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THE CHANGING INCIDENCE OF GEOGRAPHY

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ABSTRACT

The incidence of bilateral trade costs is calculated here using neglected properties of the structural gravity model, disaggregated by commodity and region, and re-aggregated into forms useful for economic geography. For Canada's provinces, 1992-2003, incidence is on average some five times higher for sellers than for buyers. Sellers' incidence falls over time due to specialization, despite constant gravity coefficients. This previously unrecognized globalizing force drives big reductions in 'constructed home bias', the disproportionate share of local trade; and large but varying gains in real GDP.

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The incidence of trade costs matters more than their level for most issues of regional specialization, welfare and policy. Neglected properties of structural gravity are used here to calculate theoretically consistent incidence measures of trade costs for Canada's provinces, 1992-2003. Canada's trade has been the focus of a prominent literature that draws wide implications for economic geography from Canada's physical geography, sharp regional differences and high quality bilateral shipments data. We add to this literature new methods and new empirical lessons. Most strikingly, sellers' incidence is falling despite constant bilateral trade costs.

Outward multilateral resistance measures the average general equilibrium sellers' incidence of bilateral trade costs.[1] It is as if each seller in a province pays a single trade cost to take his goods to a single world market for each good. Inward multilateral resistance measures the general equilibrium buyers' incidence of trade costs in a province, as if buyers purchased from a single world market. Multilateral resistance contrasts with the partial equilibrium market access and supplier access variables that have been used in the economic geography literature[2] to summarize the effect of bilateral trade costs. These do not measure incidence, do not aggregate consistently, and our results show that they are weakly and sometimes negatively correlated with multilateral resistance.

Constructed Home Bias (CHB) indexes are calculated using multilateral resistances. CHB's measure a province's predicted trade with itself relative to what it would be in a frictionless world. Another innovation decomposes overall outward multilateral resistance into domestic and international components. The Domestic Trade Cost index for sellers gives the outward multilateral resistance they face on sales within Canada, as if each provincial seller shipped to a single Canadian market, along selling to markets in the outside world.

Bilateral trade costs are calculated based on disaggregated gravity estimation. Distance and border effects on trade costs vary widely by commodity in patterns that make intuitive sense. Our gravity regressions fit well and are reasonably stable over time, the same proper-

[1] Anderson (2008), following Anderson and van Wincoop (2004).

[2] See for example Redding and Venables (2004).

ties that have legitimized the aggregate gravity literature.[3] Our results indicate downward bias in previous, mostly aggregate, gravity estimates of border effects such as Anderson and van Wincoop (2003).[4]

Outward multilateral resistance is always larger than inward multilateral resistance, on average about 5 times larger. This striking regularity is because of specialization, as explained below. Outward multilateral resistance varies widely across industries for a single province and across provinces for a single product line. More remote regions face higher sellers' incidence and products likely to have high distribution margins have higher sellers' incidence. Similarly, the constructed home bias indexes and the within-Canada domestic trade cost indexes have sensible patterns of variation and magnitudes. Inward multilateral resistance is relatively flat but higher in more remote regions.

Over time, outward multilateral resistance falls. This fall drives a dramatic 29%-86% fall in Constructed Home Bias in Canadian provinces, 1992-2003. Gravity regressions typically yield constant bilateral trade costs, a result echoed here, implying what some authors call the 'missing globalization puzzle' (Coe, Subramanian and Tamarisa, 2002). A previously unappreciated force of globalization changes multilateral resistance through specialization. Effectively, specialization of production tends to reduce the total trade cost bill.

A local approximation of the real GDP effect of the changes in outward and inward multilateral resistances reveals that all but Ontario gain, while Quebec gains least of the rest and Northwest Territories and PEI gain most. Loosely speaking, globalization in this sense appears to be equalizing regional incomes. Recognizing multilateral resistance changes as isomorphic to Total Factor Productivity (TFP) changes,[5] the magnitudes are large, more than 1% per year for star provinces. For context, TFP measures for the US, 1995-2003 are around 0.5% per year.

[3] Previous disaggregated gravity results in the literature indicating worse fit and unreasonable coefficients appear to be due to failure to use fixed effects to control for multilateral resistance.

[4] The directional asymmetry of border effects reported in Bergstrand, Egger and Larch (2007) also appears to be due to aggregation. We find no consistent evidence for directional asymmetry in disaggregated border effects.

[5] See Anderson (2008) for full discussion.

In contrast to the greater overall openness of provinces, Domestic Trade Cost indexes for Canada's provinces are constant over time. The intent of the Agreement on Internal Trade (AIT) of 1995 was to reduce internal trade costs.[6] We simulate how hypothetical domestic cost reductions would affect overall trade cost indexes within Canada. A uniform decrease in interprovincial trade costs promotes equality among the Canadian provinces and territories: the gain from such policy for the more remote regions is bigger than the gain for the more developed regions. Our simulations also suggest the possibility of 'immiserizing globalization': a uniform fall in trade costs can harm the welfare of the 'core' regions through terms of trade effects that benefit sellers but hurt buyers.

The succeeding material outlines the conceptual base of the project in Section 1. Section 2 deals with the application methods and Section 3 describes the data used, with further details in the appendix. Section 4 presents the results.

1 Conceptual Base

The economic theory of gravity[7] is based on *trade separability*: two stage budgeting obtains in both final demand and intermediate demand. The upper level general equilibrium determines the value of production and the level of expenditure on each good in each region or country while the lower level gravity equilibrium determines the allocation of supply and demand across countries or regions for each class of goods, conditional on the values of production and expenditure given from the upper level equilibrium.

Begin with definitions of variables. Let k denote a class of goods, let i denote a place of origin and let j denote a place of destination. Let X_{ij}^k denote the value of shipments at destination prices from i to j of good k. Further, let E_j^k denote the expenditure at destination j on goods of class k from all origins, while Y_i^k denotes the sales of goods at destination prices from i in goods class k to all destinations. Expenditure levels, the E's,

[6] Our econometric work finds no consistent evidence that the AIT can be picked out from other forces that affect Canada's trade.

[7] See Anderson and van Wincoop (2004).

and sales levels, the Y's, are determined in the upper level general equilibrium. The budget constraints (one for each destination's total expenditure on each goods class) and the market clearance equations (one for each goods class for goods from each origin) together with a CES demand specification combine to yield the gravity model.

Let $t_{ij}^k \geq 1$ denote the variable trade cost factor on shipment of goods from i to j in class k. σ_k is the elasticity of substitution parameter for goods class k. We abstract from fixed costs because our econometric work will not be able to identify them.

The CES demand function (for either final or intermediate products) gives expenditure on goods of class k shipped from origin i to destination j as:

$$X_{ij}^k = (\beta_i^k p_i^{*k} t_{ij}^k / P_j^k)^{(1-\sigma_k)} E_j^k. \tag{1}$$

Here, the value of shipments includes the trade costs while p_i^* is the factory gate price and β_i^k is a CES share parameter. The price index is $P_j^k = [\sum_i (\beta_i^k p_i^{*k} t_{ij}^k)^{1-\sigma_k}]^{1/(1-\sigma_k)}$, an implication of the budget constraint.

Now impose market clearance: $Y_i^k = \sum_j (\beta_i^k p_i^{*k})^{1-\sigma_k} (t_{ij}^k / P_j^k)^{1-\sigma_k} E_j^k$. Define $Y^k \equiv \sum_i Y_i^k$ and divide the preceding equation by Y^k. In a world with globally common CES preferences, the expenditure shares must effectively be generated by

$$(\beta_i^k p_i^{*k} \Pi_i^k)^{1-\sigma_k} = Y_i^k / Y^k, \tag{2}$$

where $\Pi_i^k \equiv \sum_j (t_{ij}^k / P_j^k)^{1-\sigma_k} E_j^k / Y^k$ The left hand side of (2) is a behavioral share equation for the globally common CES preferences when all destinations face a common world price $p_i^{*k} \Pi_i^k$ because the price index is equal to one due to summing (2):

$$\sum_i (\beta_i^k p_i^{*k} \Pi_i^k)^{1-\sigma_k} = 1. \tag{3}$$

Then it is as if origin i ships good k to a single world market at average trade cost Π_i^k.

To complete the derivation of the structural gravity model, use (2) to substitute for $\beta_i^k p_i^{*k}$ in (1), the market clearance equation and the CES price index. Then:

$$X_{ij}^k = \frac{E_j^k Y_i^k}{Y^k} \left(\frac{t_{ij}^k}{P_j^k \Pi_i^k} \right)^{1-\sigma_k} \tag{4}$$

$$(\Pi_i^k)^{1-\sigma_k} = \sum_j \left(\frac{t_{ij}^k}{P_j^k} \right)^{1-\sigma_k} \frac{E_j^k}{Y^k} \tag{5}$$

$$(P_j^k)^{1-\sigma_k} = \sum_i \left(\frac{t_{ij}^k}{\Pi_i^k} \right)^{1-\sigma_k} \frac{Y_i^k}{Y^k}. \tag{6}$$

Here, Π_i^k denotes outward multilateral resistance. P_j^k denotes inward multilateral resistance, equivalent to the CES price index.

(4) leads to a useful quantification of home bias that summarizes the effect of all trade costs acting to increase each province's trade with itself above the frictionless benchmark. Constructed Home Bias is given by

$$CHB_i^k \equiv \left(t_{ii} / \Pi_i^k P_i^k \right)^{1-\sigma_k}.$$

Constructed Home Bias is much more useful than a straight comparison of internal trade costs t_{ii} across regions i. Two regions i and j with the same internal trade cost $t_{ii} = t_{jj}$ may have quite different CHB's because $\Pi_i^k P_i^k \neq \Pi_j^k P_j^k$.

1.1 Properties of Multilateral Resistance

Multilateral resistance indexes simultaneously decompose trade costs into their supply (outward) and demand (inward) incidence while aggregating bilateral costs such that the general equilibrium allocation at the upper level of budgeting is independent of the details of bilateral allocation (under the hypothesis of trade separability). It is as if each province i shipped its product k to a single world market facing supply side incidence of trade costs of Π_i^k, while each province j bought its goods k from a single world market facing demand side incidence of P_j^k. This follow because if the actual set of bilateral trade costs were to be replaced by $\widetilde{t}_{ij}^k = P_j^k \Pi_i^k$, all budget constraints and market clearance conditions would continue to hold, so that no disturbance of the upper level general equilibrium would occur. See Anderson (2008) for more discussion.

