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Border Effects of Brazilian States

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NON-TECHNICAL SUMMARY

The question of domestic market integration in Brazil is particularly relevant because of large regional disparities between the North and the South. There is a growing consensus among the Brazilian political parties that addressing regional inequalities and national fragmentation is a major challenge and a priority for Brazil. Brazilian governments have tried to fight these inequalities by promoting economic zones in marginalized regions.

The aim of this paper is to estimate the degree of trade integration among Brazilian states and calculate the magnitude of the Brazilian states' engagement in international trade in the years 1991, 1997, 1998 and 1999 using the methodology of border effects. This literature has shown the negative influence of borders in the international trade. Due to the existence of such borders, the trade flows between countries stay at a lower level than the intra-national trade. A number of recent studies have also found rather large internal fragmentation within countries.

Our database includes 26 Brazilian states and 164 foreign countries and contains, for each year (1991, 1997, 1998 and 1999), 26 intra-state trade flows, 650 inter-state flows, and 4264 international export flows. Trade flows between Brazilian states are calculated from the information on the ICMS (*Imposto sobre Circulação de Mercadorias e Serviços*) tax that is applied to interstate trade. The international trade flows data are provided by the Foreign Trade Secretariat of the Brazilian Ministry of Development. We estimate a gravity type equation using different econometric specifications, including the Poisson Maximum Likelihood method in order to include the zero trade flows.

Results show that the Brazilian market is rather highly fragmented but less than the Chinese market. Brazilian sub-national borders reduced interstate trade by a factor of 23 in 1991 and a factor of 13 in 1999, indicating an ongoing process of domestic integration. International trade integration of Brazilian states increased over the period 1991-1999 in conjunction with the strategy of outward orientation. In 1991, a Brazilian state traded 390 times more with itself than with a foreign country and, in 1999, it traded 280 times more with itself than with a foreign country, all things being equal. In other words, Brazilian states traded 27 times more with each other than with foreign countries in 1999.

Border effects differ greatly across Brazilian states: internal and international trade integration is low for North and Amazonian Regions (with the exception of the State Amazonas) and high for Southern regions, the most domestically integrated states

being also the most engaged in international trade. The better internal and international trade integration of the State Amazonas is probably due to its capital, Manaus, free zone created in 1967 and based on tax incentives to economic production. Since the 60s, the Brazilian Federal Government has promoted the economic development of this empty state for strategic and political reasons. The relatively good economic insertion of the state of Amazonas indicates that it is possible to reduce regional inequalities and economic marginalization by active government policies.

Abstract

We estimate the degree of trade integration among Brazilian states and calculate the magnitude of the Brazilian states' engagement in international trade in the years 1991, 1997, 1998 and 1999 using the methodology of border effects. We show that the Brazilian market is rather highly fragmented but less than the Chinese market. Brazilian sub-national borders reduced interstate trade by a factor of 23 in 1991 and a factor of 13 in 1999, indicating an ongoing process of domestic integration. International trade integration of Brazilian states increased over the period 1991-1999 in conjunction with the strategy of outward orientation. Border effects differ greatly among Brazilian states: internal and international trade integration is low for Northern Regions (with the exception of Amazonas State) and high for Southern regions, the most domestically integrated states being also those most engaged in international trade.

JEL Classification: F14, F15
Keywords: Border effects, Brazil, International trade, domestic integration

RÉSUMÉ NON-TECHNIQUE

Le Brésil affiche de fortes inégalités régionales entre les Etats riches et développés du Sud et ceux très pauvres du Nord et de l'Amazonie. Ces inégalités, qui sont à l'origine de fortes migrations intérieures, poussent les gouvernements brésiliens à pratiquer des politiques de développement volontaristes afin de mieux intégrer sur le plan national et international les régions marginalisées.

Ce travail analyse l'intégration commerciale des Etats brésiliens, entre eux et à l'international, à l'aide de la méthodologie des effets frontières qui mesure l' impact (négatif) des frontières sur les flux de commerce qui les traversent. Cette littérature compare les échanges bilatéraux aux échanges prenant place à l'intérieur d'un territoire supposé parfaitement intégré tel qu'une nation ou une région d'un pays. Les études sur les effets frontières internes aux pays ont porté sur quelques pays seulement, notamment développés, en raison de la rareté des données de commerce intranational. Elles mettent en évidence une fragmentation interne plus ou moins importante selon les pays.

Notre base de données inclut les exportations de chacun des 26 Etats brésiliens vers les autres Etats et vers 164 pays étrangers, pour les années 1991, 1997, 1998 et 1999. L'information sur les échanges extérieurs des Etats brésiliens provient du ministère du commerce extérieur brésilien. Les données sur les flux commerciaux interétatiques ont été calculées par le ministère des finances brésilien à partir de l'ICMS, une taxe sur la valeur ajoutée s'appliquant aux échanges entre Etats.

Nos estimations, de type gravitaire, montrent qu'en 1999 un Etat brésilien commerce en moyenne 13 fois plus avec lui-même qu'avec un autre Etat brésilien, alors qu'en 1991 ce chiffre était de 23. L'équivalent tarifaire de ces effets frontières est de 68% en 1991 et de 51% en 1999 (si l'on suppose une élasticité de substitution de 7). Ceci suggère un niveau de fragmentation du territoire brésilien plus important que dans les pays développés mais moindre qu'en Chine. De plus, la baisse de l'effet frontière intérieur entre 1991 et 1999 met en évidence un processus d'intégration du marché brésilien. L'intégration des Etats brésiliens au commerce international s'est améliorée entre 1991 et 1999 suite à la politique d'ouverture commerciale mise en oeuvre depuis le début des années 90. Les estimations de l'effet frontière international montrent qu'en 1999 un Etat brésilien commerce en moyenne 280 fois plus avec lui-même qu'avec l'étranger.

Le calcul des effets frontières par Etat brésilien souligne la forte hétérogénéité du Brésil en termes d'intégration commerciale interne et externe : en moyenne, un Etat d'Amazonie commerce environ 70 fois plus avec lui-même qu'avec un autre Etat

brésilien, alors que l'Etat de São Paulo aurait un effet frontière intérieur négatif, exportant plus vers un autre Etat que vers lui-même. Néanmoins, un résultat intéressant concerne l'Etat de l'Amazonas qui présente des effets frontières, interne et international, largement inférieurs à ceux des autres Etats d'Amazonie et comparables à ceux des Etats développés du Sud. Ceci s'explique par la zone franche de Manaus : depuis la fin des années 60 le gouvernement fédéral participe à la mise en place dans la capitale de cet Etat d'un pôle industriel en soutenant le développement d'activités à haute valeur ajoutée (produits informatiques, électroniques etc.) à l'aide notamment d'une politique d'exemption fiscale et d'investissement technologique.

Résumé court

Nous mesurons le degré d'intégration du marché intérieur brésilien ainsi que le degré d'insertion des Etats brésiliens au commerce mondial pour les années 1991, 1997, 1998 et 1999 à l'aide de la méthodologie des effets frontière. Les résultats révèlent un niveau de fragmentation du territoire brésilien certes plus important que dans les pays développés mais moindre qu'en Chine. L'insertion des Etats brésiliens au commerce mondial est plutôt faible. Néanmoins, elle s'est améliorée entre 1991 et 1999, parallèlement à une importante politique d'ouverture commerciale mise en oeuvre depuis le début des années 1990. Enfin, le calcul des effets frontières par Etat brésilien souligne la forte hétérogénéité du Brésil en termes d'ouverture commerciale interne et externe.

Classification *JEL* : F14, F15
Mots-clé : Effets frontières, Brésil, commerce international, intégration du marché intérieur

Border Effects of Brazilian States[1]

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1 Introduction

After being elected president in 2002, Luiz Inácio Lula da Silva stated that efforts to combat regional and income inequalities and hunger would be one of his priorities. His government created a Cabinet for Food Security and the social *Bolsa Família* program[4] to establish the Right to Food. However much still needs to be done to reduce inequality and to achieve a better territorial balance. There is a growing consensus among the Brazilian political parties that addressing regional inequalities that expose the country to the risk of fragmentation is a major challenge and a priority for Brazil.

In Brazil, poverty is linked to racial groups and geographic location, with the North and Northeast being the poorest regions. Income disparities among Brazilian regions are substantial and are partly inherited from the historical past and the continental dimensions of the country. For example, *per capita* GDP of the Southeast region is more than three times that of the North. These regional disparities explain the important domestic migrations from Amazonia and Nordeste to São Paulo. Brazilian governments have tried to reduce these inequalities by promoting economic zones in the poorest regions and by improving their insertion into the domestic market. Since the 60s, Brazilian Federal Government has promoted the economic development of Amazonia. The Manaus Free Trade Zone (duty free zone) was created in 1967, based on tax incentives to economic production in order to balance the local unfavorable conditions of Amazonian region. The objective was also to promote the development of international trade and industries of high added value and intensive capital and technology goods (electronic products, chemicals, motorcycles, telecom and office equipments...). Manaus's free trade zone has today over 500 companies and generates

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[4]Bolsa Família (Family Stipend) gives financial aid to poor Brazilian families provided that the children of the family attend school and are vaccinated. The program aims to reduce poverty in the poorest regions of the country by providing cash transfers to families and by increasing human capital.

in average 13.7 billion US dollars a year in production.

