Brazilian Border and Mercosur Integration Effects: An Exploratory Assessment Using The Gravity Model

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1 Introduction

Significant reductions in formal trade barriers and in transportation and communication costs have created an expectation that national borders would no longer be important determinants of geographic trade patterns. That comes in contrast to the increased efforts to establish regional trade agreements whose major goal is to reduce and level the trade conditions among politically independent countries. Thus, an interesting issue is to measure the actual importance of national borders and trade block limits for the determination of trade flows and in particular the potential changes promised by integrations efforts.

It is recognized that International Trade models have been a poor performance in terms of fitting actual data. But in the 1960s the empirical success of the gravity equation for trade prediction attracted the researchers' attention. It demonstrated a high flexibility to incorporate most of empirical phenomena observed in international trade, such as the large volume of trade among industrialized countries, intra-industry trade, adjustment to trade liberalization and the relationship between aggregate incomes and export shares. One of the most widely used application of the gravity model is to measure the empirical impact of national and institutional borders over the predicted trade flows, controlling for the influence of other relevant variables.

This paper main goal is to provide an econometric estimation of the effects of the Brazilian national border on the trade flows among Brazilian states and between them and foreign countries using a gravity model estimated with a larger and more complete data set than the ones previously available. As a side result, the effects of the Mercosur agreement on trade are also assessed.

The properties and hypothesis of the econometric specification of the gravity equation have recently been examined by many papers, and some important sources of mis-specification biases have been stressed. In particular, it has been shown that the right specification of country specific effects to account for heterogeneity is essential to avoid a downward bias in the estimates. It is also an important issue to deal with the large number of zero trade observations in intra-national and international trade data sets. We discuss some of the different approaches to the problem before presenting our own estimations, but we conclude that the appropriate modeling strategy is an important open question in the field.

This paper is organized as follows. A brief literature about the empirical aspect of the gravity equation is provided in Section 2, including the conventional definition of the so-called "border effect" making reference to the seminal work of McCallum(1995); and the implications of the heterogeneity bias, according to Wall(2000) and Cheng and Wall (2002). The econometric specification of the model is shown in section 3, where the main results are also presented. The conclusions are then presented based on the results obtained in the previous section, that provided a huge border effect. In the appendix are reported some information about the data set and the complete table of the estimated coefficients of Section 3 models are reported.

2 Empirical Aspects of the Gravity Model

The use of the gravity model in international economics was first proposed independently by Tinbergen (1962) and Pöyhönen (1963). Tinbergen's original goal was to account for the factors that explained the size of trade flows between two countries. These factors were classified into three types. The first type includes the factors related to the total potential supply of the exporting country. The second type includes the factors related to the total potential demand of the importing country. These two types are basically represented by the size of Gross Domestic Product (GDP) of the exporting (Y_i) and importing (Y_j) country respectively. The third type includes the set of natural or artificial factors (A) that imposes obstacles to trade, such as transportation costs and transit time (naturals), tariffs, quotas, exchange controls and safeguards (artificial). Equation (1) depicts this general relation in a multiplicative form, where X_{ij} is the dollar value of exports (or trade) from country i to country j and α is a constant.

$$X_{ij} = \alpha Y_i^{\beta_1} Y_j^{\beta_2} A^{\beta_3} u_{ij} \tag{1}$$

Although the gravity model is generally derived in a multiplicative form, it is estimated, by Ordinary Least Squares (OLS), in its log-linear form, usually employing some measure of geographical distance between the trading partners, like in equation (2):

$$\ln(X_{ij}) = \ln(a_0) + a_1 \ln(Y_i) + a_2 \ln(Y_j) + a_3 \ln(N_i) + a_4 \ln(N_j) + a_5 \ln(Dist_{ij}) + \ln(e_{ij}) \tag{2}$$

The gravity equation arises naturally whenever trade follows an ”intra-industry” pattern, as a result of specialization of goods production in different countries. It has been extensively shown that such equilibria may result either from monopolistic competition or from perfectly competitive Ricardian or Hecksher-Ohlin models, when factor price do not equalize. On the other hand, the empirical success of the gravity equation should not be directly taken as supportive of any underlying theoretical model. A comprehensive survey about the gravity equation literature is available at Paz (2003).

2.1 Border Effect

In International Trade literature, the so-called ‘border effect’ is defined as the reduction in the trade volume due to the crossing of a political or institutionally defined border. It is measured as the difference between the expected trade flow were the foreign and the home countries part of the same political unit. From a consumption point of view the phenomenon has also been stated as a purchase bias in favor of domestically produced goods and against foreign produced goods, the “home bias” effect.

Wei (1996) defined home bias as a country’s imports from itself in excess of its imports from other countries, after taking into account the importer’s and exporter’s sizes, bilateral distance, relative locations with respect to the rest of the world and whether or not they share a common border or language.

Anderson and Smith (1999a) conjectured that besides tariff and non-tariff barriers and transportations costs, the possible reasons for border effects should include such factors as traders’ exposure to exchange rate risk, vulnerability to contingent protection, the existence and nature of trading networks within oligopolistic industries and consumers’ product differentiation by origin, in addition to standard tariff barriers and other protectionist measures which can reduce trade.

Even if it is possible to provide direct measurements or proxies for variables representative of the factors that contribute to the border effect, their aggregate and nonspecified nature invariably lead to their representation as residuals attributed to a dummy variable included in the specification of the traditional gravity model.

John McCallum (1995) in an influential paper, showed that trade among Canadian provinces was twenty times larger than trade between Canadian provinces and U.S.’ states, after controlling for the effect of the traditional gravity equation set of variables. This result was astonishing in light of the absence of apparent trade frictions between the countries. The United States and Canada are each other’s largest trading partners, and the volume of trade between them is the greatest between any two countries in the world. Starting with the 1965 Auto Pact, there has been an almost uninterrupted trend towards freer bilateral trade, culminating in the 1988 Canada-U.S. Free Trade Agreement, subsequently deepened and broadened by the North American Free Trade Agreement (NAFTA).

The simplest version of the specification estimated by McCallum can be written, for any given time period, as equation(3).

$$x_{ij} = a + by_i + cy_j + dDist_{ij} + eDummy_{ij} + u_{ij} \tag{3}$$

where x_{ij} is the natural logarithm of shipments of goods from region i to region j, y_i and y_j are the natural logarithms of GDP of regions i and j, $Dist_{ij}$ is the natural logarithm of the distance from i to j, $Dummy_{ij}$ is a dummy variable equal to "1" for interprovincial trade (i.e. i and j are Canadian provinces) and "0" for province-to-state trade, and u_{ij} is an error term.

His data set consisted of imports and exports for each pair of provinces, as well as imports and exports between each of the ten Canadian provinces and each of the fifty US' states. McCallum decided to include only 30 states, defined as the 20 states with the largest population, plus all border states, that accounted for more than 90 percent of Canada-U.S. trade in 1988.

The coefficients estimated for McCallum's model (version two in his paper) are shown in equation (4).

$$\begin{aligned} x_{ij} &= cte + \underset{(0.03)}{1.21} y_i + \underset{(0.03)}{1.06} y_j - \underset{(0.06)}{1.42} Dist_{ij} + \underset{(0.13)}{3.09} Dummy_{ij} + u_{ij} \qquad (4) \\ \bar{R}^2 &= 0.811, \quad SEE = 1.10 \quad \#\text{ of observations} = 683 \\ & \textit{Standard error in parentheses} \end{aligned}$$

The estimated coefficients on the GDP variables were close to unity, as most simple theoretical models would predict. The coefficients on the distance variable was substantially larger than the ones estimated by the internationals studies referred by McCallum, which tended to be less than 1 in absolute value. He suggested that his result rested on the fact that water transport is much cheaper than the other modes of transport for North American trade, which in contrast to most of the global trade, that goes by air and land.

