

Development of the Specific Gravitational Model Describing Foreign Trade in Georgia

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ABSTRACT

Trade Intensification Index in all the three States is computed in order to find out the export potential utilization on the major markets – the EU, CIS and NAFTA. Trade Intensification Index allowed us to compare the export potential utilization of all the state. The Gravitation model describing Georgia's foreign trade relations is developed by the simulation method. Determination of optimal values of coefficients existing within the models is carried out by our developed computer program, not by the linear optimization method within the scope of simulation mode. Analysis and dynamic formation of the change impact of export/import with the specific countries on GDP of Georgia is carried out by computer programs after development of a specific gravitational model.

Keywords

Trade intensification index, Gravitational model, Simulation method, Optimization task.

1. INTRODUCTION

Since 80's of the 20th century, gravitational models have been widely used within the research of the foreign trade processes. Foreign trade scope's functional dependence with some macroeconomic indicators-GDP, capacity of internal market and others [1] is discussed within the model. It is approved that the scope of the foreign trade is proportional to macroeconomic indicators, including GDP, and inversely proportionate to the distance between the countries.

As already mentioned above, the States shared some commonalities, however, other variables should also be taken into account. For Georgia having small domestic markets, high economic growth should be definitely bound with the growth of scale of exports. Thus, the basis for the creation of the export strategy were the resources controlled by the firm; resources played a major role in designing and realizing the competitive advantage. This statement is fully in line with the reality, when limited resources and small domestic markets dictate companies to be oriented towards fewer export markets and export a limited number of export products.

The gravitational model of the Jan Tinbergen, Nobel Prize laureate in the Economy, is the base of gravitational models developed within some countries, considering some peculiarities of the specific countries. Modification of the mentioned model is carried out quite often; in particular-some parameters are added, such as: existence of common land border with the respondent country, as well as access to the sea of the respondent country. [2]. Indicators such as custom tariffs, transport expenses, membership of trade unions, currency rate, political ties, military blocks, language barriers, etc., used within the gravitational models are systemized. In most cases we are dealing with varieties of this model.

Any variation of the model is general. It is significant to define the value of proportionality coefficients (afterwards Coefficients) included within the general model in order to provide development of a relevant model of foreign trade between the specific countries.

Therefore, for usage of gravitational model in real activities, it is necessary to develop a specific model describing foreign trade relations between two countries.

Any generally characterized gravitational model includes variables X_α , $\alpha = \overline{1..n}$ and coefficients b_k , $k = \overline{1..m}$. X_α values are known or they are calculated as: GDP, distance between the countries, elasticity coefficient, etc., b_k coefficient values are calculated by the well-known statistic method. Establishment of the coefficient values and, therefore, development of the specific gravitational model is quite tedious process, for instance: Foreign Trade data of 2004-2015 years between Russia and 220 world countries and territorial unit was analyzed during development of gravitational model of the foreign trade of Russia, for establishment of the value of the coefficient.

We have used simulation method for development of specific gravitational model describing foreign trade relations between two countries [3]. Establishment of optimal values of coefficients included within the model - GDP, Distance between the countries, trading preferences and other considerations such as specific data of Georgia and other respondent countries, - is carried out within the simulation mode.

The association agreement with the EU created a new reality, where the existing export products are oriented on the EU market, rather than CIS (The Commonwealth of Independent States) at the same time there are some possibilities to create new exporting products mainly by attracting Foreign Direct Investments (FDI). We should also analyze the NAFTA (North American Free Trade Agreement) direction. It should be mentioned that for Georgia North America has always been an important export market, that is why the Georgian Government is seeking to launch a free trade agreement with the USA. In addition, we should note that even with FTA, Georgia will be able to re-allocate existing exporting products; while for new export products the country will need solid FDI growth.

2. METHODS

To finalize our research and to clarify how the export potential is utilized, we will use Trade Intensification Index. The index will be computed for all the three States with all the major export destinations (EU, CIS, and NAFTA). This index gives us a good opportunity to assess the utilization of the export potential re-one country or country group. The formula of the index is:

$$I_{ij} = (X_{ij} / X_i) / (M_j / M),$$

where X_{ij} is the export of country i in country j ; X_i is the total export of country i ; M_j is the total imports of country j ; M is the world import.