Yet, many states in the Northern region are still marginalized and isolated from the rest of Brazil and the domestic market remains to be conquered. As Furtado (1998) explains, economies of Brazilian regions have never really been articulated to each other: since the beginning, Brazilian states have developed isolated from each other, which may have led to large domestic fragmentation and large regional inequality.[5] Federalism could be another explanation for domestic market fragmentation since sub-national jurisdictions can impose restrictions to the movement of goods from one region to another. According to Tanzi (2004), many federal or decentralized countries such as China, Russia, India and Brazil have a fragmented national market. For instance, in India, customs have been set up between states. Poncet (2005) shows that the decentralization process launched in China in 1980 is one of the reasons for Chinese domestic market disintegration. The Brazilian states enjoy significant autonomy with respect to taxation and law making. Thus, the political sub-national borders in Brazil may act as trade barriers, generating additional trade costs for interstate trade by creating administrative, legal and fiscal heterogeneity among states. This is likely to cause an internal border effect, *i.e.* a negative impact of sub-national borders on trade volumes between Brazilian states. For example, taxes are imposed by the 3 tiers of government (federal, state and municipal). The ICMS (*Imposto sobre Circulação de Mercadorias e Serviços*) is a Brazilian tax applied to interstate and intrastate trade of goods and services. The rate of ICMS for intrastate trade is set separately by each state while that for interstate trade is set by the Federal government. The intrastate rates are in general higher than the interstate rates, but there are special rates for some products and the rate concerning a particular product varies among states. According to Gonçalves de Mendonça (2004) or Varsano (1999), lack of uniformity in the ICMS tax, in tax rules, rates and legal norms among the Brazilian states leads to a very complex and burdensome administration for traders in Brazil, which makes it expensive and difficult to move products from one Brazilian state to another. This raises the question of the links between domestic integration and the federal system. Lack of transport infrastructure between regions of Brazil is also often thought as contributing to the domestic market fragmentation and marginalization of Northern states.[6]

The first objective of this paper is to measure this Brazil's domestic market fragmentation using the border effect methodology on states trade flows over the period

[5] However, Furtado (1998) indicates that, during the first half of the twentieth century, there was a slight spatial integration of markets but that was too weak to achieve a real integration.

[6] The problem of infrastructure is considered by President Lula da Silva as a major priority for Brazil. The country is at risk, he declared during an audience, in 2006, in Mato Grosso state, while speaking about infrastructure problems. Brazil needs better roads, better ports and railroads are in poor condition. Farmers complain that poor roads, and sometimes no roads, make it expensive and difficult to move products from one region to another.

1991-1999. The interstate trade flows can be inferred from the information on the ICMS tax. This data is available for the years 1991, 1997, 1998 and 1999 and makes possible to use the theory-defined Anderson and van Wincoop (2003) gravity model to estimate the negative impact of states' borders on trade flows among Brazilian states. It is generally assumed that a country has a unified market because of a high degree of cultural and institutional homogeneity. Actually, given the huge Brazilian regional disparities mentioned above, we expect the Brazilian domestic market to be rather highly fragmented. Moreover, a number of recent studies have found rather large border effects within countries.[7] Using the gravity model, Wolf (1997) compares the trade flows between the American States with internal (intra-state) flows. He finds a border effect of 4: internal trade is four times larger than interstate trade, after taking into account the effects of size and distance. Canadian domestic market integration has been studied by Helliwell (1997) who estimates a border effect of 2. Poncet (2005) analyzes the Chinese market integration and finds a border effect slightly over 30 for the year 1997. The fragmentation of developing countries markets are higher than those obtained for developed countries, suggesting a correlation between the level of development and domestic integration

This study also aims to estimate the magnitude and evolution of Brazilian states' insertion in international trade over the period 1991-1999. This is a period of intensive trade liberalization, with the launch of Mercosur in a context of intensive trade policy negotiations. In the nineties, Brazil is engaged in a regional integration process with South American countries, which may affect its fight for its national integration. The literature has generally found intra-national trade to be excessive compared to international trade, between 10 and 20 for developed countries: McCallum (1995) and Anderson and van Wincoop (2003) between the United States and Canada; Head and Mayer (2000) among European countries; Nitsch (2002) between Germany and nine European countries. Studies find larger international border effects for developing countries: Lochard and de Sousa (2005) estimates an average border effect of 880 for the CFA countries;[8] Poncet (2003) shows that the international border effects of Chinese provinces amount to 410 in 1997 and that China's greater engagement in international trade went hand in hand with domestic market disintegration between 1987 and 1997.

Concerning the literature on border effects of Brazilian states, to our knowledge, the first attempt of assessing the international and internal Brazilian border effects is the work of Hidalgo and Vergolino (1998), which use 1991 data and do not include country fixed effect as recommended by the recent gravity literature. Paz and de Mello Franco Neto (2003) is the first work extending the time coverage to years 1997, 1998 and 1999, with a proper econometric specification: They include country fixed effects

[7] See Djankov and Freund (2000) for the ex-USSR market integration and Combes et al. (2003) for the French market integration. The number of empirical research is limited because data on trade flows between sub-national units are rare.

[8] 11 CFA countries : Benin, Burkina Faso, Ivory Coast, Mali, Niger, Senegal, Togo (WAEMU countries) and Cameroon, Chad, Congo, and Gabon (CAEMC countries).

and take into account the zero trade observations. As a side result, the effects of the Mercosur agreement on trade are also assessed.[9] They show that, in the nineties, Brazilian states trade approximately forty times more with other Brazilian states than with equidistant and equal sized foreign countries. More recently, Fally, Paillacar and Terra (2008) need to estimate the internal and international border effects of Brazilian states to measure the impact of market and supplier access on wage disparities across Brazilian states. They use industrial data, which is only available for 1999.
Our contribution to this literature is thus, firstly, to provide consistent estimations of national and international Brazilian states border effects and their evolution between 1991 and 1999. In particular, we use a more sophisticated measure of distance than the usual distance between capitals. Section 2 describes the border effects methodology and Brazilian states data used. Secondly, we deal with different econometric specifications in section 3 accordingly we focus on the evolution of the domestic fragmentation, on the international border effects, on the treatment of zeros flows, or on the results by Brazilian state. Finally, in section 4, we study thoroughly the determinants of the obtained border effects by estimating the impact of infrastructure, importer tariffs and the ICMS tax on the Brazilian internal fragmentation.

2 The border effect methodology applied to Brazilian states

We assume there is perfect trade integration when national borders do not influence commercial transactions between two countries. Borders have an impact on trade when domestic firms have greater access to their domestic market than foreign competitors (or than to foreign markets). Actually, borders separate countries with different cultures, preferences, currencies, legal systems, etc. For these reasons, crossing a border may generate important trade costs for domestic firms.
We measure the effect of borders on trade patterns as the difference between the observed trade and a theoretical trade that would occur in the absence of borders. The estimated border effect is considered as a global indicator of all trade barriers. We use a theoretical gravity equation derived by Anderson and van Wincoop (2003) in order to derive a consistent prediction of what would be the nature of trading patterns in the absence of borders.

2.1 The theoretical gravity model

In its simplest form, the traditional gravity equation states that bilateral trade between two countries is proportional to their economic size and inversely proportional to the distance between them. Anderson and van Wincoop (2003) argue that the

[9] Many papers study the impact of Mercosur agreement on regional or state external flows (see, for instance, de Sá Porto and Canuto, 2004). We focus here on papers analyzing (also) the internal border effects.

traditional gravity equation is not correctly specified as it does not take into account multilateral resistance terms (*i.e.* the traditional estimation suffers from omitted variables bias). Authors assume that each region is specialized in the production of only one product. The main hypotheses of their model are: the elasticity of substitution (CES) among goods is constant and goods are differentiated by region of origin (the Armington assumption). They derive a multilateral version of the gravity model. The multilateral resistance explanatory variable represents the magnitude of average trade barriers faced by each trade partner. The program of maximization of the consumer utility function subject to budget constraints gives :

$$X_{ij} = \frac{Y_i Y_j}{Y_w} \left(\frac{t_{ij}}{P_i P_j} \right)^{1-\sigma} \tag{1}$$

Here X_{ij} are exports from region i to region j; σ is the elasticity of substitution among all goods; Y_i and Y_j are the nominal incomes. In Equation 1 exports from region i to region j depend on three kinds of trade resistance: (a) t_{ij}, the bilateral trade costs between i and j; (b) P_i, i's multilateral resistance; (c) P_j, j's multilateral resistance. The term P_i is actually the consumer price index of i that is function, among others, of all bilateral trade barriers faced by i. P_i captures the magnitude of average trade barriers faced by the region i. In other words, i's multilateral resistance is the average trade barrier of the region i with all its trade partners. Hence, the higher multilateral resistance P_i is, the lower bilateral trade costs t_{ij} are *relatively* speaking between the region i and the region j, thereby causing a raise of i's exports to j. Assuming bilateral trade costs are function of bilateral distance, D_{ij}, and of the presence of a border between i and j, B_{ij}, Anderson and van Wincoop (2003) obtain:

$$ln\frac{X_{ij}}{Y_i Y_j} = k + (1-\sigma)\rho lnD_{ij} + (1-\sigma)lnb * B_{ij} - (1-\sigma)lnP_i - (1-\sigma)lnP_j \tag{2}$$

The indexes of multilateral resistance P_i and P_j are unobserved. According to Anderson and van Wincoop (2003) and Feenstra (2002), it is possible to replace the multilateral resistance indexes with importer and exporter dummies, which leads to consistent estimates. Thereby we include country-specific and state-specific dummies, which are invariant in cross-section estimations. Our empirical equation is:

$$ln\frac{X_{ij}}{Y_{iYj}} = a_0 + a_1 lnD_{ij} + a_2 Foreign + a_3 Brazil + a_i FE_i + a_j FE_j + u_{ij} \tag{3}$$

X_{ij} is exports, in current dollars, from a Brazilian state i to another Brazilian state or to a foreign country j. X_{ii} is the intra-state trade when a Brazilian state i trades with itself. D_{ij} is the distance between i and j.[10] Y_i, Y_j are the gross domestic products in current dollars. $FE_i(FE_j)$ is a fixed effect equals to one if state $i(j)$ is the exporter(importer) and zero otherwise.

[10] More details about X_{ii} and D_{ij} are presented in the appendix on data.

Intrastate trade flows have no borders to cross and are the situation of reference in equation 3. **We include two explanatory variables *Brazil* and *Foreign* to distinguish intrastate flows than respectively intra-national (or interstate) flows and international flows**, capturing the impact respectively of intranational borders on interstate trade and of international barriers on international state exports. *Brazil* is a dummy equal to 1 for trade between Brazilian states and 0 for intrastate and international trade and captures the (negative) impact on interstate trade flows of crossing a sub-national border (rather than no border). The antilog of the estimated coefficient reflects the degree of internal fragmentation of the Brazilian market. *Foreign* is a dummy equal to 1 for international exports of Brazilian states and equal to 0 for interstate and intrastate trade. The antilog of the estimated coefficient is the average international border effect of Brazilian states and is a global indicator of all trade barriers impeding exports of Brazilian states toward foreign countries. We expect crossing a sub-national border or an international border to impede trade.
As the estimated equation is in log linear form, the zeros in trade are omitted from the sample, as it is often the case in the gravity literature. We use the Poisson estimator to include the null trade flows in the regression.[11] Econometric results show that the omission of these variables do not introduce substantial bias in the estimates of border effects variables.