The central finding was an intra-provincial trade dummy variable coefficient over 3. It meant that, other things equal, trade between two provinces was more than 20 times (e^3>20) larger than that between a province and a state, with a range from 17 to 29, plus or minus two standard errors.

McCallum's basic conclusion is, in his own words: "*whatever the reasons may be and whatever the future may hold, the fact that the relatively innocuous Canada-U.S. border continues to have a decisive effect on continental trade patterns suggests that national borders in general continue to matter*"[1].

McCallum's model has been subsequently refined and extended, with the border effect found to be: (i) asymmetric, with its trade-reducing effect greater for U.S. exports to Canada than for Canadian exports to U.S. [Anderson and Smith(1999a)]; (ii) heterogeneous across provinces [Helliwell (1996 and 1998); and Anderson and Smith (1999b)]; and (iii) asymmetric and heterogeneous [Anderson and Smith(1999b)]. In a study using post-NAFTA data, Helliwell (1998) found that the home bias ratio declined to about 12 for the period 1994-96.

Evidence of home bias has not been restricted to Canada-U.S. trade, and it has been found to be also significant at the level of U.S. states by Wolf(2000), and for OECD countries by

[1]McCallum (1995, p. 622).

Wei(1996). Also, Anderson and Smith (1999a and b) estimated Canadian and provincial border effects for the trade with countries other than the U.S..

Van Wincoop (2000) argued that even though McCallum controlled for state and province size in his gravity equation, his trade diversion measure gave an exaggerated impression of home bias in global trade because it calculated the bias from the perspective of the small country, Canada, rather than from the perspective of the large country, the U.S. Because Canada's economy is so small relative to that of the U.S., a moderate percentage diversion of U.S.-Canada trade into intra-Canada trade amounts to a spectacular percentage increase in intra-Canada trade. Using American interstate trade data, Van Wincoop estimated that the U.S.-Canada border reduces trade between the two countries by at most 30 percent.

Overall, a balanced interpretation of the literature after McCallum (1995) is that countries do exhibit a considerable degree of home bias in trade, but the bias is not as extreme as McCallum's original estimates suggested.

2.2 Heterogeneity Bias

Wall(2000) was the first to use a province disaggregated specification of the variable intended to capture the border effect. He estimated the effect of the Canada-U.S. border using the following gravity model (5) where x_{ijt} is the volume of exports from location i to location j in year t, Y_{it} is the income of i in year t, Y_{jt} is the income of j in year t, D_{ij} is the distance between i and j, and $\mathbf{B'}_{ij}$ is a vector of dummy variables specifying the Canada-U.S. border. Wall defined $\ln(1+x_{ijt})$ as dependent variable, rather than $\ln x_{ijt}$ since that allowed to include observations of zero measured trade.

$$\ln(1 + x_{ijt}) = \alpha + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \delta \ln D_{ij} + \gamma \mathbf{B}'_{ij} + \varepsilon_{ijt} \quad (5)$$

Wall's data set is based on a unique series collected by Statistics Canada of trade between Canadian provinces and between Canadian provinces and U.S. states with data from all 10 provinces and all 50 states, including District of Columbia. Within the three years from 1994 to 1996, there were 3330 observations. The distance measure was defined as the great circle distance between the largest cities in each of the trading partners.

Other than the years covered, this data set differs somewhat from those used previously by McCallum(1995) and Anderson and Smith(1999a and b) that had the same sample structure. Helliwell (1996 and 1998) also considered only 30 states, but under a slightly different selection criterion.

Wall estimated a pooled cross-section regression of each version of (5) under four different models for the Canada-U.S. border. The border specification distinctions were constructed by a combination of homogeneous/heterogeneous effects within provinces/states with symmetric/asymmetric effects depending on the direction of trade (imports vs exports).

The estimated home bias effect is on average smaller than for the pre-NAFTA period, although they are still quite large. The symmetric and homogeneous border specification provided a home bias ratio of 15, which was roughly the average of the home bias estimated under heterogeneous border effects. Under the asymmetric trade and homogeneous border specification the home bias for trade from the U.S. to Canada was larger than that from Canada to the U.S.. This was consistent with Anderson and Smith(1999a), although they found that the U.S.-to-Canada home bias exceeded the Canada-to-U.S. home bias by about 26 percent, whereas Wall found a difference of 40 percent.

As in the previous literature, the model appeared to fit the data pretty well, with a high $\bar{R}^2$ and values for the coefficients on income and distance in the typical range of most gravity models. However, after an analysis of the residuals - actual minus predicted log of exports - of the model under the asymmetric and heterogeneous border specification, it could be observed the presence of autocorrelation and heterocedasticity in the residuals. It was apparent that the model provided biased estimates, underpredicting high levels of trade, and overpredicting low levels of trade. Because the home bias compares predicted interprovincial trade - which is relatively high - to predicted international trade, the home bias estimated are, on average, biased downward. Wall(2000) called this bias problem by 'heterogeneity bias'.

Wall stated that the standard gravity model above was in fact a restricted version of a general model in that there was a gravity equation for each trading pair. The restriction imposed that the intercept and slope coefficients are homogeneous across several province-province and province-state combinations.

However, there is certainly no reason to believe *a priori* that the relationship between trade volume and income levels should keep the same under the restriction. If there are country specific factors that are correlated with the volume of trade and with border dummies, then the standard gravity model will mistakenly attribute the effects of these effects to the international border.

Because the previous argument is essentially that equation (5) does not include all of the factors that account for the differences in trade volumes across trading-pairs, the problem of heterogeneity bias can be viewed simply as a problem of missing variables. If the relevant historical, cultural, and political variables themselves could be included in the regression equation, the problem would be solved. However, cultural, historical, and political factors are often difficult to observe, let alone to quantify, which is why they are instead controlled for by assuming that they are fixed over the sample period, allowing them to be captured by a dummy variable for each trading pair. If the individual trading pair dummies are correlated with the right-hand-side variables, then the coefficients on the other variables will be biased when these trading-pair effects are not accounted for (5). This kind of specification problem was also treated by Mátyás (1997), Bayoumi and Eichengreen (1997), and Cheng and Wall(2002).

The simplest way to allow for heterogeneity is to remove the restriction that there is a single intercept applying to all trading pairs. Wall used least squares to estimate the following version of the gravity equation (6):

$$\ln(1 + x_{ijt}) = \alpha_{ij} + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \delta \ln D_{ij} + \gamma \mathbf{B}'_{ij} + \varepsilon_{ijt} \tag{6}$$

where α_{ij} is the trading pair intercept, which is allowed to differ according to the direction of trade, i.e. $\alpha_{ij} \neq \alpha_{ji}$.

The estimated residuals from model (6) revealed a tighter fit and a smaller bias as comparing to those obtained from model (5). The finding of relevant state and province specific factors other than the national border that affect the volume of Canada-U.S. trade, and of correlation with border dummies, leads to the conclusion that the standard gravity models mistakenly attribute the effects of these factors to the international border.

Although the arguments in favor of specific effects as a solution to unobserved heterogeneity is roughly the same in the literature (for example in Wall (2000) and Millimet and Osang (2001)), there is little agreement about how to actually specify the fixed effects. In Wall (1999, 2000) and Cheng and Wall (2002) each pair of countries has two fixed effects, one for each direction of trade. In Pakko and Wall (2001) and Egger (2002) each pair of countries has only one fixed effect. In Mátyás (1997) each country has two fixed effects, one as an exporter and one as an importer.

Cheng and Wall (2002) show that any specification of fixed effect is a restricted version of theirs, and suggest that those restrictions should not be employed since there is no a priori reason to support them. But it is not difficult to specify a model in which Cheng and Wall's model is a restricted version of it. Just consider the case that instead α_{ij} in equation (6), we allow α_{ij} to vary over time, i.e. α_{ijt}. After all, there is always a trade off between generality of the model on one side and the corresponding reduction in the degrees of freedom of the estimation on the other, that have to be accounted for in the specification decision.

