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BORDERS, TRADE AND WELFARE

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### ABSTRACT

International economic integration yields large potential welfare effects, even in a static constant returns competitive world economy. Our method is novel. The effect of border barriers on trade flows is often inferred from gravity models. But their rather atheoretic structure precludes welfare analysis. Computable general equilibrium models are designed for tight welfare analysis, but lack econometric foundation. Our method combines these approaches. Gravity models based on Anderson's (1979) interpretation are full general equilibrium models of a special simple sort. In Anderson and van Wincoop (NBER WP 8079, 2001) we develop and estimate this structure, then calculate the comparative static effects on trade flows of border barriers. In this paper we further deploy the model to explore the comparative statics of welfare with respect to borders, to currency unions and to NAFTA. Our NAFTA exercise does a much better job of replicating the actual trade flow changes than do computable general equilibrium models. An interesting implication is that terms of trade changes are very important, even for 'small' countries such as Mexico.

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## **Introduction**

In the era of globalization, are borders just arbitrary lines on the map? Our results (Anderson and van Wincoop, 2001) show that border barriers are large and inhibit much trade. In this paper we show that further economic integration can very substantially increase world trade and welfare. We demonstrate this point with several applications.

National borders mark differences in institutions, policies and regulations that have economic significance. The significance of these policies becomes immediately clear when comparing countries to regions within countries that are not separated by national borders. Regions within countries are clearly more integrated: they have more synchronized business cycles, they engage in more extensive risk-sharing, they trade more with each other, their growth rates converge faster, their inflation rates are more similar.<sup>1</sup>

This chapter is concerned with the barriers to the free flow of goods implied by the policies, institutions, and regulations that separate nations. Some policies are specifically aimed at erecting such barriers. All other trade restricting effects of national borders ultimately can be understood to reflect policy, with the proviso that much institutional trade friction is not easily changed. We will discuss estimates of the size of these border barriers, as well as their impact on trade levels and on welfare. Our welfare analysis takes the extreme position of treating all border barriers as trade costs without any corresponding benefits. A complete analysis would of course take account of the benefits associated with some border barriers --- differences in national languages and customs may reduce trade but surely provide non-economic and economic gains to the nations that

maintain them. Our analysis provides insights into the implications of removing the policy related barriers, either unilaterally, or through customs unions or currency unions.

Two commonly used tools to evaluate the effects of border barriers are gravity equations and computable general equilibrium models. Gravity equations generally find that borders have a substantial negative effect on trade, while integration has a positive effect. But the estimated equations are a very crude tool for policy analysis because they are based on ad hoc specifications that can be seriously questioned on theoretical grounds. The ad hoc nature of standard gravity equations also precludes welfare analysis. Computable general equilibrium (CGE) models are potentially more useful for policy analysis but they have two drawbacks: (1) they are simulated rather than estimated, and (2) they are almost always based on a very large black box consisting of dozens to hundreds of equations. The first characteristic makes it difficult to know how reliable is the simulation model while the second characteristic makes it difficult to evaluate what drives the findings. Many CGE models have been applied to evaluate the impact of NAFTA, but almost always the implied effect on Mexican trade is only a small fraction of what we have seen in reality. Moreover, these models have the additional problem that while they capture the policy barriers of interest, such as tariffs under NAFTA, they omit other relevant trade barriers. We find that these other barriers are several to many times the size of formal trade barriers and their presence alters the proper analysis of the impact of removing formal barriers.

The goal of this chapter is to provide a general understanding of how border barriers affect trade and welfare in the simple gravity with gravitas framework developed in our

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<sup>1</sup> See Hess and van Wincoop (2000).

previous work<sup>2</sup>. We discuss three specific applications: (i) the effect of estimated total border barriers on trade and welfare among OECD countries, (ii) the effect of currency unions on trade and welfare, and (iii) the removal of tariff barriers under NAFTA. The framework deploys a theoretically grounded gravity model as a full general equilibrium model which is estimated (meeting objection (1)) and yet is simple enough to open the black box (meeting objection (2)).

### **Types of Trade Costs**

The nature of trade costs is important to our modeling and to our applications. Different types of costs require different treatments. We deploy a two-way classification, dividing costs into those that are related to national borders and those that are not, and further dividing border costs into those that generate rents (payments above opportunity cost) and those which do not.

Non-border costs are largely natural trade costs that arise from distance and geographical irregularity interacting with the most efficient transport and communications technology. While most analysis on international trade policy ignores these non-border barriers, they are important even if one's interest is in the implications of border barriers. The non-border barriers generally reduce the effect of border barriers on trade and welfare. We will show that they also have implications for the terms of trade response to a reduction in border barriers.

Most international trade policy leads to border costs that involve rents. With tariffs the rent accrues to the government, and is rebated to the general public through tax and spending policy. Export and import quotas also involve rents, accruing to the license

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<sup>2</sup> See Anderson and van Wincoop (2001).

holders. A host of more devious nontariff barriers (discriminatory use of standards and the like) also lead to rents for private beneficiaries.

Most border barriers (see below for evidence) result from factors unrelated to trade policy, and do not generate rents. Differences in languages, cultures, customs, and regulations all impose barriers to trade that are specific to borders. Some of these barriers, such as differences in regulations and product standards, may be relatively easy to harmonize. Others, such as language and cultural differences, may be much more difficult to remove. Some barriers may only be removed after extreme measures such as complete political integration. A full analysis would consider that some border barriers of this type confer national benefits which are missing from our analysis which focuses on the cost side.

The distinction between rent-bearing and non-rent-bearing trade costs is fundamental. Non-rent border barriers generate trade costs that involve real resources, such as gathering information about foreign regulations, hiring lawyers familiar with foreign laws, learning foreign languages and adjusting product designs to make them consistent with foreign customs and regulations. Barriers involving rents involve a transfer between those who pay the rent and those receiving the rent.

