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AN ECONOMETRIC EFFICIENCY ANALYSIS FOR ROMANIA'S TRADE PARTNERSHIPS WITH THE E.U. MEMBER COUNTRIES

Abstract

The objective of this paper is to conduct a study on the effectiveness of international trade between Romania and its EU partners. The approach on efficiency is an econometric one, by estimating a stochastic frontier of efficiency, frontier that results from decomposing the modeling error of a gravity model. The analysis results will highlight the most effective and ineffective partnerships in foreign trade for Romania, among the EU members.

To estimate the stochastic frontier efficiency for the trade partnerships we used as endogenous variable the ratio between imports and exports, weighted by the size of trade flows with the partner country in Romania's total trade flows. As exogenous variables we used the classical gravitational variables, GDP of the partner country and the square of the distance between the capitals of the two partner countries. Efficiency scores are calculated for each partnerships using a cost function that aims at assessing trade efficiency by minimizing imports compared to exports. Partnerships have been ranked according to the obtained efficiency scores. The most effective partnerships as ratio between imports and exports are those with Hungary and Austria.

Keywords

Gravity variables, external trade efficiency, stochastic frontier analysis, econometric efficiency

1. Introduction

The study aims to analyze the efficiency of bilateral trade flows by stochastic frontier analysis and aims to highlight the trade relashionships that Romania may successfully assert in its interests.

The paper is organized in four sections. After introduction, the second section concerns a theoretical presentation of how to use the stochastic frontier method for measuring effectiveness. The next section presents the empirical study, with methodological elements, data sources, modeling results and efficiency analysis. In section four we present the conclusions of the paper, followed by references and Annexes.

Stochastic frontier analysis aims to determine an efficiency frontier where statistical units should operate to be effective. There are two methods for this type of analysis - production frontier and cost function method. Debut efficiency analysis using stochastic frontier are from the 50s, with the works of Debreu (1951), Farrell (1957), and then Arrow (1961) and Aigner and Chu (1968), which focused on the idea of analyzing individual deviations fron the estimated production or cost function to determine the best and worst performing units. On the empirical line, there are two fundamental works, those of Aigner, Lovell and Schmidt (1977) and Meeusen and van der Broeck (1977), on which almost all of the later works have been realised. The idea generated by these works is that the demarcation of a company's frontier production could not be controlled entirely by the company itself. The solution to determine the efficiency is decomposition of the modeling error ε_i in two components, a component error due to being completely random – the white noise, and the other component is the measure of a firm's efficiency. After the 90's, specific models for panel data have developed, which deals with efficiency depending on the effect of time.

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To obtain the efficiency scores a variety of software have developed, from specific procedure for SAS, STATA or R to independent applications like DEA, LIMDEP or FRONTIER. In this paper we used the program FRONTIER 4.1.

2. The methodology

The econometric model used to analyze the efficiency is a classic gravity model, linearized by logarithms to the following form:

$$\ln F_{ij} = \beta_0 + \beta_1(\ln GDP_i + \ln GDP_j) - \beta_2 \ln D_{ij} + \varepsilon$$

- F_{ij} represents the bilateral trade flows between country *i* and country *j*;
- GDP_i is the gross domestic product of country *i*;
- D_{ij} is the distance between the capitals of the two partner countries.

Gravity model for bilateral trade was first proposed by Tinbergen (1962) and Pöyhönen (1963). They used the simple gravity equation, using only three variables that appear in Newton's equation: the effect is the volume of trade between two countries and it is explained directly by the volume of GDP and negativly by the distance between countries. This is the model that we used in our paper.

Stochastic frontier estimation involves modeling error decomposition, $\varepsilon_{ij,t}$, into two components, $v_{ij,t}$ and $u_{ij,t}$, as follows:

$y_{ij,t} = f(X_{ij,t}) + \varepsilon_{ij,t} = f(X_{ij,t}) + v_{ij,t} - u_{ij,t}$, where

- $v_{ij,t}$ is independent and identically distributed, is normally distributed - $N(0, \sigma_v)$. It occurs because of the measurement errors or it is just random. Also known as bilateral error;
- $u_{ij,t}$ is independent and identically distributed. Also known as unilateral error.

