6th International Conference On Opportunities
and Challenges In **MANAGEMENT,**
ECONOMICS and ACCOUNTING

18 – 20 September , 2020 Milan, Italy

Statistical Analysis and Forecasting of Trade Relations between Italy and Georgia

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Abstract

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

According to the empirical model of import the current value of import (from Italy to Georgia) is positively related to the real exchange rate and the volume of Georgian GDP. Furthermore, the implementation of the empirical model reveals the impact of factors (COVID 19, the impact of the British referendum on the Eurozone, the Italian referendum, etc.) affecting to the economies of countries and trade relations, correspondingly.

Empirical model of export presented in the paper is not statistically valid, however, modifying functional specification from additive to multiplicative does not improve statistical characteristics of model.

The article forecasts the trade relations between the two countries using the exponential smoothing method. Forecast models indicate an increasing trend in exports and imports between countries.

Key words: *Empirical models of trade relations between Georgia and Italy, Export, Import, Exchange rate, GDP, Impact of COVID 19*

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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 centuries-old economic and political relations with Italy. The aim of the paper is economic modeling of Georgian-Italian trade relations, statistical analysis, and estimation of future trends.

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' income) of import and export volumes [4, Blanchard, O., P 591-592] in economic theory. However, the exponential smoothing method is used among various forecasting methods to estimate trends in countries' trade relations.

External trade between Georgia and Italy

In 2019 Georgian export to Italy accounted 1.1% of total export, while import from Italy amounted 2.4% of total import [25, External trade portal].

Table 1: External trade (export, import) between Georgia and Italy 2010-2019 year [25, External trade portal]

Year	Import from Italy to Georgia, Thsd. USD	Export from Georgia to Italy, Thsd. USD
2010	136692	26048.4
2011	184767.3	75596.6
2012	271675.1	53270.3
2013	220708	81100.6
2014	221862.4	86095.8
2015	197660.8	74605.6
2016	262777.5	72735.6
2017	218160.7	69488.9
2018	232083.7	43340.6
2019	228256	40461

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Graph 1 represents the Georgian-Italian external trade indicators. Since 2010, both, amount of export and import have increasing trend, furthermore in 2018-2019 the growth rate has become stable. Maximum amount of import and export volume was 271675.1 in 2012 and 86095.8 in 2014 and minimum – 136692 and 26048.4 in 2010 correspondingly.

Graph 1: External trade (export, import) between Georgia and Italy 2010-2019 year

Import to Georgia - Export from Italy

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]:

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

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:

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

+ , +

In case of import from Italy 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 2020, quarter I) of nominal GDP in Georgia [26, National Statistics Office of Georgia, Gross domestic product], nominal exchange rate (GEL/EURO) [27, National bank of Georgia, Exchange rates] and consumer price indexes [28, OECD, Inflation] are used for the empirical realization of import (from Italy 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 three values (-1; 0; 1). -1 reflects the negative impact, 0 – no impact, and 1 - the positive impact. The values for the variable are determined according to the following corresponding events:

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Table 2: Values of dummy variable which has impact on trade relations of Italy and Georgia [23, BBC news]

Date	Fact	Value	Date	Fact	Value
2010Q1	Government change in Italy	-1	2015Q3		0
2010Q2		-1	2015Q4		0
2010Q3		-1	2016Q1		0
2010Q4		-1	2016Q2	Italian Constitutional Referendum	1
2011Q1	Decrease government spending in Italy	-1	2016Q3		0
2011Q2		-1	2016Q4	Referendum about leaving EU in Great Britain and EU members consolidation	1
2011Q3		-1	2017Q1		0
2011Q4		-1	2017Q2		0
2012Q1		0	2017Q3		0
2012Q2		0	2017Q4		0
2012Q3	Increase Government spending in Georgia	1	2018Q1		0
2012Q4		0	2018Q2		0
2013Q1		0	2018Q3		0
2013Q2		0	2018Q4		0
2013Q3	Political crisis in Italy	-1	2019Q1	Recession of economy in Italy	-1
2013Q4		-1	2019Q2		0
2014Q1		0	2019Q3		0
2014Q2		0	2019Q4		0
2014Q3		0	2020Q1	COVID 19	-1
2014Q4		0	2020Q2		
2015Q1		0	2020Q3		
2015Q2		0	2020Q4		

Eventually, the empirical model will take the following form:

$$IMP_t = c_1 + c_2\varepsilon + c_3Y + c_4dummy_var + u_t \quad (4)$$

Time series include seasonal components. Based on the characteristics of variables, for the elimination of seasonal components, the article uses the multiplicative method of seasonal adjustment (**Census X13**) implemented by the bureau of the population census of the USA.