Non-rent border barriers have larger welfare implications than do tariffs and quotas. With non-rent border costs the higher price that the consumer pays for imports is a payment for real resources. In contrast, a tariff offsets the higher cost a consumer pays for imported goods with an increase in tariff revenue, which somehow gets rebated to the general public. Tariffs or quotas have welfare effects only as a result of the gap they create between marginal social costs and benefits. A reduction in the tariff will expand

imports, an activity for which the marginal benefit exceeds the marginal cost. This raises real income by reducing dead weight loss .

Although in most of what follows we will assume that tariffs and quotas are the main border barriers involving rents, some other border barriers may involve rents as well. For example, the anti-McDonald s campaign of Jos Bov and his allies presumptively protects inefficient French farmers and restaurateurs. One way to think about this is as a disinformation campaign about McDonald s. It involves no real resource costs and has exactly the same outcome as the imposition of a tariff or quota on imports from McDonald s. Another possible example is the deliberately insular customs among local business persons, making it difficult for foreign exporters to penetrate the market. Here it depends on what drives these insular customs. If they are the result of tight business relationships due to small distances between the firms, the resulting trade barriers may not be related to borders at all. If the insular customs are related to language and other cultural traits, they lead to non-rent border barriers. On the other hand, if the deliberately insular customs are the result of misinformation about doing business with foreigners, its effect is the same as that of a quota.

In the applications presented below, we have examples of reductions in both kinds of costs. As for rent-bearing costs, we analyze the effects of the reduction in tariffs resulting from NAFTA. We also analyze two examples of rent-free costs. The first involves border costs among OECD countries in 1993.<sup>3</sup> Since formal trade barriers among industrialized countries are not very high, we think of these mostly as non-rent border barriers, but for sensitivity analysis we will also consider the welfare implications if instead they were tariffs. Explaining what really lies behind the border barriers is an

important task for future work. Second, we report on the effects of joining currency unions.<sup>4</sup> The use of different moneys across borders can form a barrier as there are costs in exchanging currencies in spot and forward markets and traders face uncertainty about currency movements that cannot always be hedged. A common currency also leads to greater transparency of price differentials.

### **Understanding the Effects of Border Barriers**

What factors determine the implications of border barriers for trade and welfare? We will employ a very simple theoretically grounded gravity equation that we developed in recent work, which easily lends itself to addressing these questions in a variety of different contexts.<sup>5</sup> The theory tells us that after controlling for size, trade between two countries depends on *relative* trade barriers. What matters is the bilateral barrier between the countries relative to the average trade barriers each country faces with all its trading partners, which we refer to as *multilateral resistance* .

The basic idea from the exporters point of view is that each country produces a certain quantity of goods that needs to be sold somewhere. Relatively more goods will be sold to the countries with which border barriers are relatively low compared to other trading partners. The basic idea from the importers point of view is that each country demands the goods of each other country, but relatively more goods will be purchased from countries for which the importer s trade barriers are relatively low. The Anderson and van Wincoop model rigorously shows that size-adjusted bilateral trade depends on

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<sup>3</sup> These are estimated in Anderson and van Wincoop (2001).

<sup>4</sup> This is based on Rose and van Wincoop (2001).

<sup>5</sup> See Anderson and van Wincoop (2001). A theoretical gravity equation was first developed by Anderson (1979).



the ratio of bilateral resistance to the product of the multilateral resistances of each partner.

We utilize the estimated model as a computable general equilibrium model in order to simulate the effects of changes in various border barriers on trade flows and welfare. The commonly used empirical gravity equations are in contrast both estimated inconsistently and unable to be used for general equilibrium simulations. The typical setup assumes that only bilateral barriers matter for trade between two regions or countries. Some more recent work has nodded at the problem of barriers between a country and all of its partners, but it does so in a way inconsistent with the theory.<sup>6</sup>

We will now first describe the model and its implications in the absence of rents. After that we will describe how the presence of rents affects the results, particularly for welfare.

### **A Formal Treatment in the Absence of Rents**

The gravity equation is derived using the properties of market clearance and the CES structure of demand. We focus on final demand here, but an essentially identical structure emerges with intermediate demand systems. Each region produces a unique good and desires to consume the goods of all regions. The seller's price at the factory gate of region  $i$ ,  $p_i$ , is raised by the trade cost factors  $t_{ij}$  for each consuming region  $j$ :  $p_{ij} = p_i t_{ij}$ . The exporter incurs the trade cost and passes it on to the importer. Let income in region  $j$  be given by  $y_j$ . The CES demand structure implies that the value of shipments from  $i$  to  $j$  is

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<sup>6</sup>See the discussion in Anderson and van Wincoop (2001), page 12.

$$(1) \quad x_{ij} = (\beta_i p_i)^{1-\sigma} \left( \frac{t_{ij}}{P_j} \right)^{1-\sigma} y_j$$

$$P_j \equiv \left[ \sum_i (\beta_i p_i)^{1-\sigma} (t_{ij})^{1-\sigma} \right]^{1/(1-\sigma)}.$$

Here,  $\{\beta_i\}, \sigma$  are the distribution and substitution parameters of the CES structure.

Now we derive the gravity model. Market clearance implies that:

$$(2) \quad y_i = \sum_j x_{ij} = (\beta_i p_i)^{1-\sigma} \sum_j \left( \frac{t_{ij}}{P_j} \right)^{1-\sigma} y_j.$$

Substituting the CES price index definition into (2) yields a system which can be solved for the scaled supply prices  $\{\beta_i p_i\}^{1-\sigma}$  as implicit functions of the trade costs and the observable incomes. But Anderson and van Wincoop show that with symmetry, the solution is the same as the solution to:

$$(\beta_i p_i P_i)^{1-\sigma} = y_i / \sum y_i.$$

Substituting into (1)-(2) we obtain our version of the gravity model:<sup>7</sup>

$$(3) \quad x_{ij} = \frac{y_i y_j}{\sum y_j} \left( \frac{t_{ij}}{P_i P_j} \right)^{1-\sigma}$$

$$P_i^{1-\sigma} = \sum_j P_j^{\sigma-1} (t_{ij})^{1-\sigma} y_j / \sum y_j.$$

This equation clearly shows that bilateral trade depends on relative trade barriers: the bilateral barrier  $t_{ij}$  divided by what we refer to as multilateral resistance variables  $P_i$  and  $P_j$ , which relate to average trade barriers of the exporter and importer with all their trading partners.

