Statistical Analysis of Trade Relations between Germany and Georgia

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Abstract

The article discusses Georgian-Germany trade relations and empirically realizes the models of Georgian export to Germany and import from Germany to Georgia. Empirical models are based on the commonly used economic theory of the extrenal determinants (real exchange rate, total price index, volume of income).

According to the empirical model of import the current value of import (from Germany to Georgia) is positively related to the real exchange rate and the amount of Georgian GDP. Furthermore, the implementation of the empirical model reveals the impact of factors (COVID 19, government spending in Georgia, etc.) affecting to the economies of countries and trade relations, correspondingly.

Empirical model of export presented in the paper is not statistically significant, however, modifying functional specification does not improve statistical characteristics of model.

Key words*:* Empirical models of trade relations between Georgia and Germany, Export, Import, Impact of COVID 19

1. Introduction

At the end of the XX century, after the collapse of the Soviet Union, Georgia became a sovereign republic. The newly founded country has faced many political or economic challenges. The republic of Georgia set a goal to build a market-oriented economy, the milestone of which was to establish international relations with other countries and find reliable trade partners [13, Gelashvili, S., P. 1438].

Georgia has long term economic and political relations with Germany. The aim of the paper is economic modeling of Georgian-Germany trade relations.

The economic modeling of trade relations between the two countries is based on the analysis of the commonly used determinants (nominal exchange rate between countries, total price index, and volume of countries' GDP) of import and export volumes [4, Blanchard, O.,P 591-592] in economic theory.

2. External trade between Georgia and Germany

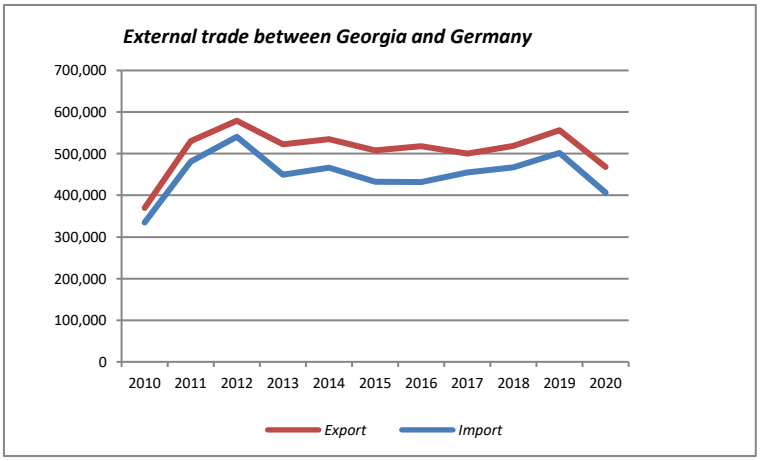
In 2020 Georgian export to Germany accounted 1.8% of total export, while import from Germany amounted 5.1% of total import [24, External trade portal].

Table 1: *External trade (export, import) between Georgia and Germany 2010-2020 year [24, External trade portal]*

Year	Import from Germany to Georgia, Thsd. USD	Export from Georgia to Germany, Thsd. USD
2010	334690.99	35003.36
2011	481356.40	49092.10
2012	540625.12	38647.09
2013	449380.69	73181.55
2014	466102.22	69191.64
2015	432428.47	75327.12
2016	432141.02	85486.55
2017	454626.22	45678.67
2018	467405.62	51393.89
2019	501941.91	54317.40
2020	406830.97	61387.40

Figure 1 represents the Georgian-Germany external trade indicators. Since 2010, both, amount of export and import have increasing trend, furthermore in 2012-2019 the growth rate has become stable. Maximum amount of import and export volume was 540625.12 in 2012 and 85486.55 in 2016 and minimum – 334690.99 and 35003.36 in 2010 correspondingly.

Figure 1: *External trade (export, import) between Georgia and Germany 2010-2020 year*



3. Import to Georgia - Export from Germany

In economic theory, the volume of imports is determined by the following variables [4, Blanchard, O.,P 591]:

$$IMP = f(Y, \varepsilon) \quad (1)$$
$$+\ ,\ +$$

Where IMP represents current value of import, Y – the national income of the country where the goods and services are imported and ε – real exchange rate. Additionally, f describes the functional connection between the variables.

According to equation (1) current value of import is positively related to Y as well as to ε.

The real exchange rate is determined by the following equation [4, Blanchard, O.,P 566]:

$$\varepsilon = E\frac{P}{P^*} \quad (2)$$

Where E represents nominal exchange rate, P – the overall price index of the country where the goods and services are imported and P^* - the overall price index of the country from where the goods and services are exported.