2.2 Brazilian states data

Trade flows by Brazilian state can be calculated from the information on the ICMS tax, applied to interstate trade. The ICMS is a value added tax on the circulation of services and goods. It is levied on both intrastate and interstate transactions and is the main source of revenue for many states in Brazil. As the Table 1 shows, the most common internal tax rate is 17%[12] and is set separately by each state. The ICMS on interstate trade is defined by the Senate. For operations from the states of the Southern and Southestern regions to the states of other regions and to the state of Espirito Santo, the tax rate is 7%. The other interstate operations are taxed at the rate of 12%. Note that the imports of goods from foreign countries are taxed by ICMS at 17%, the same as for internal operations. In order to promote Brazilian exports, most have been exempt from the ICMS tax since 1996.[13]
This kind of trade data by Brazilian state is available for 1991, 1997, 1998 and 1999. The data for the year 1991 come from SEFAZ-PE(1993) and have been calculated by the Ministry of Finance of the Pernambuco State. The Ministry of Finance of Brazil has continued the work calculating the years 1997, 1998 and 1999 (Ministério da Fazenda 2001, 2000a, 2000b). Thus, since the methodology and source data are the same, the four years data can be considered as comparable. The Federative Republic

[11] We also use the Heckman's procedure to handle these "non-participating" observations in the results appendix.

[12] 18% for São Paulo, Rio de Janeiro, Minas Gerais and Rio Grande do Sul

[13] For more details on ICMS, see Gonçalves de Mendonça (2004) or Varsano (1999).

Table 1: The ICMS tax

Operations	tax rate
Usual internal tax rate applied to intrastate trade	17%
Interstate trade	12 %
Exports from industrialized regions, in South, to the non-industrialized states, in North	7 %
Brazil's Exports to foreign countries	no tax since 1996
Brazil's Imports from foreign countries	17%

Source : ICMS tax rates are given, among others, in Gonçalves de Mendonça (2004) and in Varsano (1999)

of Brazil consists of 26 states and 1 federal district (*distrito federal*). However, our database contains export flows of 26 Brazilian states because we have merge two states, Tocantins and Goias, since they were a unique state until 1989.[14] Our database details thus intrastate, interstate and international exports of each Brazilian state towards 164 foreign countries. For each year, we have potentially 26 intrastate trade flows, 650 (26x25) interstate flows, and 4264 (26x164) international export flows from each of the 26 states to each of the 164 foreign countries included in the sample. There are, however, missing values and about half of the exports from Brazilian states to foreign countries are equal to zero for each year.[15] The appendix on data gives some descriptive statistics.

Intrastate trade flow X_{ii} is the difference between the total output of the state and its total exports to the rest of Brazil and to the rest of the world. The total output of a state i corresponds to the sum of outputs of the following tradable sectors: agriculture, mining, industry and tradable services (transport, construction, communications, financial and business services). We require the value of output of each economic sector by Brazilian state. These data are available from IBGE (*Instituto Brasileiro de Geografia e Estatística*) and are provided in current local currencies. The trade data are also provided in the current Brazilian currency: Cruzeiro for 1991 and Real for 1997, 1998 and 1999. We use the World Bank exchange rates to convert the data in local currencies to current US dollars (the same used for the official conversion into dollars of the Brazilian GDP).

The international trade flow data are provided by the AliceWeb system maintained by SECEX, the Foreign Trade Secretariat of the Brazilian Ministry of Development.

[14] In this paper, Goias means the Goias and Tocantins states taken together.

[15] For example, the Amazonian state Acre trades with only 10 foreign countries.

The data are in current US dollars.

Table 2: Exports of Brazilian states by destination (in % of total exports)

Direction of Brazilian states exports	1991	1997	1998	1999
towards itself	75	67	69	62
towards other Brazilian states	19.5	28	26	32
towards foreign countries	5.5	5	5	6

Source: Authors' calculation.

According to the rough data presented in Table 2, the share of interstate exports in total exports of Brazilian states increased from 19.5% to 32% over the period 1991-1999: in 1999, 32% of the total tradable output of a Brazilian state is sold to the other Brazilian states. Conversely, the share of intrastate trade in total exports decreased from 75% (in 1991) to 62% (in 1999), whereas the share of international exports of Brazilian states in their total exports remains nearly the same over the period 1991-1999 (about 6%). This suggests that, since 1991, a representative Brazilian state has traded less and less with itself and more and more with the other Brazilian states. Results on border effects will confirm this result, controlling for outputs.

We also need measures of distances between i and j (D_{ij}) and of distance within a Brazilian state (D_{ii}). As stressed by Head and Mayer (2002) distances are often incorrectly measured in the existing literature. We calculate them here in the same manner and taking into account the spatial distribution of the economic activity in Brazil. The idea is to calculate Brazilian states distances based on bilateral distances between their largest cities and other largest cities of their trade partners, those inter-city distances being weighted by the share of the city in the overall country's population. This procedure can be used in a totally consistent way for both internal and international distances. We take the 25 more populated cities by country and by Brazilian state. We use data for 1999 of the World Gazetteer web site, which provides current population figures and geographic coordinates for cities. For five Brazilian states and a few countries, we are obliged to take fewer cities. The distance formula used is an arithmetic mean of city-to-city bilateral distances:

$$D_{ij} = \Sigma_{k \epsilon i} w_k (\Sigma_{l \epsilon j} w_l d_{kl}) \tag{4}$$

$w_k = pop_k \ / \ pop_i$ is the share of the city k in the overall country's population and d_{kl} is the bilateral distances between cities k and l.

3 Interstate and international border effects faced by Brazilian states

3.1 National fragmentation evolution: Cross-section regressions

Our aim here is to estimate the average degree of Brazil's domestic market fragmentation by the evaluation of the impact of sub-national borders of Brazilian states on trade flows between Brazilian states. We estimate a cross-section OLS model[16] of equation 3 for each year 1991, 1997, 1998 and 1999. We use the Huber-White-sandwich estimator to provide robust standard deviation.

Table 3: OLS estimation of the internal border effect of Brazilian states

	Dependent Variable: $ln(X_{ij}/(Y_i{*}Y_j))$			
	(1991)	(1997)	(1998)	(1999)
Brazil	**-3.14**	**-2.72**	**-2.58**	**-2.57**
(log internal border effect)	(.462)***	(.464)***	(.453)***	(.456)***
Foreign	-6.91	-7.32	-6.76	-6.92
(log international border effect)	(.631)***	(.713)***	(.641)***	(.627)***
ln Distance$_{ij}$	-1.38	-1.29	-1.36	-1.34
	(.088)***	(.096)***	(.088)***	(.086)***
Constant	-14.54	-15.87	-15.49	-15.13
	(.694)***	(.695)***	(.679)***	(.681)***
Observations	2245	2421	2415	2441
exporter fixed effects	yes	yes	yes	yes
importer fixed effects	yes	yes	yes	yes
R^2	0.75	0.75	0.75	0.75
Internal border effect	**23**	**15**	**13**	**13**

Note: The coefficient on the dummy *Brazil* reflects the degree of domestic market fragmentation. The dummy *Foreign* is related to the trade relation Santa Catarina - USA. Robust standard errors in parentheses : ***, ** and * represent respectively statistical significance at the 1%, 5% and 10% levels. Coefficients of exporter and importer fixed-effects are not reported for space reason. The internal BE is the antilog of the estimated coefficient on the dummy *Brazil*.

As Table 3 shows, all explanatory variables are highly significant and display coefficients with the expected signs. The coefficient on our distance measure is equal to

[16]We do not estimate this cross-section regressions using the Poisson Pseudo-Maximum Likelihood (PPML) estimator because Poisson iterations have not converged.

-1.34 in 1999, just a bit larger than the distances of McCallum (1995) (from -1.12 to -1.42) or Anderson and van Wincoop (2003) (from -0.79 to -1.25).
The results on the Brazil dummy show that the **Brazilian market is fragmented**. The internal border effect is equal to $exp(3.14) = 23$ in 1991 and to $exp(2.57) = 13$ in 1999.[17] In 1999, the Brazilian sub-national borders reduce interstate trade by a factor of 13, after controlling for distance, size and multilateral resistance of i and j. Theory and equation 2 show that the border effect is equal to the product of the elasticity of substitution and the tariff-equivalent of the border barrier. The tariff-equivalent of the border barrier is then: $exp[(border)/(\sigma - 1)] - 1$. The literature[18] shows that the elasticity of substitution σ must be in the range of 5 to 10. If we assume that the elasticity of substitution is, for example, equal to 7, the tariff-equivalent of the internal border effect amounts to 51% in 1999 and to 68% in 1991.

By construction, each complete set of dummy variables is equal to the constant term. In order to avoid perfect collinearity, the exporter and importer fixed effects of one Brazilian state have to be dropped. The constant term is then dependent on the state whose fixed effects have been removed. In fact, the equation 3 suffers from another problem of perfect collinearity: the set of importer fixed effects of foreign countries is equal to the *Foreign* variable. An importer fixed effect of a foreign country has to be also dropped to avoid such a collinearity. The estimated coefficient on the dummy *Foreign* is thus relative to the country whose importer fixed effect has been dropped. In the regressions of Table 3, we have dropped the exporter and importer fixed effects of the Brazilian state Santa Catarina and the importer fixed effects of the United States. The coefficient of the dummy *Brazil* is the average internal border effect of all Brazilian states and allows us to calculate the degree of Brazil's domestic market fragmentation. However, the coefficient of the dummy *Foreign* is the international border effect between Santa Catarina and the United States.
The dummy *Brazil* is not affected by a problem of collinearity: it is neither equal to the set of exporter fixed effects of Brazilian states nor equal to the set of importer fixed effects of Brazilian states since this dummy *Brazil* takes the value of 0 for intra-state trade.[19] As an illustration, we run the same regressions changing the exporter and importer fixed effects to be dropped. Table 10 in the appendix show results after dropping the Brazilian state Acre and the importer fixed effect of Argentina. The estimated coefficient on the dummy *Brazil* remains the same. However, the

[17] To explore the impact of adjacency on internal border effects, we include an interaction term between *Brazil* and a dummy *no adjacency* that is equal to 1 when the Brazilian state i and its trading partner j do not share a common border and 0 otherwise. The coefficient on this interaction term is significant and equal to - 0.42. The internal border effect is now equal to -3.05 in 1991 and to -2.50 in 1999. This is the border effect between adjacent Brazilian states.