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<sup>7</sup> Anderson and van Wincoop (2001) argue that the same gravity equation can be estimated under a wide range of asymmetric trade barriers, interpreting the barrier between two regions as an average of the barrier in both directions.

The empirical model is completed by linking the unobservable trade costs to observables:

$$t_{ij} = d_{ij}^{\rho} b^{\delta_{ij}}$$

where  $d_{ij}$  is distance between the economic centers of  $i$  and  $j$ , capturing non-border barriers, and  $b$  represents the cost factor imposed by the international border.  $\delta_{ij}$  is equal to zero if  $i$  and  $j$  are in the same country and is equal to one if they are in separate countries. System (3) was estimated using nonlinear least squares in Anderson and van Wincoop. The market clearing equations yield estimates of  $P_i^{1-\sigma}$  for each region; these are substituted into the gravity equation to compute the level of trade implied by the model.

The gravity model can very usefully be treated as a simulation model. For this purpose we close the supply side of the model with the simplest assumption possible: an endowment economy. Thus each region is assumed to be endowed with a stock of goods  $\bar{y}_i$ , nominal income  $y_i$  being equal to  $p_i \bar{y}_i$ . Given the estimates of the trade cost parameters, we calculate the effect of various changes on trade flows.<sup>8</sup>

We can also calculate the effect of changes in trade costs on welfare:

$$(4) \quad U_i = \bar{y}_i \frac{p_i}{P_i}$$

Welfare is therefore inversely related to the average trade barrier a country faces with all its trading partners, the multilateral resistance term  $P_i$ .

We will now discuss a set of general implications of the model that has just been described. This will facilitate the interpretation of our findings when we conduct various

policy experiments below. In what follows we will define size-adjusted trade as the bilateral flow divided by the product of importer and exporter GDP and multiplied by world GDP. The following five properties then follow from the model:

1. *Border barriers lead to a larger percentagewise increase in size-adjusted domestic trade in small countries than in large countries.*

Countries either export the goods they produce or sell them domestically. Border barriers only affect international trade, therefore reducing the relative barrier of domestic trade. Small countries rely more on exports than large countries, so that border barriers raise their average trade barrier more and the relative barrier of domestic trade is reduced more. This leads to a larger increase in domestic trade of small countries.

There is another way to look at this, which leads to the same conclusion. In a world consisting of a large and a small country, a given reduction in trade between them leads to an identical absolute increase in domestic trade within both countries. But since the level of domestic trade is much smaller in the small country, the percentagewise increase in domestic trade is much larger for the small country.

2. *Border barriers reduce size-adjusted trade between large countries more than between small countries, but they have a larger effect on the welfare of small countries.*

Since border barriers raise average trade barriers more for small countries, the relative barrier between small countries rises less than between larger countries.

Therefore trade drops less among small than large countries.

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<sup>8</sup> An assumption also needs to be made about  $\sigma$ , but this turns out to have a negligible effect on equilibrium prices and quantities. It does affect welfare though.

The welfare effect is in contrast larger for small countries. We saw that welfare is inversely related to the average trade barrier a country faces. Small countries rely more on international trade, so that border barriers raise their average trade barrier more than for large countries, resulting in a bigger decline in welfare. This is a familiar theme in international trade analysis: small countries get most of the gain from trade.

3. *The rise in size-adjusted trade among the members of a regional trade agreement (RTA) is smaller the larger the size of the union. On the other hand, the welfare effect is larger the bigger the union.*

The average trade barrier for the members of a RTA drops more the bigger the size of the union. Therefore relative trade barriers between those members drop less the bigger the union's size, leading to a smaller rise in trade among the union's members. On the other hand, the bigger drop in average trade barriers for a large RTA leads to a bigger rise in welfare. A world union has the largest possible effect on welfare, but the smallest effect on trade.

This also illustrates how the traditional empirical gravity approach, which only controls for bilateral barriers, can lead to misleading conclusions. For the same drop in border barriers in a small RTA as in a large RTA, the traditional gravity approach would predict that the impact on trade is the same.

4. *The rise in size-adjusted trade among the members of a RTA is smaller the higher the level of pre-union trade among its members. But the welfare effect is larger the higher the level of pre-union trade.*

This result is closely related to the previous one about the size of the union. A reduction in border barriers among a set of countries reduces their average trade barriers

more the greater their level of pre-union trade. If the countries are located far apart and are trading little to start with, a reduction in border barriers between them will have much less of an effect on their average trade barriers. As discussed above, a larger reduction in average border barriers leads to a smaller effect of the RTA on trade, but a bigger effect on welfare.

5. *The effect of border barriers on trade and welfare is smaller the larger the non-border trade barriers.*

This result arises because non-border trade barriers, such as transport or communication costs, lead to a home bias in trade. It is most easily understood by considering the extreme of very high non-border barriers due to prohibitive transport costs. In that case there would be a low level of international trade even in the absence of border costs. The increase in international trade that can be achieved by removing border barriers is naturally very small.

### **The Role of Rents**

We now introduce rents in the form of tariffs. The tariff on shipments from  $i$  to  $j$  is  $\tau_{ij}$ , leading to the following modified trade cost expression:

$$t_{ij} = \tau_{ij} d_{ij}^{\rho} b^{\delta_{ij}}$$

Let  $s_{kj}$  be the CES spending share on good  $k$  in country  $j$ ,  $p_{kj} m_{kj} / z_j = (\beta_k p_{kj} / P_j)^{1-\sigma}$ , where  $m$  denotes the quantity demanded and  $z$  denotes expenditure. Tariff revenue is rebated to consumers so that total consumer income expended by residents of region  $j$  becomes  $z_j = y_j + \sum_k (\tau_{kj} - 1) p_{kj} m_{kj} / \tau_{kj}$ .<sup>9</sup> The income of region  $j$  can be solved using the system of demand equations as  $z_j = y_j / [1 - \sum_k (\tau_{kj} - 1) s_{kj} / \tau_{kj}]$ . Nominal income is

multiplied on the right hand side by a tariff multiplier, reflecting the rebated tariff revenue. As a result of this complication we now no longer get the simple gravity equation expression (3), but  $x_{ij} = p_{ij}m_{ij} / \tau_{ij}$  can still be derived by substituting the solution to the modified goods market equilibrium conditions into the modified demand equation. The trade results are not much different than in the model without rents and the five general implications of the model listed above still hold with regards to trade.

