ASYMMETRY IN THE LOG-LINEAR GRAVITY MODEL, BEEF TRADE AND TRADE BARRIERS

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Introduction

Gravity models have been extensively used to model aggregate trade flows at the country level (Tinbergen, 1962; Anderson and van Wincoop, 2003). They have also been successfully used to model trade flows at a more disaggregated level. For example, Sun and Reed (2010, Amer. J. Agr. Econ. 92(5):1351-1363) have used agricultural trade data to analyze the impact of bilateral trade agreements while Ghazalian, Tamini, Larue and Corniaux (2010, J. of Inter. Trade and Dev. Econ. forthcoming) have used meat commodity data to analyze multilateral trade liberalization scenarios.

This study draws attention on the importance of asymmetries in log-linearized gravity models with homoskedastic errors. We based our study on the model of Helpman, Melitz and Rubinstein (2008), henceforth HMR. These authors developed an insightful theoretical model capable of explaining three important stylized facts about international trade flows. Firstly, the model allows zero trade to occur between two countries, and another country. This feature makes it possible to measure the determinants of the selection of countries into trading relationships, or equivalently, why some countries do not export or import at all to/from certain destinations/sources in the world. Second, the model allows for asymmetric trade flows between country pairs. In particular, the model has the potential to explain why country i exports to, but does not import from country j. Finally, the model generates a gravity equation in which distance and GNPs along with other variables condition positive trade flows.

In the HMR model, each country in the world is endowed with an infinite number of firms. But many exporting industries are characterized by a few number of players. For example, a large proportion of international trade in cars and processed agricultural products is dominated by a few companies. It is to account for these empirical features, a modified HMR model in which the number of firms in each country is finite is proposed. This version of the model implies that the aggregate trade flow is random and subject to productivity shocks. We then show that the log of random variables are often negatively skewed. An immediate implication of this model is that the log-linear gravity model should be estimated as a Frontier model. An empirical application based on international beef meat trade supports the presence of asymmetry in the data.

Objective

The goal pursued in this paper is to measure the impact of trade barriers on international beef trade flows. The trade barriers considered are the tariffs, the non-tariff barriers, the nature of the tariffs (specific or ad valorem). The impact of trade agreements and BSE (Bovine spongiform encephalopathy) disease are also discussed. The transient effects caused by the ignorance of this asymmetry on parameter estimates are assessed while calibrating our workhorse model with a benchmark estimator. The latter estimator is the nonlinear least squares of HMR (2008) which is modified in the direction of Santos Silva and Tenreyro (2008).

Methods

We assume that the number of firms in each country is finite, but that the productivity of each firm is random and follows the truncated Pareto measure assumed in the HMR model for the distribution of firms. This approach breaks the deterministic link assumed in the original model between each firm and its productivity. In the current approach, firms are homogenous ex-ante with respect to the distribution of the productivity, but they are heterogenous ex-post regarding the realizations of the productivity. Given this assumption, trade flows between country pairs are random, but expected trade flows are equal to the expressions one obtains when the numbers of firms per country is infinite, as given in HMR (2008). Hence in our framework, the log of the trade flow is equal to the log of the expected trade plus the log of an error term whose expectation is equal to one. It turns out that the log of a random variable with expectation equal to one is negatively skewed, unless this random variable is more positively skewed than the log-normal distribution. In particular, our Monte Carlo simulations show that when the firms’ productivity is Pareto distributed, the error term becomes negatively skewed by log-transformation, and this finding is robust across different values of the parameters characterizing the distribution. This suggests that the log-linearized HMR gravity model should be estimated as a production frontier model. For quite different reasons, Santos Silva and Tenreyro (2006) have warned against the log-transformation approach. They point out that the estimated coefficients from the log-linearized model are biased in the presence of heteroscedasticity.

They also claim that the multiplicative form of the model permits to use the whole sample for estimation, including the data points with zero trade flows. While the first argument is true, the second argument which addresses the log of zero problem is nevertheless problematic given the observed empirical evidence suggesting that the probability of zero trade flow between certain country pairs is strictly positive. We apply our methodology to disaggregated agri-food data and found little support for heteroscedasticity. We assess the impact of ignoring the residual asymmetry on the estimated elasticities. In our empirical framework, we approximate the log of the error term by a gaussian error minus an exponential error that aims to capture the negative skewness implied by the theoretical model.

Results and Discussion

The data used for this study describes 41 countries and covers the period 1995 to 2005. This period is characterized by the BSE disease. The asymmetry parameter is significant while the sample selection and heterogeneity correction parameter (r and delta) are not. The impact of the log-distance is slightly lower in the model that accounts for asymmetry (NSL-Frontier). The GDP of the importing country, which is aimed at capturing demand size effects, is not significant in the benchmark model, contrary to what is observed in the NLS-Frontier model. The importers population and production are more significant in the NLS-Frontier model compared to benchmark and the signs of their coefficients are intuitive. The tariffs have a negative impact on trade flows. All tariffs are converted in their ad-valorem counterpart. When the tariffs are specific, they have an additional negative impact which is highly significant. The BSE disease in importing countries impacts negatively on beef trade flows, but the effect is not significant which is true also of BSE in exporting countries. However, BSE seems to have indirect impacts through the coefficients of trade agreements and TRQs. Indeed, countries that are linked by a trade agreement are also those for which the trade volume is high. These countries’ trade flows have also been affected by BSE. The NLS-Frontier estimator suggests that the impact of trade agreement in this context is not significant. By the same token, countries using TRQs have had trade flows that have been relatively more resilient to BSE.

Conclusion

Accounting for asymmetry has a substantial impact on the estimates of certain coefficients. Kothoni and Larue’s (2011) simulation results have shown that ignoring asymmetry causes biased estimates. This leads us to prefer the NLS-Frontier estimator. Our empirical results show if specific trade policies limit trade beyond the negative impact of their ad valorem equivalent. Specific tariffs maintain a fixed margin when world prices fall and hence might be motivated by downside risk concerns which could rationalize the concurrent use other trade barriers.

Related studies