Added insight into gravity follows. The first ratio on the right hand side of (4) is the volume predicted for frictionless trade. The second ratio contains the effects of trade costs, directly and through their general equilibrium incidence. Viewed from the demand side, Π_i^k being the supply side incidence, t_{ij}^k/Π_i^k is the bilateral demand side incidence and $t_{ij}^k/\Pi_i^k P_j^k$ is the bilateral demand side incidence relative to the average incidence of such costs at j.

Since (5)-(6) solves for $\{\Pi_i^k, P_j^k\}$ only up to a scalar for each class k, an additional restriction from a normalization is needed. For full general equilibrium, consistency between upper and lower level equilibrium modules requires (3). Relative multilateral resistances are what matters for the allocation across markets in conditional general equilibrium, so alternative normalizations are admissible for convenience in computation or interpretation. In the absence of information on $\beta_i^k \widetilde{p}_i^k$'s, normalization through a units choice is natural: $P_k^i = 1, \forall k$ for some convenient reference country i. This is our procedure below.

Three propositions about the properties of multilateral resistance help explain our results. Proofs are in Appendix D.

Proposition 1 *Given $\sigma_k > 1$, if the trade frictions are uniform border barriers, the multilateral resistances (inward and outward) are decreasing in the supply shares of economies and increasing in the expenditure shares of economies. For given expenditure shares, multilateral resistances are increasing in net import shares.*[8]

Intuitively, in the conditional general equilibrium, the product of the factory gate price and the supply side incidence of trade costs is lowered by larger supply share, by (2). Proposition 1 gives a sufficient condition, uniform border barriers, for lower supply side incidence to result from larger share. Our empirical results suggest that the intuition of Proposition 1

[8]The proposition extends that of Anderson and van Wincoop (2003), which deals with a the introduction of a small uniform border barrier in a one good balanced trade economy for which $P^j = \Pi^j$.

may apply more generally. Proposition 1 also states that the larger the expenditure share, all else equal, the larger is inward multilateral resistance. General equilibrium links the outward and inward multilateral resistances together.

Next, we extract a formal property that sheds light on our finding that outward multilateral resistance exceeds inward.

Proposition 2 *If regions have equal sized supplies and expenditures and bilaterally symmetric trade costs, then increases in supply from low trade cost regions raise outward multilateral resistance above inward.*

The comparative statics of multilateral resistance with respect to supply and expenditure shares shed still more insight on our empirical results. Differentiate (5)-(6) with respect to the shares at constant bilateral trade costs $\{t_{ij}\}$. The share changes are exogenous to the multilateral resistances in conditional general equilibrium. The changes in the expenditure shares reflect response to price changes, possibly lagged, or changes in tastes (for final goods) or technology (for intermediate goods). The changes in the supply shares reflect response to price changes, possibly lagged or changes in technology or endowments.

Now impose *Assumption M*: shares change to reduce multilateral resistance. Assumption M expresses the intuitively plausible force of shipment bill minimizing adjustment of shares, reallocating both supply and demand at given costs of shipment to and from an 'as if' unified world market.[9]

Proposition 3 *If Assumption M holds, Constructed Home Bias falls on average.*

Individual CHB's may rise, but the proof of Proposition 3 indicates that this will be under special conditions. Discussion following the proof helps interpret our empirical finding that P's are constant over time while Π's fall driven by specialization. In full general equilibrium, economizing occurs on many more margins than trade costs, the multilateral resistances are determined simultaneously with the shares, and there is no guarantee that Assumption M will be met.[10] Our results suggest that it is met.

[9] No single actor minimizes, but rather the invisible hand of market forces.

[10] Literally minimizing multilateral resistance with respect to shares subject to the adding up constraint on

1.2 Domestic vs. International Incidence

Economic geography is usefully enriched by decompositions of multilateral resistance focused on key features of geography. Here we focus on the domestic vs. the international supply side incidence of trade costs. The focus on the supply side is justified by the primacy of producer interests and the much bigger magnitude and intertemporal variation of supply side incidence, while the focus on domestic vs. international incidence is important for countries like Canada with sharp regional differences.

We define the uniform domestic trade cost for inter-provincial trade that preserves each province's shipments to Canada as a whole, and thus each province's shipments to the world as a whole. Complementary to this we define the uniform external trade cost that preserves each province's shipments to the outside world. These are the two components of outward multilateral resistance. Very similar methods can generate the decomposition of inward multilateral resistance.

Consider a generic product shipped from i to j within Canada, temporarily deleting the k superscript for simplicity. The gravity equation tells us that

$$Y\frac{X_{ij}}{Y_i} = E_j\left(\frac{t_{ij}}{\Pi_i P_j}\right)^{1-\sigma} \tag{7}$$

where Y is world trade. The aggregate volume shipped from i to locations within Canada divided by i's market share is solved from

$$\bar{Y}_{iC} = \sum_{j\in C} E_j\left(\frac{t_{ij}}{\Pi_i P_j}\right)^{1-\sigma}. \tag{8}$$

On the left hand side of (8) is the fitted volume of trade from i to locations within Canada, all divided by i's market share. On the right hand side is the formula that gives this volume summing equation (7).

shares will generally result in corner solutions. But because share changes affect marginal costs and benefits on margins other than trade costs, these 'frictions' prevent the corners from being reached.

The theoretical uniform trade cost is calculated with two steps. The first step is a partial equilibrium calculation that takes the MR's as given. The uniform domestic trade cost solves

$$\bar{Y}_{iC} = \sum_{j \in C} E_j (\frac{t_{iC}}{\Pi_i P_j})^{1-\sigma}. \tag{9}$$

This single equation can be solved for t_{iC}^k for each province i and sector k. t_{iC}^k is recognized as the supply side incidence of domestic shipment costs using the same reasoning that identifies outward multilateral resistance on shipments to all locations as supply side incidence to a world market. Denoting t_{iC}^k as Π_{iC}^k:

$$\Pi_{iC}^k = \Pi_i^k \left(\sum_{j \in C} (P_j^k)^{\sigma_k - 1} \frac{E_j^k Y_i^k / Y^k}{\sum_{j \in C} \widetilde{X}_{ij}^k} \right)^{1/(\sigma_k - 1)}. \tag{10}$$

Here $\widetilde{X}$ denotes the fitted value of X. The fitted value of internal trade being larger than the frictionless value, the term multiplying Π_i^k should ordinarily be less than one, satisfying the intuitive property that the supply side incidence on domestic sales is larger than the incidence on all sales. Solidifying intuition, note that the expression on the right-hand-side of equation (10) simplifies to Π_i^k when aggregation is across all locations in the world instead of just across the regions within Canada.

The same logic as in (10) yields the supply side incidence on external trade:

$$\Pi_{i\bar{C}}^k = \Pi_i^k \left(\sum_{j \in \bar{C}} (P_j^k)^{\sigma_k - 1} \frac{E_j^k Y_i^k / Y^k}{\sum_{j \in \bar{C}} \widetilde{X}_{ij}^k} \right)^{1/(\sigma_k - 1)}. \tag{11}$$

Here, $\bar{C}$ denotes destinations not in Canada. Ordinarily $\Pi_{i\bar{C}}^k > \Pi_i^k$.

The general equilibrium solution is to solve for the Π_{iC}^k's simultaneously with the MR system for sector k. For each $i \in C$, (9) combines with the system of equations for MR's to simultaneously solve for the Π_{iC}^k's and the new MR's.[11]

[11] In the setup above, t_{ii} is part of the t_{iC}. An alternative computation, the one actually used in our results, keeps t_{ii} at its original value and imposes a uniform cost for interprovincial trade. Then in the

The method of aggregation and decomposition in this section is very general and has many applications. Our methodology can be adapted to decompose incidence of different trade cost component, for example the portion of trade cost incidence due to distance vs. other causes, and so forth. The method allows for trade cost aggregation for any specific region of interest. We focused on the domestic vs. external trade costs for Canada's provinces, but the same logic can be applied to construct regional trade costs for the European union, for example.

2 Application Methods

The structural gravity model (4), after dividing through by $E_j^k Y_i^k$, can be estimated using fixed effects to control for multilateral resistance and using proxies for bilateral trade cost such as distance and borders. Estimates of multilateral resistance will be calculated from (5)-(6) based on the estimated t_{ij}'s, the remainder of the estimated fixed effect being assigned to other sources of regional fixed effects.

The proposed research will conclude with an investigation of the patterns of multilateral resistance, addressing cross-commodity and cross-region variation. Plausibly, trade costs and multilateral resistance vary across goods and regions in richly informative ways. Some regions can be anticipated to have systematically higher multilateral resistance, while some commodities are expected to have lower multilateral resistance. But the cross-commodity pattern may differ over regions in such a way as to powerfully affect the efficient patterns of production.

Theory provides some guidance. Our results give only mixed support to the pattern of Proposition 1, presumably due to the much more complex pattern of trade costs. But Proposition 2 is confirmed by the data.

The application description is completed by putting structure on the unobservable trade

preceding steps, t_{iC} is defined as above for all $i \neq j; i, j \in C$ while all other t_{ij}'s remain unchanged: those inside Canadian provinces and those for all trade that is not interprovincial.

costs and error terms. Freight rates and tariffs can be observed with measurement error. The unobservable costs are assumed to be related to observable z's, indexed by h. Trade costs are assumed to be given by

$$\ln t_{ij}^k = \sum_h \gamma_h^k z_{ij}^k(h) \tag{12}$$

The z's include variables such as the log of bilateral distance, contiguous borders, and the presence or absence of a provincial or international border. Some z variables are questionably exogenous, such as freight rates or tariffs. See Anderson and van Wincoop (2004) for more discussion of the specification of (12). With panel estimation in which observations are taken over time as well as trade partners, the presence or absence of the AIT enters as a dummy variable in the list of the z's.