[18] See Head and Ries (2001) for example

[19] In consequence, the coefficient on the dummy *Brazil* is not related to the Brazilian state whose fixed effects have been dropped.

coefficient of the dummy *Foreign* is now relative to the international border effect between Acre and Argentina.
The average internal border effect decreased over the period 1991-1999, from 23 to 13 is suggesting that, since 1991, a Brazilian state has traded less and less with itself and more and more with the other Brazilian states (after controlling, among others, for economic size). Intrastate trade declined in conjunction with a rise in interstate trade. Brazilian states are more and more connected with each other, from an economic perspective, which increases the interdependence among states. This **ongoing process of domestic integration** may be the result of the economic development of the country and of the new strategy of market reforms and privatizations implemented by the Cardoso administration (1995-2002). Indeed, until 1990, Brazil did not have a strong tradition of respect for free markets. Such a process of integration could also be the consequence of further regional policy in Brazil aiming to promote lagged regions. For example, in 1990, a new and important instrument of regional promotion, the Constitutional Funds, was created in Brazil. Constitutional Funds finances the investment in the Northeast, North and mid-West regions by collecting 3% of income and industrial taxes. The state and federal governments are committed to continuing the diversification of the economies of the lagged regions. We explore the influence of this process on the increasing domestic integration in section 4.

3.2 International trade integration evolution: Random-effects estimations

The coefficient on the dummy *Foreign* of Table 3 reflects the negative impact of international borders on Brazilian states exports towards foreign countries. Contrary to the internal border effect, this international border effect is quite stable over time. However, in the estimation of international border effects, we need to introduce other usual controls affecting trade costs such as contiguity or common language. This raises the same problem of collinearity linked to the *Foreign* variable mentioned previously. To go round this problem, we use the Random estimator, in one dimension. Egger (2000) advocates in favor of the rejection of the random effects in the gravity model. However, it permits to keep covariates which have only a bilateral (and no time) dimension, such as contiguity or common language. Thus, we estimate the equation 3 with exporter fixed effects and importer random effects, even if in theory the country effects are fixed. This allows us, in addition, to obtain an international border coefficient no longer relative to a country.[20]
Table 4 reports the results of this estimation including a dummy common language$_ij$ and a dummy common border$_{ij}$. The language dummy is equal to one when trade

[20]Technically, the variable of the importer partner j, that is a foreign country or a Brazilian state, corresponds to the unit index (or to the panel ID variable). The Random estimator controls for importer random effects. In this case, the dummy *Foreign* is no longer equal to the set of importer fixed effects of foreign countries since the importer effects are now random.

Table 4: Random-effects estimation of the international border effects of Brazilian states

	Dependent Variable: $ln(X_{ij}/(Y_i{}^*Y_j))$			
	(1991)	(1997)	(1998)	(1999)
Brazil	-2.90	-2.53	-2.31	-2.34
(log internal border effect)	(.392)***	(.410)***	(.410)***	(.413)***
Foreign	**-5.97**	**-5.18**	**-4.82**	**-5.63**
(log international border effect)	(.704)***	(.644)***	(.664)***	(.678)***
ln Distance$_{ij}$	-1.36	-1.27	-1.33	-1.28
	(.097)***	(.092)***	(.095)***	(.095)***
Common border$_{ij}$	.33	.25	.42	.42
	(.205)	(.211)	(.212)**	(.213)**
Common language$_{ij}$	-.01	.82	1.05	.47
	(.519)	(.430)*	(.453)**	(.468)
Constant	-17.43	-19.45	-19.78	-19.57
	(.907)***	(.860)***	(.887)***	(.884)***
Observations	2245	2421	2415	2441
exporter fixed effects	yes	yes	yes	yes
importer random effects	yes	yes	yes	yes
Internal border effect	**18.2**	**12.6**	**10.1**	**10.4**
International border effect	**390**	**180**	**120**	**280**

Note: Standard errors in parentheses: ***, ** and * represent respectively statistical significance at the 1%, 5% and 10% levels. Coefficients of exporter fixed-effects are not reported for space reason.

partners i and j speak the same language.[21] This dummy is also equal to one for intrastate and interstate trade. The common border$_{ij}$ dummy variable is equal to 1 when the Brazilian state i and its trade partner j share a common border and 0 otherwise. The dummy is also equal to one for intrastate trade.[22]
The coefficients on *Foreign* are highly significant.[23] **International trade integra-**

[21]The countries whose language is Portuguese are Portugal, Angola, Mozambique, Cap Verde, Guinea-Bissau, West Timor and Sao Tome and Principe.

[22]In Table 11 in the appendix, GDP variables are put on the right hand side of the gravity equation in order to check the stability of the estimated coefficients. The results of Table 4 and those of Table 11 are very close. In addition, coefficients of GDP variables are close to one as assumed in the theoretical gravity equation.

[23]We have also estimated the international border effects using the traditional gravity equation, without the exporter and importer dummies. Results are close: the coefficient on

tion of Brazilian states is limited but has increased in the period. In 1999, a Brazilian state traded 280 (exp(5.63)) times more with itself than with a foreign country, all things being equal. An alternative reading of results is that, in 1999, Brazilian states trade 27 (exp(5.63-2.34)) times more with each other than with foreign countries. Assuming that the elasticity of substitution is equal to 7 as previously, the tariff-equivalent of border effects between Brazilian states and foreign countries amounts to 169% in 1991 and to 153% in 1999.
These substantial international border effects encountered by Brazilian states exports can appear excessive but they are in the same wavelength that other studies. The World Bank (2004), for instance, has examined in detail the trade policy liberalization of Brazil in the 1990s. It concludes that, at the end of the 1990's, Brazil's international trade barriers were still high in relation to those of other countries and that the incentives are greater for selling in Brazil than to foreign countries. In 1998, the simple average nominal tariff is equal to 16 per cent. In the nineties, some sectors (textile, motor vehicles) kept demanding protectionist measures and safeguard clauses. Although international trade barriers faced by Brazilian states exports are high in 1999, Brazil's international trade integration increased between 1991 and 1999: The international border effect has decreased from 390 to 280. This is a consistent result insofar as trade policy reform had been introduced in 1987. The Cardoso administration (1995-2002) pursued a strategy of outward orientation which led to reductions in tariffs and removal of other trade barriers in the nineties. For instance, the Brazilian government eliminated some non-tariff import barriers and simplified administrative controls on imports and exports. Moreover, as explained in the next subsection, this results are also consistent with those obtained in the literature of the border effects, which shows that international border effects should decline over time in conjunction with trade liberalization.

3.3 Robustness tests: Panel data estimations and the Poisson estimator

The aim of this section is to check the order of magnitude of international border effects estimated previously with cross-section regressions. Panel data estimations using the random-effects model, the *fevd* procedure and the Poisson estimator permit us to estimate the internal and international border effects of Brazilian states while controlling for multilateral resistance of both trade partners i and j by including bilateral effects (pair dummies). According to Egger and Pfaffermayer (2003) or Cheng and Wall (2005), a panel model with pair dummies is equivalent to a model with exporter and importer fixed effects. Moreover, Baldwin and Taglioni (2006) show that pair dummies are superior to nation dummies in panel data for controlling multilateral resistance of i and j.[24]

the dummy *Foreign* is equal to -5.60 in 1991 and -5.23 in 1999.

[24]Baldwin and Taglioni (2006) also explain that including time-varying country dummies with pair dummies is optimal to control for multilateral resistance because multilateral re-

More precisely, we estimate here the following equation using panel data methods that include bilateral effects (pair dummies) : FE_{ij} is a dummy that is one for all observations of trade between a given pair ij of trade partners. Times dummies λ_t are included to control for all events specific to a year t and common to all countries. Trade flows and GDP are in constant US dollars (base 1990).

$$ln\frac{X_{ijt}}{Y_{it} * Y_{jt}} = a_0 + a_1 lnDistance_{ij} + a_2 Foreign + a_3 Brazil + FE_{ij} + \lambda_t + u_{ijt} \quad (5)$$

To estimate this equation, we use three different estimators that control for multilateral resistance. Firstly, we use the **random effects estimator (RE)** including random bilateral effects[25] and permits us to estimate time-invariant variables. Secondly, we use an alternative procedure for the estimation of time-invariant variables in the presence of fixed pair dummies: **the fixed effect vector decomposition (fevd) technique** proposed by Plümper and Troeger (2007).[26] This technique described in the appendix includes bilateral fixed effects. The fevd method is a three-stage procedure for the estimation of time-invariant variables in panel data models with individual effects. Finally, we follow Santos Silva and Tenreyro (2006) who recommend the use of the **Poisson Pseudo-Maximum Likelihood (PPML) estimator** as a good alternative to include the zero values of the dependent variable since it consists of estimating the bilateral trade X_{ij} in levels.[27] In order to run panel data estimations, we use the random-effects Poisson model that is a maximum likelihood estimator. Pair dummies that control for multilateral resistance are random variables.
Table 5 reports estimations of equation 4 using the random-effects (column 1), *fevd* (column 2) and Poisson (column 3) methods. The Hausman test rejects the random effects specification, results are presented anyway to facilitate the comparison with previous results, in which the time average of coefficients is -5.4. The estimated coefficients of the dummy *Foreign* in Table 5 are significant and close to those obtained in cross-section regressions. The coefficient of the distance variable (equal to - 0.50) and of the GDP variables (equal to about 0.50) are a bit lower than those estimated by Santos Silva and Tenreyro (2005) on another data set. They find GDP elasticities just above 0.7 and a distance elasticity of 0.78. The magnitude of the internal border

sistance can vary every year. But including time-varying country dummies involves a lot of dummies (about 850) and a loss in degree of freedom. Moreover, as regards our gravity equation, it is not necessary to include these dummies since Baldwin (2006) shows that absence of time-varying dummies leads to biased results only if the trade costs are also time-varying. Our border effects and distance variables are constant. In consequence, we don't include time-varying country dummies.