2.3 Zero Trade Observations

The existence of zero amount of trade observed for a given pair of countries brings problems of two distinct natures to the estimation. Firstly, despite the convenience of allowing the direct interpretation of the coefficients as elasticities, the double log specification cannot handle zero observations, for which the natural logarithm is not defined. Researchers have approached this problem in different ways, but none of them are free of shortcomings.

The direct approach is based on the recognition that there may be censoring at zero of the observation of the dependent variable, what indicates the use of a Tobit model to condition observation of the non-zero values [2]. This procedure implicitly incorporates the information in the zero observations to the estimation of the probability that trade is positive, which conditions the estimation of the elasticities. Foroutan and Pritchett (1993), and Soloaga and Winters (2001) are examples of that treatment.

The second approach, used by Wall(2000), consists in considering the natural logarithm of $(1+\mathrm{X}_{ij})$ as the dependent variable in the place of $\ln(\mathrm{X}_{ij})$. For large values of X_{ij}, $\ln(1+\mathrm{X}_{ij}) \approx \ln(\mathrm{X}_{ij})$, preserving the double-log relationship. For small values of X_{ij} though, $\ln(1+\mathrm{X}_{ij}) \approx \mathrm{X}_{ij}$, approximating the semi-log Tobit relationship above. Wall (2000) reported that his specification yielded results similar to the Tobit models'. This finding could be explained by the small number of zero observations in his data sample.

The third approach is simply to exclude the zero observations from the sample, and then estimate the model with the remaining observations by OLS. Wang and Winters (1992); and Frankel, Stein, and Wei (1993); and Hidalgo and Vergolino (1998) are examples of that strategy. The price of simplicity of that approach is the loss of important information about the determinants of low levels of trade and the corresponding bias it brings. According to Greene (1993), the size of the bias is inversely proportional to the share of the non-zero sample included in the regression. Our sample contains roughly fifty percent of zero trade observations, therefore a simple OLS estimate would provide biased estimates, and according to Greene(1993) this bias would be a large one.

2.4 Brazilian Data Results

Hidalgo and Vergolino (1998) is, to our knowledge, the only attempt at assessing border effect issues using Brazilian international and internal trade data employing the gravity model. The border effect measured by them represents the resistance found by an export flow from a Northeastern state to a foreign country, or according their other dummy variable to a non-Northeastern state. Since their model did not include specific country effect dummy variable to take account of heterogeneity bias, its results may be a useful comparable benchmark to our own estimations that follow ahead.

Their data set was composed by 1991 inter-state trade matrix provided by SEFAZ-PE(1993) and international trade data between Brazilian states and 75 foreign countries obtained from Secex(2002).

They estimated border effects between the nine Northeastern Brazilian states (namely: Maranhão, Piauí, Ceara, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, Sergipe and Bahia) and foreign countries, in McCallum's sense, and between the Northeastern states and the rest of the Brazilian states, using the following model (7), where M_{ij} is the value of exports from i to j. FBR

[2] More informetion on Tobit models can be found in Davidson and Mackinnon (1993) chapter 15.

is a dummy variable that assumes the value "1" in case of inter-state trade and "0" otherwise, while FNE_{ij} is a dummy variable equal to "1" only in case that both states i and j belongs to the Northeastern Region of Brazil. Gross Regional Product (GRP) is used as a proxy for the Brazilian states GDP.

$$\log M_{ij} = a_0 + a_1 \log GDP_i + a_2 \log GDP_j + a_3 DIST_{ij} + a_4 FBR + a_5 FNE_{ij} + u_{ij} \qquad (7)$$

The foreign country data was taken from World Development Indicators (World Bank). The distance variable was measured as the distance through paved roads between Brazilian State capitals and the distances between those and foreign countries were proxied by distance between principal seaports or airports. Their data set contained 927 observations for the year 1991, with only 461 observations of non-zero trade, of which 219 refer to Brazilian inter-state trade and 242 to international trade.

Hidalgo and Vergolino (1998), hereafter HV, estimated (7) by OLS eliminating all zero trade observations. The estimated coefficients are reported in (8) where the t-statistics are in parentheses.

$$\begin{aligned} \log M_{ij} &= a_0 + \underset{(11.87)}{1.47} \log GDP_i + \underset{(15.88)}{0.88} \log GDP_j - \underset{(-7.14)}{1.17} DIST_{ij} + \\ &\quad + \underset{(8.46)}{2.45} FBR + \underset{(1.65)}{0.56} FNE_{ij} \\ \bar{R}^2 &= 0.55 \text{ ; F-statistic=112.7; \# of obs=461} \end{aligned} \qquad (8)$$

They got statistically significant coefficients for the FBR and FNE dummies, meaning that Brazilian inter-state exports are something like 11.5 ($e^{2.4}$=11.5) larger than exports from states to foreign countries, at the same time that exports inside the Northeastern region are 1.75 ($e^{0.56}$=1.75) times larger than trade between a Northeastern region state and other Brazilian states not belonging to the region.

HV also presented another estimation of the gravity equation, equation (9), this time using only Brazilian inter-state trade data. Their second model defined M_{ij} as the sum of exports and imports when strictly larger than zero.

$$\begin{aligned} \log M_{ij} &= a_0 + \underset{(14.97)}{1.37} \log GDP_i + \underset{(30.6)}{1.46} \log GDP_j - \underset{(-10.18)}{1.28} DIST_{ij} + \underset{(1.78)}{0.39} FNE_{ij} \\ \bar{\bar{R}}^2 &= 0.76 \text{ ; F-statistic=354.0; \# of obs=437} \end{aligned} \qquad (9)$$

They still found a significant border effect between the Northeastern Region and the rest of the country representing a volume of trade 1.5 ($e^{0.39}$=1.5) times larger intra-region than between Northeastern states and the other Brazilian states.

2.5 Impact of Mercosur

Azevedo(2002)[3] assessed the effects of the Mercosur trade agreement through the estimation of a gravity equation with a large sample of international trade data pooled over the period 1987-98 and tested for stability of the regression coefficients during the main phases of Mercosur

[3]This paper was based on Azevedo's(2001) Doctoral Dissertation

integration. His model attempted to identify the impact of the agreement on intra-bloc trade overall imports and overall exports, the latter results allowing direct inferences about the 'export diversion' issue. These is done at three periods of time, namely before the signature of the Asunción Treat, after the Treat but before customs union, and after customs union in January, 1^{st} 1995.

The dependent variable in his model is the total bilateral imports net of fuels (total imports less SITC 3) taken from United Nations Comtrade database for 55 countries for each year between 1987 and 1998. The set of countries covered was responsible for about 69% of world imports in the whole period analyzed.

As the presence of heterocedasticity was noted for the OLS results, weighted least squares with the GDP of importers as weights and the White estimation were performed. The estimation omitted the zero trade pairs from the data set and substituted small values, like 0.001, in the place of the zero trade observations. He then compared these results with the ones provided by a Tobit style model with the same specification for the for the linear part. Azevedo reported no significant differences in the estimated coefficients.

After controlling for the traditional variables that determine bilateral trade flows in the gravity equation, the apparent surge in intra-bloc trade could not any longer be attributed to the Mercosur agreement. The gravity equation estimations confirmed that even before the bloc formation (1987-90), intra-bloc trade was already regionally biased. They also confirmed the lack of dynamism of extra-bloc exports, which have been falling behind the performance of extra-bloc imports significantly since 1991. It seemed that the role attributed to regional integration had been overestimated and intra-bloc trade would have evolved in a similar fashion even if the bloc had not been in force.

