

Analysis of the Development of Trade Relations Based on the Gravity Model in Georgia

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The laws of physics are widely used in modern economic science. In this respect, it is significant that for the analysis of international trade relations, demographic processes, problems of the regional economy, the principle of gravity reflected in the relevant econometric models is need. The gravity model of international trade is an econometric tool for analyzing the country's trade potential, the use of which is important for a country with a small economy like Georgia. The paper presents an overview of the main approaches to estimate gravity trade models. The model we selected is a popular tool for analyzing international trade flows. The econometric tools of gravity modeling have been greatly enriched over the past decade, yet all estimation methods have their advantages and disadvantages. The selection of a specific method is not apriori, it largely depends on the features of the available data and the research objectives. In practice, to check the stability of the obtained results, as a rule, several methods of estimation of the gravity equation are used. The paper discusses an alternative method of considering the structural indicators of international trade, which is based on: calculating the distance and GDP indicators between the countries participating in international trade, using the common border and landlock variables, taking into account the fixed effects of the exporter and importer. Although there are many modifications of the gravity model, in our case, the specifics and features of Georgia's international trade were taken into account by introducing additional variables into the model. By including new factors in the model, it was possible to make valid conclusions that fully reflect the features of the country's foreign trade in the transition period.

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gravity model, modification, linear regression, additional variables, foreign trade of Georgia, peculiarities

The main approaches to the gravitational model derive from Newton's classical theory of gravity. The law of gravitation in classical physics tells us that every point of mass on a body exerts a gravitational force on every other point of mass. This law was first formulated by Isaac Newton in 1687 [1]. Modern science widely uses the econo-

metric approach to study international trade. The econometric tools for gravity modeling have been greatly enriched in recent decades. Based on sharing the basic principles of Newton's law of gravity, gravity modeling has become one of the main methods for analyzing trade flows between countries. However, the set of parameters used in

classical gravity models is quite conservative and includes mainly the economic size of countries as a contributing factor to trade growth and the distance between them. Some modifications of the model include additional variables, for example: trade barriers, transport costs, socio-cultural and other factors that have a significant impact on the development of trade relations. Various variables were reflected in the different modifications of the gravity model, which helped to improve the original form of the model and increase the validity of the calculations. At the same time, gravity models practically do not use various socio-economic factors to determine the degree of their influence on the volume of trade flows between countries and regions. One of these factors can be considered the economic similarity of the countries. To explain the volume of bilateral trade between countries, the gravity equation was first used in 1962 by I. Tinbergen [2]. He explained the volume of bilateral trade between the countries both by the economic size of the trading partner countries and by trade costs between them. The GDP volume of the countries was used to determine the economic size, and the distance between them was used as an indicator of trade costs. Subsequently, gravity trade models have become one of the most important tools for empirical analysis of international and interregional trade flows. To date, economic modeling methods, including modified gravity models, are actively used to assess the impact of certain factors on the volume of bilateral trade. In recent years, for the analysis of the peculiarities of international trade, the following variables have been included in the gravity model: the influence of transport costs, natural and political borders, monetary and many other factors on trade. These studies were systematized in the most complete form by J. Anderson and E. Van Wincoop [3, 4].

These scientists, as a result of testing modern trade data, evaluated the potential of gravity methods of international trade based on the theory of similarity of countries. One of the first attempts

to explain the phenomenon of the growth of international trade after the Second World War was presented in the theory of the similarity of countries by the Swedish economist Stefan Linder. Based on this methodology, in 1961, the author published his study [5], which was about the analysis of the transformation of international trade. After analyzing the changes in international trade, Linder came to the conclusion that international trade in industrial goods takes place as a result of similar preferences of consumers from different countries at similar levels of economic development. Based on the Linder's theory of similarity of countries, the most intensive trade relations should be carried out between countries in which consumers have similar indicators of average income and purchasing power of the population. According to this concept, the similarity factor should have a positive effect on the volume of bilateral trade relations. According to the Swedish economist, the most promising markets for exporting companies are the markets of those countries in which the buyer's preferences are similar to the needs and demands of domestic consumers. Linder argued that differences in factor levels between countries do not always reflect international exchange. Linder's approaches differ from the postulates of the earlier theories of international trade, including Heckscher-Ohlin's theory of the ratio of production factors [6, 7]. Based on trade data, it is important to evaluate the application of Linder's theory in the process of analyzing modern international trade relations. From a pragmatic point of view, it is important to use the capabilities of the gravity model for the analysis of trade flows of Georgia [8-12]. The aim of our study was to empirically test these theses based on trade relations between countries. Based on the existing approaches, the volume of Georgia's trade flows can be considered as a functional relationship that determines the impact of the volume of GDP and the geographical distance between countries on international trade. According to the gravity model, trade flows increase with the size of the