[25]We also tried the Hausman-Taylor method with GDP on the right hand side of equation but we did not find exogenous time-varying variables as good instruments.

[26]we very sincerely thank Thomas Plümper and Vera Troeger for giving us the ado file necessary to use the *fevd* technique. For more details on the *fevd* method, see Plümper and Troeger (2007).

[27]We have also applied the Heckman method with similar results (see results appendix).

Table 5: Robustness test: Estimations of the international and internal border effects of Brazilian states using panel data estimations with the random-effects estimator, the fevd procedure and the Poisson method

	Dependent Variable: exports from i to j		
	($\ln X_{ijt}$)	($\ln X_{ijt}$)	(X_{ijt})
	(random (1))	(fevd (2))	(Poisson (3))
Brazil	**-2.66**	**-2.64**	**-2.62**
(internal border effect)	(.417)***	(.006)***	(.874)***
Foreign	**-5.50**	**-5.31**	**-5.67**
(international border effect)	(.516)***	(.009)***	(1.007)***
ln Distance$_{ij}$	-1.12	-1.15	-.50
	(.070)***	(.033)***	(.090)***
Common border$_{ij}$	.74	.68	1.18
	(.207)***	(.022)***	(.415)***
Common language$_{ij}$	.53	.56	.15
	(.256)**	(.156)***	(.456)
ln PIB$_{it}$	1.25	1.26	.53
	(.028)***	(.032)***	(.00002)***
ln PIB$_{jt}$	.88	.91	.45
	(.017)***	(.033)***	(8.93e-06)***
year 1997	-.57	-.47	-.10
	(.040)***	(.081)***	(1.00e-05)***
year 1998	-.62	-.51	-.10
	(.039)***	(.062)***	(1.00e-05)***
year 1999	-.13	-.02	-.07
	(.035)***	(.123)	(5.74e-06)***
Constant	-22.19	-22.95	1.13
	(.962)***	(.312)***	(1.137)
Observations	9526	9526	19760
pair countries effects	random	fixed	random
Hausman test, Chi(5)	75.82		
$prob \succ chi2$	0.00		
Internal border effect	**14.3**	**14.0**	**13.7**
International border effect	**244.7**	**202.4**	**290.0**

Note: Standard errors in parentheses: ***, ** and * represent respectively statistical significance at the 1%, 5% and 10% levels. Coefficients of time dummies are not reported for space reasons. All coefficients were significant and negative.

effects is also confirmed. The coefficients of the dummy *Brazil* are estimated to be around - 2.64 in panel data estimations, the mean of previous coefficients being -2.6. In a nutshell, the omission of the null trade flows do not introduce substantial bias in the estimates of the border effects. These robustness tests confirm the order of magnitude of our estimated international and internal border effects in cross-section regressions.

Table 6 summarizes results on border effects literature. The estimated border effects on developing countries are systematically higher than those obtained for developed countries.[28] For example, international border effect among OECD countries is comprised between 12 and 15 at the beginning of the nineties. Unlike China, India and Brazil seem to experience the opposite. Poncet (2003) shows that China's greater engagement in international trade went hand in hand with domestic market disintegration between 1987 and 1997, which creates potential for political disunity and national fragmentation. In India, rising regional disparities that pose threats to the political unity of the Indian federation are probably linked to India's insertion into the global market (Daumal, 2008). Our results suggest that, at the end of the nineties, the Brazilian market is more unified than the Chinese market that has an internal border effect of around 30. At that time, Brazilian states were also still better integrated into the global market than the Chinese provinces since international border effects of Chinese provinces amount to 410 in 1997.

While filling some gaps of the literature on Brazilian states border effects, our estimations confirm previous results. Hidalgo and Vergolino (1998) estimated border effects between the nine Northeastern states and the rest of Brazilian states and between the Northeastern states and the foreign countries (they do not consider the intra-state trade) for the year 1991. Their nine Brazilian states trade 11.5 times more with the rest of Brazilian states than with a foreign country. This can be compared with our first column of Table 4 ($exp(-5.97 + 2.9) = 21$) but in our sample we have all the Brazilian states, and we compare international and interstate trade to the intrastate trade. Using the same four years than us, Paz and de Mello Franco Netto (2003) take into account zero flows and include nation and states dummies. However, their treatment of zeros is quite out-of-date (they explain $ln(1 + X_{ij})$) and they do not consider neither the intra-state trade flows, as ideal reference for totally free trade. They find that a Brazilian state trades 20 times more with another Brazilian state than with another country in the world. This is to be compared with our Poisson estimations in column 3 of Table 5 reported in Table 6 as our preferred specification. The Fally, Paillacar & Terra (2008) paper has the advantage to deal with disaggregated manufacturing trade data by state, which solve the problem of the tradable services present in the intra and interstate data but not included in external trade. This may explain their international border effects lower than ours: since services are more locally oriented, their intrastate trade is much more open than the our. They obtain similar national border effect suggesting that the tradable services do not count

[28] Of course, it is delicate to compare results of the diverse studies because they use different methods and data. Therefore, we have to remain cautious concerning these comparisons.

Table 6: Estimated border effects (BE) in the literature: National (N), International (I) or International relative to National BE (I/N)

References	Country/Region	BE obtained
Developed countries:		
McCallum (1995)	between Canadian provinces and USA states, 1988	22 I BE
Helliwell(1997b)	among Canadian provinces	2 N BE
Wolf (1997)	among USA states, 1993	between 3 and 4.5 N BE
Anderson & van Wincoop (2003)	between Canadian provinces and USA states, 1993	11 I BE
Nitsch (2002)	between Germany Länder and European countries, 1992-1994	2.5 I BE
Head & Mayer (2000)	EU countries, 1993-1995	12 I BE
Combes et al. (2003)	French departments, 1993	6 N BE
Helliwell (1997a)	OECD countries, 1988-1992	between 12 and 15 I BE
Developing countries:		
Poncet (2005)	Chinese provinces, 1992	24 N, 580 I
Poncet (2005)	Chinese provinces, 1997	31 N, 410 I
Lochard & de Sousa (2005)	CFA countries, 1990-1999	880 I
Djankov & Freund (2000)	between Russian regions and the ex-Soviet Republics, 1996	1.6 N
Brazil:		
Hidalgo & Vergolino (1998)	9 states, 1991	11.5 I/N[a]
Paz & de Mello Franco Netto (2003)	26 states, 1991, 1997, 1998, 1999	20 I/N[b]
Fally, Paillacar & Terra (2008)	26 states, 1999, manufacturing detailed data	13 N, 75 I
This paper	26 states, 1991, 1997, 1998, 1999	14 N, 290 I, 21 I/N[c]

Note: National (N) or International (I) BE meaning relative to the intraregion trade (sub-national), as in this paper. Papers don't considering the intra-region trade obtain international BE relative to national BE I/N. [a] Don't consider the intra-state trade, they compare inter-state trade to international state of the Northeast region. Their nine Brazilian states trade 11.5 times more with each other than with a foreign country. This is to be compared with our first column of Table 4. Precisely, with $exp(-5.97+2.9)=21$ (but in our sample we have all the Brazilian states). [b] Even if they use the same four years than us, they do not estimate the border effects year by year. They do not consider neither the intra-state trade flows. Taking into account zero flows (by explaining $ln(1+X_{ij})$) and including nation and states dummies, they find that a Brazilian state trades 20 times more with another Brazilian state than with another country. This is to be compared with our Poisson estimations in column 3 of Table 5 reported here ([c]).

for much in the difference between intrastate and interstate trade. The inconvenient of this industrial approach is that data is only available for 1999. Our contribution to this literature is thus: (i) to provide consistent and theory based estimations of national and international Brazilian border effects and their evolution between 1991 and 1999 (we estimate the border effects year by year in cross-section regressions); (ii) taking into account properly the zero flows (even if we show that the omission of the null trade flows do not introduce substantial bias in the estimates of the border effects); (iii) using a more sophisticated measure of distance than the usual distance between capitals; (iv) to give results by Brazilian state (next subsection); and finally, (v) explores possible explanations of these estimated border effects (next section).

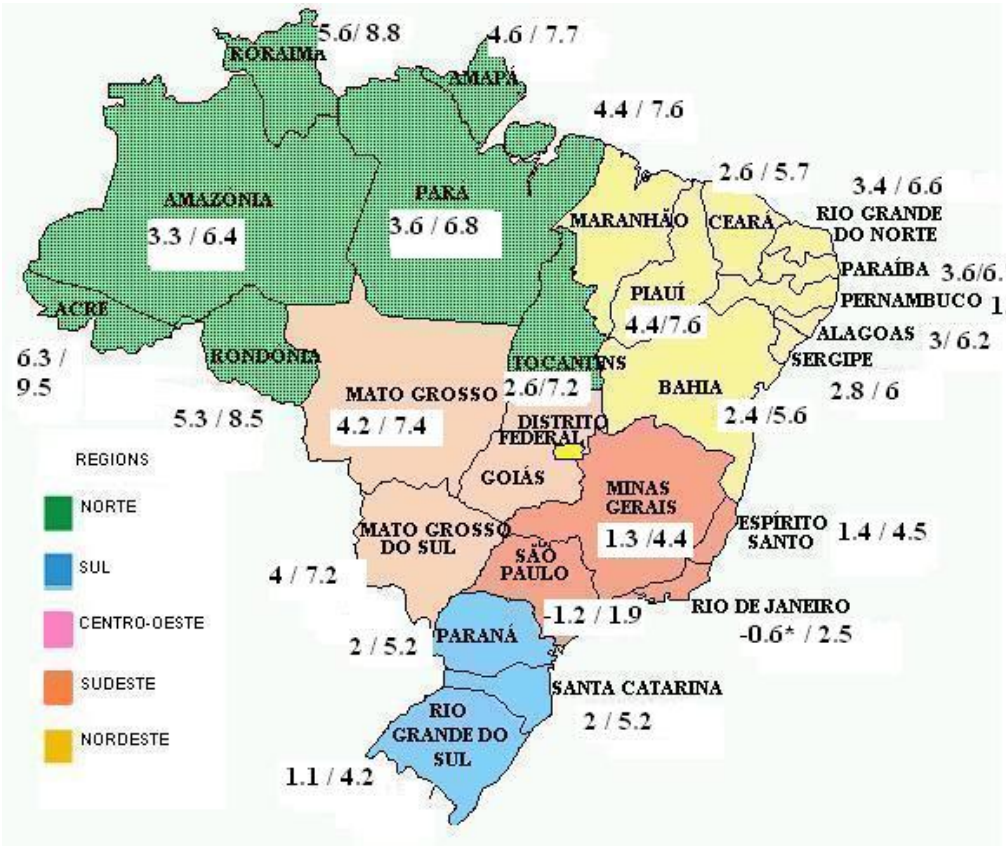
3.4 Border Effects by Brazilian State

We have discuss the mean magnitude of internal and international border effects of the whole Brazilian states. However, Brazilian states may have different levels of internal and international trade integration. To estimate internal and international border effects by Brazilian state, we perform panel data estimations using the *fevd* technique like in column 2 of Table 5.