The welfare implications change significantly once rents are introduced. Rents are a transfer so a reduction confers a benefit to consumers offset by a loss to the former rent recipient. Utility of residents from region  $i$  becomes

$$(5) \quad U_i = \bar{y}_i \frac{p_i / P_i}{1 - \sum_k (\tau_{ki} - 1) s_{ki} / \tau_{ki}}.$$

The difference with the welfare expression (4) for the case without rents is the tariff multiplier term.

In order to compare welfare effects of borders with and without rents it is useful to decompose the welfare effect of lowering border barriers into three components: (i) the direct welfare impact measured at the old terms of trade and trade levels, (ii) the welfare impact associated with a change in trade levels, (iii) the welfare impact associated with a change in the terms of trade. In the applications below we will decompose the welfare effect into each of the components described above. We will now first focus on the first two effects, keeping the terms of trade constant.

For the no rent case, differentiating (4) while holding the terms of trade constant, we have

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<sup>9</sup> The tariff is levied on the external (pre-tariff) value of imports.

$$\frac{\partial U_i}{\partial t_{ji}} = -\frac{U_i}{P_i} \frac{\partial P_i}{\partial t_{ji}} \Rightarrow \frac{\partial \ln U_i}{\partial \ln t_{ji}} = s_{ji}.$$

This is a familiar expression from consumer theory. Intuitively, when a trade cost falls, real resources are saved (in terms of iceberg trade costs, less is melted away). We will use the label *resource effect* to denote the direct impact on welfare with non-rent border barriers. This welfare effect is entirely associated with the first type of welfare gains, measured at a constant terms of trade and trade levels. There will be an optimal change in trade levels when non-rent border barriers change. The welfare effect from that is second order and therefore does not show up in the expression above. Since trade levels were optimal before the change in barriers, the Envelope Theorem tells us that a marginal change in the trade composition does not have any first order welfare effects. A second order welfare effect can nonetheless be very big when the change in trade barriers is large, which will be illustrated in the first application below.

For the rent case, differentiating (5) with respect to  $\tau_{ji}$ , and using Shephard's Lemma for the CES case, all when holding the terms of trade constant gives

$$(6) \quad \begin{aligned} \frac{\partial U_i}{\partial \tau_{ji}} &= \frac{(U_i / P_i) \pi_{ji}}{1 - \sum_k (\tau_{ki} - 1) s_{ki} / \tau_{ki}} \left[ -\partial P_i / \partial p_{ji} + \partial P_i / \partial p_{ji} + \sum_k (\tau_{ki} - 1) \pi_{ki} \partial P_i^2 / \partial p_{ki} \partial p_{ji} \right] \\ &= \frac{1}{P_i} \frac{\pi_{ji}}{1 - \sum_k (\tau_{ki} - 1) s_{ki} / \tau_{ki}} \sum_k (p_{ki} - \pi_{ki}) \partial m_{ki} / \partial p_{ji}. \end{aligned}$$

Here  $\pi_{ji} = p_{ji} / \tau_{ji}$  is the import price net of tariffs and  $\partial m_{ki} / \partial p_{ji}$  is the compensated demand derivative. The transition from the first to the second line formalizes the intuition that a change in a rent-bearing trade cost has no net effect at constant trade volumes because it is a transfer. Thus in contrast to the case without rents the direct effect of the change in trade costs, the first welfare effect, is equal to zero. The summation term on the second



line is familiar from public finance and trade policy analysis; it is marginal dead weight loss. Trade is allocated such that the marginal willingness to pay  $p_{ji}$  exceeds marginal cost  $\pi_{ji}$  and a reduction in demand of such a good as a result of a rise in its price is welfare reducing. The second line therefore gives the second welfare effect, associated with the change in trade levels. In contrast to the case without rents, here it is a first order welfare effect.

For the purpose of analyzing regional trade agreements, it is useful to make a further decomposition of the first order welfare effect associated with the change in trade levels when there are rents. Note that regional trade agreements lower a set of bilateral tariffs in the partnership while maintaining others. At constant world prices of all goods (i.e., those of the partners too), regional free trade agreements are simultaneously a move toward free trade, creating added trade volume, and a move away from free trade, diverting trade from the rest of the world (ROW) to a partner. A large and rather confusing literature was initiated by the classic Viner analysis of free trade agreements focusing on the concepts of trade creation and trade diversion.<sup>10</sup> In our decomposition, trade creation increases welfare while trade diversion reduces it. Formally, expanding the summation term on the second line of (6), we have, assuming that  $i$  and  $j$  are members of the regional agreement  $N$ , the welfare effect of a small reduction in bilateral tariff  $\tau_{ji}$  is proportional to:

$$\sum_{k \in N} (p_{ki} - \pi_{ki}) \frac{\partial m_{ki}}{\partial p_{ji}} d\tau_{ji} + \sum_{k \notin N} (p_{ki} - \pi_{ki}) \frac{\partial m_{ki}}{\partial p_{ji}} d\tau_{ji}.$$

The first term is positive if there is only one partner (since  $p_{ii} - \pi_{ii} = 0$  and  $\partial m_{ji} / \partial p_{ji} < 0$ );

the second term is ordinarily negative (and is necessarily so for the CES case). Regional integration involves changing the set of bilateral tariffs among the partners, hence summing the preceding expression across all bilateral tariff reductions. The aggregate of the first term should again be positive while the aggregate of the second term will be negative. We call these terms marginal trade creation and marginal trade diversion respectively and we use a discrete analog to the expressions above to compute them.