The econometric model is completed by substituting (12) for t_{ij}, then expanding the gravity equation with a multiplicative error term. The structural model implies that size-adjusted trade is the natural dependent variable in the gravity regression:

$$X_{ij}^k / Y_i^k E_j^k = \frac{1}{Y^k} \left(\frac{t_{ij}^k}{\Pi_i^k P_j^k} \right)^{1-\sigma_k} \epsilon_{ij}^k \tag{13}$$

where ϵ_{ij}^k is the error term. This form tends to control for heteroskedasticity in the error term. The unobservable multilateral resistance terms are proxied by directional fixed effects for each region. The final step in getting an operational econometric model is to translate (13) into a logarithmic form and to substitute for the observable trade costs to get:

$$\begin{aligned} ln\left(\frac{X_{ij}^k}{Y_i^k}\right) &= \alpha_0 + \alpha_1 LNDIST_{ij} + \alpha_2 CB\_PROV\_PROV_{ij} + \alpha_3 CB\_PROV\_STATE_{ij} + \\ &+ \alpha_4 CAN\_USA_{ij} + \alpha_5 USA\_CAN_{ij} + \alpha_6 CAN\_ROW + \alpha_7 SMCTRY_{ij} + \\ &+ \alpha_8 ln(\Pi_i^k)^{(1-\sigma_k)} + \alpha_9 ln(P_j^k)^{(1-\sigma_k)} + \varepsilon_{ij}^k, \end{aligned} \tag{14}$$

where: $LNDIST_{ij}$ is the logarithm of bilateral distance between trading partners i and j.

Motivated by Brown and Anderson (2002), who find that provinces and states that share a common border tend to have higher levels of trade, we introduce two variable in order to capture contiguity: $CB\_PROV\_PROV_{ij}$ is a dummy variable equal to one if the two trading partners are provinces and they share a common border, and $CB\_PROV\_STATE_{ij}$ is a dummy variable that reflects the presence of contiguous border between two trading partners when one of them is a province and the other is a state. Using aggregate cross section data Bergstrand et al (2007) find that the border effect between Canada and the US is not symmetric. Motivated by their results we use three dummy variables to account for a Canadian border: CAN_USA_{ij} is equal to one when a province exports to a state, USA_CAN_{ij} is equal to one when a state exports to a province, and CAN_ROW_{ij} captures the border between Canada and the rest of the world for any direction of trade flows. Finally, $SMCTRY_{ij}$ takes a value of one for internal trade, e.g. when a province trades with itself. Our dependent variable deviates from the specification in (13) because, due to lack of data on total imports of individual states, we were not able to construct expenditures at the state level. Therefore the effect of the missing expenditures in our specification is picked up by the directional fixed effects, which we also use to control for multilateral resistance.

We use directional fixed effects OLS with robust standard errors to consistently estimate Equation (14) for each commodity and each year in our sample. We defer until the end of Section 4.1 a discussion of the possible bias in estimation due to selection effects. Then, employing Equation (12), we construct bilateral trade costs from the gravity estimates.

Multilateral resistance variables are computed using the estimated t's in (4)-(6) along with a normalization. We set Alberta's inward multilateral resistances to be equal to one for each good, $(P_{AB}^k)^{1-\sigma_k} = 1$. Thus, for each year and product, multilateral resistances for all other provinces and territories are relative to the inward multilateral resistances of Alberta for the corresponding year and commodity. Relative multilateral resistances are what matters for resource allocation in general equilibrium.

One final issue with the data must be resolved to calculate multilateral resistances. To solve (4)-(6) we need data on individual state expenditures at the commodity level, which, unfortunately, we cannot construct due to lack of data on total US state imports. The problem is resolved as follows. We aggregate to the US level for calculating multilateral resistances for Canadian provinces. Thus, the inputs needed to solve the multilateral resistances system are the provincial outputs and expenditures, the US output and expenditure and the ROW output and expenditure along with the bilateral trade costs. The original bilateral trade costs come from gravity equations that give province to individual US state bilateral trade costs. These costs must be aggregated consistently to form the appropriate US to province bilateral trade costs for the multilateral resistance calculations. We form an aggregate bilateral trade cost from each Canadian province to the US (aggregate), from the US (aggregate) to each Canadian province as follows. The generic commodity ships from Canadian province i to US state j with trade cost (from gravity) given by t_{ij}. The average bilateral trade cost to the US from province j is given by:

$$\bar{t}_{i,US}^{1-\sigma} = \sum_{j \in US} w_{ij} t_{ij}^{1-\sigma},$$

where $w_{ij} = X_{ij} / \sum_{j \in US} X_{ij}$. The average bilateral trade cost from the US to Canadian province i is given by:

$$\bar{t}_{US,i}^{1-\sigma} = \sum_{j \in US} w_{ji} t_{ji}^{1-\sigma},$$

where $w_{ji} = X_{ji} / \sum_{j \in US} X_{ji}$. The last step in setting the system (4)-(6) in operational form is to aggregate trade costs from the US (aggregate) to ROW, and from ROW to the the US (aggregate). We follow the same procedure and define the aggregate trade cost from the US to the rest of the world as:

$$\bar{t}_{US,ROW}^{1-\sigma} = \sum_{j \in US} w_{j,ROW} t_{j,ROW}^{1-\sigma},$$

where $w_{j,ROW} = X_{j,ROW} / \sum_{j \in US} X_{j,ROW}$. Finally, aggregate costs from ROW to the the US (aggregate) are defined as:

$$\bar{t}^{1-\sigma}_{ROW,US} = \sum_{j \in US} w_{ROW,j} t^{1-\sigma}_{ROW,j},$$

where $w_{ROW,j} = X_{ROW,j} / \sum_{j \in US} X_{ROW,j}$. After aggregating the US costs, we are able to solve (4)-(6) for the inward and outward multilateral resistances at the commodity level for each province and territory, the US as a whole, and the rest of the world. Before we provide and analyze our results, we discuss several refinements of the estimation approach and procedures and we describe the data.

3 Data Description

This study covers trade during 1992-2003 where trading partners include all Canadian provinces and territories,[12] the fifty US states and the District of Columbia, and the rest of the world (ROW), which we define as an aggregated region consisting of all other countries. Data availability allowed us to investigate 19 commodities.[13] In order to estimate gravity and calculate multilateral resistances, we use industry level data on bilateral trade flows, output, and expenditures for each trading partner all measured in current Canadian dollars for the corresponding year. In addition, we use data on bilateral distances, population, contiguous borders, and the presence or absence of provincial or international borders. Lastly, we generate a dummy variable to explore the effects the Agreement on Internal Trade (AIT), effective since July 1, 1995, on trade flows and trade costs within Canada.

[12] We treat Northwest Territories and Nunavut as one unit, even though they are separate since April 1, 1999.

[13] Commodity selection is based on (but is not completely identical to) the S-level of aggregation as classified in the Statistics Canada's Hierarchical Structure of the I-O Commodity Classification (Revised: January 3, 2007). The 19 commodity categories include: Agriculture (crop and animal production); Mineral Fuels (coal, natural gas, oil); Food; Leather, Rubber and Plastic Products; Textile Products; Hosiery, Clothing and Accessories; Lumber and Wood Products; Furniture, Mattresses and Lamps; Wood Pulp, Paper and Paper Products; Printing and Publishing; Primary Metal Products; Fabricated Metal Products; Machinery; Motor Vehicles, Transportation Equipment and Parts; Electrical, Electronic, and Communications Products; Non-metallic Mineral Products; Petroleum and Coal Products; Chemicals, Pharmaceutical, and Chemical Products; Miscellaneous Manufactured Products.

4 Results

We begin with the results of estimating gravity equation (14) for each year and commodity in our sample. Then we calculate and analyze inward and outward multilateral resistances by province, commodity and year. Next, we present constructed home bias indexes over provinces and time. These indicate a significant fall in home bias associated with trade-cost reducing effects of specialization. A crude measure of the real GDP gains that result is calculated over 1992-2003. Next, we present the domestic trade cost component of outward multilateral resistance, the average incidence facing provincial sellers within Canada. Finally, we provide assessments of the effects of the Agreement on Internal Trade, and perform counterfactual experiments to gauge how hypothetical cost reductions from AIT would affect domestic trade cost indexes within Canada.

4.1 Gravity Results

Our gravity coefficient estimates vary significantly across commodities and are relatively stable over time.[14] Thus the values in Table 2 are calculated as the average of our estimates over time weighted by the yearly trade share for each commodity in the sample.[15]

The coefficient on distance is always negative and significant with an average value of -1.51 (std.err. 0.362). There is significant variability in the effect of distance on trade across different commodities, displayed in column (2) of Table 2 in Appendix A. Distance is a bigger obstacle to trade for commodities such as Agricultural Products and Petroleum and Coal Products, while a lesser obstacle for commodities such as Electrical Products and Hosiery and Clothing. Transportation costs are the natural explanation.

[14] The only exception is the distance coefficient for Fuels, which is relatively unstable over the years. The economic theory of gravity (Anderson and van Wincoop, 2004) implies that gravity regressions pick up *relative* trade costs in a cross section, and cannot reflect changes in the level. Compression of trade costs could occur over time as external trade costs fall relative to internal ones, but this force is apparently absent. The effect of the fall in the *level* of trade costs might also be picked up by time-and-region dummy variables in the gravity model. (Unfortunately these can also reflect forces other than trade costs, such as scale economies, nonhomothetic preferences or other size related unobservable variables.) Our results do not reveal any systematic decline in trade cost levels over time via this channel.

[15] Estimation results for individual commodities and each year are available upon request.

Contiguity matters, especially when the common border is between a province and a state. Column (4) of Table 2 presents evidence supporting the argument in Brown and Anderson (2002) that contiguous provinces and states trade more with each other.[16] This should not be surprising since almost all provinces are contiguous to at least one US state, and this is likely to be a major trade partner as well. Fuels is the only commodity category for which the coefficient on the dummy variable capturing contiguity between provinces and states is consistently not significant. There is weak evidence in support of a negative, often significant relationship between interprovincial contiguity and trade shown in column (3) of Table 2.[17] The value of the coefficient on the interprovincial contiguity dummy variable varies across commodities and the effect is strongest for Lumber and Wood Products and Wood Pulp and Paper Products.