We calculate the internal border effect by Brazilian state by including twenty-six state-specific *Home(i)* dummies. *Home(i)* is equal to 1 when the Brazilian state i trades with itself and 0 otherwise. Firstly, we remove the dummy *Brazil* to avoid perfect collinearity. Interstate trade is now the reference situation. The coefficients of the 26 state-specific *Home* dummies are capturing now an internal trade surplus relatively to the interstate trade. Secondly, the dummy *Brazil* is included in the equation and we remove the dummy *Foreign*. The reference situation is now international trade. The estimated coefficients on the 26 state-specific *Home* dummies compare intrastate trade to international trade. Figure 1 reports internal and international border effects by Brazilian state.

Unsurprisingly, border effects differ greatly across Brazilian states: internal and international border effects are high for Amazonia, Northeast and Centro-Oeste regions and low for Southern regions. For example, the state of Pará has an internal border effect of 35 (exp of 3.6): Pará trades 35 times more with itself than with the other Brazilian states, all things being equal. The Amazonian and Northern regions seem to be marginalized and isolated from the rest of the country and from international trade, after controlling for distance and economic size. Conversely, São Paulo and Rio de Janeiro have no internal border effect: they trade more in interstate than in intrastate, when the effects of economic size and distance are taken into account. Other Southern states, Espírito Santo and Rio Grande do Sul, have also very low internal border effects. One plausible explanation for the absence of state border effects for São Paulo and Rio is the concentration of economic activity in Rio and São Paulo. In particular, the industrial sector is concentrated in the Southeast region. São Paulo and Rio de Janeiro account for 48% of the Brazilian GDP and produce a large variety of goods that the other states do not produce. São Paulo produces almost everything Brazil needs: agriculture, agroindustry, sugar, coffee, textile, metallurgy, chemistry,

Figure 1: Internal and international border effects by Brazilian state over the period 1991-1999



Note: This map of Brazil provides, for each state, the surplus of intra-state trade relatively to inter-state and international trade. For example, for the state of Bahia, the 2.4 represents the surplus of intra-state trade relatively to inter-state and 5.6 relative to international trade. The internal and international border effect are equal to $-(exp2.4) = 11$ and $-(exp5.6) = 270$. The higher the border effect, the more the state is trading with itself comparative to its trade with other states or countries.

vehicles, airplanes and so on. The other Brazilian states are specialized in one or two traditional products. For example, Maranhão is specialized in aluminium and iron. In the Amazonian state Acre, the service sector is the largest component of GDP at 66%. The Paraíba economy is mainly based upon the making of a few leather products such as shoes. Nevertheless, all Brazilian states produce a few agriculture products for

themselves. According to IBGE (*Instituto Brasileiro de Geografia e Estatística*), the agriculture and livestock sectors are the least concentrated activity over the Brazilian territory. Thus, the state of São Paulo may function as provider for Brazil, producing for the Brazilian market and selling to all Brazilian states, which would explain the absence of border effects for this state. The lack of economic connections among Brazilian states (excepted São Paulo), due to this industrial concentration, may be playing a role in the fragmentation of the Brazilian market.[29]

Our empirical results also show that the Amazonian region that displays, on the average, the largest border effects (8 for the international border effect and 4.8 for the national border effect) is the most marginalized from the rest of the country and from international trade, all things being equal. Its particular geography, with the infrastructure and transportation problems associated, could also explain partly the low trade integration of Northern states. It is likely more difficult and expensive to move products to Amazonian regions than our measure of distance is capturing. However, an interesting result is that the state of Amazonia enjoys a better internal and international trade integration than that of the other Amazonian states such as Acre, Roraima, Amapa or Rondonia. Its internal and international border effects are equal to 3.3 and 6.4 respectively, whereas those of Acre, for example, are equal to 6.3 and 9.5. The state of Amazonia is not that isolated. This better trade integration is certainly due to its capital, Manaus, a duty free zone created in 1967 and based on tax incentives to economic production. Since the 60s, the Brazilian Federal Government has promoted the economic development of this empty state for strategic and political reasons. In particular, the objective was to promote international trade and industries of high added value and intensive capital and technology goods (electronic products, chemicals...). Consequently, this state produces a large variety of consumer goods such as mobile phone, motorcycles, electronic goods. The successful story of the Brazilian state of Amazonia, which also enjoys a GDP *per capita* as high as that of the richer Brazilian states, shows that active government policies can reduce regional inequalities and economic marginalization. Two comparable countries, China and India, now face the same issues as Brazil since their economic development and their insertion into the global economy have generated high regional inequalities threatening domestic integration and national political unity. Chinese and Indian governments could take inspiration from Brazil's experience: active government policies may be successful in promoting the economic development of remote areas.

4 Determinants of Brazilian states border effects

As mentioned in the introduction, the process of national development (during which Brazilian states have developed isolated from each other), the federal system that cre-

[29] More economic diversification throughout the national territory, more trade connections among all Brazilian states, probably reduce the level of domestic market fragmentation.

ates administrative, legal and fiscal heterogeneity among states and lack of infrastructure between regions of Brazil make it difficult to ship products in the national market and probably explain in part the fragmentation of the Brazilian market. The effect of heterogeneity resulting from federalism is not easily testable empirically because the difficulty to be put into figures. In this section, we test show that lack of infrastructure in Brazilian states is detrimental to their interstate and international trade (section 4.1). We estimate also the impact of the ICMS tax on the international and internal trade integration of Brazilian states (section 4.2.

4.1 The role of infrastructure

We ask here whether the low level of Brazilian states trade integration could be partly explained by lack of infrastructure in Brazil. The problem of infrastructure is considered by Brazilian President Lula da Silva as a major priority for Brazil. After being re-elected in 2006, Brazilian President unveiled his plan to double Brazil's economic growth, the so-called Accelerated Growth Program. He declared that "*the main challenge facing the country is to accelerate economic growth*" by, among others, increasing private and public investment in infrastructure.
What are the potential links between infrastructure and international and internal trade integration? Limão and Venables (2001) look at the relationship between the quality of infrastructure and trade costs and show that a deterioration of infrastructure can reduce trade volumes very importantly. Their analysis of African trade flows indicates that their relatively low level is largely due to poor infrastructure. Firstly, lack of infrastructure (roads, railways) between regions of Brazil must contribute to the domestic market fragmentation, making difficult the transportation of products and commodities in the national market. Secondly, economic growth in Brazil depends partly on infrastructure. Lack of basic infrastructure probably reduces productivity of national economic activity, by creating high transaction costs, which can have a negative impact on the export performance of Brazilian states. And thirdly, regional inequalities in infrastructure are quite high. There is a high density of roads in Southern regions and a low density in Amazonia and in Centro-Oeste (see figure 2 and Table 9 in the appendix). Better infrastructure in Southern regions reinforces their comparative advantages and lack of infrastructure in Northern regions probably hinders their economic development and their trade integration.

To our knowledge, the only data on infrastructure that are available for each Brazilian state are the number of kilometres of roads. The same data for other countries in the world are also available. Data for Brazil are for the year 2000 and are derived from the *Anuário Estatístico dos Transportes Terrestres*/2005 (AETT) published by the Brazilian ministry of transport and the *Agência Nacional de Transportes Terrestres*. Data for other countries and for the year 2000 are taken from the World Bank's World Development Indicators.[30] **We approximate the quality of infrastruc-**

[30]Data are missing for very small countries such as Andorra, San Marino, Uganda, Tuvalu

ture in the region i by the number of kilometres of roads per square km and per person. We divide the number of kilometres of roads by the area and the population of the Brazilian state or country i.[31] Population data for each Brazilian State and each year (1991, 1997, 1998 and 1999) are provided by the Brazilian statistical institute IBGE (*Instituto Brasileiro de Geografia e Estatística*). Data for population of countries come from World Bank. In the data appendix, Table 9 gives these measures and figure 2 the official federal highway map of 2005 (Brazilian ministry of transports). It shows a high density of federal roads in Southern regions and a low density in Amazonia and in Centro-Oeste. A railway map would reflect the same contrast.

The two first columns of Table 7 report the results of random and fevd estimations[32] including our measure of infrastructure for both exporter (i) and importer (j), the $infrastructure_i$ (j) variable (the number of kilometres of roads per square km and per person for each exporter (importer) i (j)) and the landlocked condition. Indeed, many landlocked Brazilian states in Amazonia have poor infrastructure. The higher the indicator, the better the infrastructure in i (j). The log of infrastructure$_i$) variable has a positive coefficient, but significant only in the *fevd* estimation, suggesting that Brazilian states with a high density of roads export more towards foreign countries and the rest of Brazil than Brazilian states with a low level of infrastructure. The importer infrastructure, however, has no significant coefficient. The other explanatory variables show expected signs. A common border and a common language have a positive impact on trade volume between two partners. The dummy landlocked$_i$ has a negative and significant coefficient (- 0.26 and - 0.20), which means that landlocked Brazilian states export less than coastal Brazilian states, all things being equal.[33] and foreign trade mainly transits by ports. This results can be compared with the two first columns of Table 5. In the new fevd estimation, including our infrastructure proxies, national fragmentation appears lower (13.1 vs 14.0 in the previous estimations), explaining thus a portion of this internal border effect. But the international integration is not increased pointing that the infrastructure of the exporter state is not affecting the international border effects in the same way.

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etc.