The final welfare effect is the result of terms of trade changes. Similar terms of trade effects apply to the case with and without rents. It is common to believe that only large countries can affect their terms of trade through tariffs on imported goods. Strictly speaking no country is small in the gravity model since, similarly to most applied general equilibrium models, each country is assumed to produce unique goods. Nevertheless, tiny countries would have little effect on their terms of trade in a frictionless world. If tariffs were the only trade barriers that exist, since they are low, small countries would again have little power over their terms of trade. But as we have pointed out, there are many other trade barriers, both border barriers and non-border barriers, which swamp the tariff barriers in effect. These all lead to a home bias in trade.

A small country can affect its terms of trade substantially by changing tariffs on imported goods because it buys a disproportionately large fraction of its own goods due to high border barriers. A drop in a nation's own tariff will ordinarily lead to a terms of trade deterioration, while a drop in the tariffs of trading partners will lead to a terms of trade improvement. This point will be further elucidated below in the discussion of NAFTA.

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<sup>10</sup> What Viner really meant and what others have interpreted these concepts to mean subsequently is a digression we avoid.

### **Application #1: Border Barriers among OECD countries**

Tables 1 and 2 report some results based on estimation of the theoretical gravity equation in Anderson and van Wincoop for US states, Canadian provinces and twenty other OECD countries (denoted ROW). Table 1 reports the tariff equivalent of estimated border barriers assuming an elasticity of substitution equal to five among goods of different countries. The welfare results in Table 2 also depend on this elasticity. In contrast the trade change numbers of Table 1 are not sensitive to the elasticity. The estimation assumes a single border barrier among the entire set of ROW countries.<sup>11</sup>

Most of the border barriers have a tariff equivalent in the neighborhood of 50%. Even if the elasticity of substitution were as high as 10, which is above most estimates in the literature, the border barriers would still be around 20%. It is therefore clear that the policies, institutions and regulations that separate nations create very large barriers to trade across borders. Just what these border barriers represent is an important task for future research. Our results only indicate that they are large and that they have large consequences for trade and welfare.

Table 1 also reports the increase in international trade achieved by the removal of all border barriers. We are able to compute these numbers by solving the general equilibrium model both before and after the removal of all the border barriers. The removal of border barriers raises trade between the US and Canada by 79%, while raising trade among ROW countries on average by 41%. While these are substantial numbers, the enormous size of the reported border barriers might be expected to cause much larger trade changes. The explanation is that trade between countries is not determined by the absolute size of

the border barriers, but rather by relative trade barriers. While borders raise barriers between any pair of countries, they also raise barriers of each partner with all their other trading partners (only domestic barriers are unaffected by borders). This significantly dampens the effect of borders on relative barriers and therefore on trade. For example, trade between the US and Canada would have increased by a factor five if we removed the bilateral border barrier between them while keeping constant the average trade barriers that both countries face with all their trading partners.

US-Canada trade rises a bit more than trade among other OECD countries, even though the US-CA barrier is a little lower. This is because the US is a large country, so that its average trade barrier is less affected by borders. This leads to a more substantial drop in relative trade barriers that the US faces with other countries, and therefore a bigger rise in trade. Trade between the US and ROW countries rises even more since ROW countries tend to be larger than Canada.

It is useful to cast these findings in the context of the so-called trade home bias puzzle . Estimation of empirical gravity equations has found enormous effects of borders on trade. One well known finding is that, after controlling for distance, trade between Canadian provinces is about twenty times larger than between provinces and US states.<sup>12</sup> Partially, as we have shown in our recent work, this is a result of estimating a misspecified equation, which focuses on bilateral rather than relative trade barriers. To a large extent it is also the result of a very large increase in domestic trade. Our earlier work showed that borders raise trade between Canadian provinces by a factor 6. As discussed above, for small countries border barriers significantly reduce the relative

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<sup>11</sup> See Anderson and van Wincoop (2001) for details.

<sup>12</sup> See McCallum (1995).

barrier associated with domestic trade, leading to a large increase in domestic trade. It is therefore misleading to interpret the trade home bias numbers that have been reported in the traditional gravity literature as indicators of the effect of borders on *international* trade.

Table 2 reports the increase in welfare following the removal of border barriers, measured as the percentage rise in the real level of consumption. The number for ROW refers to an unweighted average of the percentage welfare increase of the twenty other OECD countries. These results show that the estimated border barriers have enormous welfare effects, as large as 52% for Canada. The numbers depend on the assumed elasticity of substitution of 5, but even for a high elasticity of 10 Canadian welfare would still rise by 20% if all border barriers were removed. As anticipated above, the welfare effect is smaller for a large country such as the United States as it relies less on international trade. Nonetheless even the US stands to gain significantly from a reduction in border barriers. The results suggest the importance in future work of trying to understand what costs lie behind the border barrier.

The breakdown of the welfare effect into the three components discussed above shows that they are all important.<sup>13</sup> The resource effect is the biggest, about half of the total welfare effect for the US and ROW countries and slightly less for Canada. Even though the trade effect is technically a second order effect, the welfare improvement associated with it is nonetheless very large, as much as 13% for Canada. This is because the size of the border barriers is big. For a small change in border barriers the welfare

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<sup>13</sup> If one sums the numbers in the three columns that provide the breakdown, they do not exactly add up to the total in the first column. That is because the numbers in the breakdown columns are cumulative. For example, for Canada  $0.516=1.183*1.129*1.135-1$ .

improvement associated with the change in trade patterns would be small compared to the resource and terms of trade effects (which are both first order effects).

The terms of trade effect is negative for the US, while positive for Canada and the average of the ROW countries. The latter hides the fact that the largest ROW countries, Japan, Germany and France, experience negative terms of trade effects, while the smaller ones experience a terms of trade improvement. As expected, large countries gain from trade restrictions. The relative price of goods from small countries will rise when border barriers are removed since they rely more on exports for the sale of their goods. Lower border barriers raise export demand and the price.