The international border has a big depressing effect on trade. The estimation results in columns (5), (6), and (7) of Table 2 show that the Canadian border effect is large and varies widely across commodities. We do not find any clear evidence in support of symmetric or asymmetric border effects between Canada and US.[18] Directional border effects between Canada and US are unstable over time, which we interpret to mean that they are not separately identified in the data. Imposing a symmetric border effect results in relatively stable, large border coefficients between Canada and US. We use symmetric border estimates to construct multilateral resistances and related measures.

The border between Canada and the rest of the world appears to be smaller than that with the US and fairly stable over time. One explanation for the first result is that the effects of contiguity and border are being confounded for the US-Canada border. Treating

[16] As suggested by Brown and Anderson (2002), breaking the contiguity dummy variable into two is important. Estimation results, available upon request, with a single common border dummy variable show no significant effects of contiguity on trade, which should not be surprising in the light of our findings that contiguity between provinces and contiguity between provinces and states work in opposite directions.

[17] Fuels are an exception.

[18] Estimation results at the commodity level show that even when the same commodity is considered, the relationship between the border coefficient when Canada is the exporter and the corresponding coefficient when US is the exporter varies over time. For example, the coefficient on CAN_USA for Printing and Publishing Products in 1995, 1999, and 2002 is significantly smaller than the corresponding coefficient on USA_CAN for the same years, while the relationship is reversed for the rest of the years in our sample.

the net border effect between Canada and the US as the sum of the coefficients on the US-Canada border variable(s) and the dummy for contiguous provinces and states still leaves the US-Canada border effect smaller.

It is possible that aggregation (a feature of almost all gravity investigations) biases gravity estimates. Anderson and van Wincoop (2004) provide an extensive discussion of aggregation bias in gravity estimation, setting out forces pushing in either direction, and concluding that no theoretical presumption can be created.

To investigate aggregation bias, we perform several experiments. We start by estimating the gravity equation using data on aggregate trade flows and output obtained by summing up commodity level values for each province and state.[19] Estimation results for the last six years in our sample are reported in Table 1 of Appendix A.[20] Distance coefficients vary by commodity in Table 2 but look like averaging out to the level in Table 1. Aggregate border effects are in contrast significantly lower than the average border effects estimated with commodity level data. Aggregated data also reveal that the border dummy CA_US, which indicates that the direction of the trade flow is from provinces to states, loses significance. Our findings suggest that the asymmetry in the border effects found by Bergstrand, Egger and Larch (2007) is weakly identified.

The border effects reported here are mostly larger than those inferred from aggregate trade flow data in Anderson and van Wincoop (2003). It is similarly notable that the distance elasticities reported in Table 2 are mostly twice as large as those inferred from aggregate data in Anderson and van Wincoop (2003). Much of the difference is explained by differences in data: our commodity aggregations are less comprehensive.

Aggregated border effect estimates move closer to those from McCallum (1995) and Anderson and van Wincoop (2004) by keeping only the 30 states and 10 provinces employed

[19]It should be noted that the estimates obtained by aggregating our data will not be identical to estimates obtained with aggregated data from government agencies. One reason is that data for some products such as tobacco and alcoholic beverages is often not reported at the commodity level but included in the aggregate statistics.

[20]Results for the first six years in the sample are very similar to the ones presented and are available upon request.

in their estimations and by combining the two border dummies between US and Canada into one. The new, aggregated border effects estimates are less than a third of the average border effects for some individual products. A possible explanation could be that international trade flows data is reported at the first destination of shipments and, therefore, one would expect that reported trade between border states and provinces will be more intense than it actually is. Such bias is partially corrected for by dropping the remote states and provinces to match the sample from McCallum (1995). An additional experiment drops Agricultural products and Fuels out of the sample. The resulting border effects estimated with aggregated data are consistently lower than the corresponding coefficients obtained with commodity level data. Overall, our tests and experiments imply that aggregation biases border effect estimates downward.

Finally, we look for province level border effects with the coefficient of the variable SMCTRY to find no empirical evidence that internal provincial trade is higher or lower than interprovincial and international trade.[21] Three commodities constitute exceptions: Internal provincial trade is significantly higher in the case of Printing and Publishing Products for the years before 1996. The effect is largest in 1992 and gradually decreases in magnitude to become insignificant in 1996. Food Products and Petroleum and Coal Products are the other two commodity categories for which the coefficients on the dummy variables for internal trade are consistently significant. In both cases, the coefficients are negative. In the case of Food Products, the coefficient gains significance in 1996 and is relatively stable over time. The coefficient for Petroleum and Coal Products gains significance in 1995 and increases in magnitude since then. The most plausible explanation is that the functional form for trade costs imposed in (12) is inaccurate for Petroleum and Coal Products and increasingly so with Alberta's resource boom. For comparability of results over commodities we have elected to keep the common form of trade costs in this report.

The large and varying border effects as we disaggregate raises the question of how be-

[21] In contrast, Wolf (2000) found evidence of US state border effects using aggregate shipments data.

lievable are the results. The main contribution of our paper, the calculation of multilateral resistance and its implications, is rather robust to variations in the gravity estimation that change the gravity coefficients because multilateral resistance is normalized, but this is still an important question.

The good fit and relative stability of coefficients over time (once symmetric border effects are imposed) argue that the gravity regression picks up a genuine statistical regularity, while the economic theory of gravity assigns economic significance to those coefficients. These properties have legitimized the empirical gravity literature based on aggregate data, so we think they legitimize our disaggregated results. Large magnitudes have three explanations. First, trade costs really are large. Second, what we call "trade costs" may reflect home bias in preferences. Our approach assumes common preferences and so identifies variations in consumption patterns with relative price differences due to trade costs. There is no way in a pure gravity setting to decompose the two forces. Third, fixed costs of exporting impose a selection effect that recent research emphasizes. Our estimates of variable trade costs are probably biased upward by our inability to control for selection due to the nature of the data.

Helpman, Melitz and Rubinstein (2008) develop a formal model of selection. Potential exporters must absorb fixed costs to enter a market, screening out the less productive ones. The HMR technique requires an exogenous variable that enters selection but is excluded from determination of the volume of trade. In their cross country case, common religion was the excluded variable, but in our state and province based data set there is no plausible variable that differs across the observations.

Santos Silva and Tenreyro (2007) argue that the truncation of trade flows at zero biases the standard loglinear OLS approach. They propose an alternative Poisson Pseudo-Maximum Likelihood (PPML) estimator. Our PPML estimates lower the effects of distance and borders. We use OLS estimates here based on Martinez-Zarzoso, Nowak-Lehmann and Volmer (2007), who argue that the PPML estimator is outperformed by OLS.

4.2 Multilateral Resistance Results

Inward and outward multilateral resistance indexes are calculated by solving system (5)-(6), normalized by setting the inward multilateral resistances for Alberta equal to one.[22]

For the purposes of describing multilateral resistance over time, it seems desirable to have a time-invariant normalization, resembling the use of CPI or GDP deflators to convert current prices to base year prices.[23] The procedure we adopt is to convert Alberta's current inward multilateral resistance into base year Alberta multilateral resistance.[24] Thus, initially we calculate MR's for each commodity with $P_A(t) = 1$ for each year t. This yields for each commodity a set $\{P_i(t), \Pi_i(t)\}$ for each region i and year t. We aggregate the commodity level MR's to form the provincial MR's. To convert them to intertemporally comparable values, we construct an inflator variable for Alberta, drawn from province level CPI's (for goods only, excluding services). The inflator is equal to $\pi_A(t) = CPI_A(t)/CPI_A(1992)$. The new set of 'time-consistent' MR's is $\{\pi_A(t)P_i(t), (1/\pi_A(t))\Pi_i(t)\}$. Conceptually, any region's inward MR is converted to a 1992 dollars Alberta equivalent. For example, $P_i(t)/P_A(t)$ is replaced by $P_i(t)/P_A(1992)$. The scale of outward MR's is inversely related to the scaling of inward MR's due to the structure of (5)-(6), so outward MR's are also interpreted as being in

[22]Mechanically, we solve system (5)-(6) for the power transforms $\{(\Pi_i^k)^{1-\sigma_k}, (P_j^k)^{1-\sigma_k}\}$. To obtain $\{(\Pi_i^k), (P_j^k)\}$, we use our own estimates of elasticity of substitution at the commodity level based on country level data. The theory calls for valuing shipments at delivered prices while our data is at FOB prices. Gravity coefficients are unbiased by this practice because the fixed effects control for effect of the measurement error on the gravity equation. In contrast, the MR estimates could be biased if the measurement errors in the shares Y_k^i/Y_k and E_k^j/Y_k are correlated with the calculated trade costs t_{ij}^k. The alternative procedure is to use transport cost markups to value shipments at CIF prices. These markups are well-known to be full of measurement error as well, so there is no ideal procedure.

[23]Within each year, only relative multilateral resistances have allocation consequences.

[24]The IMR values in principle are comparable to price indexes, and in particular their variation across provinces might be expected to reflect variation in consumer (or user) price indexes across provinces. The IMR's have more variation than CPI's, and they only loosely track variations in consumer price indexes. The difference does not necessarily indicate problems with our approach of calculating IMR's. The difference has a number of explanations. First, the inward incidence of trade costs probably falls on intermediate goods users in a way that does not show up in measured prices. Second, the production weighted IMR's are not really conceptually comparable to the consumer price indexes of final goods baskets. Third, home bias in preferences may be indicated by our results. Home bias in preferences results in attributions to 'trade costs' that cannot show up in prices. But fourth, the IMR's are no doubt are subject to measurement error and are based on a CES model that itself may be mis-specified. We think it is premature to adopt this negative interpretation that vitiates our approach.

1992 Alberta dollars. The undeflated series shows essentially flat inward MR's and declining outward MR's while the CPI deflated series has upward trend in inward MR's and amplified downward trend in outward MR's.