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

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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 Italy, 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: 08/19/20 Time: 17:19
Series: IMP_SA E1 DUMMY_VAR GDP_GEO_SA
Sample (adjusted): 2010Q1 2020Q1
Included observations: 41 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_SA	-4.382594	0.0501	-27.04105	0.0352
E1	-1.890419	0.8980	-7.241055	0.8934
DUMMY_VAR	-4.892579	0.0168	-32.31150	0.0074
GDP_GEO_SA	-3.090207	0.4027	-14.12626	0.4818

*MacKinnon (1996) p-values.

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

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Graph 1: 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_SA

Method: Least Squares

Date: 08/04/20 Time: 16:49

Sample (adjusted): 2010Q1 2020Q1

Included observations: 41 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
E1	56447.80	16429.45	3.435769	0.0014
GDP_GEO_SA	0.008512	0.001602	5.314428	0.0000
DUMMY_VAR	11980.08	1570.937	7.626072	0.0000
R-squared	0.748040	Mean dependent var		54300.49
Adjusted R-squared	0.734779	S.D. dependent var		10222.08
S.E. of regression	5264.330	Akaike info criterion		20.04565
Sum squared resid	1.05E+09	Schwarz criterion		20.17103
Log likelihood	-407.9358	Hannan-Quinn criter.		20.09131
Durbin-Watson stat	1.304699			

Note: Empirical model does not include constant variable as it is not statistically significant.

Durbin-Watson test is not recommended for checking autocorrelation in residual member, as the model assumption is violated: the model does not contain a constant member [2,

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Ananiashvili, 10-13]. 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	1.120316	Prob. F(4,34)	0.3631
Obs*R-squared	4.773941	Prob. Chi-Square(4)	0.3113

While checking the heteroscedasticity in residual member with Glejser null hypothesis is accepted with a 99% confidence interval, which means the existence of homoscedasticity [17, Glejser..., P. 316-323]. Accordingly, the variance of the residual member is constant.

Table 6: Glejser's test results on heteroscedasticity

Heteroskedasticity Test: Glejser

F-statistic	1.179102	Prob. F(3,37)	0.3309
Obs*R-squared	3.577681	Prob. Chi-Square(3)	0.3108
Scaled explained SS	3.296150	Prob. Chi-Square(3)	0.3482

After excluding a non-significant constant member from the empirical model all the coefficients are statistically reliable, as for all coefficients the H1 hypothesis on statistical significance is accepted. The determination and corrected determination coefficients have significantly high values (0.75; 0.73), indicating the high 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.

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Import to Italy - 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 Italy, the empirical realization of the model (6) is based on several assumptions: 1) instead of national total income of Italy 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 2020, quarter I) of nominal GDP in Italy [30, OECD, Quarterly Growth Rates of real GDP], nominal exchange rate (GEL/EURO) [27, National bank of Georgia, Exchange rates], and consumer price indexes [28, OECD, Inflation] are used for the empirical realization of export (from Georgia to Italy) 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:

$$EXP_t = c_1 + c_2 \varepsilon + c_3 Y^* + c_4 dummy_var + u_t \quad (7)$$

Time series include seasonal components. Based on the characteristics of variables, for the elimination of seasonal components, the article uses the multiplicative method of seasonal adjustment (**Census X13**) implemented by the bureau of the population census of the USA.

The procedure suggested by J. J. Dolado, T. Jenkinson, and S. Sosvilla-Rivero determines that the series belong to the first-order integrated I(1) type [6, Dolado... P. 249-273].

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H₁ hypothesis about the existence of cointegration among time-series is accepted according to the Engel-Granger test. According to the results of the above-mentioned test, there is no co-integration among the time-series, therefor stationary series must be used in the empirical model to avoid false regression.

Table 7: Engel-Granger test results on timeline series cointegration

Date: 08/20/20 Time: 10:24
 Series: EX_SA E1 GDP_ITA_SA POL_FACT_IMP
 Sample (adjusted): 2010Q1 2020Q1
 Included observations: 41 after adjustments
 Null hypothesis: Series are not cointegrated
 Cointegrating equation deterministics: C
 Automatic lags specification based on Schwarz criterion (maxlag=9)

Dependent	tau-statistic	Prob.*	z-statistic	Prob.*
EX_SA	-3.580250	0.2094	-18.67847	0.2342
E1	-2.197798	0.8085	-8.814408	0.8181
GDP_ITA_SA	-2.760927	0.5612	-14.98518	0.4282
DUMMY_VAR	-4.670855	0.0274	-30.82099	0.0118

*MacKinnon (1996) p-values.