We have assumed that the estimated border barriers are non-rent barriers. As a form of sensitivity analysis it is useful to compute the welfare implications if instead the estimated barriers were tariff barriers. In that case the welfare increase is 2.9% for the US, 30% for Canada and 16.8% for ROW countries. So even if rents were involved in some of the estimated border barriers, they still have very large welfare effects. These numbers are close to the welfare effects in Table 2 when subtracting the resource effect, which does not apply with rent barriers.

The results reported here depend on our estimate of non-border barriers, which in the model is captured by distances within and between regions and countries. If there were no distance related barriers, the welfare effects would be even larger: 19% for the US, 75% for Canada and 58% on average for ROW countries. Reductions in the costs of transportation and communication therefore make the existing border barriers only more important.

One might argue that these large welfare improvements are not realistically attainable since the policy experiment we have conducted here, the removal of all border barriers, is not easy to achieve in practice. We will therefore now turn to a policy experiment that is more easily implemented, the formation of currency unions.

### **Application #2: Currency unions**

Rose and van Wincoop have applied the theoretical gravity model to determine the size of the border barrier associated with the use of different currencies across national borders, as well as its effects on trade and welfare.<sup>14</sup> The analysis is based on a large dataset of 143 countries, of which 36 are part of currency unions. Existing currency unions, such as the CFA Franc zone in Africa and the East Caribbean Currency Area, are relatively small, but provide potentially useful information about the extent to which currency unions reduce border barriers. This information can then be applied to evaluate the impact of other currency unions that are not yet in existence.

With an elasticity of substitution among goods equal to five, the tariff equivalent of the national money border barrier is found to be 26%. This implies that about half of the total border barriers reported in Table 1 may be attributable to the use of different currencies.

Table 3 reports some implications of this for EMU and a couple of dollarization scenarios. Trade among the existing twelve EMU members would rise by 59%, while welfare would rise by 11%. While the effect on trade is significant, it is dampened by the fact that these countries already had high trade levels among each other before EMU. As discussed above, the larger the size of a currency union and the higher the trade levels

before the union, the smaller its effect on trade and the larger its effect on welfare. The table shows that an expansion of EMU to all fifteen EU members would reduce the trade increase to 40%, while raising the rise in welfare to 14%.

The dollarization scenarios also show substantial increases in both trade and welfare. When comparing different countries that could dollarize, those with closer trade relationships with the US face a smaller increase in trade but a larger increase in welfare once the dollar is adopted. The comparison is quite stark when comparing Argentina and Canada. Argentinian trade with the US is expected to rise by 132%, while Canadian trade with the US is expected to rise by only 38%. Nonetheless the Canadians experience a much larger increase in welfare of 30%, versus 3.3% for Argentina.

The final row of the table shows that the biggest possible monetary union, among all countries in the world, would raise trade by only 10%, but leads to a very large average increase in welfare of 21%.

These estimation results reported by Rose and van Wincoop could be subject to reverse causality and omitted variables bias. But in another paper Rose has found that the results hold up under a host of sensitivity analysis, including an extensive search for omitted variables and the use of instrumental variables.<sup>15</sup> There is also little evidence in the political science literature that countries join currency unions to increase trade, suggesting that reverse causality is not an issue.

There is another piece of evidence which also suggest that the impact of national borders is closely linked with the use of different currencies across borders. It has been found that relative prices of the same goods are much more volatile across cities in

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<sup>14</sup> Rose and van Wincoop (2001).



different countries than across cities in the same country, even after controlling for distance.<sup>16</sup> This evidence has been closely linked to nominal exchange rate volatility across locations in different countries. By itself this does not necessarily imply, though, that the use of different moneys across borders provides a barrier to trade.

### **Application #3: NAFTA**

In the final application of our theoretical gravity model we consider the implications of tariff removals as part of the North American Free Trade Agreement (NAFTA).

Negotiations leading to NAFTA began in June 1990, an accord was signed in December 1992 and the agreement went into effect on January 1, 1994. For some goods the existing tariffs were removed immediately, while for others there was a gradual phase-out, ranging from five to fifteen years. Average tariffs on US exports to Mexico were 18.6% before NAFTA, with an average phase-out time of 5.6 years. Average tariffs on Mexican exports to the US were 5.9%, with an average phase-out time of 1.4 years.<sup>17</sup>

Figure 1 presents the actual size-adjusted trade flows among the NAFTA partners from 1985-99. Here trade is measured as the average of exports and imports.<sup>18</sup> The inescapable conclusion is that NAFTA spectacularly affected partner trade flows. A plausible model of integration must explain the near doubling of the US-Mexican size

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<sup>15</sup> See Rose (2000).

<sup>16</sup> See Engel and Rogers (1996, 2000).

<sup>17</sup> See Kowalczyk and Davis (1998), page 236-239.

<sup>18</sup> There is good reason to only look at the average of exports and imports in the data since Mexico experienced large real exchange rate movements that affected the difference between exports and imports (the trade balance).

adjusted trade. Notably, the Computable General Equilibrium models deployed prior to NAFTA very substantially underpredict the effect of NAFTA.<sup>19</sup>

In order to evaluate the implications of NAFTA we conduct the following exercise. We start from the world model of twenty-two OECD countries for which we estimated total (non-rent) border barriers in 1993. We then add Mexico to this model, allowing for both non-rent and tariff barriers between Mexico and other countries. We assume that the non-rent barriers between the US and Mexico are of the same size as between the US and Canada, while the non-rent barriers between Mexico and all other countries are the same as between Canada and other countries. It is assumed that all tariffs on Mexican imports and exports are the same as those between Mexico and the US. We then consider the implications of a removal of all tariffs on trade between Mexico and the US and between Mexico and Canada. This is done by solving the general equilibrium model before and after the removal of the tariffs.

The results are reported in Tables 4 and 5. The effect on size-adjusted trade levels is shown in Table 4. The model predicts an increase in exports from Mexico to the US of 59% and an increase in exports from the US to Mexico of 74%. The same changes are predicted with regards to trade with Canada. These numbers correspond quite closely to the data.