We find significant variation, within reasonable bounds, in IMR's across provinces and territories for a single product, and across commodity lines for a given province or territory. For brevity we concentrate on IMR's aggregated over goods as they vary across provinces and territories. Commodity level results are summarized in Appendix C. We present point estimates of MR's only, but the MR's are generally rather precisely estimated.[25]

Table 3 from Appendix A summarizes the evolution over time of IMR's by province and territory across all product lines.[26] The values in each table are the yearly average inward multilateral resistances for each province across all goods weighted by the provincial expenditure share on each commodity. Overall, the values of uninflated IMRs are stable over time. They are significantly different across provinces, and the pattern of IMR variation makes good intuitive sense. More 'remote' regions, geographically and in terms of industry concentration, face larger buyers' incidence: The Northwest Territories (NT)(including Nunavut), the Yukon Territories (YT), and Newfoundland and Labrador (YT) are consistently among the regions with largest IMR indexes. In contrast, Ontario (ON) and Quebec (QC) are consistently among the regions with lowest buyers' incidence.

Alberta is representative of our results.[27] Inward trade costs for most commodity categories puts Alberta somewhere in the middle as compared to the high-costs NT, YT, and NL on the one hand, and the low-costs ON and QC on the other. There are, however, a few expected exceptions. Alberta has very low relative IMR indexes for several commodity categories including Agricultural Products, Fuels, Mineral Products, Petroleum and Coal Products, and Chemical Products. Given Alberta's fuels resources, it should be no surprise

[25] In work available on request, we constructed standard errors of MR's by bootstrapping the constructed bilateral trade costs from our regression model. The standard deviations relative to the means averaged 7% for IMR's and 15% for OMR's. The maximum ratio for IMR's was 35% and for OMR's was 42%.

[26] Individual figures presenting the variation of internal multilateral resistance across regions are available upon request.

[27] This made Alberta our choice for normalization.

that the inward trade costs for Fuels and Petroleum and Coal Products are relatively low. The low inward multilateral resistance for Agricultural Products should also be expected given that Alberta is one of the biggest agricultural producing provinces in Canada. Chemical Products is another industry where Alberta has low inward multilateral resistance index, higher only than the corresponding indexes for Ontario and Quebec. Once again, this result is driven by the fact that, along with ON and QC, Alberta dominates production in this industry, especially when Petrochemicals and Synthetic Resins are considered. Finally, Alberta has the fourth lowest inward trade cost for Mineral Products, which reflects the province's fourth place, after Ontario, Quebec, and British Columbia, in terms of output share in in this industry.

Outward multilateral resistances are considerably larger than the inward multilateral resistances. This is a striking regularity. The reason is that specialization effectively makes supply less elastic than demand. Supply shares tend to be higher for low trade cost sellers (due to upper level general equilibrium forces, all else equal) and this force is more powerful than than the analogous expenditure share force. See Proposition 2 for formal insight.[28]

The OMR's vary widely across industries for a single province and across provinces for a single product line. The pattern of variation makes good sense for the most part. We summarize our findings about the patterns of OMR variation across commodity categories in Appendix C. We summarize our findings about the variation of aggregated OMR's across provinces in Table 4. This time, we use commodity shipment shares as weights in order to calculate the average OMRs for each province or territory across all goods. More remote regions face larger sellers' incidence: Yukon Territories (YT), and Newfoundland and Labrador (NL) are consistently the two regions with largest outward multilateral resistance indexes, while Ontario (ON) and Quebec (QC) are always among the regions with lowest outward

[28]The large OMR's may at first appear implausible, since they may appear to imply large relative factor price differences between regions for immobile factors. But this is not a necessary implication because the large amount of regional specialization allows substantial factor price equality to coexist with large differences in OMR's. Note that our method in principle allows the construction of a Π_i^k for a province i that produces no k.

trade costs. The explanation is the combination of remote vs. central geographical location and low vs. high industry concentration in these regions.

Northwest Territories (NT)(including Nunavut), British Columbia, and Alberta are among the regions with low outward multilateral resistances. In the case of the Northwest Territories, this result is driven by the fact that Fuels, which take more than 70% of NT's shipments, are a commodity category with relatively low outward trade cost. Fuels also explain the low OMR values for Alberta. Finally, British Columbia has very low relative outward multilateral resistances for some commodity categories such as Food, Leather, Rubber, and Plastic Products, Printing and Publishing, Fabricated Metals, and Machinery, which represent the leading manufacturing industries in the province.

The pattern suggested by Proposition 1 holds up strikingly well in our data when applied to OMR's: they are significantly decreasing in output shares and increasing in expenditure shares in regressions run at the product or province level. Tables 5 and 6 illustrate our results at the province level:[29] All coefficients on output shares are negative and significant,[30] while all coefficients on expenditure shares are positive and significant at any level.

In contrast, the sign pattern is sometimes reversed for IMR's: Our regressions indicate a mixed relationship between IMR's and output and expenditure shares at the province level. As can be seen from Tables 7 and 8, IMRs and output shares are positively and significantly related for most of the provinces and negatively related for the remote regions such as NL, NT, and YT. Similarly, the coefficients on expenditure shares are negative for most regions with the exception of NL, NT, YT, and PE. What seems to explain this pattern is that for given Π's the P's are inversely related to the Π's by (6). Most of the incidence of trade costs falls on the Π's and this incidence is driven by the forces suggested by Proposition 1, hence due to (6) these forces reverse sign in explaining the pattern of the P's.

Over time there is strong evidence of a decline in OMR's. See Table (4). Since gravity

[29] To obtain these estimation results, we regress MR's to the power of $(1-\sigma)$ on output and expenditure shares for each province in our sample.

[30] NT is the only province for which the output share coefficient is negative but not significant.

coefficients are stable over time, we take the suggestion from Proposition 3 that the decline in OMR's is interpreted as driven by economizing on trade costs.

MR's stand in sharp contrast to share-weighted Laspeyres indexes of bilateral trade costs.[31] In theory, share-weighted indexes are 'naive incidence' measures that put all incidence on alternately the seller or buyer. In practice, naive and MR incidence measures are very significantly different. Share-weighted indexes are presented in Table 9 from Appendix A.[32] Several properties stand out. First, share-weighted indexes vary across provinces in a counter-intuitive way. For example the Yukon Territories are consistently among the regions with lowest trade costs. Our methods yield more plausible rankings. Second, the share-weighted index suggests that the 'average' incidence of the constant bilateral costs has increased over time, while outward multilateral resistance decreases over time. Third, there is unsystematic correlation between multilateral resistance and share-weighted indexes of bilateral trade costs. OMR is weakly positively correlated with the corresponding share-weighted indexes at the province level, shown in column 3 of Table 10. IMR has no systematic correlation with its counterpart share-weighted index. Column 2 of Table 10 shows that IMR's and share-weighted trade costs are positively related for the remote regions, such as NL, NT, SK, and YT, and negatively related for the more developed regions.

Constructed Home Bias captures the combined implications of gravity for home bias. The calculation is based on

$$\left(\frac{t_{ii}^k}{\Pi_i^k P_i^k}\right)^{1-\sigma_k},$$

where t_{ii}^k is the estimated from gravity internal trade cost for province or territory i and commodity k relative to the smallest internal provincial trade cost for commodity k across all provinces and territories.[33] Recall that CHB is interpreted as the ratio of predicted

[31]Such measures have been used by Redding and Venables (2004), among others.

[32]The outward index in Table 9 is calculated as $\sum_k T_i^k Y_i^k / \sum_k Y_i^k$ where $T_i^k \equiv \sum_j t_{ij}^k X_{ij}^k / Y_i^k$. The inward counterpart calculation is $\sum_k T_j^k E_j^k / \sum_k E_j^k$ where $T_j^k \equiv \sum_i t_{ij}^k X_{ij}^k / E_j^k$.

[33]In most cases, the smallest internal provincial cost is the one in Prince Edward Island due to its small size and, therefore, small internal distance.

trade flows to predicted frictionless trade flows.[34] Note that the normalization used to solve system (4)-(6) does not play any role: CHB is independent of the normalization. Notice also that CHB is independent of the elasticity of substitution because it is constructed using the $1-\sigma_k$ power transforms of t's, Π's and P's. The reported CHB values are calculated for each province and territory as the weighted average of commodity level values of $(t_{ii}^k/\Pi_i^k P_i^k)^{1-\sigma}$.

Table 11 displays the variation and the evolution of CHB across the provinces and territories in our sample. Three properties stand out. First, the values are all big, there is massive home bias in trade flows. Second, CHB is larger for more remote regions and smaller for more developed regions. In each year, the Northwest Territories (NT), the Yukon Territories (YT), and Newfoundland and Labrador (NL) are the three regions with highest CHB, while Ontario (ON) and Quebec (QC) are the two provinces with lowest CHB. Third, most strikingly, home bias falls over time. Table 11 shows that on average, each Canadian province or territory experiences a relatively stable decrease in CHB over time. The last rows of Table 11 report the percentage decrease (as a positive number) in CHB. There is a very economically significant decrease in CHB for each province and territory except the Yukon Territories.[35] The decrease in CHB varies from 29% for British Columbia to 86% for the Northwest Territories.

The dramatic fall in CHB's reflects 'globalization', a fall in external (both international and inter-provincial) trade costs relative to internal trade costs. The fall is not due to the usual understanding of globalization because the fitted t_{ij}'s are nearly constant due to almost constant gravity coefficients.[36] Instead, the fall in home bias is due to the general equilibrium effect of changes in production and expenditure shares on multilateral resistance. Neverthe-

[34]A complementary approach captures another aspect of the effect of time on trade flows via the *residual fixed effects*, the difference between directional fixed effects and OMRs. Our results indicate no systematic effect of time on home bias via this channel.

[35]This result is driven by the unexpectedly high CHB value for 2003, which is not in accordance with the decrease in CHB for previous years.

[36]We also note that the residual fixed effects, the difference between the estimated fixed effects and the calculated multilateral resistances, have no evident time series pattern. Thus our CHB fall contains all the power of gravity to explain the fall in home bias.

less, a fall in the *level* of trade costs[37] could be causing the specialization in production over time that drives the fall in constructed home bias.

Finally, the changes in OMR's and IMR's over the period 1992-2003 have sizable effects on real GDP. We construct a crude approximation of real GDP changes as follows. Assume for simplicity that no rent is associated with the trade barriers. Fix all the supply and expenditure shares for a first order approximation to the change in real GDP by province.[38] The real GDP change is given by the sum of the effects of OMR changes on sellers and the effects of IMR changes on buyers (both final and intermediate). We use changes in the undeflated (current Alberta prices) MR's, but the measure we construct is invariant to the normalization, as we explain below.