If the figure I_{ij} is greater than 1, then your trading partner is more important to you, than you are to the trading partner. If the figure equals 1, it means, that your export utilization is proportional, if the figure is less than 1, your export potential is underutilized.

Our **First aim** is to work out specific gravitational model describing foreign trade between two countries, by simulation method;

Second aim is to study the impact of the change of volume of export/import on GDP of Georgia, using the worked out model.

The Object of the research is our developed Gravitational model of the foreign trade of Georgia, worked out on the base of the models belonging to Y. Izard and J. Tinbergen¹, Models SAQ1 and SAQ2 have a logarithmic form:

SAQ1 model:

$$Q_{i,j} = \ln b_1 + b_2 * \ln X1 - b_3 * \ln X2 + b_4 * X3 + b_5 * X4 + b_6 * X5 + b_7 * X6 + b_8 * X7$$

SAQ2 model:

$$Q_{i,j} = \ln b_1 + b_2 * \ln X1 - b_3 * \ln X3 + b_4 * \ln X2 + b_5 * X4 + b_6 * X5 + b_7 * X6 + b_8 * X7$$

Symbols used in SAQ1 and SAQ2 models have the following content significance:

$Q_{i,j}$: Volume of Export from i country (Georgia) to j country or Import from j country, within t time period.

$D_{i,j}$: Distance between i country (Georgia) and j respondent country, in kilometers.

$X1_t$: GDP of i country (Georgia) within t time period.

$X2_j$: GDP of j respondent country within t time period.

$X3_{i,j}$: Having common land border between i country (Georgia) and j respondent country.

$X4_{i,j}$: Possibility of i country (Georgia) of having connection to respondent j country through the sea.

$X5_{i,j}$: Trade preferences between i country (Georgia) and j respondent country.

$X6_{i,j}$: Historical-cultural relation between i country (Georgia) and j respondent country.

$X7_{i,j}$: Political relation between i country (Georgia) and j respondent country.

SAQ3 model:

$$\begin{aligned} SAQ3 = & \ln(0.7769848) + 0.9082364 * \ln(X1) \\ & + 0.163151 * \ln(X2) - 1.018411 \\ & * \ln(X3) + 0.1106653 * X4 \\ & + 0.1109382 * X5 + 0.9929988 \\ & * X6 + 0.02021067 * X7 \\ & + 0.2547248 * X8 \end{aligned}$$

where:

X1: GDP of Georgia;

X2: GDP of the respondent;

X3: Distance between Georgia and the respondent country;

X4: Common land border;

X5: Access to the sea of the respondent; X6 – Trade preferences;

X7: Cultural relation;

X8: Political relation;

Distance between the capitals of the countries is considered as the distance between the countries. Values of X1, X2 are taken from (<http://geostat.ge>, <https://knoema.ru/atlas/>) X3, X4, X5 get two values 1 – from the boundary, the presence of preferences, 0 – opposite cases. X6, X7 takes values: 1 - good; 0,5 - medium; 0 - bad.

Finding the values of optimal coefficients of $b_j, j = \overline{1..m}$ within the simulation mode is carried out by solving of optimization task.

1. Is given:

The minimum and maximum values of the coefficients $b_k, k = \overline{1..m}$ is defined within simulation mode of $minb_k = 0.0001$. $maxb_k$, forensically. Such values of b_k are chosen at which time the calculated maximum values of $Q_{i,j}$, are few times more than the factual value of $Q_{i,j}$.

2. $X_i, i = \overline{1..n}$ values of variables - $X_i \geq 0$.

Necessary to:

Find the values $minb_k \leq b_k \leq maxb_k$ of $b_k, k = \overline{1..m}$ coefficients at which time $Q_{i,j}^{t,fact} - Q_{i,j}^{t,count} \leq \sigma$ is calculation inaccuracy and is $<3\%$.