The results suggested that as far as Mercosur is concerned, the bloc formation did not have a significant impact on intra-bloc trade, but it positively affected imports from non-member countries and negatively affected exports to third countries in both transition and incomplete customs union periods, in relation to the pre-integration era.

These results are similar to the ones in Soloaga and Winters (2001), and in some extent, to Krueger (1999). Both suggested that Mercosur imports from the rest of the world have increased during the 1990s, as a result of the bloc formation. Soloaga and Winters (2001) estimates, based on cross-sections from 1980 to 1996, suggested that although intra-Mercosur trade was significantly above expected levels over the whole period, it did not vary much over the sample. The same outcome was obtained from their pooled estimation, with intra-bloc coefficients statistically not different over 1986-88 and 1995-96. However, Krueger (1999), who estimated the PTAs effects on intra-bloc trade and imports from non-member countries, based on pooled data and employing a trend dummy to assess the changes in the PTAs from 1987 to 1997, found no Mercosur intra-bloc effect whatsoever.

3 Estimation of the Brazilian border and Mercosur integration effects

The models that we used to estimate the Brazilian border effect follow the strategy that McCallum (1995) employed to assess the Canadian border effect, i. e. the estimated border effect will be the difference between the predicted and the actual trade flow between a Brazilian state and a foreign country. The predicted trade flow between a Brazilian state and a foreign country is the one that would take place if the foreign country were a Brazilian state.

The econometric models used to infer the extent of the border effect usually are models that do not cover all world trade flows. Our models are no exception to this rule. As a consequence, our data encompass the exports and the imports among Brazilian states and the exports and imports between Brazilian states and each of the 192 foreign countries included in the sample. The years covered by the data are 1991, 1997, 1998 and 1999. A brief description of the data set is provided in Appendix A. An extensive description is available in Paz(2003) on request.

We also included in our models a dummy variable, in the same sense as Azevedo(2002), to capture the Mercosur Integration effects over the trade flow patterns of Brazilian states.

Our estimations are divided into two subsections. The regression run in the first subsection does not take into account the zero trade observations. In the second subsection special care is given to the zero trade observations problem, in account of what we used Wall(2000) approach and Tobit-like models to estimate the Brazilian border effect and the Mercosur integration effect.

3.1 Estimations discarding zero trade observations

In this section we will be dealing with an OLS estimated pooled cross-section model leaving out the zero trade observations. The model estimated is depicted in equation (10), where we introduced a dummy variable to capture the effects brought by the Mercosur customs union, put in place on January 1^{st}, 1995. The dependent variable V_{ijt} is the trade volume that is defined as the sum of the exports and the absolute value of the imports. The Mercosur dummy variable takes the value "1" when j is a Mercosur member country, for t=1997, 1998, and 1999, and "0" otherwise.

$$\begin{aligned} \ln(V_{ijt}) &= \alpha_0 + \beta_1 \ln(gdp_{it}) + \beta_2 \ln(gdp_{jt}) + \beta_3 \ln(dist_{ij}) + \beta_4 border_{ij} + \\ &\quad + \beta_5 Mer\cos ur_{ij} + \beta_6 year97 + \beta_7 year98 + \beta_8 year99 + \varepsilon_{ijt} \end{aligned} \tag{10}$$

where V_{ijt} is the volume of trade (X+|M|) in US$ from country i to country t at time t;

α_0 is the intercept;

gdp_i is state i GRP at time t;

gdp_j is country j GDP (or state j GRP) at time t;

$dist_{ij}$ is the straight line distance between the economic centers of the states (or state and country);

$border_{ij}$ is a dummy variable that is "1" when the trade flow is between two Brazilian states, and "0" otherwise;

ε_{ij} is the error term, that is supposed to be ID(0, σ^2).

Table (1) reports the estimated coefficients.

Variable	Coefficient	t-statistic
lgdpi	1.244	71.39
lgdpj	1.032	100.19
ldistij	-1.254	-31.61
Mercosur	1.335	10.41
border	4.135	54.99
year97	-0.515	-8.24
year98	-0.552	-8.95
year99	-0.559	-8.92
constant	-28.990	-50.98
# of obs.	10,193	
Adjusted R^2	0.6002	
Root MSE	2.1457	

Table1

All the estimated coefficients had the expected signs, and the year-specific dummies reflected the economic downturn that affected Brazil in the late 1990s. The estimated border effect is 4.135 and it means that Brazilian states would be trading among them 62.489 ($e^{4.135}$= 62.489) times more on average than they do with foreign countries. The estimated Mercosur variable coefficient was 1.335 which means that Brazilian states trades on average 3.8 ($e^{1.335}$=3.8) times more with Mercosur member countries than they do with non Mercosur member countries.

3.2 Estimations including zero trade observations

Our complete data set has 50% of its observations taking "zero" value, i. e. zero observed trade flow. There are two model specifications that could cope with the zero trade observations: Wall(2000)'s suggestion of using (1+V_{ijt}) as dependent variable and Tobit-like models.

A pooled cross-section model as in Wall(2000) was estimated through OLS, according to equation (11).

$$\begin{aligned} \ln(1+V_{ijt}) &= \alpha_0 + \beta_1 \ln(gdp_{it}) + \beta_2 \ln(gdp_{jt}) + \beta_3 \ln(dist_{ij}) + \\ &+\beta_4 border_{ij} + \beta_5 Mer\cos ur_{ij} + \beta_6 year97 + \beta_7 year98 + \beta_8 year99 + \varepsilon_{ijt} \end{aligned} \tag{11}$$

where V_{ijt} is the volume of trade (X+|M|) in US$ from country i to country t at time t. The remaining variables keep the same previous definition. The estimated coefficients are reported on table (2).

The border effect is around 3,615 ($e^{8.193}$=3,615.55). The inclusion of the zero trade observations in the regression led to a large increase in the estimated border effect. The Mercosur coefficient found was also large. It means that Brazilian states traded 56 ($e^{4.024}$=55.92) times more with Mercosur member countries than they did with other non Mercosur member countries.

The pooled cross-sections estimates is subject to several criticisms as shown in the Literature Review section. In response to those criticisms Polak(1996) suggested the use of either a relative distance variable or country specific dummy variables. The relative distance alternative does not make sense in our case, because we are not dealing with a world model, so we do not have a way to define a relative distance. The pooled cross-section models could incorporate Polak's second suggestion, that is to include country specific dummy variables. This type of approach was also subsequently recommended by Anderson and van Wincoop (2001), Mátyás(1997), and Cheng and Wall(2002).

Variable	Coefficient	t-statistic
lgdpi	2.447	115.74
lgdpj	1.782	140.92
ldistij	-2.014	-33.89
Mercosur	4.024	18.28
border	8.193	64.94
year97	-0.742	-8.14
year98	-0.882	-9.70
year99	-0.871	-9.61
constant	-72.316	-104.61
# of obs.	21,268	
Adjusted R^2	0.6327	
Root MSE	4.6014	

Table 2

In those lines the next estimated model was a pooled cross-section incorporating the country specific dummy variables. There are many ways to specify the specific state and countries dummy variables. The model proposed by Cheng and Wall(2002) needs, for example, the use of almost 6,000 dummy variables. The problems inherent to the excessive number of dummy variables led us to choose a fixed effects specification similar to Mátyás (1997), i.e. a specific dummy variable for each state, each country, and each year, except for 1991. Despite the loss of generality as compared to a specification of a specific effect for each state/country pair, as proposed by Cheng and Wall (2002), approximately 6,000 degrees of freedom are saved by our choice of specification.