In 1993, which we use as the pre-NAFTA year, (size-adjusted) Mexico-US trade was 40% lower than (size-adjusted) US-Canada trade. In the model Mexico-US trade was 41% lower than US-Canada trade. In the data Mexico-US trade rises by 85% from 1993 to 1999, which is quite close to the trade increase predicted by the model reported in

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<sup>19</sup> See Hufbauer and Schott, 1992, pp58-9 for predicted NAFTA trade flow changes from a set of models. The estimates imply growth of US-Mexican trade ranging from 5% to

Table 1. In 1999 US-Mexico trade remains 20% lower than US-Canada trade in the data, while in the model it is 5% lower. The model therefore does a reasonable job in explaining both relative trade levels and changes in trade levels.

Note by the way that almost all of the increase in US-Mexico trade occurs in one year, 1995. This is a bit deceptive though since Mexico experienced a large devaluation that lowered its GDP when measured in dollars. Since most of its trade is priced in dollars, this devaluation by itself leads to a large jump in the size-adjusted trade measure shown in Figure 1. Without the devaluation the size-adjusted trade level would likely have increased more gradually. A comparison of 1993 to 1999 data is therefore most relevant.

The model predicts that Mexican exports to the other OECD countries (ROW) rise by 19%, while Mexican imports from ROW countries drop by 25% (fifth and sixth rows of Table 1). The drop in imports from ROW countries is a result of trade diversion, while the rise in exports to ROW countries is the result of the predicted drop in the relative price of Mexican goods. The relative price of Mexican goods falls (the Mexican terms of trade deteriorates) because Mexican consumers switch to buying more products from the US and Canada, and less from Mexico, after the removal of tariffs on those imports. In the data both size-adjusted exports to ROW countries and imports from ROW countries rise after NAFTA, but this is likely the result of a reduction in trade barriers with ROW countries independent of NAFTA.

Table 4 also reports to what extent the trade changes are the result of the removal of Mexican import tariffs versus the removal of US and Canadian tariffs on Mexican exports. Not surprisingly given its much bigger size, most of the trade changes result

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25%. The data (Figure 1) imply growth of 80% or more.

from the removal of the Mexican import tariffs. It is noteworthy that the removal of either set of tariffs raises trade in both directions. This is a result of general equilibrium considerations. For example, while one would expect lower Mexican import tariffs to raise Mexican imports, the resulting drop in the relative price of Mexican goods also raises Mexican exports.

The welfare effects of NAFTA, reported in table 5, are quite revealing. First consider the removal of Mexican tariffs. It results in trade creation that raises welfare by 1.4%, offset slightly by trade diversion that lowers welfare by 0.2%. But the removal of Mexican tariffs leads to a deterioration in Mexico's terms of trade that results in a 2.5% drop in welfare. The terms of trade deterioration overwhelms the gains from trade creation, leading on balance to a 1.3% welfare drop.

The large effect of the Mexican terms of trade deterioration on welfare may not be surprising in light of our previous discussion of the fact that even small countries can significantly affect their terms of trade. Here we will shed further light on this result by somewhat simplifying the high dimensional complexity and nonlinearity of our gravity model. Suppose that we consider the market for the national product of Mexico, broken into two parts: its sales in Mexico and its sales to everyone else. The unilateral tariff reduction lowers Mexico's prices for US and Canadian goods, but let us for simplicity assume that Mexico's demand shift is too small to raise the supply price of US or Canadian goods. Mexican demand shifts away from Mexican goods, so the Mexican supply price must fall to clear the market. For simplicity let us assume that the effect of a fall in the Mexican supply price on the US and Canadian price indexes  $P$  is negligible. Now all the action needed to clear the market for Mexican goods is isolated to Mexico's

supply price and its consumer price index; we suppress changes in rest of the world prices  $p_R, P_R$ . The unilateral Mexican liberalization lowers  $\tau_{RM}$  and induces a change in  $p_M$ . Define  $\delta \equiv (\tau_{RM} - 1) / \tau_{RM}$ , the ad valorem tariff imposed by Mexico on goods from the rest of the world, defined as a percent of the domestic price. Mexican income is equal to revenue from goods sales plus tariff revenue, or  $z_M = y_M + \delta(1 - s_{MM})z_M$ . Solving for total nominal income,  $z_M = y_M / [1 - \delta(1 - s_{MM})]$ . The market clearance equation for Mexican goods is

$$y_M = s_{MM}z_M + s_{MR}z_R \quad ? \quad \frac{(1 - \delta)(1 - s_{MM})\bar{y}_M}{1 - \delta(1 - s_{MM})} = p_M^{-\sigma} k$$

where  $k$  is a constant under the simplifying assumptions. The Mexican expenditure share of Mexican goods is given by:

$$s_{MM} = \frac{(\beta_M p_M t_{MM})^{1-\sigma}}{(\beta_M p_M t_{MM})^{1-\sigma} + (\beta_R p_R t_{RM})^{1-\sigma}}.$$

Substituting into the preceding equation, and noting that  $p_R t_{RM} = \pi_{RM} \tau_{RM} = \pi_{RM} / (1 - \delta)$ , we have a nonlinear equation which can be solved for changes in  $p_M$  as a function of changes in  $\delta$ .

Differentiating and solving with some simplification, we obtain, where a  $\hat{\phantom{x}}$  denotes percentage change:

$$\hat{p}_M = \frac{\sigma s_{MM} / (1 - \delta)}{\sigma [1 - \delta(1 - s_{MM})] + (\sigma - 1) s_{MM}} d\delta.$$

A fall in Mexico's tariff will induce a less than proportional reduction in the Mexican supply price, but when Mexico consumes a large proportion of its output, the effect can be large. (Note that the expression for  $\hat{p}_M / d\delta$  is increasing in  $s_{MM}$ .) Using  $\sigma=5$  and  $s_{MM} = 0.7$ , the 18.6% tariff removal used in our simulations implies a Mexican

supply price decline of 8.6%. The welfare effect of this change, if evaluated from the free trade position (our setup suppresses the non-NAFTA countries so Mexican liberalization is equivalent to free trade), is  $(1 - s_{MM})\hat{p}_M$  where the nominal income decline is partially offset by the cheaper Mexican consumer price. This implies a welfare loss of 2.6%, quite close to the 2.5% reported in Table 5. The key element of this result is the large fraction spent on Mexican goods by Mexicans themselves. It illustrates the importance of introducing in the model all the non-tariff trade barriers (both border and non-border barriers), which leads to a similar home bias towards Mexican goods as observed in the data.