Using equations (1) and (2), the volume of imports can be defined as:

$$IMP = f(Y, E\frac{P}{P^*}) \quad (3)$$
$$+\ ,\ +$$

In case of import from Germany to Georgia, the empirical realization of the model (3) is based on several assumptions: 1) instead of national total income of Georgia current value of GDP is used in the empirical model; 2) consumer price indexes are used instead of overall price indexes; 3) Additive specification is used as a functional connection between the variables.

However, there are two possibilities of representing a real exchange rate variable in the empirical model: 1) the individual participation of all component-variables of the real exchange rate; 2) calculation of the real exchange rate for each period; the latest approach is adopted.

Quarterly data (from 2010, quarter I to 2021, quarter II) of nominal GDP in Georgia [25, National Statistics Office of Georgia, Gross domestic product], nominal exchange rate (GEL/EURO) [26, National bank of Georgia, Exchange rates] and consumer price indexes [27, OECD, Inflation] are used for the empirical realization of import (from Germany to Georgia) model (3).

From a practical point of view, in the empirical model, it is necessary to take into account the notable factors (economic, political, et al.) that occurred during the reporting period, which would have a significant impact on trade relations between the two countries. To measure the effect size of the mentioned factors, the model includes a dummy variable that takes on two values (1; 0). 1 reflects the positive impact and 0 – no impact. The values for the variable are determined according to the following corresponding events:

Table 2: *Values of dummy variable which has impact on trade relations of Germany and Georgia*

Date	Fact	Value	Date	Fact	Value
2010Q1		0	2015Q4		0
2010Q2		0	2016Q1		0
2010Q3		0	2016Q2		0
2010Q4		0	2016Q3		0
2011Q1		0	2016Q4		0
2011Q2		0	2017Q1		0
2011Q3		0	2017Q2		0
2011Q4	Increase Government spendings in Georgia	1	2017Q3		0
2012Q1		1	2017Q4		0
2012Q2		1	2018Q1		0
2012Q3		0	2018Q2		0
2012Q4		0	2018Q3		0
2013Q1		0	2018Q4		0
2013Q2		0	2019Q1		0
2013Q3		0	2019Q2		0
2013Q4		0	2019Q3		0
2014Q1		0	2019Q4	Covid 19	1
2014Q2		0	2020Q1		1
2014Q3		0	2020Q2		1
2014Q4		0	2020Q3		1
2015Q1		0	2020Q4		1
2015Q2		0	2021Q1		1
2015Q3		0	2021Q2		1

Eventually, the empirical model will take the following form:

$$IMP_t = c_1 + c_2\varepsilon + c_3Y + c_4 dummy\_var + u_t \quad (4)$$

Time series should be tested whether they are TSP or DSP type by the procedure suggested by J. J. Dolado, T. Jenkinson, and S. Sosvilla-Rivero. Particularly, the TSP type implies that series are non-stationary because of the variable trend, whereas DSP type implies non-stationarity because of variable variance [6, Dolado... P. 249-273]. Using the Dickey-Fuller test for all three series the null hypothesis is derived about having unit root, which implies their non-stationarity [5, Dickey..., P.427-431]. Using differences for making series stationary, identify that all three time-series are determined to the first-order I(1).

The risk of false regression may arise while building model (4) because the time-series belong to the non-stationary first-order series.

Engle-Granger test checks the risk of false regression by testing the co-integration between the values of import from Germany, GDP of Georgia, real exchange rate, and dummy variable. The null hypothesis of the Engle-Granger test implies the absence of co-integration between series, whereas according to alternative hypothesis co-integration exists between series [2, Ananiashvili, P.1-8]. The alternative hypothesis about the existence of co-

integration between import and output series is accepted with the 5% significance level. While using the above-mentioned tests, 4 lags are chosen as the lag length, since the quarterly data is used for the realization of the model.

