Proximity analysis of dynamics of economic indicators of Germany

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Abstract—The article presents a comparative analysis of the proximity of the dynamics of economic indicators of Germany and Russia according to the International Monetary Fund. The study is based on a systematic approach using statistical and cluster analysis. Global problems of economic growth of Germany and Russia caused by transformation of a world order, world economic activity, change of a technological way of life are considered. The use of comparative analysis of the proximity of the dynamics of economic indicators of Germany and Russia has revealed not only the internal problems of these countries, but also the possibility of using the potential of proximity, reducing the risks of structural changes in the structure of the world economy. The results of the study can be used in the process of adjusting international cooperation between Germany and Russia. The article concludes that the process of globalization and aggravation of international competition increases the gap between the economies of Germany and Russia. To eliminate this phenomenon, it is necessary to combine the potential of these countries, taking into account the proximity of the dynamics of economic growth, thereby synchronizing their joint development.

Keywords—proximity, two-sample F-test, dynamics, cluster analysis, potential, growth rate.

I. INTRODUCTION

The global problems in the world economy caused by the change of technological structure and the change of the world order made it necessary to compare the proximity of the dynamics of economic indicators of developed and developing countries. A comparative analysis of the proximity of the dynamics of economic indicators of developed and developing countries makes it possible not only to compare them, but also to identify both the internal problems of these countries and structural changes in the structure of the world economy.

A comparative analysis of the proximity of the dynamics of economic indicators of developed Germany and developing Russia includes a comparison of the growth rate of gross domestic product, gross national savings, total investment, imports of goods and services, exports of goods and services, the unemployment rate using the "two-sample F-test". Complementing the comparative analysis with the cluster analysis it is possible to reveal the potential of the proximity of the dynamics of economic indicators of Germany and Russia.

II. METHODOLOGY

The gap in the level of technology used is increasing for the production of products for export recently. This is due to increased international competition and, as a consequence, the need to improve the aggregate productivity of factors of production and the level of product quality.

The analysis shows a growing inequality between developed and developing countries. From the point of view of globalization, new models of specialization in advanced economies allow them to maintain and even expand their leading positions compared to lagging ones, even when some developing countries show significant growth [1, 2].

Technological progress has actually shortened the distance that knowledge and innovation have between countries, it has been found that the growth rates of innovation, technology dissipate between countries slowly. Under these conditions, countries that are genetically closer to countries with higher growth may experience higher growth rates or "side effects of growth". Genetic relationships are important because countries with common genetic characteristics share common languages, business practices, and areas of economic interest, which make the process of interaction easy. The effect of genetic proximity to high-growth economies can be separated from the influence of geographic proximity or trade relations with these countries [3].

Countries surrounded by dynamic structures will grow faster. Also, all sorts of political and financial crises in neighboring countries will have a very lasting impact on the volume of national production [4]. These phenomena necessitate coordinated policies of countries for directed high accumulation of physical and human capital, taking into account the synergy [5], as well as strengthening the relationship between the quality of public administration and economic growth, with an emphasis on the role of the currency regime [6].

Considerable attention in Germany is paid to the processes of knowledge production. At the same time, little attention is paid to the type of technological knowledge produced in certain places [7].
Germany and Russia differ significantly in their innovative capabilities. Germany has been able to maintain global leadership in innovation and technology, while Russia continues to lag behind. The strong differences in the spatial organization of innovation in Germany determine the diversity of contributions to economic geography – the impact on innovation outcomes. The higher mobility of capital, population and knowledge in Germany not only facilitates the agglomeration of research activities in specific areas of the country, but also allows the various territorial mechanisms to take full advantage of local innovation and (information) synergies. In Russia, on the contrary, imperfect market integration and institutional and cultural barriers across the continent prevent innovation agents from maximizing the benefits of the external economy and localized interaction [8].

In general, Germany with a stable use of resources has better socio-economic indicators than Russia with a growing or declining use of resources. A sustainable economy can be socially sustainable in condition that countries become much more effective in transforming natural resources into human well-being [9].

III. ANALYSIS

The two-sample F-test of the proximity of the dynamics of economic indicators of Germany and Russia includes a comparison of the growth rate of gross domestic product [11], gross national savings, total investment, imports of goods and services, exports of goods and services [12, 13], the unemployment rate.

Growth rate of GDP per capita (Growth rate of GDP per capital) (Fig. 1). The two-sample F-test revealed the proximity ($F_0 = 0$) [14] of the dynamics of GDP growth per capita in Germany and Russia.

This proximity is indicative in the "failed" periods of economic crises (global financial and economic 2008–2010 and the tightening of trade relations 2014–2016), and the subsequent adaptation to them.

![Fig. 1. Gross domestic product per capita growth rate (current prices, percentage change). Source: International Monetary Fund, World Economic Outlook Database. URL: https://www.imf.org.](image)

Germany and Russia show negative average growth rates of the unemployment rate (1999–2023) [16]. The highest peak in the growth rate of unemployment is observed in 2009–Germany (3.85%).

Growth rates of gross national savings (Growth rates of gross national savings). The two-sample F-test revealed the proximity of the dynamics of growth rates of gross national savings of Russia and Germany (Fig. 3). Consequently, the growth rate of gross national savings of Russia can be conditionally linked to external factors – the German economy.