[31] It does make sense to control for population because infrastructure and roads are certainly less important and vital in a region that is little populated.

[32] We cannot estimate the impact of infrastructure in cross-section regressions because unilateral variables such as $infrastructure_i$ are, of course, perfectly collinear to exporter fixed effects. It is impossible to include nation dummies and any unilateral variable in the same equation. The alternative is to estimate the gravity equation by performing panel data estimations with random-effects and fevd methods. Pair dummies control for multilateral resistance of i and j and we can include any unilateral variables (equation 4). The GDP variables are now on the right hand side of equation and we include the unilateral infrastructure variables.

[33] Principal international airports are in coastal states (the Rio de Janeiro Airport, the Guarulhos Airport in São Paulo, and the Guararapes Airport in Recife).

Table 7: The impact of infrastructure (columns 1 an 2), tariff and ICMS tax (columns 3 an 4) on Brazilian states exports

	Dependent Variable: lnX_{ij}			
	(random)	(fevd)	(random)	(random)
Brazil (log of national border effect)	-2.56 (.423)***	-2.57 (.006)***	-2.48 (.407)***	-2.31 (.451)***
Foreign (log of international border effect)	-5.79 (.527)***	-5.59 (.010)***	-5.13 (.684)***	-4.58 (.931)***
ln Distance$_{ij}$	-1.14 (.074)***	-1.14 (.032)***	-1.27 (.097)***	-1.27 (.096)***
Common border$_{ij}$	.81 (.213)***	.77 (.032)***	.49 (.211)**	.47 (.212)**
Common language$_{ij}$	.26 (.260)	.32 (.027)***	1.10 (.484)**	1.10 (.472)**
ln PIB$_{it}$	1.24 (.031)***	1.26 (.032)***		
ln PIB$_{jt}$	.85 (.020)***	.87 (.032)***		
$ln(GDP_i * GDP_j)$			1.08 (.036)***	1.08 (.035)***
ln (infrastructure$_i$)	.04 (.033)	.06 (.022)***		
ln (infrastructure$_j$)	-.007 (.018)	-.001 (.154)		
Landlocked$_i$	-.26 (.087)***	-.20 (.121)*		
Landlocked$_j$	-.56 (.106)***	-.42 (.061)***		
ln Good Governance$_j$			-.64 (.211)***	-.65 (.207)***
ln(1+tax)$_{ij}$			-2.06 (.889)**	
ln(1+ICMS)$_{ij}$				1.48 (4.426)
ln(1+tariff)$_{ij}$				-2.24 (.890)**
Constant	-20.20 (1.065)***	-20.43 (.332)***	-23.96 (1.788)***	-24.68 (1.939)***
e(N)/observations	9142	9142	2187	2187
pair countries effects	random	fixed	no	no
exporter fixed effects	no	no	yes	yes
importer random effects	no	no	yes	yes
National border effect	**12.9**	**13.1**	**11.9**	**10.1**
International border effect	**327.0**	**267.7**	**169.0**	**97.5**

Note: Panel data estimations including dyad trading partners (1991, 1997, 1998, 1999) using the random-effect model and the fevd procedure for the impact of infrastructure (columns 1 and 2). Random-effects estimations of equation 3 with exporter fixed effects and importer random effects with the GDP on the right hand side of the equation (columns 3 and 4). Standard errors in parentheses: ***, ** and * represent respectively statistical significance at the 1%, 5% and 10% levels.

4.2 Impact of the ICSM tax and of tariffs applied to Brazilian exports

We explore now the impact of the ICMS on exports from Brazil to foreign countries and to the rest of Brazil. As described in Table 1, interstate rates (12 or 7%) are most of the time lower than internal rates (17%), which could promote interstate trade. However, some authours argue that the heterogeneity of tax rules, rates and legal norms among the Brazilian states leads to a very complex and burdensome administration for traders in Brazil, may discourage interstate flows (Gonçalves de Mendonça, 2004, or Varsano, 1999). The sign of estimated impact of the ICMS could settle the argument.

International exports of Brazilian states are taxed by the tariff implemented by the importer country. We investigate the role of tariffs on exports of Brazilian states by including the bilateral tariff applied to Brazilian exports by foreign importers *j*. Our tariffs are a world trade-weighted average of detailed *ad valorem* tariffs from the MAcMap-HS6 database (Bouët et al., 2005).[34].

Owing to availability of the data, we also include an explanatory variable that controls the quality of institutions in the importer foreign country j. Anderson and Marcouiller (2002) suggest that good governance and good institutions can foster trade by reducing transaction costs and by increasing trust among foreign traders. To examine the impact of good governance that on the Brazilian states exports, we use data on corruption from the dataset *Governance Matters IV: Governance Indicators for 1996-2004* provided by the World Bank and Kaufmann, Kraay and Mastruzzi (2005). We rescale original values for the year 1998 in order to get values for the [0,1] segment: a value of 1 corresponds to a good quality of institutions and a value of 0 to a low quality of institutions. For example, Cameroon has a score of 0.27, Brazil 0.52 and Canada has the best score equal to 1.

In the two last columns of Table 7, we use similar specification than in section 3.2, with exporter fixed effects and importer random effects to control for multilateral resistance of partners *i* and *j*, and controls for common border and common language, for the year 1998 only. In column 3, we include the variable $ln(1+taxe)_{ij}$ containing ICMS rates and bilateral tariffs between a Brazilian state and its trading partner (that can be itself for intrastate trade). Its estimated coefficient is significant and negative (equal to - 2.06) : **tariffs and ICMS taxes impede sales of Brazilian states producers**. In column 4, we distinguish the impact of the ICMS from the impact of bilateral tariffs. The variable $ln(1+tariff)_{ij}$ has a significant and negative coefficient (-2.24). Tariffs applied by importer countries on Brazilian exports have a

[34]For more information on MAcMap-HS6 database, see http://www.cepii.fr/francgraph/bdd/macmap.htm. Note that the number of observations decreases from 2305 to 2187 since we have bilateral tariff data for 138 countries out of the 164 in the sample. The missing countries are Angola, Bhutan, Burundi, Cape verde, Comores, Zaire, Djibouti, Fiji, Gambia, Guinea, Haiti, Irak, Kiribati, North Korea, Liberia, Malte, Marshall Islands, Micronesia, Mongolia, Nauru, Palau, San marino, Sierra leone, Somalia, South Africa, Tonga, Tuvalu, Vanuatu.

negative influence on Brazilian exports. The variable $ln(1 + icms)_{ij}$ is positive but has no significant coefficient. As the ICMS system is very complex in reality, it seems difficult to estimate its real impact on both internal and international trade.

The coefficient of the variable $lngoodgovernance_j$ is significant and negative (- 0.65), which implies that exports of Brazilian states are positively associated with corruption levels in importing countries or, in other words, corruption in importing countries (j) fosters exports of Brazilian states towards foreign countries. This is quite a puzzling result although some studies point that corruption probably greases *the wheels of commerce* in second-best cases in the sense that trade can be facilitated by corruption and bribes. For example, bribes may be used to get an import license. The payment of commissions may be useful to some companies in order to obtain contracts over competitors in foreign countries. In the same way, giving commissions to customs can promote exports towards the importing corrupt country by avoiding its policy barriers. De Jong and Udo (2005) explain that bribe paying may be beneficial in countries with very long waiting-times or low-quality customs.
In a nutshell, we explain a large part of interstate and international border effects if we compare latter results with those of the first column of Table 5, reducing them from 14.3 and 245 respectively to 10.1 and 97.5 in the last column of Table 7.

5 Conclusion

This paper uses the border effect methodology to measure the barriers faced by Brazilian producers in the domestic and international markets for the years 1991, 1997, 1998 and 1999.
Our findings underline the imperfect integration of the Brazilian market but also stress an ongoing process of domestic integration over the period 1991-1999. Cross-section (random-effects) estimations allow us to give reults year by year: in 1999, the Brazilian sub-national borders reduce trade between Brazilian states by a factor of 13 (10), instead of 23 (18) in 1991, after controlling for distance, size and multilateral resistance of trade partners.
The international integration of Brazilian exporters is limited but has increased between 1991 and 1999 in conjunction with the Brazilian strategy of outward orientation. Our random-effects estimations show that, in 1999, a Brazilian state trades 280 times more with itself than with a foreign country, all things being equal. More sophisticated econometric specifications, including the country pair fixed effects and the zero flows, give similar results over the period: around 14 for the national border effect and between 202 and 290 for the international border effect of Brazilian states.
Results show that border effects differ greatly across Brazilian states. Brazil appears as a very heterogeneous country with open and industrialized states in the South and non-industrialized and marginalized states in the North. Since the 60's, the Brazilian government launched programs to reduce regional disparities. The relatively good economic insertion of the state Amazonas, suggests a positive impact of such active

government policies.
Our research on the determinants of the obtained border effects of Brazilian states show that infrastructure and international tariff barriers impact Brazilian states sales. However, the ICSM rate variability is not a significant explanation of border effects faced by Brazilian exporters, although favorable in principle to interstate trade.

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7 Appendix

7.1 Data

The Gross Domestic Product data of the foreign countries come from the United Nations Statistics Division. The Gross Domestic Product data for Brazilian states are from IBGE (Instituto Brasileiro de Geografia e Estatística) and are provided in local currency.

Concerning trade flows between Brazilian states, there are some missing data since several states do not report all trade data. For example, in 1999, five states (Acre, Amapá, Maranhão, Rio Grande do Norte and Roraima that are very small states) did not provide information on their trade data. As a consequence, there are 20 missing values. In 1998, nine states did not report information and there are 72 missing values. In 1997, there are 42 missing values. We have calculated these missing values according to 1991 values or to values for the years when the trade data were not missing. For example, we know, according to the data for 1991, that Acre accounts for 1% of the total exports of Amapá towards Brazilian states. Then we use this percentage for 1999 and we estimate the exports from Amapá to Acre based upon the data of 1991. There are also missing data for the year 1991 but they have been estimated by the Ministry of Finance of the Pernambuco State upon the data of 1985. The Ministry of Finance of the Pernambuco State provides a complete dataset for 1991.