In the literature have been several proposed distributions for $u_{ij,t}$:

- exponential or semi-normal (Aigner et al. 1977);
- truncated normal (Stevenson 1980);
- gamma (Greene 2003).

According to the literature (Kumbhakar and Knox Lovell, 2000, 74-78), we assume that $u_{ij,t}$ and $v_{ij,t}$ are distributed independently of each other and independent of the independent variables $X_{ij,t}$.

The unilateral error $u_{ij,t}$ is the measure of performance or the degree to which real value is below the theoretical potential, given by the stochastic frontier equation, for the production function, or indicate the degree to which the actual value is above potential. Therefore, the production function is presented as a function of maximum and the cost function as a function of minimum.

3. Empirical study

We have proposed to estimate the stochastic frontier of trade partnerships efficiency. Endogenous variable is the ratio of imports and exports. The stochastic frontier method calculates efficiency scores for partnerships, in this case as a result of using a cost function that aims at assessing efficiency by minimizing imports compared to exports.

The data source used in the analysis were Eurostat and the Romania's National Institute of Statistics. The database contains the 26 E.U. partner countries with which Romania has bilateral trade. The software used for data analysis is FRONTIER 4.1.

The necessary steps to obtain the results are presented in Appendix 1.

The model chosen is that of Batelli and Coello (1992), and the cost function is estimated. As an output variable we used the ratio between imports and exports, weighted by the size of

the bilateral trade flow in Romania's total trade flow. The cost function has determined the stochastic frontier that shows Romania's trade partnerships efficiency by minimizing imports compared to exports. Efficiency scores calculated for each partner country are presented in the table below. Depending on the score, countries were ranked by assigning a rank between 1 and 26. The country with the highest efficiency score received rank 1 and the country with the lowest efficiency score the rank 26. Table 1 shows the results of efficiency analysis, and Figure 1 shows graphically the hierarchy situation of partner countries according to the score of efficiency achieved.

Table 1.

Rankings of the trade partnerships of Romania according to their bilateral trade flow efficiency

Country	**Efficiency**	
	Efficiency score	**Efficiency rank**
Austria	0.884	2
Belgium	0.33	8
Bulgaria	0.125	22
Ciprus	0.131	19
Denmark	0.22	10
Estonia	0.13	20
Finland	0.21	11
France	0.114	25
Germany	0.63	4
Greece	0.117	14
Irland	0.31	9
Italy	0.117	24
Latvia	0.135	18
Lithuania	0.155	16
Luxemburg	0.167	15
Malta	0.127	21
Netherlands	0.56	5
Poland	0.67	3
Portugal	0.144	17
Czech Rep.	0.41	6
Slovakia	0.40	7
Slovenia	0.20	12
Spain	0.10	26
Sweden	0.19	13
UK	0.121	23
Hungary	0.91	1

Source: Author's computation based on the FRONTIER results

In Figure 1 was represented, by the dotted line, the efficiency frontier for which the placement below this frontier shows the extent to which Romania is seen as having inefficient import-export relationships with the partner country.

