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Analyzing Romania GDP: Final consumption, gross investment, and net exports influence compared to previously published models

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Abstract. *This paper analyzes final consumption, gross investment, and net exports influence on gross domestic product (GDP) for Romania from 1990-2014. The results show final consumption and gross investment being the dominant influences during this time period, whereas net exports had a minimal yet statistically significant effect. This paper also compares the model created against a previously published model to determine which is best suited for this type of analysis.*

Keywords: gross domestic product (GDP), consumption, investment, net exports, multiple linear regression, Romania.

JEL Classification: C51, C52, E21, E22, F10.

Introduction

Gross domestic product (GDP) is one of various key macroeconomic indicators often utilized in research when analyzing the health of a country's economy (Wolla, 2018). Reason being is that GDP is one measurement of a country's economic activity, specifically measuring the total value of all goods and services produced in a country during a given year. Accordingly, GDP data is widely analyzed in determining whether an economy is expanding or contracting. Based on which of the two a country is experiencing, recommendations and decisions are then discussed, and used to map out economic policy (Kira, 2013). The focus of this paper is regarding the analysis of Romania GDP post-communism through the utilization of linear regression models.

Previous literature constructed simple linear regression models to determine possible correlations between a variable of interest – chosen at the discretion of researcher – and Romania GDP (Ioneci and Mîndreci, 2010; Anghelache, 2011). Simple linear regression models are represented by the following equation:

$$Y_i = \beta_0 + \beta_1 X_i + U_i \quad (1)$$

where Y_i is the dependent variable; X_i is the explanatory variable that influences the dependent variable; and U_i is the error term representing unobservable factors other than the included explanatory variable that affects the dependent variable. As stated previously, prior research has applied Equation (1) to examine relationships between two specific variables. Ioneci and Mîndreci (2010) analyzed the effect of foreign direct investment on Romania GDP. Their analysis determined that there is a direct and strong relationship between the two variables indicating investments positively affect Romania GDP. Anghelache (2011) identified a relationship between Romania GDP and final consumption (FC): an increase in FC (defined by Anghelache as the sum of private consumption and public consumption) leads to an increase in Romania GDP.

Although simple linear regression models result in establishing whether two variables have a relationship or not, there is a shortcoming due to the error term. This term, as stated previously, represents factors other than independent variable that affects the dependent variable. In the simple linear regression model, it is assumed the factors contained in the error term are unobserved and therefore unable to be effectively utilized. However, if the error term does contain an observed variable, then the simple linear regression model suffers from omitted variable bias. Continuing to use a simple linear regression model with omitted variable bias presents the following issue: the coefficient estimates produced are either underestimated or overestimated, in which case the relationship once established between two variables is flawed. Therefore, it is ideal to extend a simple linear regression model into a multiple linear regression model to counteract omitted variable bias.

Extension into a multiple linear regression model requires adding one or more observed, relevant variable(s) into Equation (1) resulting in the following new equation:

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_k X_{ki} + U_i \quad (2)$$

with k independent variables, and where the definitions provided in Equation (1) still applies. Using the multiple linear regression model in Equation (2) is more appropriate

when analyzing economic trends, such as a country's GDP, that are influenced by more than one variable (Constantin, 2017). This concept was previously realized by Anghelache, Manole, and Anghel (2015) who provided further analysis on Romania GDP by utilizing a multiple linear regression model. They investigated the impact of FC and gross investment (INVMT) on Romania GDP, whereby they concluded changes in either of the two variables has a positive and significant influence on Romania GDP (Anghelache et al., 2015).

The purpose of this paper is two-fold. First, to provide a deeper insight into the analysis of Romania GDP by adding a third relevant variable to the model Anghelache et al. (2015) presented in their paper. Second, to compare the new model against the model Anghelache et al. (2015) presented. In comparing the two models, it will be demonstrated which of the two is more beneficial when analyzing Romania GDP.

Methodology and data

The multiple linear regression model being used in this paper is an extension of the model created by Anghelache et al. (2015): their model included FC, INVMT (both as explanatory variables), and Romania GDP (defined as the dependent variable). This paper's model will include these variables with the addition of net exports (NETEX). The inclusion of NETEX is predicated on the following economic foundation: GDP has been traditionally measured by using consumption, investment, government spending, and net exports (Wolla, 2018; Kira, 2013). Furthermore, exports and imports have been shown to have a positively significant effect on a country's GDP (Kartikasari, 2017). The following equation represents the model used in this paper:

$$Romania\ GDP_i = \beta_0 + \beta_1 FC_i + \beta_2 INVMT_i + \beta_3 NETEX_i \quad (3)$$

where: FC, INVMT, and NETEX are the explanatory variables; Romania GDP is the dependent variable.