Table 8: Descriptive statistics of trade data of Brazilian states for 1999

	intrastate trade X_{ii}	interstate trade	international trade
Observations	26	650	4264
Mean	$1.85\ 10^{10}$	$3.06\ 10^{8}$	$1.07\ 10^{7}$
Min	$3.68\ 10^{8}$	551	0
Max	$1.87\ 10^{11}$	$1.35\ 10^{10}$	$4.30\ 10^{9}$
Standard deviation	$3.72\ 10^{10}$	$1.17\ 10^{9}$	$9.52\ 10^{7}$
% of zero values	0	0	57%

Note: The standard deviation is defined as the square root of the variance.

7.2 The *fevd* method

Plümper and Troeger (2006) propose a three-stage procedure for the estimation of constant variables in panel data models with individual effects. Variables X are time-varying, Z are constant and u_i is an individual effect.

$$y_{it} = \alpha + \sum_{k=1}^{K} \beta_k X_{kit} + \sum_{m=1}^{M} \gamma_m Z_{mi} + u_i + \epsilon_{it} \tag{6}$$

First step : estimation of equation with fixed effects estimator
The *fevd* procedure estimates a standard fixed effects (Within) model, excluding time-invariant Z-variables, in order to obtain estimates of the unit effects $\hat{u}_i$.

Figure 2: Federal Highway Map of Brazil, in 2005. Source : Brazilian ministry of transport

$$y_{it} - \overline{y} = \beta_k \sum_{k=1}^{K} (x_{kit} - \overline{x}_{ki}) + (e_{it} - \overline{e}_i) = \ddot{y}_{it} = \beta_k \sum_{k=1}^{K} \ddot{x}_{kit} + \ddot{e}_{it} \tag{7}$$

Second step : the procedure splits the individual effects into an explained and an unexplained part
We obtain $\hat{u}_i$:

$$\hat{u}_i = \bar{y}_i - \sum_{k=1}^{K} \beta_k^{FE} \bar{x}_{ki} - \bar{e}_i \tag{8}$$

The procedure splits the individual effects $\hat{u}_i$ into an explained and an unexplained part h_i by regressing the unit effects on the time-invariant explanatory variables of the original model. Regression of the unit effects $\hat{u}_i$:

$$\hat{u}_i = \sum_{m=1}^{M} \gamma_m Z_{mi} + h_i \tag{9}$$

The unexplained part h_i is obtained by predicting the residuals :

Table 9: Number of kilometres of roads (1), per square km (2) and per 100,000 inhabitant (3) by Brazilian state, in 2000

Brazilian state	1 in thousands, 2 in %, 3 in %	Brazilian state	1 in thousands, 2 in %, 3 in %
Norte		**Centro-Oeste**	
Acre	5.4, 3, 0.6	Goiás	87.7, 26, 0.5
Amazonas	6.2, 0.3, 0.01	Mato Grosso	54.1, 5, 0.2
Amapá	2.1, 1.5, 0.3	Mato Grosso Sul	85.5, 24, 1
Para	34.6, 2.7, 0.04	Distrito Federal	1.5, 25, 2
Rondônia	22.3, 9.4, 0.6		
Roraima	5.3, 2.3, 0.7		
Nordeste		**Sudeste**	
Alagoas	12.9, 46, 1.6	São Paulo	195.1, 79, 0.2
Bahia	120, 21, 0.1	Rio de Janeiro	22.2 51, 0.3
Cearà	50.3, 34, 0.4	Minas Gerais	265, 45, 0.2
Maranhão	53.2, 16, 0.2	Espírito Santo	30.2, 66, 2.1
Paraíba	33.8, 59, 1.7		
Pernambuco	41.7, 42, 0.5	**Sul**	
Piauí	56.8, 23, 0.8	Paraná	115.6, 58, 1.7
Sergipe	9.4, 43, 2.4	Santa Catarina	62.5, 66, 1.2
Rio grande do Norte	27.4, 52, 1.8	Rio grande do sul	152, 54, 0.5
Country	2 in %, 3 in %	Country	2 in %, 3 in %
France	163, 0.27	Brazil	20, 0.01
UK	159, 0.27	Chile	10
USA	66, 0.02	Argentina	7, 0.02
World	62		

Source for Brazil : *Anuário Estatístico dos Transportes Terrestres*/2005 (AETT) and calculation of the authors for km of roads per sq-km and per inhabitant. The number of kilometres of roads per square km is divided by the population in 1999. Source for foreign countries : World Bank's World Development Indicators.

$$h_i = \hat{u}_i - \sum_{m=1}^{M} \gamma_m Z_{mi} \tag{10}$$

Third step : a pooled OLS estimation with the unexplained part of the fixed effects
The third stage runs a pooled OLS estimation of the model by including all explanatory time-variant variables, the time-invariant variables, and the unexplained part of the fixed effects vector h_i.

$$y_{it} = \alpha + \sum_{k=1}^{K} \beta_k X_{kit} + \sum_{m=1}^{M} \gamma_m Z_{mi} + h_i + \epsilon_{it} \tag{11}$$

7.3 Results

Table 10: OLS estimation of the internal border effect of Brazilian states (relative to the pair Acre-Argentina)

	Dependent Variable: $ln(X_{ij}/(Y_i{*}Y_j))$			
	(1991)	(1997)	(1998)	(1999)
Brazil	**-3.14**	**-2.72**	**-2.58**	**-2.57**
(Brazil's internal border effect)	(.462)***	(.464)***	(.453)***	(.456)***
Foreign	-7.92	-6.49	-5.87	-6.36
(relative to Acre-Argentina)	(.644)***	(.647)***	(.639)***	(.638)***
ln Distance$_{ij}$	-1.38	-1.29	-1.36	-1.34
	(.088)***	(.096)***	(.088)***	(.086)***
Constant	-15.69	-17.98	-17.66	-17.54
	(.792)***	(.956)***	(.875)***	(.880)***
Observations	2245	2421	2415	2441
R^2	0.75	0.75	0.75	0.75
exporter fixed effects	yes	yes	yes	yes
importer fixed effects	yes	yes	yes	yes

Note: Robust standard errors in parentheses: ***, ** and * represent respectively statistical significance at the 1%, 5% and 10% levels. Coefficients of exporter and importer fixed-effects are not reported for space reason.

In our dataset, about 50% of the exports from Brazilian states to foreign countries are equal to zero for each year. We use the Heckman's procedure to handle these non-participating observations. The first step is to create the selection model using a probit estimator and a binary dependent variable (coded 0 for trade equal to zero). The predictor variables are the GDP variables in log and in level and the bilateral distance. Then, we calculate the Inverse Mills Ratio (IMR). The second step of the

method is to include the IMR as a separate predictor variable in the gravity equation, which helps to determine whether there was bias in the initial gravity equation.
Table 12 reports results (to be compared to those of Table 4). The IMR is significant only the year 1991: the existence of a bias, due to the omission of the null trade flows, is confirmed only for this year. But the selection bias is probably weak since rho is low (when rho is equal to zero, regression provides unbiased estimates). The results on the dummies *Foreign* and *Brazil* are very close to those found with cross-section regressions estimated without the Heckman's correction. In consequence, the omission of the null trade flows does not introduce substantial bias in the estimates of coefficients. This result is confirmed through a Poisson Maximum Likelihood analysis in section 3.3.

Table 11: Random-effects estimations of the international border effects of Brazilian states (with GDP variables on the right hand side)

	Dependent Variable: lnX_{ij}			
	(1991)	(1997)	(1998)	(1999)
Brazil	-3.00	-2.50	-2.26	-2.31
	(.396)***	(.414)***	(.413)***	(.415)***
Foreign	-5.91	-5.05	-4.73	-5.53
	(.621)***	(.592)***	(.625)***	(.631)***
ln Distance$_{ij}$	-1.30	-1.27	-1.35	-1.29
	(.093)***	(.088)***	(.094)***	(.093)***
Common border$_{ij}$	.40	.28	.41	.42
	(.207)*	(.213)	(.213)*	(.215)*
Common language$_{ij}$	.07	.86	1.04	.48
	(.418)	(.360)**	(.401)***	(.408)
ln(GDP$_i$*GDP$_j$)	.92	.99	1.00	1.00
	(.027)***	(.025)***	(.027)***	(.027)***
Constant	-15.91	-19.45	-19.75	-19.55
	(1.355)***	(1.236)***	(1.366)***	(1.335)***
Observations	2245	2421	2415	2441
exporter fixed effects	yes	yes	yes	yes
importer random effects	yes	yes	yes	yes
Interstate border effects	20.1	12.2	9.6	10.1
International border effects	368.7	156.0	113.3	252.1

Note: Standard errors in parentheses: ***, ** and * represent respectively statistical significance at the 1%, 5% and 10% levels. Coefficients of exporter fixed-effects are not reported for space reason.

Table 12: Heckman method in a Random effects estimation of the international border effects of Brazilian states

	Dependent Variable: $ln(X_{ij}/(Y_i{*}Y_j))$			
	(1991)	(1997)	(1998)	(1999)
Brazil	-2.99	-2.50	-2.23	-2.28
(log internal border effect)	(.397)***	(.415)***	(.414)***	(.417)***
Foreign	**-5.91**	**-5.06**	**-4.70**	**-5.51**
(log international border effect)	(.631)***	(.606)***	(.635)***	(.645)***
ln Distance$_{ij}$	-1.50	-1.28	-1.30	-1.24
	(.105)***	(.099)***	(.108)***	(.109)***
Common border$_{ij}$	.38	.26	.38	.39
	(.208)*	(.214)	(.214)*	(.216)*
Common language$_{ij}$	.06	.85	1.05	.48
	(.428)	(.377)**	(.412)**	(.424)
Inverse Mills ratio	-.15	.002	.05	.06
	(.072)**	(.066)	(.073)	(.073)
Constant	-16.64	-19.45	-20.21	-19.49
	(.987)***	(.928)***	(1.008)***	(1.009)***
Observations	2245	2421	2415	2441
exporter fixed effects	yes	yes	yes	yes
importer random effects	yes	yes	yes	yes
rho	0.08	0.05	0.08	0.08
Internal border effect	**19.9**	**12.2**	**9.3**	**9.8**
International border effect	**368**	**157**	**110**	**250**

Note: Standard errors in parentheses: ***, ** and * represent respectively statistical significance at the 1%, 5% and 10% levels. Coefficients of exporter fixed-effects are not reported for space reason.

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