Table 5 also reports the effect of the removal of the US and Canadian tariffs on their imports from Mexico. This shifts demand toward Mexican goods and results in a terms of trade improvement for Mexico that improves welfare by 1.1%. The overall net effect is a loss of 0.3%. The US and Canada experience a small 0.1% improvement in welfare, while welfare of ROW countries is virtually unaffected.

Our conclusion that NAFTA harmed Mexico differs from the conclusion of the CGE model literature (Hufbauer and Schott, 1992; Francois and Shiells, 1994). The difference is due to two factors. First, our gravity model with high nontariff border costs implies large terms of trade movements that are missed in the standard CGE literature. Second, our gravity model is an endowment economy. The disaggregated CGE models allow for specialization as a result of liberalization, adding to the gains from NAFTA. Various other CGE models allow for gains due to increased output of industries with scale economies and for dynamic gains due to foreign investment in Mexico. We think that our estimate of Mexico's gains from NAFTA is too low because it omits the resource

reallocation featured in conventional CGE models. But in contrast we think the conventional CGE models give estimates which are too high because they understate the terms of trade changes featured in the gravity model.

The welfare effects of NAFTA are very small compared to those in Table 2. Partially this is because in Table 2 we considered the removal of non-tariff barriers among OECD countries, which also have a significant resource effect. But as noted earlier, even if the estimated barriers among OECD countries were tariff barriers, the welfare gains would still be large, for example 16.8% for ROW countries. There are several reasons why the effect on Mexican welfare is so small in Table 5. First, if tariffs on Mexican exports had been the same as on Mexican imports, the model predicts that Mexican welfare would rise by 1.5%. Second, if additionally we remove the non-tariff border barriers, NAFTA would raise Mexican welfare by 5.9%.

Finally, if on top of this we raise the tariffs to 50%, which is the size of the border barriers reported in Table 1, removing these tariffs would raise Mexican welfare by 14.8%. So to summarize, the effect on Mexican welfare is small because (i) tariff rates are asymmetric (much higher on Mexican imports than exports), (ii) the tariffs are much smaller than the non-tariff border barriers, and (iii) the presence of non-tariff border barriers dampens the welfare effect of tariff reductions.

## **Conclusion**

We have shown that policies associated with borders are very costly, even in a world with low formal trade policy barriers. The potential for deep integration even between such closely associated countries as Canada and the US remains astonishingly large. Small

countries have much more to gain from integration than large countries, but even huge countries such as the US will earn substantial benefit from deep integration.

The large size of the estimated border barriers points to the need for more research to understand what the costs are and why they are so high. The benefit of currency unions in our work provides a useful clue, but the implied costs are very high compared to intuitive notions of the cost of exchange rate uncertainty and foreign exchange.

Methodologically, our work indicates that further development and use of the gravity model is likely to yield useful insights. Its attractiveness combines ease of estimation, success in prediction and the consistency and power of readily understood general equilibrium structure.



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**Table 1 Impact of Border Barriers on Trade of OECD countries**

	Tariff Equivalent of Border Barriers (in percent)	% Change in Trade due to Borders
US-CA	49	79
US-ROW	52	150
CA-ROW	78	117
ROW-ROW	51	41

Source: Authors' calculations using the results in Tables 2 and 4 of Anderson and van Wincoop (2001).

**Table 2 Increase in Welfare OECD countries when Borders are Removed**

	Total	due to resource effect	due to increased trade	due to terms of trade changes
US	6.4	3.2	4.7	-1.5
CA	51.7	18.3	12.9	13.5
ROW	37.3	18.3	8.7	6.4

Source: Authors' calculations using the results in Anderson and van Wincoop (2001).

**Table 3: Impact of Currency Unions on Trade and Welfare**

	% Trade Increase	% Welfare Increase
EMU for current 12 members	59	11.1
EMU for all 15 EU members	40	14.4
Argentina dollarizes	132	3.3 (Argentina)
Mexico dollarizes	53	24.3 (Mexico)
Canada dollarizes	38	29.7 (Canada)
World monetary union	10	21.3

Source: Rose and van Wincoop (2001, Table 2, p. 389) and authors' calculations.

**Table 4 Impact of NAFTA on Trade**

	% Rise in Exports		
	Removal Mexican tariffs	Removal US,CA tariffs	Removal all tariffs
Mexico to US	38	17	59
US to Mexico	61	9	74
Mexico to Canada	38	16	59
Canada to Mexico	61	9	74
Mexico to ROW	36	-12	19
ROW to Mexico	-30	8	-25
US to Canada	-0.8	0.0	-0.9
Canada to US	-0.9	-0.1	-0.7

Source: Mexican tariffs on imports from the US and Canada are reduced from 18.6% to zero. US and Canadian tariffs on imports from Mexico are reduced from 5.9% to zero. The numbers in the table are obtained by adding Mexico to the multi-country model of Anderson and van Wincoop (2001). It is assumed that the non-rent barriers between the US and Mexico are of the same size as between the US and Canada, and that non-rent barriers between Mexico and all other countries are the same as between Canada and ROW countries.

**Table 5 Impact of NAFTA on Welfare**

		% Change in Welfare		
		Removal Mexican tariffs	Removal US,CA tariffs	Removal all tariffs
Mexico	Total	-1.3	1.1	-0.3
	Due to: 1. Trade Creation	1.4		
	2. Trade Diversion	-0.2		
	3. Terms of Trade Changes	-2.5	1.1	
US		0.1	-0.03	0.1
CA		0.1	-0.03	0.1
ROW		0.00	-0.01	-0.01

Source: See notes to Table 4.