national economy and decrease with increasing geographic distance. In the process of calculations, we used the mentioned model in linear logarithmic form. In order to increase the reliability of the research results, such parameters as: border (BORDER), this variable in the model is equal to 1 if there is a common border between Georgia and its trading partners, and it is equal to 0 if they do not have one. It is also necessary to take into account the fact that Georgia is landlocked, which should contribute to the development of international trade in the country. Therefore, another dummy variable was added to the equation – sea (SEA), which is equal to 1 if the trading partner is landlocked and 0 if it is not landlocked. Taking these features into account, the modified gravity model will take the following form:

$$\begin{aligned} \ln(\text{TRADE}_{ij}) = & \alpha + \beta \ln(\text{GDP Geo}_t) + \\ & \gamma \ln(\text{GDP Partner}_{ti}) + \Delta \ln(\text{DIST}_i) + \\ & \varepsilon_1 \text{BORDER}_i + \varepsilon_2 \text{SEA}_i, \end{aligned} \quad (1)$$

where:

(TRADE_{ij}) – the volume of trade turnover between countries *t* and *j*;

(GDP Geo_t) – Georgia's GDP in the time period *t*;

(GDP Partner_{ti}) – GDP of the partner countries in the time period *t*;

(DIST_i) – distance indicator between countries;

(BORDER_i) – the indicator of the common border between the countries;

(SEA) – index of landlocked countries;

ε₁ε₂ – proportionality index of additional parameters;

a = ln(G) G proportionality factor.

In the model, we entered the data of Georgia's trade with the world's trade partners (32 countries) in 2015-2022. The data were used as the information base: trade between countries according to the United Nations [13], nominal GDP data were taken from the World Bank data [14], and the distance between countries from the relevant source [15]. The model is calculated separately for export and import. The results of the calculation are presented in the Table.

Table. Calculation of gravity model of bribery foreign trade

| Variables | Export | Import |
|--|-----------------|----------------|
| GDP Geo | 0.11 (0.12) | 0.21 (0.14) |
| GDP Partner | 1.08 (0.2) | 1.43 (0.03) |
| Distance | -1.75 (0.09) | 1.10 (0.10) |
| Border | 1.29 (0.20) | 1.88 (0.26) |
| SEA | 0.22 (0.12) | 0.78 (0.14) |
| of observations (number of samples) | 2012 | 2108 |
| Coefficient of determination R | 0.63 | 0.64 |
| F-Statistic | 868 | 765 |
| Modelaverage error | 10% | 19% |
| Modelmedian error | 7% | 10% |

It follows from the calculations that even this kind of modified gravity model in which several fictitious variables are entered, quite fully describes the international trade parameters of Georgia. The average error of the model does not exceed 19% and the median error does not exceed 10%. The coefficient of determination R does not exceed 0.64, which is normal. The F statistic is always greater than Fisher's criterion. From the significance of the obtained coefficients it follows that the volume of GDP as well as the common border (both land and sea) have a great influence on the international trade of Georgia the given coefficients are important in the calculations according to the t-student criterion. The variables that reflect the impact of distance on Georgia's international trade are negative which indicates that the increase in geographical distance does not have a positive impact on the country's exports and imports.

It is also worth noting the fact that the country's GDP is essential for Georgia's imports because GDP determines the demand in the domestic market and if it increases imports also increase. However, it is less important than the GDP

indicator of the host country because the latter has a significant impact on the parameters of trade between countries.

It is important to analyze the landlocking ratio of the partner country. This coefficient shows that the landlocked trade partner has insufficient impact on international trade of Georgia. This can be explained by the fact that partner countries have more opportunities to diversify trade.