The pooled cross-section model was estimated including the state and country specific dummy variables, as shown by equation (12).

$$\begin{aligned} \ln(1+X_{ijt}) &= \alpha_0+\gamma_i+\theta_j+\beta_1\ln(gdp_{it})+\beta_2\ln(gdp_{jt})+ \\ &+\beta_3\ln(dist_{ij})+\beta_4\ln(redist_{ij})+\beta_5 border_{ij}+ \\ &+\beta_6 Mer\cos ur_{ij}+\beta_6 year97+\beta_7 year98+\beta_8 year99+\varepsilon_{ijt} \end{aligned} \quad (12)$$

α_0 is the intercept;

γ_i is the dummy variable that is "1" when the trade flow involves state i and "0" otherwise;

θ_j is the dummy variable that is "1" when the trade flow involves country j, and "0" otherwise. The definitions of the remaining variables are the same used earlier.

Table (3) and (4) reports the estimated coefficients of the equation (12).

Variable	Coefficient	t-statistic	Coefficient	t-statistic
lgdpi	1.590	10.14	1.603	10.24
lgdpj	0.345	2.35	0.359	2.45
ldistij	-0.545	-4.99	-0.545	-4.99
Mercosur	0.937	1.86		
border	2.928	2.97	3.010	3.06
year97	0.058	0.41	0.062	0.44
year98	-0.074	-0.52	-0.070	-0.50
year99	-0.111	-0.83	-0.107	-0.80
constant	-28.572	-4.05	-29.220	-4.15
# of obs.	21,268		21,268	
Adjusted R^2	0.7205		0.7205	
Root MSE	4.0341		4.0343	
Number of fixed effect dummies		214 (1 dropped)	214 (1 dropped)	
Non significant country dummies (5%)		22	25	

Table 3

At first, the Mercosur coefficient was found not to be statistically significant. It was discarded and the regression was run again. The coefficients are also reported in table (3). The year specific dummies remained not statistically significant. So, we discarded year97 and re-included Mercosur variable, estimating the model again. This regression output is shown in table (4). We opted to exclude year98. After we ran the regression, year99 became statistically insignificant. As a result, year99 was also excluded from the regression. The regression was run and the coefficients are shown in table(4).

The Mercosur coefficient remained not statistically significant in all these regressions. The border effect ($border_{ij}$) estimated was 2.720, what represents a border effect of 15.18 ($e^{2.72}$=15.18). It means that Brazilian states trade among themselves 15.18 times more than with a foreign country, after controlling for the influence of other variables. Table (7) in Appendix B contains the full output of this last regression.

Variable	Coefficient	t-statistic	Coefficient	t-statistic
lgdpi	1.646	18.71	1.553	19.88
lgdpj	0.391	4.36	0.312	3.80
ldistij	-0.546	-5.00	-0.545	-4.99
Mercosur	0.940	1.86	0.928	1.84
border	3.228	4.97	2.720	4.47
year97				
year98	-0.124	-1.66		
year99	-0.158	-2.19		
constant	-30.921	-7.51	-26.949	-7.26
# of obs.	21,268		21,268	
Adjusted R^2	0.7205		0.7205	
Root MSE	4.0340		4.0343	
Number of fixed effect dummies		214 (1 dropped)	214 (1 dropped)	
Non significant country dummies (5%)		21	18	

Table 4

Finally we estimated the Tobit-like models. This econometric specification does not model the reason that make the dependent variable censored. It just extracts from the sample the probability, assuming a normal distribution, of the trade flow been larger than zero. The parameters of the Tobit model are estimated by the maximum likelihood method, under the crucial assumption that the errors terms are homocedastic and normally distributed.

Accordingly, we employed a Tobit model as depicted in (13) to re-estimate the equation, where the variables have the same meaning as the ones used in (12).

$$\begin{aligned} y_t^* &= \ln(V_{ijt}) = \alpha_o + \gamma_i + \theta_j + \beta_1 \ln(gdp_{it}) + \beta_2 \ln(gdp_{jt}) + \\ &+\beta_3 \ln(dist_{ij}) + \beta_4 \ln(redist_{ij}) + \beta_5 border_{ij} + \beta_6 Mer\cos ur_{ij} + \\ &+\beta_6 year97 + \beta_7 year98 + \beta_8 year99 + \varepsilon_{ijt} \\ y_t &= y_t^* \; if \;\; y_t^* > 0; \, y_t = 0 \text{ otherwise} \end{aligned} \tag{13}$$

The estimated coefficients of the model (13) are shown in table (5). The coefficients of Mercosur variable was not statistically significant again. We then re-estimated the same Tobit model excluding the Mercosur dummy. This regression output is also shown in table (5).

Variable	Coefficient	t-statistic	Coefficient	t-statistic
lgdpi	4.488	32.29	4.629	35.78
lgdpj	3.287	10.72	3.371	10.92
ldistij	-1.271	-2.81	-1.253	-2.80
lredistij	-0.988	-3.25	-1.06	-3.44
Mercosur	0.326	0.20		
border	14.48	15.49	12.296	25.88
year97	-1.24	-7.06	-1.338	-7.79
year98	-1.463	-8.41	-1.559	-9.16
year99	-1.49	-8.55	-1.581	-9.24
constant	-166.86	-14.01	-171.982	-14.58
# of obs.	21,268		21,268	
Pseudo R^2	0.2358		0.2357	
LR χ^2	23385.31		23377.19	
Log likelihood	-37889.063		-37560.952	
Ancilliary parameter (se)		6.306 (0.0485)	6.308 (0.0485)	
Number of fixed effect dummies		215	215	
Non significant f.e. dummies		63	63	

Table 5

To save space, the state and country specific dummy variable coefficients were not reported in this section. A complete table of estimated coefficients is available at table (8) in Appendix B.

Even though all the estimated coefficients, except some of the specific state and country dummy coefficients, are significantly different from zero and show the right expected sign. Remember that the estimated coefficients of a Tobit model cannot be directly interpreted as elasticities, like in the OLS double log specification.

Note that the elasticities are given by the following equation (14). Where $\mathbf{z}$ is the vector of independent variables, $\boldsymbol{\beta}$ is the vector of estimated coefficients, se is the ancillary parameter, and Φ is the normal distribution function.

$$\frac{\partial E(y \mid \mathbf{z})}{\partial z_j} = \Phi(\frac{\mathbf{z}\boldsymbol{\beta}}{se})\beta_j \tag{14}$$

The term $\Phi(\frac{\mathbf{z}\hat{\boldsymbol{\beta}}}{se})$ is called the estimated scale factor[4] for a given $\mathbf{z}$. The scale factor is a real number between 0 and 1 This factor can also be interpreted as the estimated probability of observing a positive response given $\mathbf{z}$. The estimation of the elasticities of dummy variables can be performed by the difference in $E(y \mid \mathbf{z})$ at different values of $\mathbf{z}$.

The estimated scale factor for a trade flow between São Paulo state, or Rio de Janeiro state, and Argentina is 0.9999 for 1991, 1997, 1998, and 1999. The estimated scale factor for a trade flow between Acre state and United Sates for 1991 is 0.9744, but for the trade flow between Acre state and Tonga for 1999 is 0.0002. In terms of inter states trade flows, the estimated scale factor for trade between Rio de Janeiro and São Paulo states is 1.

In particular to the case where the scale factor is approximately 1, the estimated border effect coefficient implies that inter state trade is larger than international trade by the order of

[4]For more information on the scale factor, refer to Wooldridge (2001), chpater 16 p. 523.

hundreds of thousands ($e^{12.218}$=218,819). The estimated coefficients for the GDP variables are also significantly larger than the ones usually found in the literature and are the largest among our estimations.

These contrasting estimates of the border effect indicate that the right treatment of zero trade observations actually is the main issue underlying the judgement of the usefulness of the gravity equation to predict and evaluate the border effects under its usual interpretation as conventional in the literature. Our experiments with Brazilian data show that the established range of estimated border effects for a number of other studies based on data mainly from developed countries do not replicate unless the zero trade observations are eliminated.