The analysis of Equation (3) is performed over the period 1990-2014 for the country of Romania. Yearly data for FC, INVMT, and Romania GDP were obtained from within the Anghelache et al. (2015) paper. They obtained their data from the Statistical Yearbook of Romania through the National Institute of Statistics. The authors then transformed the data to reflect million Romanian Leu (RON) while also deflating the values to reflect 1990-RON value (deflation to represent 1990-RON values was conducted at the discretion of the authors using the consumer price index). To generate the values for NETEX, Romania's exports and imports had to first be obtained followed by subtraction from each other in the following manner:

$$NETEX_i = Exports_i - Imports_i \quad (4)$$

Data for Romanian exports and imports were obtained from the World Bank's World Development Indicators database. After computing NETEX from 1990-2014, the values were transformed to be measured in million RON, and then deflated to represent 1990-RON value (deflation was calculated by: $\left[\frac{Nominal\ value_n}{CPI_n}\right] \times CPI_{base\ year}$, where n

represents the given year to be converted). Figure 1 contains graphical representations of the transformed data for the four variables.

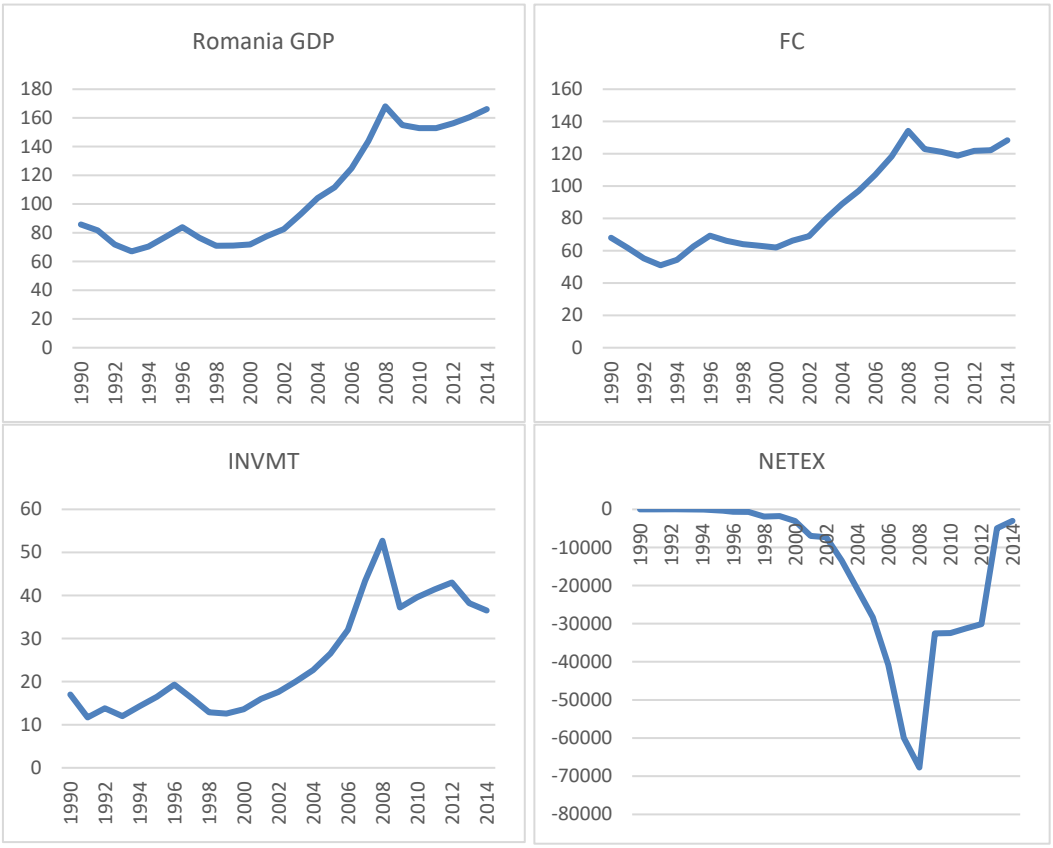
Upon analyzing the data, there appears to be a positive relationship between Romania GDP, FC, and INVMT based on the similar patterns the three graphs are experiencing from 1990 – 2014. For the first few years from 1990 to about 1994, these three variables experienced declines followed by a gradual increase. Each of the three variables are shown to have steep increases from about 1996 until 2008 when there is a drop-off. On the contrary, NETEX experienced opposite progression. It is shown to have a steep decrease beginning about 2002 until 2008 when it sharply increases, followed by a slight increase, and then progress to another sharp increase until it almost flattens out at the end of the data in 2014.