It is also important that Georgia's GDP does not significantly influence the volume of exports. This can be explained by the structure of export goods and their scarcity. The goods that we export to the receiving countries are not in high demand and are relatively less competitive.

Conclusion

As a result of the research, it was determined that the gravity model is an important tool for international trade research. The inclusion of

additional variables in the model expands the possibilities of its use. The construction of the model and the calculations made on this basis quite accurately characterize the trend established in Georgia's foreign trade. As a result of the calculations, it was determined that it is important to improve Georgia's competitiveness to increase its export potential to produce goods in demand on international markets and to perfect export products. The research has established that Georgia's trade relations are developing successfully with the countries with which it has a common border. In the perspective, it is important to use the resource potential of the sea which should be focused on those countries that are distinguished by a large geographical distance. The gravitational effect of trade shows that Georgia has a great trade potential the utilization of which depends a lot on the reasonable economic policy of the country which ultimately has a positive impact on the country's economic development.

ეკონომიკა

საქართველოში სავაჭრო ურთიერთობების განვითარების ანალიზი გრაფიტაციული მოდელირების საფუძველზე

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თანამედროვე ეკონომიკურ მეცნიერებაში ფართოდ გამოიყენება ფიზიკის კანონები. ამ მხრივ ნიშანდობლივია, რომ საერთაშორისო სავაჭრო ურთიერთობების, დემოგრაფიული პროცესების, რეგიონალური ეკონომიკის პრობლემების ანალიზისთვის მეცნიერები იყენებენ ეკონომეტრიკულ მოდელებში ასახულ გრაფიტაციის პრინციპს. საერთაშორისო ვაჭრობის გრაფიტაციული მოდელი წარმოადგენს ქვეყნის სავაჭრო პოტენციალის ანალიზის ეკონომეტრიკულ ინსტრუმენტს, რომლის გამოყენება მნიშვნელოვანია ისეთი მცირე ეკონომიკის ქვეყნისთვის, როგორც საქართველოა. ნაშრომში წარმოდგენილია გრაფიტაციული ვაჭრობის მოდელების შეფასების ძირითადი მიდგომების მიმოხილვა. ჩვენ მიერ შერჩეული მოდელი პოპულარული ინსტრუმენტია საერთაშორისო სავაჭრო ნაკადების ანალიზისთვის. გრაფიტაციული მოდელირების ეკონომეტრიკული ინსტრუმენტები მნიშვნელოვნად გამდიდრდა ბოლო ათწლეულის განმავლობაში. მიუხედავად ამისა, შეფასების ყველა მეთოდს აქვს თავისი დადებითი და უარყოფითი მხარეები. კონკრეტული მეთოდის შერჩევა არ წარმოადგენს აპრიორს, ის დიდწილად დამოკიდებულია არსებული მონაცემების თავისებურებებსა და კვლევის მიზნებზე. პრაქტიკაში, მიღებული შედეგების სტაბილურობის შესამოწმებლად, როგორც წესი, იყენებენ გრაფიტაციული განტოლების შეფასების რამდენიმე მეთოდს. ნაშრომში განხილულია საერთაშორისო ვაჭრობის სტრუქტურული მაჩვენებლების გათვალისწინების ალტერნატიული მეთოდი, რომელიც ეფუძნება: საერთაშორისო ვაჭრობაზე ზეგავლენის მქონე ქვეყნებს შორის არსებული მანძილისა და მშპ-ს ინდიკატორების გაანგარიშებას, საერთო საზღვრისა და ზღვაზე გასასვლელის ცვლადების გამოყენებით, ექსპორტიორისა და იმპორტიორის ფიქსირებული ეფექტების გათვალისწინებით. მიუხედავად იმისა, რომ გრაფიტაციული მოდელის მრავალი მოდიფიკაცია არსებობს, ჩვენს შემთხვევაში, მოდელში დამატებითი ცვლადების შეყვანით გათვალისწინებულ იქნა საქართველოს საერთაშორისო ვაჭრობის სპეციფიკა და თავისებურებები. ახალი ფაქტორების მოდელში ჩართვით შესაძლებელი გახდა მართებული ხასიათის დასკვნების გაკეთება, რომლებიც სრულად ასახავს ქვეყნის საგარეო ვაჭრობის თავისებურებებს გარდამავალ პერიოდში.

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