Another controversial issue is the estimated Mercosur variable coefficient size and statistical significance. In the pooled-cross section model without state and country specific dummy variable, the Mercosur coefficient is positive, varying in a range from 1.335 to 4.024, and statistically significant. But when state and country specific dummy variables are included, the Mercosur coefficient turns out to be statistically insignificant. Both facts are corroborated by the previous literature. The first one finds support in Porto(2002), and the second one in Krueger(1999) and Azevedo(2002). After all, the effects of the Mercosur trade arrangement are also highly dependent on the econometric specification.

4 Conclusions

The usage of the gravity equation applied to the International Trade field to assess the border effect has been the target of a lot of research, specially after McCallum's seminal paper. This research encompassed the microeconomic foundations of the gravity equation and its econometric specifications.

In this paper, the Brazilian border effect was estimated using pooled cross-section and Tobit models, discarding and taking into account the zero trade observations and including specific effect dummies to control for heterogeneity bias. The estimated impact of the Mercosur on intra-bloc trade volume is dubious. In models without state and country specific dummy variables it was positive and statistically significant, but when these specific dummies are included the coefficient remains positive but turns out to be statistically insignificant. Both results are corroborated by the previous empirical findings in the literature. The estimated national border effect always had the expected positive sign but only had a meaningful size as compared to the range commonly found in the literature when the zero trade observations were eliminated from the data sample. When the full sample was employed, the size of the estimated border effect was too large as a comparable measure.

The current state of research about the gravity equation does not provide a definitive explanation for this result. Nevertheless it seems clear that it is necessary to qualify the conventional border effect in two fronts. The first front would be the modelling of the probability of observing strictly positive trade flows in any data set, what could be accomplished for example by sample selection models or two-part models like the one in Cragg(1971).

The second front would be in the lines of the analysis of the trade flows disaggregated by industries, as it is done by Hillberry(2001). That could clarify the links between the border effect and the real hidden costs of trading or to the endogenous firm location problem. When the location decision of the firm is endogenous, they will choose to locate their plants in order to minimize border-crossing costs. The trade flow will then be smaller than predicted by the gravity equation, attributing to the intra-national trade-flow dummy this apparent lack of trading.

5 Appendix

5.1 Data Set

The data set covers the years of 1991, 1997, 1998, and 1999. These years were chosen because the inter-state trade flow matrices exist only for them. The sample is composed by twenty-five (of twenty-six) Brazilian states plus the Federal District (Distrito Federal) and by 192 countries, representing at least 96.84% of World GDP. The countries, other than Brazil, were selected on the basis of availability of GDP data. All dollar values were inflated by PPI Index, by US Bureau of Labor Statistics to be valued in 1999 US dollars.

The Mercosur (Southern Common Market) formation coincides with the 'boom' of the new generation of Preferential Trade Agreements (PTAs). Created in March 1991 by the treaty of Asuncion, its ultimate goal is to form a common market among Argentina, Brazil, Paraguay and Uruguay by 2006. It will comprise the free circulation of all goods, services, labour and capital, the adoption of a common trade policy towards non-members and the coordination of macroeconomic and sectorial policies in many areas.

Table (6) depicts the total number of observation, including the zero trade observation, that accounted for a little bit more than the half of the observations.

Observations	Year				Total
	1991	1997	1998	1999	
Non Zero	2307	2676	2624	2586	10193
Zero	3010	2641	2693	2731	11075
Total	5317	5317	5317	5317	21268

Table 6

The trade flow data between Brazilian states and foreign countries were obtained through AliceWeb system from SECEX(2002). The methodology of this collection of data is available in MDIC(2003). The Gross Domestic Product (GDP), population, and surface area data of the countries were collected mainly at 2001 World Development Indicators CD-ROM from World Bank(2001).

There is no GDP data for Brazilian states, but GRP was used as a proxy of it. The Brazilian states' Gross Regional Product (GRP) series in local currency units, surface area and population were supplied by IBGE-Instituto Brasileiro de Geografia e Estatística (Brazilian Institute of Geography and Statistics).

The exchange rate used to convert the states' GRP from local currency to current US$ is the same rate employed to convert Brazilian GDP from local currency to current US$.

The distances between a state and a country (or a state) were calculated as the length of a straight line connecting the state's (country's) economic center. The length of the straight line were calculated using the geographic coordinates (latitude and longitude) and it takes into account the earth's curvature. The formula of this calculation was obtained at aondefica.com(2003).

The points chosen as representative of the Brazilian states economic center is the respective state capital. These geographic coordinates were supplied by www.aondefica.com. For the foreign countries, it was chosen as the economic center the geographic center of the country.

5.2 Estimated Models Output

The dummy variable for Acre was omitted to avoid multicollinearity. Table (7) reports the estimated coefficients of model (12), without the year specific dummy variables.