![Fig. 2. The rate of increase in the unemployment rate (percentage of the total labour force). Source: International Monetary Fund, World Economic Outlook Database. URL: https://www.imf.org.](image)
Russian growth rates of gross national savings are the most unstable, showing a deep decline in 2001 – -12.56% (with high levels 1999 – 69.77% and 2000 – 30.20%) and 2009 – -32.33%, so the rise in 2011 – of 19.53%. With the fall in the rate of growth of national savings, Russia is more comparable to Germany.

Growth rate of total investment (Growth rate of total investment). The two-sample F-test revealed the proximity of the dynamics of the growth rate of the total investment of Russia and Germany (Fig. 4), which is similar to the dynamics of the growth rate of gross national savings (see Fig. 3). The growth rate of total investment, as well as gross national savings, Russia, can be conditionally linked to external factors – the German economy.

Deviation of statistical hypotheses about equality of variances of two normal distributions in Russia and Germany are revealed. The highest growth rates of imports of goods and services in Germany in 2013 – 742.39%, the lowest – Germany in 2009 -639.78%, Russia in 2014 -970.81%, 2017 -575.33%.

Growth rate of exports of goods and services (Growth rate of exports of goods and services). The proximity of the dynamics of the growth rate of exports of goods and services revealed deviations of statistical hypotheses about the equality of the variances of the two normal distributions of Germany and Russia (Fig. 6).

Potential. Determination of the potential of the proximity of the dynamics of economic indicators of Germany and Russia is associated with the use of cluster and non-parametric analysis. Clustering refers to statistical processing as well as a broad class of unsupervised learning tasks. Let's use the hierarchical cluster analysis procedure implemented in the SPSS Statistics package.

As a result of cluster analysis of GDP growth per capita, unemployment, gross national savings, total investment, imports of goods and services, exports of goods and services identified the main clusters (Table 1).
TABLE I. THE MAIN CLUSTERS IN TERMS OF GROWTH RATES OF ECONOMIC INDICATORS OF GERMANY AND RUSSIA

<table>
<thead>
<tr>
<th>The combined cluster</th>
<th>The square of Euclidean distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany / Gross domestic product per capita, current prices</td>
<td>323367.381</td>
</tr>
<tr>
<td>Russia / Gross domestic product per capita, current prices</td>
<td></td>
</tr>
<tr>
<td>Germany / Gross national savings</td>
<td>1956475.082</td>
</tr>
<tr>
<td>Russia / Volume of imports of goods and services</td>
<td></td>
</tr>
<tr>
<td>Germany / Unemployment rate</td>
<td>10254.632</td>
</tr>
<tr>
<td>Russia / Unemployment rate</td>
<td></td>
</tr>
<tr>
<td>Germany / Unemployment rate</td>
<td>3058.664</td>
</tr>
</tbody>
</table>

Note to the table: Hierarchical cluster analysis. The average distance between the clusters and the square Euclidean distance.

Source: Statistics SPSS Statistics according to the international monetary Fund, world Economic Outlook database. URL: http://www.IMF.org.

For Germany (high-tech imports), the rationality of increasing GDP growth is associated with the use of high potential trade with Russia (import of raw materials and export of industrial products).

Combining the results of cluster and statistical analysis made it possible to determine the possibility of realizing the potential of proximity of the dynamics of economic indicators at the level of Gross domestic product per capita, current prices, Gross national savings, Unemployment rate.

IV. DISCUSSION OF RESULTS

The two-sample F-test of the proximity of the dynamics of economic indicators of Germany and Russia showed the proximity of the Russian economy in terms of GDP growth per capita with Germany. This closeness is significant in periods of economic crisis, due to the loss of the position of developed countries relative to their competitive advantage. To ensure stable growth of the Russian economy, the dynamics of GDP per capita should be higher than in Germany.

The Bank of Russia's inflation targeting policy is helping to bring the per capita GDP growth rates of Germany and Russia closer together, bringing the Russian economy closer to recession. The Russian economy is comparable to Germany in terms of gross national savings. This phenomenon is associated with the greatest instability in the growth rate of gross national savings. At the same time, Russia is comparable to Germany with the fall in the rate of growth of national savings.

Russia's growth rate of total investment, as well as gross national savings, is comparable to the dynamics of the German economy, which confirmed the problem of the Russian economy – the lack of balanced economic growth. In terms of the increase in the volume of exports of goods and services, the economies of Germany and Russia are comparable.

As a result of cluster analysis of GDP growth per capita, unemployment, gross national savings, total investment, imports and exports of goods and services revealed the possibility of realizing the potential of the proximity of the dynamics of economic indicators on Gross domestic product per capita, current prices, Gross national savings, Unemployment rate.

V. CONCLUSION

The process of globalization of the economy and the accompanying transformation of the world order and world economic activity, makes it necessary the identification of countries comparable in dynamics of economic indicators, which makes it possible not only to compare them with each other, but also to identify both the internal problems of these countries and structural changes in the world order.

A two-sample F-test to analyze the proximity of the dynamics of economic indicators of Germany and Russia showed their proximity in terms of growth: Gross domestic product per capital, current prices, Gross national savings, Unemployment rate. The possibility of Russia realizing its potential from the proximity of the dynamics of economic indicators with Germany is associated with the development of trade and economic relations.

REFERENCES