The gross effect of OMR changes on sellers from a particular province or territory is given by a weighted average of the decreases in OMR's in each product, where the weights are the average shares of shipments of each product in the total provincial shipments for the period 1992-2003.[39] Formally:

$$\sum_i \Delta OMR_{i,k} WS^w_{i,k},$$

where $\Delta OMR_{i,k}$ is the percentage decrease (as a positive number) in the outward multilateral resistances that each province k faces when shipping product i to the rest of the world, including all other Canadian provinces and territories, and $WS^w_{i,k}$ is the average product i's shipment share in province k's shipments to the rest of the world for the period 1992-2003. The gross effects on sellers are reported in column 2 of Table 12. They are positive across all provinces and territories, except Ontario, and larger for the more remote regions and lower for the more developed regions. The negative value for Ontario is driven by the fact that over the period 1992-2003 there has been a significant increase in OMR's for Transportation

[37] The level of trade cost is not identifiable from gravity because size-adjusted trade is invariant to equiproportionate reductions in bilateral trade costs.

[38] A full general equilibrium treatment requires specifying the upper level supply and expenditure allocation processes, while treating rents requires marginal dead weight loss calculations.

[39] We also experiment by using the 1992 shares of shipments of each product in the total provincial shipments and the results are very similar to the ones discussed here.

Products, which account for a significant portion of Ontario's shipments. The increase in OMR's can be explained in part by the world wide intensified competition in the motor vehicle market.

The gross effect of IMR changes on buyers (including intermediate input buyers) is given by:

$$\sum_i \Delta IMR_{i,k} WD_{i,k},$$

where $\Delta IMR_{i,k}$ is the percentage decrease in the trade costs faced by buyers in province k from 1992-2003, and $WD_{i,k}$ is product i's expenditure share in province k's total expenditure. Gross effects on provincial buyers are reported in column 3 of Table 12. Buyers in most provinces gain modestly. The two exceptions are Northwest Territories and Quebec. Columns 2 and 3 in Table 12, reveal that the gross effects on sellers are systematically higher.[40] Both levels and changes in the incidence of trade costs fall much more on sellers than on buyers.

The net real GDP effect of the change in the incidence of trade costs is the sum of column 2 and column 3 from Table 12,[41] given in column 4. Change in the incidence of trade costs is effectively change in the productivity of distribution, isomorphic to change in Total Factor Productivity. The 1% per year average annual changes of the star performers imply big TFP effects, comparable to star performances found in productivity studies.

The gain from specialization is stronger for the more remote regions and weaker for the more developed regions. For example, the Yukon Territories will enjoy an 11.2% increase in real GDP and the Northwest Territories will experience an 11.1% in real GDP, while the corresponding numbers for Quebec for example is only 3.6% while for Ontario it is negative. Globalization in this sense reduces inequality among Canada's provinces and territories.

[40] Manitoba is the only exception.

[41] The logic is that a fall in outward MR permits an accompanying rise in 'factory gate' prices and hence returns to primary factors. A rise in inward MR lowers returns to primary factors due to intermediate input costs and also lowers real income for consumers. The logic shows that normalization does not affect net welfare because an x% fall in outward MR induces an x% rise in producer factory gate prices while an x% rise in inward MR induces an x% rise in input prices and final goods prices, the net effect canceling out.

4.3 Incidence of Domestic Costs

Domestic Trade Cost (DTC) indexes are calculated using the procedures of Section 1.2. For a generic commodity:

$$\Pi_{iC} = \Pi_i \left(\frac{\sum_{j \in C} E_j (P_j)^{\sigma-1}}{\bar{Y}_{iC}} \right)^{1/(\sigma-1)}, \tag{15}$$

where $\bar{Y}_{iC}$ is defined by (8), and all other variables in (15) are previously defined. We solve for the Π_{iC}'s simultaneously with the multilateral resistance indexes using (15), (5)-(6) and the normalization.[42] Section (1.2) shows that DTC's are independent of the normalization.

Summary results for the DTC's for each province and territory across all commodities and for each year in our sample are presented in table 13.[43] On average, the provincial DTC's are a little less than half than the corresponding multilateral resistances.[44] The DTC's are very stable over time and uniform across provinces and territories. Since outward multilateral resistance falls significantly, that means that the second term of (15) rises, due to shipments within Canada (picked up by $\bar{Y}_{iC}$) falling toward their frictionless level.

4.4 Assessing the AIT

The Agreement on Internal Trade (AIT) is a voluntary agreement by provinces to reduce barriers to trade within Canada that came into effect on July 1, 1995. To capture the AIT effect econometrically we introduce a dummy variable, which takes a value of one for the years after 1995 and a value of zero for the years before 1996, and we estimate equation (14) using time-varying directional fixed effects in a panel setting.[45] We find no consistent evidence that the AIT reduced Canada's internal trade costs.[46] The coefficient of the AIT

[42] Sensitivity checks show that the uniform internal Canadian costs calculated in the general equilibrium system are very close to the the corresponding costs obtained when we first solve for the MR's using system (4)-(6), and then substitute those MR's directly into to (15).

[43] In Appendix C, we discuss our findings about DTC's at the commodity level.

[44] We perform mean comparison tests to find that, without exception, each province faces significantly lower uniform trade costs to its Canadian partners as compared to the world as a whole.

[45] Moving the cutoff date for the "AIT" variable forward and back in time to an earlier or a later year did not have any effect on the significance of our estimation coefficients.

[46] Estimation results for each product in our sample are available upon request.

dummy variable varies in sign and is insignificant for almost all commodity categories. Three exceptions are Fuels, Paper and Pulp Products, for which the AIT coefficient is positive and significant, and Transportation Products, for which the coefficient is negative and significant. Considering the magnitude of those coefficients, we believe that they capture the effect of forces other than the AIT.

Possible effects of the *intent* of the AIT are revealed by counterfactual experiment. Assume that the first year after the introduction of the AIT (1996), there is a uniform decrease of 5% in all interprovincial bilateral trade costs. We re-calculate the multilateral resistance indexes using the new bilateral trade costs and use the changes in trade costs to estimate the real GDP effects in each province and territory.[47] The uniform 5% decrease in interprovincial trade costs lowers both OMR's and IMR's. More importantly, the responses of IMR's and OMR's vary significantly across industries for a single province and across provinces for a single product line. The effect is much stronger for the outward multilateral resistances, corresponding to the incidence of trade costs being more on the supply side. The real GDP effects are calculated using the changes in OMR's and IMR's and the methodology introduced in Section 4.2.

Gross effects on provincial buyers are reported in column 2 of Table 14. Buyers in most provinces will gain from a reduction in interprovincial trade costs. The three exceptions are Manitoba, Ontario and Quebec. When domestic Canadian trade costs are decreased, firms from these industrial regions find it more profitable to "export" to the rest of Canada, which naturally increases internal prices in the three provinces, hurting buyers. The gross gains to sellers by province of origin are reported in column 3 of Table 14. They are positive for all provinces and territories, and the gross effect on sellers is systematically higher than on buyers.

The net real GDP effect is the sum of columns 2 and 3 in Table 14, given in column 4.

[47] It is worth noting that our DTC methodology could be used to decompose the AIT welfare effects into those due to the domestic trade cost reduction and those due to the full incidence changes. Moreover, the same techniques could be applied to trace the welfare effects on producers and consumers by commodity category.

The gain is bigger for the more remote regions and smaller for the more developed regions. For example, the Yukon Territories will enjoy a 3% increase in real GDP and the Northwest territories will experience a 2.5% increase in real GDP, while the corresponding numbers for Ontario and Quebec are only 0.8% and 1.5%, respectively. Thus a uniform decrease in interprovincial trade costs would promote equality among the Canadian provinces and territories. The fall in inequality is similar to the result of globalization over 1992-2003, but it is driven by a fall in bilateral trade costs rather than the effect of specialization.

Our simulations point to the theoretical possibility of 'immiserizing globalization'. A uniform fall in domestic Canadian trade costs induces 'core' regions to trade more intensively with the rest of Canada, raising prices to provincial buyers in core regions. Ontario's numbers illustrate. The 1.6% loss to buyers happens to be more than offset by the 2.4% gain to sellers, but the net positive effect is not guaranteed.

The non-neutral effects may imply that efficient trade cost policy should be tailored with particular industries and particular provinces in mind. The conditional general equilibrium techniques used for the simulation of the effects of a hypothetical AIT are readily applicable to different policy issues and exogenous shocks. For example, similar counterfactual experiments could trace the effects on trade costs and welfare of the opening in 1997 of the Confederation Bridge linking Prince Edward Island to the continental part of Canada.[48]

5 Conclusion

This paper pioneers the application of multilateral resistance theory to economic geography. Constructed home bias falls over time in Canada, due to a fall in sellers' incidence of trade costs driven by cost-reducing reallocation of supply and demand with constant bilateral trade costs, a previously unappreciated force of globalization. Real GDP effects on Canada's provinces are big, for star performers comparable to star TFP performance.

[48] Another potential candidate is the investment and labor mobility agreement (TILMA) between Alberta and British Columbia, which became effective in April 2007. The analysis here requires elaboration of the upper level general equilibrium structure because the effects of TILMA would primarily be on supply shares.

We decompose sellers' incidence to break out internal incidence. Internal incidence for Canada's provinces is constant over time; globalization is acting on Canada's external trade. The AIT was an attempt to promote internal trade but we find no econometric evidence it affected Canadian inter-provincial trade. Reflecting its intent we simulated a uniform fall in trade costs on within-Canada trade. It has unequal effects that promote equality between the Canadian provinces and territories. The simulation indicates that general equilibrium effects can amplify or offset the direct effect of a fall in internal trade costs.

Our results turn up new questions. The cross sectional variation of multilateral resistance over provinces and commodities is large, with large implications for resource and expenditure allocation that can be checked. How generally significant is the force of specialization observed here with Canadian data? Declines in tariffs and transport costs explain much of the 1958-88 growth in average trade to GDP ratios but only 40% of the variance in Baier and Bergstrand (2001). Changes in the multilateral resistance terms they could only poorly approximate would alter the picture.

