	0.2	0.6	-0.3	0.5
5. Broad money growth (annual %)	-0.6	0.7	-0.2	-0.1	1.0	0.3	0.8	-0.3	-0.8	0.0
6. Bank capital to assets ratio (%)	-0.8	0.5	0.7	0.8	0.3	1.0	0.6	0.1	-0.4	0.6
7. Inflation, GDP deflator (annual %)	-0.8	0.9	0.1	0.2	0.8	0.6	1.0	-0.3	-0.6	0.5
8. Bank liquid reserves to bank assets ratio (%)	0.0	-0.2	0.7	0.6	-0.3	0.1	-0.3	1.0	0.2	0.3
9. Bank nonperforming loans to total gross loans (%)	0.8	-0.3	0.1	-0.3	-0.8	-0.4	-0.6	0.2	1.0	0.0
10. Gross capital formation (annual % growth)	-0.4	0.4	0.8	0.5	0.0	0.6	0.5	0.3	0.0	1.0

[g.] *Note:* Hierarchical cluster analysis. The average distance between clusters, the square of the Euclidean distance.

[h.] *Source: Source:* calculated on the basis of data "World Bank Group, All Rights Reserved". URL: http://databank.worldbank.org (Accessed on 28 September 2019).

It was revealed that Russia regulates RG "Broad money (% of GDP)", "Bank nonperforming loans to total gross loans (%)", "Gross capital formation (annual % growth)" and "Gross capital formation (% of GDP)" actively using the mechanism of budget rules (Ministry of Finance of the Russian Federation) and the policy of inflation targeting (Central Bank of the Russian Federation).

Clustering allowed to reveal belonging to clusters:

1) Gross savings (% of GNI), Gross capital formation (% of GDP), Gross fixed capital formation (% of GDP) and Broad money growth (annual %);

2) "Bank capital to assets ratio (%)", "Inflation, GDP deflator (annual %)", "Bank liquid reserves to bank assets ratio (%)", "Bank nonperforming loans to total gross loans (%)" and "Gross capital formation (annual % growth)".

TABLE VI.   IMPORTANCE OF RUSSIA'S FINANCIAL SOLVENCY INDICATORS

Indicator	Importance
Broad money growth (annual %)	100.0%
Inflation, GDP deflator (annual %)	97.6%
Gross capital formation (% of GDP)	84.5%
Gross savings (% of GNI)	81.6%
Bank capital to assets ratio (%)	66.9%
Gross capital formation (annual % growth)	58.0%
Broad money (% of GDP)	52.3%
Gross fixed capital formation (% of GDP)	31.9%
Bank liquid reserves to bank assets ratio (%)	16.1%
Bank nonperforming loans to total gross loans (%)	14.3%

[i.] *Note:* Multilayer perceptron, batch training.

[j.] *Source:* calculated on the basis of data "World Bank Group, All Rights Reserved". URL: http://databank.worldbank.org (Accessed on 28 September 2019).

High values of importance of indicators of financial solvency of Russia (table 6) are connected with "Broad money growth (annual %)" and "Inflation, GDP deflator (annual %)". The growth of "Gross capital formation (annual % growth)" and "Gross capital formation (%of GDP" is due to the ruble issue while maintaining the budget rule.

V.   DISCUSSION

As a result of the analysis of the dynamics of economic growth, the following areas of cooperation between China and Russia are identified: "GDP per capital, PPP (current international $)" and" Gross capital formation (current US$)", due to the increase in hydrocarbon exports and equipment purchases.

For China, the priorities are improving productivity "Manufacturing, value added (% of GDP)"; strengthening returns from a combination of factors "Gross domestic savings (% of GDP)", "GDP per capita, PPP (current international $)", "Gross domestic savings (% of GDP)", "Gross savings (% of GDP)" and "GDP growth (annual %)"; increasing gross investment spending and net exports associated with technological upgrading enterprises and improving the productivity of firms. For Russia, the priorities are "Expense (% of GDP)", "GDP per capita, PPP (current international $)" and "GDP growth (annual %)".

The results of the analysis of the proximity matrix of indicators of financial solvency of China and Russia revealed the following priorities: China – "Inflation, GDP deflator (annual %)" and "Gross capital formation (% of GDP)"; Russia – "Broad money growth (annual %)" and "Inflation, GDP deflator (annual %)". So, the common to ensure the financial solvency of China and Russia is "Inflation, GDP deflator (annual %)".

VI.   CONCLUSION

As a result of the assessment of the dynamics of the development indicators of China and Russia using linear approximation by the method of least squares, high positive average RG of economic indicators, as well as their low

negative values of asymmetry and high values of the correlation coefficient were revealed.

As a result of the forecast assessment of the dynamics of industrial development indicators taking into account the polynomial trend, the pair correlation coefficients R Spearman, Tau Kendall and cross-correlation, a favorable direction of economic cooperation between China and Russia – "GDP per capital, PPP (current international $)" and "Gross capital formation (current US$)" was revealed. At the same time, China's economy is the leader in terms of development indicators, and Russian-Chinese cooperation will be decisive in world economic activity.

As a result of the assessment of the financial solvency of China and Russia, their common need for the growth of the broad money supply was revealed. But there are some differences in the ways of achieving a high level of financial solvency of China – gross (domestic) savings, of Russia – the growth of gross savings. China's financial system generates gross savings for the growth of added value, Russia increases gross savings by replenishing the Reserve Fund.

A hierarchy of the importance of indicators of financial solvency of China was revealed - from broad growth of money to gross (domestic) savings, and of Russia - from non-bank loans to gross fixed capital formation, which allowed us to determine the direction of financial cooperation between China and Russia - "Inflation, GDP deflator (annual %)".

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