Statistically non-reliable results are obtained 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: D_EX
 Method: Least Squares
 Date: 08/20/20 Time: 10:46
 Sample (adjusted): 2010Q2 2020Q1
 Included observations: 40 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D_E1	50807.32	54845.08	0.926379	0.3604
D_DGP_ITA	1.59E-05	3.94E-05	0.404203	0.6885
DUMMY_VAR	-2123.443	1259.941	-1.685351	0.1006
C	-270.0742	747.5541	-0.361277	0.7200
R-squared	0.105902	Mean dependent var		97.54564
Adjusted R-squared	0.031393	S.D. dependent var		4460.381
S.E. of regression	4389.809	Akaike info criterion		19.70660
Sum squared resid	6.94E+08	Schwarz criterion		19.87549
Log likelihood	-390.1320	Hannan-Quinn criter.		19.76766
F-statistic	1.421341	Durbin-Watson stat		2.840283

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Prob(F-statistic) 0.252470

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

Forecasting trade relations between Georgia and Italy

Out of many statistical methods available in statistics (extrapolation, method of leading indicators, timeline series, econometric systems, etc.), the exponential smoothing method was used to forecast the future values of trade relations between Georgia and Italy.

Exponential smoothing: Using simple exponential smoothing for forecasting the future value is estimated as a linear combination of current, and previous observations and model has the following form [22, Totladze, Chapter 5, P. 13-19]:

$$Y_{T+1|T} = \alpha Y_T + \alpha(1 - \alpha)Y_{T-1} + \alpha(1 - \alpha)^2 Y_{T-2} + \dots \quad (8)$$

where $0 \leq \alpha \leq 1$ is smoothing parameter. If the value of the smoothing parameter is close to 0, then the higher importance is given to the observations that are in the distant past, while it is close to 1, then the higher influence is granted with the latter observations. It is noteworthy that the weights of this method of forecasting create geometric progression whose sum is equal to 1.

While using the exponential smoothing method, it is necessary to estimate the α parameter of the equation, which depends on the researcher's view. Both subjective opinion and “Data Grid Search” method can be used in the evaluation.

With simple exponential smoothing forecasting method, when $\alpha = 0.3$:

Georgian Import - Italian Export:

$$y_{2020 \text{ IIQ imp}_{sa}} = 0,3 * y_{2020 \text{ IQ imp}_{sa}} + 0,3 * 0,7 y_{2019 \text{ IVQ imp}_{sa}} + 0,3 * 0,49 y_{2019 \text{ IIIQ imp}_{sa}} + \dots = 55837.33 \quad (9)$$

Georgian Export - Italian Import:

$$y_{2020 \text{ IIQ exp}_{sa}} = 0,3 * y_{2020 \text{ IQ exp}_{sa}} + 0,3 * 0,7 y_{2019 \text{ IVQ exp}_{sa}} + 0,3 * 0,49 y_{2019 \text{ IIIQ exp}_{sa}} + \dots = 9953.31 \quad (10)$$

The forecasted volume of Georgian import from Italy in the second quarter of 2020 equals to 55837.33 thousand USD, which is 2839.11 thousand greater than in the previous period, while the forecasted volume of Georgian export to Italy is 9953.31 thousand USD, which is 1023.12 thousand greater than in the preceding period.

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The use of a weighted exponential smoothing method for forecasting is based on the assumption about the first forecast value. Since forecasting is done at the last stage, additional assumptions will significantly decrease the quality of the current forecast value.

Conclusion

The empirical model of import from Georgia to Italy 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 Italy 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 (0.008512), 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 Italy to Georgia, the increase of the GDP of Georgia by one unit (in USD) causes import to increase by 0.009 USD, while the increase of the exchange rate - increases import by 56447.8 thousand USD (**Note:** the value of exchange rate varies from 0.3 to 0.4 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. In particular, the factor of positive impact on countries leads to an increase in the volume of import from Italy to Georgia by 11980.08 thousand USD, while a negative event - reduces the volume by the same amount.

The empirical model of Georgian import reveals that the COVID 19 had a negative impact on Italian Georgian trade relations, the volume of its negative impact, as already mentioned, is 11980.08 thousand USD.

The empirical model of Georgian export to Italy is not statistically reliable. In particular, the variables of the empirical model are non-stationary series that are not cointegrated. 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.

The forecasted volume of Georgian import from Italy in the second quarter of 2020 amounted 55837.33 thousand USD, which is greater with 2839.11 thousand USD than in the previous period, while the forecasted volume of Georgian export to Italy is 9953.31

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thousand USD, which is 1023.12 thousand dollars more than the latest period. The use of a weighted exponential smoothing method for forecasting is based on an assumption about the first forecast value. Since forecasting is done at the last stage, additional assumptions will significantly decrease the quality of current forecast value.

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