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Appendix A: Estimation Results and Summary Tables

Table 1: Gravity with Aggregated Data: 1998-2003

	1998	1999	2000	2001	2002	2003
LNDIST	-1.581	-1.528	-1.586	-1.602	-1.651	-1.582
	(0.098)**	(0.097)**	(0.100)**	(0.100)**	(0.104)**	(0.101)**
CB_P_P	-0.456	-0.506	-0.423	-0.494	-0.354	-0.457
	(0.470)	(0.443)	(0.451)	(0.455)	(0.526)	(0.458)
CB_P_S	0.792	0.970	0.767	0.850	0.796	0.820
	(0.260)**	(0.270)**	(0.277)**	(0.277)**	(0.285)**	(0.272)**
CAN_USA	0.052	0.813	0.501	-0.658	-1.534	-3.079
	(0.605)	(0.801)	(0.894)	(0.744)	(0.824)+	(0.601)**
USA_CAN	-3.439	-4.060	-2.581	-2.316	-3.985	-1.408
	(0.500)**	(0.684)**	(0.565)**	(0.550)**	(0.507)**	(0.609)*
CAN_ROW	-2.310	-2.333	-2.139	-1.877	-2.055	-2.016
	(0.434)**	(0.412)**	(0.436)**	(0.300)**	(0.363)**	(0.328)**
SMCTRY	-0.202	-0.145	-0.247	-0.348	-0.386	-0.301
	(1.156)	(1.113)	(1.114)	(1.096)	(1.213)	(1.135)
CONST	-16.908	-16.528	-18.778	-17.246	-15.255	-17.265
	(1.009)**	(0.953)**	(1.063)**	(1.033)**	(1.156)**	(1.037)**
N	1277	1292	1280	1264	1265	1244
r2	0.649	0.661	0.649	0.658	0.661	0.677

Table 2: Commodity Level Weighted Average Gravity Coefficients

(1) Commodity	(2) LNDIST	(3) CB_P_P	(4) CB_P_S	(5) CA_US	(6) US_CA	(7) CA_ROW	(8) SMCTRY
Agriculture	-2.237	-0.123	0.553	-4.363	-4.952	-1.021	-0.002
Chemical Products	-1.505	-0.753	1.091	-8.881	-5.932	-2.528	0.068
Electrical Products	-0.816	-0.216	1.047	-3.309	-1.856	-2.714	1.532
Fabricated Metal Products	-1.488	-0.808	0.922	-6.527	-5.824	-3.139	-0.437
Food	-1.712	-0.863	0.628	-6.310	-6.923	-2.396	-1.210
Fuels	-1.461	1.468	0.318	-0.982	-4.437	-2.522	1.080
Furniture	-1.291	-0.663	0.814	-6.584	-6.206	-3.496	-0.300
Hosiery and Clothing Products	-1.014	-1.030	1.076	-7.780	-6.644	-4.502	-0.056
Leather, Rubber, and Plastic Products	-1.501	-0.914	0.893	-7.224	-4.280	-3.093	-0.666
Lumber and Wood Products	-1.669	-1.050	0.752	-8.605	-5.545	-3.049	-0.813
Machinery	-1.254	-0.312	0.758	-4.315	-2.859	-2.062	0.864
Mineral Products	-1.595	-0.351	1.002	-4.937	-6.077	-3.325	0.483
Miscellaneous Products	-1.201	-1.000	0.836	-8.124	-5.331	-4.018	0.595
Petroleum and Coal Products	-2.313	-0.477	1.156	-7.245	-9.472	-2.118	-1.471
Primary Metal Products	-1.581	-0.536	0.839	-6.399	-6.388	-2.115	-0.233
Printing and Publishing Products	-1.459	-0.895	0.756	-8.008	-5.395	-4.820	1.081
Textile Products	-1.215	-0.605	1.044	-8.479	-5.751	-4.295	-0.085
Transportation Products	-1.512	-0.771	0.950	-5.634	-2.711	-2.661	-0.498
Wood Pulp and Paper Products	-1.786	-1.333	0.404	-7.372	-7.367	-2.093	-1.207

Table 3: Evolution of IMR by Province

Year	AB	BC	MB	NB	NL	NS	NT	ON	PE	QC	SK	YT
1992	1.00	1.01	0.97	1.12	1.16	1.09	1.21	0.90	0.98	0.87	1.06	1.22
1993	1.00	0.99	0.96	1.14	1.18	1.08	1.20	0.87	0.97	0.87	1.04	1.20
1994	1.01	1.01	0.99	1.09	1.17	1.06	1.23	0.88	1.00	0.88	1.05	1.22
1995	1.03	1.04	1.01	1.20	1.24	1.11	1.28	0.91	1.00	0.92	1.07	1.26
1996	1.05	1.06	1.02	1.26	1.29	1.13	1.31	0.91	1.02	0.93	1.09	1.28
1997	1.08	1.07	1.04	1.24	1.30	1.14	1.31	0.89	1.04	0.93	1.10	1.27
1998	1.08	1.06	1.04	1.27	1.28	1.14	1.30	0.89	1.00	0.91	1.11	1.27
1999	1.10	1.10	1.06	1.18	1.27	1.13	1.33	0.89	1.04	0.94	1.12	1.30
2000	1.14	1.13	1.12	1.20	1.43	1.26	1.41	1.02	1.11	1.03	1.17	1.33
2001	1.16	1.13	1.13	1.42	1.42	1.25	1.43	1.01	1.08	1.02	1.21	1.32
2002	1.19	1.20	1.15	1.43	1.41	1.25	1.45	0.99	1.11	1.04	1.24	1.40
2003	1.24	1.22	1.20	1.46	1.49	1.32	1.53	1.06	1.15	1.10	1.28	1.44

Table 4: Evolution of OMR by Province

Year	AB	BC	MB	NB	NL	NS	NT	ON	PE	QC	SK	YT
1992	4.69	5.62	5.68	5.72	7.03	5.88	5.52	4.25	6.86	5.14	5.65	6.28
1993	4.79	5.37	5.83	5.53	7.01	5.90	5.69	4.31	6.70	4.96	5.76	6.40
1994	4.34	4.82	5.32	5.12	6.65	5.65	5.93	4.09	5.88	4.60	5.01	6.05
1995	4.12	4.87	5.37	5.10	6.59	5.60	4.83	4.07	6.05	4.55	5.07	5.67
1996	4.06	4.62	5.37	4.97	6.01	5.85	4.73	4.18	6.17	4.60	4.89	6.10
1997	4.27	4.88	5.44	5.12	6.01	5.95	5.44	4.25	5.97	4.51	5.15	5.50
1998	4.06	4.77	5.55	5.35	6.08	6.12	4.16	4.39	6.16	4.66	5.17	5.11
1999	4.10	4.46	5.34	5.21	6.26	6.18	4.74	4.11	6.21	4.45	5.05	5.48
2000	3.58	4.19	4.92	4.84	4.95	5.36	3.56	3.72	5.72	4.02	4.57	4.53
2001	3.88	4.26	5.11	4.57	5.16	5.26	4.78	3.70	5.87	4.11	4.60	5.24
2002	3.49	4.39	5.17	4.49	4.28	5.19	4.54	4.02	5.48	4.25	4.42	4.71
2003	3.16	3.98	4.71	3.93	4.01	4.58	3.09	3.49	5.00	3.76	4.11	4.20

Table 5: OMR Correlations by Province I

	AB	BC	MB	NB	NL	NS
OUT_SHARE	-0.042	-0.028	-0.111	-0.085	-0.093	-0.128
	(0.005)**	(0.004)**	(0.024)**	(0.020)**	(0.023)**	(0.027)**
EXP_SHARE	0.091	0.131	0.323	0.419	0.283	0.327
	(0.009)**	(0.013)**	(0.039)**	(0.076)**	(0.054)**	(0.042)**
CONST	0.000	0.000	0.000	-0.000	0.000	0.000
	(0.000)**	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
N	216	216	216	216	216	216
r2	0.377	0.308	0.339	0.210	0.232	0.320

Standard errors in parentheses, + $p < 0.10$, * $p < .05$, ** $p < .01$

Table 6: OMR Correlations by Province II

	NT	ON	PE	QC	SK	YT
OUT_SHARE	-0.410	-0.051	-0.595	-0.030	-0.106	-5.950
	(0.910)	(0.007)**	(0.163)**	(0.010)**	(0.015)**	(1.092)**
EXP_SHARE	0.269	0.075	2.373	0.081	0.219	3.118
	(0.096)**	(0.010)**	(0.473)**	(0.019)**	(0.026)**	(0.396)**
CONST	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)**	(0.000)**	(0.000)	(0.000)	(0.000)	(0.000)**
N	216	216	216	216	216	216
r2	0.046	0.311	0.216	0.141	0.391	0.170

Standard errors in parentheses, + $p < 0.10$, * $p < .05$, ** $p < .01$

Table 7: IMR Correlations by Province I

	AB	BC	MB	NB	NL	NS
OUT_SHARE	0.000	177.754	995.516	93.038	-306.235	529.126
	(0.000)	(23.067)**	(170.217)**	(55.915)+	(46.291)**	(132.905)**
EXP_SHARE	0.000	-184.233	-818.891	-310.747	429.685	-534.478
	(0.000)	(46.905)**	(185.950)**	(199.116)	(99.524)**	(182.999)**
CONST	1.000	1.554	1.486	1.419	0.520	1.449
	.	(0.151)**	(0.160)**	(0.111)**	(0.043)**	(0.131)**
N	216	216	216	216	216	216
r2	.	0.539	0.227	0.011	0.101	0.090

Standard errors in parentheses, + $p < 0.10$, * $p < .05$, ** $p < .01$

Table 8: IMR Correlations by Province II

	NT	ON	PE	QC	SK	YT
OUT_SHARE	-1099.612	648.137	1400.947	373.404	126.745	-5545.277
	(2014.960)	(144.069)**	(752.168)+	(94.152)**	(46.551)**	(5380.367)
EXP_SHARE	330.068	-354.607	3257.245	-379.961	-107.745	2186.170
	(430.448)	(111.586)**	(1848.520)+	(165.207)*	(42.403)*	(2258.841)
CONST	0.407	0.521	1.417	4.810	0.877	0.507
	(0.033)**	(0.810)	(0.171)**	(0.804)**	(0.041)**	(0.044)**
N	216	216	216	216	216	216
r2	0.005	0.395	0.042	0.097	0.079	0.006