The movements observed from Figure 1 in Romania GDP, FC, INVMT, and NETEX can be attributed to three specific events: 1 – the fall of communism in 1989 with a subsequent movement towards a democratic, market-economy (Doroftei and Păun, 2013; Bălă, 2014), 2 – joining the European Union in 2007 (Zaman et al., 2016), and 3 – the financial crisis of 2008 (Belaşcu and Budac, 2016). After the fall of communism, there is a period of decrease in Romania GDP, FC, and INVMT until about 1993 reflecting the difficulty in transitioning away from communism. The following year until about 1996 there is observed growth with these three variables followed by another decrease until about the end of 1999. This decrease is a result from a change in political leadership, upon which a subsequent political leadership change at the end of 1999/beginning of 2000 resulted in a lengthy, gradual increase in Romania GDP, FC, and INVMT until 2008 (Bălă, 2014).

During the entire period of the data set, majority of the increase observed in FC has been attributed to an increase from household final consumption (Savu and Voicu, 2017). Additionally, Bălă (2014) stated the transition from communism resulted in a growth from 66% to over 83% in household final consumption as a proportion of GDP from 1990 to 2012. Regarding INVMT, this transition along with subsequent monetary policies helped the country become more attractive to foreign investors in addition to domestic investors (Ioneci and Mîndreci, 2010). The decrease in NETEX into the negatives is demonstrating that imports have outweighed exports, indicating Romania has been dependent on imports as it transitioned after 1989 (Zaman et al., 2016).

Additionally, the end of 2014 shows NETEX slightly increasing closer to zero. If continued in this direction, exports will soon balance out imports, and eventually exports will outweigh imports. Zaman et al. (2016) attribute this recent movement to Romania's involvement in the European Union upon which has resulted in steadily increasing Romania's openness, allowing more exposure to international markets. This openness has also allowed Romania to become increasingly attractive to foreign investors, hence the recent increase in NETEX (Carp, 2014) and the progression to more exporting and less importing. Geamănu (2014) additionally attributes the recent movement in NETEX to investments, specifically foreign direct investments, upon which improvements in production has occurred. The drastic decrease (increase) in Romania GDP, FC, and INVMT (NETEX) is attributed to the 2008 global financial crisis as European countries were negatively affected in addition to the US (Belaşcu and Budac, 2016).

Figure 1. *Romania GDP, FC, INVMT, and NETEX yearly development from 1990-2014*



Results

Equation (3) was estimated in STATA by use of ordinary least squares method to produce the following results in Table 1. FC has a positive and statistically significant effect on Romania GDP, indicating an increase of one million RON would increase Romania GDP by about 963,000 RON. INVMT also has a positive and statistically significant effect on Romania GDP. Its coefficient estimate indicates a one million RON increase would lead to an increase in Romania GDP by about 1,227,000 RON. The NETEX coefficient is also positive and statistically significant, indicating Romania GDP would increase by about 357 RON for every one million RON increase in NETEX. These results would signify there is a direct and positive relationship between Romania GDP, final consumption, gross investment, and net exports. The R-squared reported indicates 99.3% of the variation in Romania GDP is explained by the three explanatory variables in the model.

Although the coefficient estimate for NETEX is significantly smaller than FC and INVMT, it is still considered relevant. The Romania economy has been relying more on imports rather than exports during this time period, due in part to the low value placed on products

manufactured within the country as well as transitioning away from communism (Doroftei and Păun, 2013; Zaman et al., 2016). Thus, the NETEX graph in Figure 1 displays data taking on a negative value throughout the time period. Additionally, the level of NETEX is in the billions whereas Romania GDP, FC, and INVMT are within the millions. This further indicates the high degree of reliance on imports during this time period, the inability to establish a stable dependence on exports, and the lesser value of the coefficient estimate compared to FC and INVMT. Overall, FC and INVMT are shown to be the dominant factors behind Romania's economy expanding after the fall of communism.