Considering the model, the hereof task belongs to not linear optimization task. Option of $Q_{i,j}$, satisfying the condition of the task shall be chosen within the simulation mode. Searched $Q_{i,j}$ relevant $b_k, k = \overline{1..m}$ values are considered as a basic option.

Thus, the specific gravitational model of the foreign trade between two countries has developed for the specific time moment, on the base of the general gravitational model, by usage of non linear optimization model within the simulation mode. Working out of the model is carried out separately for the export and import of every respondent country connected with Georgia through the foreign trade.

Realization of the purpose of research is carried out easily, after development of the specific gravitational model of the foreign trade between two countries- impact of the change of volume of export/import on GDP of Georgia.

Development of the specific gravitational models and formation numbers of decisions on the base of the mentioned model are implemented by our worked out computer program, by simulator SAGAREO 1.0.

Finding out the optimal value $b_k, k = \overline{1..m}$ and accordingly solving the nonlinear optimization task is carried out by the Solver program, existing within the Excel. Choosing of optimal option is done through evolutionary method existing within the Solver.

Establishment of the Value of GDP through the change of Export or Import $X1 = f(Q_{i,j})$ is carried out by the program

¹ <https://www.nobelprize.org/prizes/economic-sciences/1969/tinbergen/lecture/>

- Goal Seek, existing within Excel. Visualization of the modeling results is carried out by graphs and reports.

Optimal values of the coefficients included in the model resulted by solving optimization task through simulator

Table.1

Export/Import	Model	Country	Year	Calculated turnover	GDP of Georgia	B1	B2
Export	SAQ3	Turkey	2017	216708	216674	0.669247	0.8633065

B3	B4	B5	B6	B7	B8	B9	Probability %
0.6750029	2.33897915	0.09089742	0.08915068	0.2222156	0.32049608	0.26704	0.02%

Establishment of the Value of GDP through the change of Export
Table.2

Export/Import	Model	Country	Year	Calculated turnover	GDP of Georgia
Export	SAQ3	Turkey	2017	216674	15160352
Export	SAQ3	Turkey	2017	266674	19055516
Export	SAQ3	Turkey	2017	316674	23034846
Export	SAQ3	Turkey	2017	366674	27074683
Export	SAQ3	Turkey	2017	416674	31168861
Export	SAQ3	Turkey	2017	466674	35312108
Export	SAQ3	Turkey	2017	516674	39485031
Export	SAQ3	Turkey	2017	566674	43720154

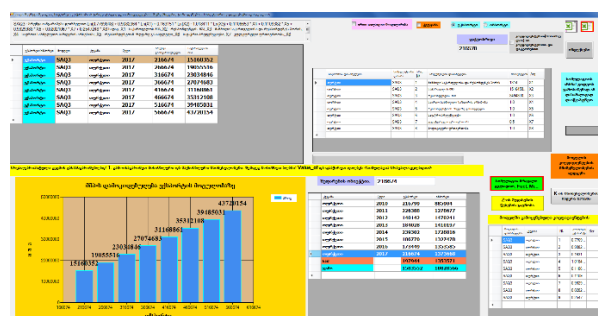


Fig. 1. Results of modeling based on the specific gravitational model $X1 = f(Q_{ij})$ of the foreign trade between two countries

Computer simulator is written in VB.NET as for the data base-it's organized on SQL Server.

3. CONCLUSION

The Association agreement with the EU seriously influenced foreign trade figures in all the three states. It is obvious that the share of CIS market is decreasing, while the share of the EU market is increasing. So, the reallocation of the existing export products is under way. Trade Intensification Index

analysis gave the way for these judgments. The gravitational model of Georgia's foreign trade was developed by

the simulation method. When using mathematical and economic models for assessing foreign trade, it is necessary to choose the optimal value coefficients that we developed during the simulation, the value of GDP changes.

Development of the specific gravitational model of the foreign trade between two countries, by simulation method and impact dynamic on GDP resulted on the base of changes of Export/Import allow us to make decisions as well as to define strategies of Structural changes of Georgian economy and development.

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