A STOCHASTIC FRONTIER ANALYSIS APPROACH FOR ESTIMATING ENERGY DEMAND AND EFFICIENCY IN THE TRANSPORT SECTOR OF LATIN AMERICA AND THE CARIBBEAN

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Reducing energy consumption and pollutant gas emissions has become a key energy and environmental objective for most governments across the globe during recent decades. The promotion of energy efficiency as a means to that end has converted the definition and measurement of this concept into a necessary purpose prior to the design and assessment of energy and environmental policies.

Since there is no single definition universally accepted for energy efficiency, various quantitative indicators that are related to this idea have been used for international comparisons. In that sense, the use of a stochastic frontier analysis approach to estimate aggregate energy demands has recently been suggested to obtain energy efficiency measures at country level. Efficiency measures obtained through this approach, are based on the comparison of energy consumption with respect to the minimum energy consumption predicted by the frontier, which takes into account the optimizing behavior of companies and individuals. The estimation of these models allows us to control for characteristics such as economic or environmental factors that affect the sector and may bias the results obtained from standard energy intensity indicators. Therefore, through the frontier approach it is possible to obtain a "pure" measure of the inefficient use of energy.

Countries that aim to reduce their energy consumption and mitigate their greenhouse gas emissions should be particularly concerned about the adoption of measures that improve the energy efficiency in those sectors which are more energy intensive. In this paper a frontier analysis approach is applied to estimate energy demand functions in the transport sector of Latin America and the Caribbean. This sector involves the largest energy consumption of the region (around 43% with respect to total energy consumption) and the ECLAC (Economic Commission for Latin America and the Caribbean) indicates that its share will even increase in the future. Despite this, there is a scarcity of empirical research on the transport sector of this region due to data unavailability and the absence of a formal link between institutions that are in charge of providing information on energy and transport. Given the magnitude of the sector and the increase of energy prices that these countries have experienced in recent years, it is necessary to conduct studies focused on energy consumption in transport that help raise awareness about the environmental sustainability issues that are mentioned in the "Millennium development goals" proposed by ECLAC.

As far as we are aware, this is the first application of a stochastic energy demand frontier approach to measure energy efficiency in the transportation sector. The database used in this essay consists of a sample of 24 Latin American and Caribbean countries for the period 1990-2010. The use of a random

parameters stochastic frontier model is proposed to capture unobserved heterogeneity due to the likely different features of this sector in each country. This model enables us to accommodate these differences including individual effects along with different income and price elasticities per country. As the transport of both goods and passengers implies the consumption of different types of energy, an index that aggregates various energy prices is thus required for the analysis. However, international agencies do not provide specific indicators of aggregate energy prices in transport for the majority of the countries analyzed. For this reason, the construction of a transitive multilateral index is proposed, which, in contrast to those frequently presented by the aforementioned agencies, facilitates international comparisons over time.

Regarding our main findings, significant differences in income and price elasticities are observed within the sample. The estimation of our model allows us to identify the most efficient countries in energy consumption (Guatemala, Brazil and Ecuador) that are indeed some of those that have successfully implemented programs of improved public transport in some of their cities. Generally speaking, the ranking of countries that is obtained when a frontier approach is employed to measure energy efficiency is slightly correlated with the ranking derived from the widely-used energy intensity indicators. Moreover, there is a lack of correlation between both measures over time for some countries, which may indicate that variations in energy intensity indicators are associated with circumstances other than changes in energy efficiency.

It should be mentioned that in practice, the achievement of savings in energy consumption through the promotion of energy efficiency might not fully coincide with the values predicted by the model due to the so-called rebound effect. Future research about the incorporation of this phenomenon in energy demand frontier models should be encouraged. Finally, as a policy recommendation, it should be suggested that the countries in our sample ought to follow the example of those identified as benchmarks. The adaptation of the national transport sector policies implemented in the most efficient areas of the region might help those countries lagging behind to improve their energy efficiency and reduce their levels of urban contamination.