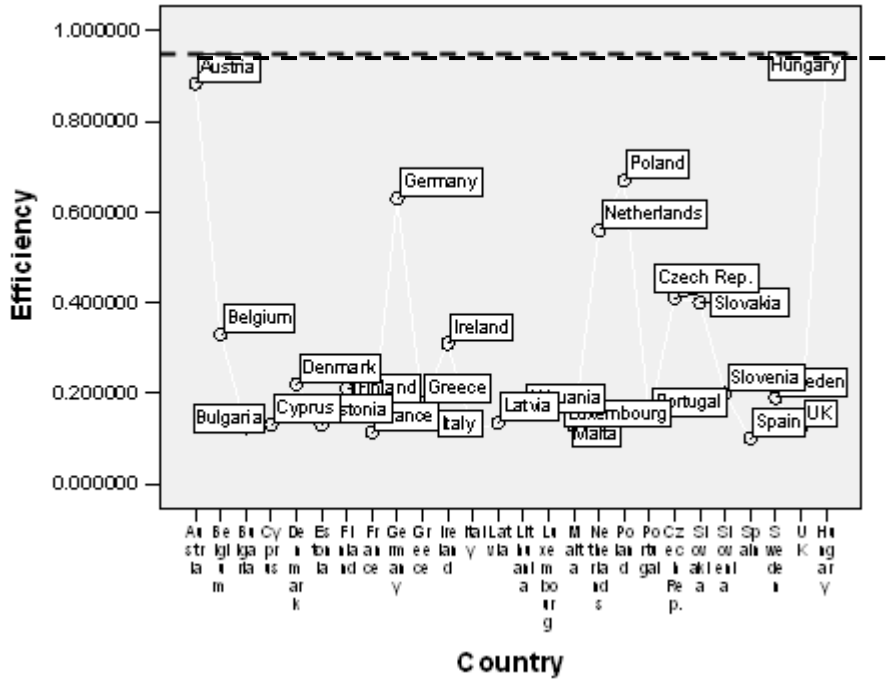

Figure 1. **Efficiency scores of Romania's trade partner countries, obtained by the method of stochastic frontier**

It is observed that countries with which Romania has its most efficient import-export relations and which drawns the efficiency frontier are Austria and Hungary. The more the countries depart from the dotted line, the more inefficient their trade partnerships with Romania are. On the opposite side of the efficiency frontier are Spain, Italy, France, Malta, UK

4. Conclusions

To analyze the efficiency of econometric foreign trade partnerships we used a gravity model, based on which variables we could estimate the efficiency scores with stochastic frontier method, using a cost function that estimated the efficiency frontier by minimizing the ratio between imports and exports. Partner countries were ranked according to their obtained scores, thus achieving the most effective and ineffective partnerships of foreign trade for Romania. Effective partnerships are those with Austria and Hungary, and among inefficient partnerships as import-export ratio are Spain, Italy, France, Malta or UK.

A future improvementof this study aims primarily to build a panel model for evaluating the efficiency of Romania's foreign trade partnerships, and use a more complex computer program, allowing a wider variety of modeling options.

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Appendix

The steps followed in using FRONTIER 4.1

Data

Country	Year	Y	X1	X2
1	1	2.75927	26.65	6.75
2	1	0.707005	26.87	7.49
3	1	-1.426241	24.59	5.69
4	1	-0.132576	23.94	7.09
5	1	0.134261	26.46	7.36
……				
24	1	0.068555	26.85	7.46
25	1	-0.687722	28.44	9.09
26	1	3.117139	25.59	6.46

Software's instructions

```
1            1=ERROR COMPONENTS MODEL, 2=TE EFFECTS MODEL
Eg1ie.txt        DATA FILE NAME
Eg1-out11.txt    OUTPUT FILE NAME
1            1=PRODUCTION FUNCTION, 2=COST FUNCTION
y            LOGGED DEPENDENT VARIABLE (Y/N)
26           NUMBER OF CROSS-SECTIONS
1            NUMBER OF TIME PERIODS
26           NUMBER OF OBSERVATIONS IN TOTAL
2            NUMBER OF REGRESSOR VARIABLES (Xs)
n            MU (Y/N) [OR DELTA0 (Y/N) IF USING TE EFFECTS MODEL]
n            ETA (Y/N) [OR NUMBER OF TE EFFECTS REGRESSORS (Zs)]
n            STARTING VALUES (Y/N)
            IF YES THEN    BETA0
                           BETA1 TO
                           BETAK
                           SIGMA SQUARED
                           GAMMA
                           MU          [OR DELTA0
                           ETA           DELTA1 TO
                                         DELTAP]
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