Variable	Coefficients	p-value	Variable	Coefficients	p-value	Variable	Coefficients	p-value	Variable	Coefficients	p-value
lgdpi	1.5536	0.000	Botswana	-11.1366	0.000	Guinea	-9.1239	0.000	Panama	-2.7291	0.000
lgdpj	0.3121	0.000	Brunei	-11.6135	0.000	Equatorial Guinea	-10.7814	0.000	Papua New Guinea	-10.5026	0.000
ldistij	-0.5453	0.000	Bulgaria	-6.9941	0.000	Guinea-Bissau	-11.2041	0.000	Pakistan	-4.0930	0.000
Mercosur	0.9289	0.066	Burkina Faso	-9.4836	0.000	Haiti	-7.2291	0.000	Paraguay	-0.5910	0.455
border	2.7205	0.000	Burundi	-11.6274	0.000	Honduras	-6.3327	0.000	Peru	-2.5222	0.000
Alagoas	1.0188	0.000	Bhutan	-11.2490	0.000	Hong Kong, China	-0.2256	0.684	French Polynesia	-9.9277	0.000
Amapa	1.2964	0.000	Cape Verde	-7.6986	0.000	Hungary	-4.3890	0.000	Poland	-3.2442	0.000
Amazonas	1.7578	0.000	Cameroon	-7.1329	0.000	Yemen, Rep.	-8.2717	0.000	Puerto Rico	-2.8761	0.000
Bahia	1.7839	0.000	Cambodia	-10.8289	0.000	India	-1.3835	0.012	Portugal	0.6990	0.143
Ceará	2.0402	0.000	Canada	1.2800	0.007	Indonesia	-1.6778	0.004	Kenya	-7.7089	0.000
Distrito Federal	-1.4085	0.000	Qatar	-8.3469	0.000	Iran, Islamic Rep.	-3.9568	0.000	Kyrgyz Republic	-11.1123	0.000
Espirito Santo	3.5636	0.000	Kazakhstan	-10.2156	0.000	Ireland	-2.6655	0.000	United Kingdom	0.8748	0.076
Goias	0.8452	0.003	Chad	-10.6815	0.000	Iceland	-8.3418	0.000	Central African Republic	-9.9629	0.000
Maranhão	0.3987	0.104	Chile	-0.3688	0.487	Israel	-1.1531	0.029	Dominican Republic	-3.5694	0.000
Mato Grosso	1.1541	0.000	China	-0.5133	0.377	Italy	2.1409	0.000	Reuniao	-10.0377	0.000
Mato Grosso do Sul	0.1858	0.458	Cyprus	-6.5651	0.000	Yugoslavia, FR (Serbia/Montenegro)	-8.4593	0.000	Romania	-5.6314	0.000
Minas Gerais	2.9511	0.000	Singapore	-2.6924	0.000	Jamaica	-6.1694	0.000	Rwanda	-11.3083	0.000
Pará	2.0652	0.000	Colombia	-2.0485	0.000	Japan	2.4459	0.000	Russian Federation	-1.5168	0.013
Paraíba	0.6800	0.005	Comoros	-10.5500	0.000	Jordan	-7.7306	0.000	Saint Kitts e Nevis	-11.7462	0.000
Paraná	4.3443	0.000	Congo, Rep.	-9.5636	0.000	Kiribati	-10.7871	0.000	Solomon Islands	-11.0216	0.000
Pernambuco	1.1198	0.000	Congo, Dem. Rep.	-9.6906	0.000	Lao PDR	-11.7004	0.000	Samoa	-8.1693	0.000
Piauí	0.4615	0.027	Cook, Ilhas	-10.7167	0.000	Lesotho	-11.9028	0.000	St. Lucia	-11.5133	0.000
Rio de Janeiro	2.9836	0.000	Korea, Rep.	0.4806	0.359	Latvia	-6.8503	0.000	Sao Tome and Principe	-10.6139	0.000
Rio Grande do Norte	0.9441	0.000	Korea, Dem. Rep.	-3.7958	0.000	Lebanon	-4.0745	0.000	St. Vincent and the Grenadines	-8.8269	0.000
Rio Grande do Sul	4.5222	0.000	Cote d'Ivoire	-6.0084	0.000	Lithuania	-8.2214	0.000	Senegal	-6.7769	0.000
Rondônia	0.2878	0.170	Costa Rica	-4.4782	0.000	Luxembourg	-7.8248	0.000	Sierra Leone	-10.3032	0.000
Roraima	0.1361	0.531	Kuwait	-7.9278	0.000	Macao, China	-9.5152	0.000	Seychelles	-9.8631	0.000
Santa Catarina	5.0849	0.000	Croatia	-7.2917	0.000	Macedonia, FYR	-10.3381	0.000	Syrian Arab Republic	-6.0657	0.000
São Paulo	5.2241	0.000	Cuba	-6.0775	0.000	Madagascar	-9.3370	0.000	Sri Lanka	-6.9527	0.000
Sergipe	-0.1520	0.501	Denmark	-1.8435	0.001	Malaysia	-1.1595	0.041	Swaziland	-10.5390	0.000
South Africa	-1.8296	0.001	Djibouti	-9.1873	0.000	Malawi	-10.2662	0.000	Sudan	-9.4456	0.000
Albania	-10.9968	0.000	Dominica	-8.2198	0.000	Maldives	-10.7164	0.000	Sweden	-0.4940	0.302
Germany	1.9344	0.000	Egypt, Arab Rep.	-3.1292	0.000	Mali	-8.3792	0.000	Switzerland	0.8823	0.056
Andorra	-11.4357	0.000	El Salvador	-6.9992	0.000	Malta	-8.0052	0.000	Suriname	-6.5057	0.000
Angola	-4.2256	0.000	United Arab Emirates	-4.6651	0.000	Morocco	-4.7635	0.000	Tajikistan	-11.0161	0.000
Anguilla	-10.1884	0.000	Ecuador	-4.2076	0.000	Marshall Islands	-10.5489	0.000	Thailand	-1.4433	0.012
Antigua and Barbuda	-8.7722	0.000	Slovak Republic	-6.5741	0.000	Martinica	-6.5061	0.000	Taiwan	0.5164	0.286
Netherlands Antilles	-4.2343	0.000	Slovenia	-5.9716	0.000	Mauritius	-9.2218	0.000	Tanzania	-9.0330	0.000
Saudi Arabia	-4.2030	0.000	Spain	1.3328	0.005	Mauritania	-9.8596	0.000	Czech Republic	-3.0433	0.000
Algeria	-6.1871	0.000	United States	3.5068	0.000	Mexico	-11.5283	0.000	Togo	-8.3462	0.000
Argentina	1.8291	0.003	Estonia	-8.7474	0.000	Myanmar	(dropped)		Tonga	-11.0336	0.000
Armenia	-9.8059	0.000	Ethiopia	-10.8074	0.000	Micronesia, Fed. Sts.	-11.0697	0.000	Trinidad and Tobago	-4.1075	0.000
Aruba	-7.7905	0.000	Faeroe Islands	-11.0586	0.000	Mozambique	-9.5405	0.000	Tunisia	-4.9904	0.000
Australia	-1.4380	0.004	Fiji	-10.2622	0.000	Moldova	-10.9938	0.000	Turkmenistan	-10.1037	0.000
Austria	-2.4544	0.000	Philippines	-3.8874	0.000	Monaco	-9.5915	0.000	Turkey	-2.4985	0.000
Azerbaijan	-10.5572	0.000	Finland	-1.1191	0.032	Mongolia	-11.2833	0.000	Ukraine	-5.2801	0.000
Bahrain	-7.6505	0.000	France	1.5675	0.000	Namibia	-10.8188	0.000	Uganda	-10.9666	0.000
Bangladesh	-6.9262	0.000	Gabon	-9.9429	0.000	Nepal	-10.6897	0.000	Uruguay	-0.0163	0.982
Barbados	-7.6334	0.000	Gambia, The	-7.6917	0.000	Nicaragua	-8.3168	0.000	Uzbekistan	-7.1542	0.000
Belarus	-8.6906	0.000	Ghana	-7.3247	0.000	Niger	-11.5288	0.000	Vanuatu	-10.8128	0.000
Belgium	1.7543	0.000	Georgia	-8.7959	0.000	Nigeria	-4.2371	0.000	Venezuela, RB	0.4345	0.439
Belize	-9.5308	0.000	Grenada	-9.1073	0.000	Norway	-1.9732	0.001	Vietnam	-6.8507	0.000
Benin	-6.7838	0.000	Greece	-3.6436	0.000	New Caledonia	-10.0343	0.000	Zambia	-10.4039	0.000
Bermuda	-9.5204	0.000	Guatemala	-4.8490	0.000	New Zealand	-5.2026	0.000	Zimbabwe	-7.5648	0.000
Bolivia	-0.8383	0.190	Guyana	-8.1985	0.000	Oman	-8.8588	0.000	_cons	-26.9493	0.000
Bosnia and Herzegovina	-11.0817	0.000	French Guiana	-6.8725	0.000	Netherlands	1.9740	0.000			

Table 7

Table (8) shows the estimated coefficients of the Tobit model (13) without the Mercosur variable.

