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Econometric analysis of foreign trade efficiency of E.U. members using gravity equations

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Abstract

This paper aims to analyse the foreign trade efficiency for Romania and compare it with the other E.U. member states. We use stochastic frontier analysis to estimate the efficiency component of foreign trade of Romania and EU countries. We built 27 econometric models, one for each country, considering EU members trade partners units plus eight extra-EU partners. We estimated the 27 member countries' efficiency coefficients associated with each partnership. These coefficients were used to estimate the average efficiency scores for each of the 27 countries. The analysis results have shown that the economic crisis has not significantly changed trade patterns and hierarchies between EU countries, only lowered trade performances.

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Keywords: econometric efficiency, gravity model, stochastic frontier analysis

1. Introduction

The purpose of this paper is the econometric analysis of Romania's foreign trade efficiency compared to the efficiency of the European Union member states. The paper has two major objectives:

- Presentation of the methodology for evaluating the effectiveness of econometric foreign trade;
- Econometric estimation of the efficiency component of Romania's foreign trade and comparative analysis to the EU Member States.

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The econometric approach aims at analyzing the efficiency of foreign trade through stochastic frontier method that seeks to determine an efficiency frontier where countries should operate to be effective. There are two methods for this type of analysis - the production frontier method and the cost function method. The production frontier refers to the maximum output that can be obtained using a set of inputs, with existing technology. The solution to determine the efficiency factor is the decomposition of the model error ε_i into two components, one component being the white noise, the error due to complete randomness, and the other component being the measure of a country's efficiency. After the '90s, there have been developed specific panel data models, which treats efficiency based on the time effect. In the paper we use the production frontier method and we applied a panel type model for Romania and the rest of the EU countries in order to estimate the efficiency component of foreign trade.

50 years ago, Farrell (1957) introduced a methodology for measuring the economic (EE), technical (TE) and allocative (AE) efficiency. TE is associated with the ability to produce at production frontier, while AE refers to the ability to produce a given level of output at minimum cost of inputs. In other words, technical inefficiency refers to deviations from the production frontier, allocative inefficiency reflects deviations from the minimum cost of inputs and EE is defined as the ability of a firm to produce a predetermined amount of output at minimum cost, for a given level of technology. There are thus two types of approaches: deterministic and stochastic.

Stochastic production frontier, proposed by Aigner, Lovell, Schmidt (1977) and Meeusen and van den Broeck (1977), is motivated by the idea that deviations from the production frontier may not be entirely under the control of the company studied, but may be due also to random perturbations, and not as it is considered in the deterministic interpretation of the frontier, where deviations from the frontier are considered to be due entirely to the company.

In the deterministic interpretation, any random failures of production equipments, bad weather, any measurement or recording error should be considered as a measure of inefficiency. A more appropriate alternative to measure the efficiency is the stochastic approach of the production frontier, where inefficiency is separated from random noise. A formulation suitable for econometric estimation of efficiency using production function is:

$$y_i = f(x_i) TE_i e^{\varepsilon_i},$$

where the last term includes the measurement errors, random noise and random variation of the frontier across firms. A reformulated form of the model is:

$$ln\, y_i = \alpha + \beta^T x_i + \varepsilon_i = \alpha + \beta^T x_i + v_i - u_i,$$

where v_i and u_i are the two components of error, random noise and TE respectively. The major objective of the analysis is to estimate the stochastic frontier inefficiency component, u_i.

Next, we will present the methodology used to estimate the econometric models and the empirical results obtained by analysing the stochastic efficiency of the EU members' foreign trade.

2. Data and methodology

The econometric analysis of foreign trade efficiency is based on the model errors resulting from estimating a gravity model for a production or cost function.

Trade gravity model analyzes the determinants of bilateral trade flows, and the efficiency of those trade flows is achieved through stochastic frontier analysis.

In order to estimate the gravity equations for the 27 EU Member States we use a panel model. Data were recorded during 2001-2010, and have targeted a number of gravity variables for the foreign trade partners of the EU countries. As partners, we considered, for each country, the other 26 EU countries, plus eight extra-EU partners, namely Norway, Switzerland, Russia, USA, Canada, China, Japan and Hong Kong.

The gravity model used to explain the bilateral trade flows for the countries of the European Union with their trading partners has the classical gravitational variables, i.e. the distance between the two partner countries and the economic output, expressed by GDP, plus a number of dummy variables covering common aspects of the relationships between the trading partners.

The form of the econometric model proposed in this paper to explain the trade of EU members with the partner countries, is as follows:

$$\ln BTF_{ij} = \beta_0 + \beta_1 \ln GDP_j + \beta_2 EU\_dummy_j + \beta_3 \ln DIST_{ij}^2 + \beta_4 Borders\_dummy_j + \beta_5 land\_dummy_j + \varepsilon$$