Table 1. *Extended model*

VARIABLES	Romania GDP
FC	0.963***
	(0.109)
INVMT	1.227***
	(0.285)
NETEX	0.000357***
	(6.70e-05)
Constant	-1.760
	(3.607)
Observations	25
R-squared	0.993

Standard errors in parentheses
*** p < 0.01, ** p < 0.05, * p < 0.1.

Comparison of two models

The secondary purpose of this research paper is to compare this paper's extended model against the model Anghelache et al. (2015) constructed in order to establish which of the two is preferred when analyzing Romania GDP. Anghelache et al. (2015) included FC and INVMT as their explanatory variables whereas this paper's model used those same variables with the extension of NETEX. From this point forward, Anghelache et al. (2015) model will be referred to as 'Model 1', whereas this paper's model will be represented as 'Model 2'. Table 2 displays the results of each model's regression estimates. The results for Model 1 were obtained directly from within their 2015 paper.

The positive effect FC and INVMT has on Romanian GDP remained the same in both models. However, the magnitude of these two explanatory variables were affected in addition to the level of significance for INVMT with the addition of NETEX. The coefficient estimate for FC decreased slightly (1.163 to 0.963) whereas INVMT's coefficient estimate increased considerably (0.325 to 1.23). Furthermore, the addition of NETEX improved INVMT level of significance (p-value) from 0.3557 to 0.000 thereby now becoming individually statistically significant. Considering these changes that occurred with the inclusion of NETEX, it is assumed that Model 1 suffered from omitted variable bias. Most notably the coefficient estimates for FC and INVMT were overestimated and underestimated, respectively, in addition to the drastic improvement in the statistical significance of INVMT from individually statistically insignificant to significant. The relationship between the explanatory variables and Romanian GDP was strengthened as evident by increases in both the R^2 and adjusted-R^2.

Based on Table 2, there is evidence Model 2 is preferred over Model 1 when analyzing Romania GDP. However, to provide further support for this assumption, the Bayesian Information Criterion (BIC) was calculated to assist in the comparison of the two models.

Table 2. *Comparison of models*

	Model 1	Model 2
Constant		
Coefficient	-2.143838	-1.75998
Standard Error	5.40557	3.606827
t-Statistic	-0.396598	-0.49
P-value	0.6955	0.631
FC		
Coefficient	1.163113	0.9625384
Standard Error	0.152743	0.1086176
t-Statistic	7.614816	8.86
P-value	0.000	0.000
INVMT		
Coefficient	0.324933	1.226545
Standard Error	0.344446	0.2852881
t-Statistic	0.94335	4.3
P-value	0.3557	0.000
NETEX		
Coefficient		0.0003571
Standard Error		0.000067
t-Statistic		5.33
P-value		0.000
R^2	0.98308	0.9928
Adjusted R^2	0.981542	0.9918

The BIC is a statistic commonly utilized to identify which model is a better fit for its specific data set. A key component of the BIC is the inclusion of a "penalty" which accounts for irrelevant, random data that has the possibility of producing misleading results. The preferred model will be the one with the smallest BIC. The BIC results are presented in the table below.

Table 3. *BIC results*

Model 1	158.8614
Model 2	140.6773

As we can see from Table 3, Model 2 better fits the current data set. These results coincide with what was determined from Table 2, indicating there is evidence Model 2 should be the preferred model when analyzing Romania GDP.

Conclusion

This paper expanded upon previous studies regarding the analysis of Romania GDP, specifically after its shift from communism towards a market-economy from 1990 – 2014. Final consumption and gross investment were discovered to be the main factors driving the expansion of Romania's economy. Net exports, on the other hand, was observed to have a minimal effect during this time period. However, Romania has been heavily dependent on imports and less on exports during this period. This strategy is the rationale behind net export's minimal effect on Romania's economy.

In addition to analyzing final consumption, gross investment, and net export's influence on Romania's economy, this paper's model was compared against the Anghelache et al. (2015) model to determine which is better suited in analyzing Romania GDP. The results suggest the model we created is preferred and should be the model utilized. It was also demonstrated the model Anghelache et al. (2015) created suffered from omitted variable bias. Future analysis should both expand the time period and include another relevant variable such as government spending to further investigate Romania GDP post-communism.

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