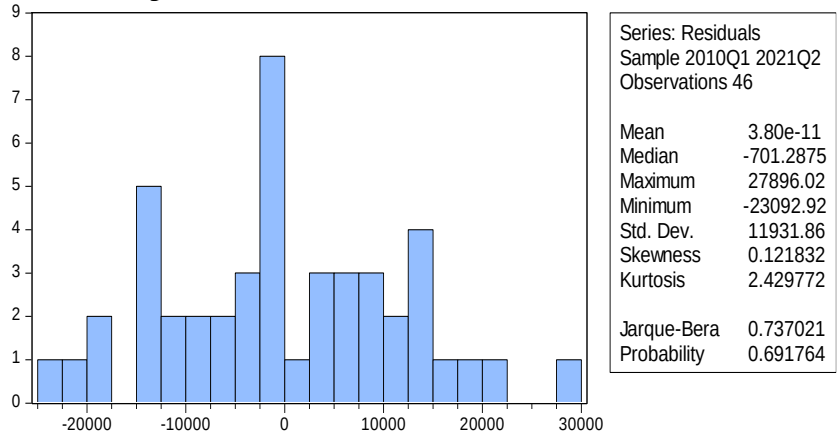
Table 3: *Engel-Granger test results on cointegration among timeline series*

Date: 09/30/21 Time: 21:30
Series: IMP GDP_GEO E_R DUMMY_VAR
Sample (adjusted): 2010Q1 2021Q2
Included observations: 46 after adjustments
Null hypothesis: Series are not cointegrated
Cointegrating equation deterministics: C
Automatic lags specification based on Schwarz criterion (maxlag=4)

Dependent	tau-statistic	Prob.*	z-statistic	Prob.*
IMP	-4.666971	0.0253	-29.85092	0.0200
GDP_GEO	-2.902081	0.4904	-21.12936	0.1528
E_R	-2.516029	0.6769	-11.43319	0.6673
DUMMY_VAR	-2.499394	0.6845	-12.47046	0.6004

Distribution of (4) model's residual members estimated by using the least square method will have the following form:

Figure 2*: Distribution of (4) model's residual members*



As the histogram shows, residual members have normal distribution.

Estimating model (4) with the least square method will have the following form:

Table 4: *Regression Results of model (4)*

Dependent Variable: IMP
Method: Least Squares
Date: 09/30/21 Time: 21:28
Sample (adjusted): 2010Q1 2021Q2
Included observations: 46 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP_GEO	0.021340	0.003274	6.517479	0.0000
E_R	188345.5	47186.48	3.991513	0.0003
DUMMY_VAR	16204.22	4703.201	3.445360	0.0013
C	-49489.69	23633.12	-2.094082	0.0423

R-squared	0.595801	Mean dependent var	112555.4
Adjusted R-squared	0.566930	S.D. dependent var	18767.68
S.E. of regression	12350.65	Akaike info criterion	21.76375
Sum squared resid	6.41E+09	Schwarz criterion	21.92276
Log likelihood	-496.5662	Hannan-Quinn criter.	21.82331
F-statistic	20.63642	Durbin-Watson stat	1.288011
Prob(F-statistic)	0.000000		

Breusch-Godfrey's Lagrange multiplier (LM) test is recommended for checking serial correlation in residual member. According to the null hypothesis of the LM test, there is no autocorrelation in residual member, whereas alternative hypothesis states that there is serial correlation in residual member [3, Breusch, P., 334-355; 42, Godfrey, P. 1293-1301]. Breusch-Godfrey test results show that the null hypothesis is statistically significant, which states that there is no serial correlation in residual member.

Table 5: *Breusch –Godfrey's Lagrange Multiplier (LM) test results*

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.458480	Prob. F(4,38)	0.2339
Obs*R-squared	6.122207	Prob. Chi-Square(4)	0.1902

While checking the heteroscedasticity in residual member with White null hypothesis is accepted with a 99% confidence interval, which means the existence of homoscedasticity. Accordingly, the variance of the residual member is constant.

Table 6: *White's test results on heteroscedasticity*

Heteroskedasticity Test: White

F-statistic	1.520379	Prob. F(8,37)	0.1836
Obs*R-squared	11.38049	Prob. Chi-Square(8)	0.1811
Scaled explained SS	6.782359	Prob. Chi-Square(8)	0.5603

All the coefficients of empirical model are statistically reliable, as for all coefficients the H1 hypothesis on statistical significance is accepted. The determination and corrected determination coefficients have high values (0.59; 0.57), indicating the normal explanatory ability of the factor variables [1, Ananiashvili, P 109-129]. The estimates obtained from the empirical model (4) are statistically reliable as no autocorrelation is observed in the residual members, which indicates that there is no absence of statistically significant explanatory variables or having incorrect functional specification. The residual members are having constant variation, the coefficients and the model are statistically significant.