Variable	Coeficient	p-value	Variable	Coeficient	p-value	Variable	Coeficient	p-value	Variable	Coeficient	p-value
lgdpi	4.62989	0.00000	Bolivia	8.24641	0.00000	Guyana	2.31202	0.00800	Oman	-3.40678	0.00000
lgdpj	3.37134	0.00000	Bosnia and Herzegovina	-7.41312	0.00000	French Guyana	5.00867	0.00000	Netherlands	5.51087	0.00000
ldistij	-1.25305	0.00600	Botswana	-7.95206	0.00000	Guinea	-2.15986	0.01300	Panama	6.64412	0.00000
border	12.29673	0.00000	Brunei	-11.31795	0.00000	Equatorial Guinea	-4.38616	0.00000	Papua New Guinea	-5.82933	0.00000
year97	-1.33824	0.00000	Bulgaria	0.55379	0.48600	Guinea-Bissau	-5.26916	0.00000	Pakistan	2.63781	0.00000
year98	-1.55969	0.00000	Burkina Faso	-2.31459	0.01000	Haiti	1.39336	0.08600	Paraguay	0.71767	0.46600
year99	-1.58193	0.00000	Burundi	-10.89683	0.00000	Honduras	2.79923	0.00000	Peru	1.26518	0.19100
Alagoas	1.46921	0.00000	Bhutan	-10.15916	0.00000	Hong Kong, China	6.02389	0.00000	French Polynesia	1.77055	0.04800
Amapa	3.87745	0.00000	Cape Verde	3.87217	0.00000	Hungary	1.88793	0.01300	Poland	1.45634	0.05400
Amazonas	0.78081	0.06300	Cameroon	0.18059	0.82100	Yemen, Rep.	-0.71982	0.39700	Puerto Rico	2.98130	0.00000
Bahia	-0.71097	0.13300	Cambodia	-6.69679	0.00000	India	2.42252	0.00200	Portugal	6.50002	0.00000
Ceará	1.00956	0.02100	Canada	4.11972	0.00000	Indonesia	4.26509	0.00000	Kenya	-0.61592	0.45200
Distrito Federal	-4.92565	0.00000	Qatar	-1.76399	0.03900	Iran, Islamic Rep.	1.05135	0.17000	Kyrgyz Republic	-7.28847	0.00000
Espirito Santo	3.69234	0.00000	Kazakhstan	-6.70694	0.00000	Ireland	3.30382	0.00000	United Kingdom	1.80641	0.01900
Goias	-0.57914	0.18300	Chad	2.76559	0.06400	Iceland	-1.20168	0.14900	Central African Republic	-2.09252	0.03100
Maranhão	0.11187	0.78600	Chile	5.02310	0.00000	Israel	4.98422	0.00000	Dominican Republic	4.50052	0.00000
Mato Grosso	1.11012	0.00700	China	2.26221	0.00400	Italy	3.53401	0.00000	Reuniao	-4.12093	0.00000
Mato Grosso do Sul	-0.94390	0.02200	Cyprus	1.97946	0.01200	Yugoslavia, FR (Serbia/Montenegro)	-2.34520	0.00500	Romania	-2.09898	0.01800
Minas Gerais	-0.97855	0.06800	Singapore	4.14146	0.00000	Jamaica	2.23924	0.00400	Rwanda	1.61060	0.05200
Pará	2.86385	0.00000	Colombia	2.66578	0.00000	Japan	2.50585	0.00200	Russian Federation	2.12716	0.00600
Paraíba	0.46357	0.27200	Comoros	-2.50706	0.04000	Jordan	0.01596	0.98500	Saint Kitts e Nevis	-7.53854	0.00000
Paraná	2.31734	0.00000	Congo, Rep.	-2.17236	0.01700	Kiribati	-39.95967	.	Solomon Islands	0.55341	0.48900
Pernambuco	-0.42951	0.34500	Congo, Dem. Rep.	-4.17530	0.00000	Lao PDR	-15.45978	0.00000	Samoa	-6.95983	0.00000
Piauí	0.15179	0.71800	Cook, Ilhas	-4.18867	0.01000	Lesotho	-13.90812	0.00000	St. Lucia	-3.08164	0.00000
Rio de Janeiro	-0.68544	0.21300	Korea, Rep.	4.91789	0.00000	Latvia	1.71320	0.03200	Sao Tome and Principe	2.34770	0.01100
Rio Grande do Norte	1.08540	0.01000	Korea, Dem. Rep.	5.09005	0.00000	Lebanon	5.08597	0.00000	St. Vincent and the Grenadines	1.54444	0.05400
Rio Grande do Sul	2.29652	0.00000	Cote d'Ivoire	1.36360	0.08100	Lithuania	-1.59260	0.05500	Senegal	0.66874	0.39800
Rondônia	0.55858	0.18600	Costa Rica	3.63607	0.00000	Luxembourg	-1.69419	0.03700	Sierra Leone	-0.90812	0.38600
Roraima	-3.77179	0.00000	Kuwait	-2.48066	0.00300	Macao, China	-2.63203	0.00500	Seychelles	1.62487	0.03600
Santa Catarina	5.38557	0.00000	Croatia	-1.09596	0.17000	Macedonia, FYR	-4.78084	0.00000	Syrian Arab Republic	0.90500	0.26000
São Paulo	-0.83947	0.21300	Cuba	0.40285	0.60400	Madagascar	-2.12383	0.01900	Sri Lanka	-4.48515	0.00000
Sergipe	-1.56924	0.00000	Denmark	2.89937	0.00000	Malaysia	6.26765	0.00000	Swaziland	-4.10959	0.00000
South Africa	2.91112	0.00000	Djibouti	-0.45503	0.74100	Malawi	-4.29906	0.00000	Sudan	5.16482	0.00000
Albania	-6.78801	0.00000	Dominica	4.13443	0.00000	Maldives	-4.04360	0.00200	Sweden	5.00650	0.00000
Germany	2.04436	0.00900	Egypt, Arab Rep.	2.88204	0.00000	Mali	0.09830	0.90800	Switzerland	-6.26806	0.00000
Andorra	7.86883	0.00100	El Salvador	0.04013	0.96000	Malta	0.96846	0.24300	Suriname	4.86876	0.00000
Angola	5.05178	0.00000	United Arab Emirates	1.80041	0.01900	Morocco	2.28950	0.04700	Tajikistan	5.89659	0.00000
Anguilla	0.81541	0.46100	Ecuador	2.85223	0.00000	Marshall Islands	-3.60156	0.02400	Thailand	-2.70887	0.00200
Antigua and Barbuda	1.54610	0.08400	Slovak Republic	0.73511	0.34400	Martinica	2.96419	0.00000	Taiwan	3.95300	0.00000
Netherlands Antilles	7.37326	0.00000	Slovenia	1.38945	0.07200	Mauritius	2.36802	0.03100	Tanzania	0.79237	0.36100
Saudi Arabia	0.00718	0.99300	Spain	3.68316	0.00000	Mauritania	-2.04271	0.03200	Czech Republic	-6.49084	0.00000
Algeria	-1.40355	0.07300	United States	2.28316	0.07600	Mexico	2.94208	0.00000	Togo	4.59696	0.00000
Argentina	5.27435	0.00000	Estonia	-1.23444	0.15000	Myanmar	-10.60311	0.00000	Tonga	2.60032	0.00100
Armenia	-2.35811	0.01400	Ethiopia	-7.26679	0.00000	Micronesia, Fed. Sts.	-7.82276	0.00000	Trinidad and Tobago	-3.28543	0.00100
Aruba	1.64923	0.05100	Faeroe Islands	-5.35262	0.00000	Mozambique	-0.45300	0.65800	Tunisia	1.95100	0.01000
Australia	2.73691	0.00000	Fiji	-3.60267	0.00100	Moldova	-5.77237	0.00000	Turkmenistan	0.51360	0.50300
Austria	1.67826	0.02600	Philippines	3.01111	0.00000	Monaco	0.23019	0.81100	Turkey	-7.88353	0.00000
Azerbaijan	-5.63043	0.00000	Finland	4.52613	0.00000	Mongolia	-8.62051	0.00000	Ukraine	-0.21497	0.78800
Bahrain	2.74937	0.09600	France	2.47734	0.00100	Namibia	-6.40488	0.00000	Uganda	8.04200	0.00000
Bangladesh	-1.19275	0.14100	Gabon	-4.09336	0.00000	Nepal	-5.90596	0.00000	Uruguay	-5.10159	0.00100
Barbados	1.25549	0.13300	Gambia, The	4.22050	0.00000	Nicaragua	0.45937	0.59100	Uzbekistan	5.46752	0.00000
Belarus	-3.96026	0.00000	Ghana	-0.03751	0.96300	Niger	-9.47769	0.00000	Vanuatu	0.11759	0.88600
Belgium	6.32176	0.00000	Georgia	-0.83693	0.33800	Nigeria	2.07983	0.00600	Venezuela, RB	-5.38055	0.00000
Belize	-0.15890	0.86600	Grenada	1.12466	0.35200	Norway	3.03847	0.00000	Vietnam	0.17425	0.83000
Benin	3.19163	0.00000	Greece	1.12799	0.13500	New Caledonia	-3.63143	0.00000	Zambia	0.331	0.398
Bermuda	-2.01055	0.02700	Guatemala	2.71586	0.00000	New Zealand	1.03497	0.17800	Constant	-171.9822	0

Table 8

6 References

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