4. Import to Germany - Export from Georgia

In economic theory, the volume of exports is determined by the following variables [4, Blanchard, O.,P 592]:

$$EXP = f(Y^*, \varepsilon) \quad (5)$$
$$+\ ,\ -$$

Where EXP represents current value of export, Y^* – the national income of the country from where the goods and services are exported and ε – real exchange rate. Additionally, f describes the functional connection between the variables.

According to equation (5) current value of export is positively related to Y^* but - negatively related to ε.

Using equations (2) and (5), the volume of export can be defined as:

$$EXP = f(Y^*, E\frac{P}{P^*}) \quad (6)$$
$$+\ ,\ -$$

In case of export from Georgia to Germany, the empirical realization of the model (6) is based on several assumptions: 1) instead of national total income of Germany current value of GDP is used in the empirical model; 2) consumer price indexes are used instead of overall price indexes; 3) Additive specification is used as a functional connection between the variables.

In the empirical model of export, the real exchange rate is calculated for each period, as well as in the import model.

Quarterly data (from 2010, quarter I to 2021, quarter II) of nominal GDP in Germany [29, OECD, Quarterly Growth Rates of real GDP], nominal exchange rate (GEL/EURO) [26, National bank of Georgia, Exchange rates], and consumer price indexes [27, OECD,

Inflation] are used for the empirical realization of export (from Georgia to Germany) model (6).

Similarly, as in the import model, the empirical model of export contains the dummy variable (values presented in Table 2).

Empirical model of export will take the following form:

$$EXP_t = c_1 + c_2\varepsilon + c_3Y^* + c_4 dummy\_var + u_t \quad (7)$$

The procedure suggested by J. J. Dolado, T. Jenkinson, and S. Sosvilla-Rivero determines that the series belong to the TSP type series [6, Dolado... P. 249-273]. Statistically non-reliable results are obtained after excluding trend parameters and using stationary series in the empirical model (Statistically non-significant variables, low explanatory power of the model, etc.).

Table 8: *Empirical model of export where series are stationary.*

Dependent Variable: EX_D
Method: Least Squares
Date: 09/30/21 Time: 20:15
Sample (adjusted): 2010Q2 2021Q2
Included observations: 45 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D_E	56993.31	99135.57	0.574903	0.5685
D_GDP_GER	1.19E-05	2.81E-05	0.425028	0.6730
FIC_VAR	484.3016	2900.923	0.166947	0.8682
C	214.9171	1385.131	0.155160	0.8775

R-squared	0.011848	Mean dependent var	266.5656
Adjusted R-squared	-0.060456	S.D. dependent var	7801.828
S.E. of regression	8034.202	Akaike info criterion	20.90549
Sum squared resid	2.65E+09	Schwarz criterion	21.06608
Log likelihood	-466.3735	Hannan-Quinn criter.	20.96536
F-statistic	0.163858	Durbin-Watson stat	1.418727
Prob(F-statistic)	0.920089		

Additionally, changing the functional specification from additive to multiplicative and logarithmic does not improve the statistical characteristics of the model.

5. Conclusion

The empirical model of import from Georgia to Germany is statistically valid, which indicates that the theoretical model characterizes the economic relations between the two countries well.

According to the empirical model of import from Germany to Georgia, the current value of import is positively related to the real exchange rate and the volume of GDP in Georgia. The obtained results are totally comparable with the economic theory about the import's determinants. However, the estimated value of the GDP coefficient (0.021340), which belongs to the (0; - 1) interval, confirms the validity of the model according to the economic theory.

According to the empirical model of import from Germany to Georgia, the increase of the GDP of Georgia by one unit (in USD) causes import to increase by 0.021 USD, while the increase of the exchange rate - increases import by 188345.5 thousand USD (Note: the value of exchange rate varies from 0.2 to 0.5 since decreasing of the exchange rate by one unit is not possible). However, the statistical characteristics of the coefficient of the dummy variable indicating that the factors affecting the policy of the countries have a significant impact on the trade relations (import volume) of the two countries..

The empirical model of Georgian import reveals Interesting result that the COVID 19 had a positive impact on Germany Georgian trade relations, the volume of its positive impact, as already mentioned, is 16204.22 thousand USD. In the pandemic situation Georgia increase volume of import from Germany

The empirical model of Georgian export to Germany is not statistically reliable. In particular, the variables of the empirical model are non-stationary. Additionally, the use of stationary series as factorial variables is not statistically valid and the explanatory power of the empirical model is close to 0. Changing the functional specification from additive to multiplicative and logarithmic does not improve the statistical characteristics of the model.

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