Standard errors in parentheses, + $p < 0.10$, * $p < .05$, ** $p < .01$

Table 9: Evolution of Share Weighted Trade Costs by Province

Year	AB	BC	MB	NB	NL	NS	NT	ON	PE	QC	SK	YT
1992	10.61	15.34	6.07	7.20	11.65	7.96	8.34	4.79	6.91	4.61	9.26	2.39
1993	12.20	6.91	5.99	6.75	13.85	7.02	10.77	3.88	8.49	3.93	9.86	3.20
1994	6.77	7.87	4.98	5.64	6.41	4.68	8.00	5.61	4.41	5.23	6.74	2.68
1995	4.82	8.02	5.72	6.60	8.74	5.85	3.65	5.69	5.37	5.19	6.53	2.06
1996	6.78	7.30	8.02	8.25	13.27	7.85	5.97	6.48	10.97	5.51	7.64	2.93
1997	8.78	12.58	8.36	7.70	10.05	6.31	12.18	6.74	7.51	6.75	9.39	5.61
1998	5.35	9.44	8.40	8.07	11.04	9.45	4.17	7.49	6.75	6.84	7.65	3.12
1999	7.86	9.65	9.15	8.77	14.51	8.08	8.62	5.04	12.42	5.88	9.80	5.64
2000	13.54	9.20	15.25	16.63	35.45	15.07	7.90	6.32	61.04	6.74	13.37	5.47
2001	12.65	11.69	9.07	9.43	16.05	9.12	17.92	5.07	15.74	5.67	11.06	11.13
2002	7.57	19.86	11.63	11.80	10.97	11.16	4.45	6.31	13.00	8.45	9.18	4.30
2003	16.15	19.01	10.30	10.79	14.10	10.57	7.54	5.03	9.76	6.84	11.40	5.13

Table 10: IMR and OMR Correlations with Share-Weighted Trade Costs Indexes by Province

Province	IMR	OMR
Alberta		.3166702
British Columbia	-.2642099	.3609433
Manitoba	.0041226	.3211284
New Brunswick	-.0202212	.3184878
Newfoundland and Labrador	.091838	.1754505
Northwest Territories	.3093609	.330305
Nova Scotia	-.0611895	.3657702
Ontario	-.1883683	.4872436
Prince Edward Island	-.1957324	.1777058
Quebec	-.177604	.4324464
Saskatchewan	.1642961	.4066874
Yukon Territories	.2532978	.2516487

Table 11: CHB by Province

Year	AB	BC	MB	NB	NL	NS	NT	ON	PE	QC	SK	YT
1992	1031	526	1739	2630	10693	2754	48420	348	3067	414	1381	30570
1993	683	509	1627	1760	5010	1904	51980	276	2839	382	1147	35005
1994	539	476	1567	1399	5403	2039	43916	288	2900	364	1005	30667
1995	485	402	1416	854	3912	1621	34994	234	2260	308	870	23416
1996	393	428	1436	841	3619	1743	49677	189	2315	271	754	30520
1997	286	318	1035	744	2759	1312	41476	149	1739	232	515	17933
1998	435	450	1004	944	4162	1534	14831	156	1586	247	877	23774
1999	494	540	1394	1264	3190	1922	30985	198	1838	326	1049	22167
2000	658	444	1246	1343	4327	2167	9678	168	1499	249	1188	14046
2001	227	324	887	670	2026	981	7670	128	1025	195	595	9591
2002	501	487	1343	908	3528	1571	64213	176	1260	277	860	19431
2003	354	375	846	496	2081	1165	6835	88	1019	157	609	33154
$\%\Delta 92-03$	0.66	0.29	0.51	0.81	0.81	0.58	0.86	0.75	0.67	0.62	0.56	-0.08

Table 12: Trade Costs and Real GDP Effects by Province 1992-2003

Province	Sellers	Buyers	Real GDP
Alberta	0.114	0.000	0.114
British Columbia	0.084	0.002	0.086
Manitoba	0.014	0.027	0.040
New Brunswick	0.090	0.006	0.096
Newfoundland and Labrador	0.080	0.024	0.104
Northwest Territories	0.115	-0.004	0.111
Nova Scotia	0.055	0.017	0.072
Ontario	-0.121	0.069	-0.052
Prince Edward Island	0.146	0.041	0.187
Quebec	0.039	-0.002	0.036
Saskatchewan	0.050	0.017	0.067
Yukon Territories	0.095	0.017	0.112

Table 13: Evolution of DTC by Province

Year	AB	BC	MB	NB	NL	NS	NT	ON	PE	QC	SK	YT
1992	2.69	3.33	2.89	2.60	2.82	2.67	2.37	2.41	2.71	2.45	2.99	2.66
1993	2.81	3.45	2.97	2.72	3.02	2.77	2.54	2.50	2.68	2.40	3.13	2.48
1994	2.64	3.26	2.86	2.63	2.84	2.73	2.34	2.51	2.58	2.36	3.03	2.56
1995	2.59	3.18	2.90	2.63	3.05	2.72	2.02	2.54	2.89	2.37	3.13	2.68
1996	2.84	3.32	3.03	2.77	3.10	2.88	2.23	2.66	2.85	2.44	3.29	2.42
1997	2.78	3.24	2.98	2.81	3.19	2.90	2.36	2.72	2.80	2.47	3.19	2.35
1998	2.68	3.21	2.99	2.72	3.04	2.89	1.85	2.80	2.90	2.48	2.99	2.07
1999	2.76	3.22	2.96	2.81	2.98	2.86	2.06	2.78	2.90	2.46	3.02	2.34
2000	2.59	3.27	2.95	2.68	2.82	2.99	1.68	2.94	2.87	2.48	2.86	2.17
2001	2.80	3.32	3.09	2.80	3.00	3.05	2.14	2.94	3.01	2.53	3.24	2.76
2002	2.75	3.30	3.19	2.85	2.57	2.95	2.16	3.12	3.26	2.65	2.99	2.58
2003	2.82	3.16	2.99	2.68	2.67	2.82	1.82	2.98	3.09	2.60	3.02	2.22

Table 14: Real GDP effects of AIT by Province 5% Decrease in Trade Costs

Province	Buyers	Sellers	Real GDP
Alberta	0	0.0056557	0.0056557
British Columbia	0.0056513	0.0057871	0.0114384
Manitoba	-0.0006938	0.0173772	0.0166834
New Brunswick	0.0101609	0.0237364	0.0338973
Newfoundland and Labrador	0.0097973	0.0171951	0.0269924
Nova Scotia	0.0084759	0.0274803	0.0359562
Northwest Territories	0.0129653	0.012331	0.0252963
Ontario	-0.0155844	0.0239812	0.0083968
Prince Edward Island	0.0109322	0.0309557	0.0418879
Quebec	-0.0067504	0.0215225	0.0147721
Saskatchewan	0.0064498	0.0117438	0.0181936
Yukon Territories	0.0125445	0.0174748	0.0300193

Appendix B: Data Description and Sources

We use several sources to collect trade data: Interprovincial trade flows at producer prices are from Statistics Canada's tables 386-0001 and 386-0002.[49] Data on trade between Canadian provinces and territories and individual states, as well as trade between the provinces and territories and the rest of the world are from the Trade Data Online web interface of Industry Canada, which provides access to Canadian and US trade data by product classified according to NAICS.[50] An advantage of this database is that it reports the imports of individual provinces and territories from individual states valued F.O.B. (free on board).[51] The United Nation Statistical Division (UNSD) Commodity Trade (COMTRADE) Data Base provides data on bilateral trade flows for more than 130 countries starting as early as 1962. We use this database to calculate trade flows within ROW, which we define as the difference between total world exports and the exports from the world to Canada and the US. We also use COMTRADE to get US exports and imports to and from the rest of the world. We need the latter data in order to be able to calculate total US expenditures at the commodity level, which we use in the calculations of the multilateral resistances due to lack of data on the imports of individual states from the world.[52] COMTRADE reports trade flow values in annual US dollars and, in order to convert the values to Canadian dollars, we use the exchange rates tables of the Federal Reserve Bank of Saint Louis.[53]

[49] It should be noted that data on interprovincial trade flows for five categories of commodities including furniture, fabricated metals, machinery, transportation, and miscellaneous was clearly missing in the original data, as opposed to having values of zero, for the years before 1996. We have interpolated those missing values.

[50] Due to the specifics of the S-level of aggregation, as compared to other industrial classifications, we needed to generate several tables of concordance specifically for this project. These concordances are available upon request.

[51] In principle, gravity theory calls for valuation of exports at delivered prices. In practice, valuation of exports FOB avoids measurement error arising from poor quality transport cost data. This deviation from theory is without consequence for our results save for possible effects on the multilateral resistance calculations that will be examined below.

[52] Every 5 years, starting at 1993, the US department of transportation publishes a database, the Commodity Flow Survey, which includes interstate trade flows and individual state exports to the world. Unfortunately, data for individual state imports is not available, therefore we cannot calculate individual state expenditures.

[53] Url: http://research.stlouisfed.org/fred2/categories/283 The original source of the data is the Board of Governors of the Federal Reserve System.

Industrial output level data comes from several sources. Provincial output at the S-level of commodity disaggregation is from tables 386-0001 and 386-0002 of Statistics Canada.[54] The primary source of output data for individual states are the Regional Economic Accounts of the Bureau of Economic Analysis, U.S. Department of Commerce, which provides industry output data at producer prices in current US dollars classified according to SIC for the years before 1998 and according to NAICS for the years after 1998. Data on output for ROW is mainly from United Nations' UNIDO Industrial Statistics database, which reports industry level output data at the 3 and 4-digit level of ISIC Code (Revisions 2 and 3). In addition to UNIDO, we have use the World Database of International Trade (BACI) database, constructed by CEPII, as a secondary source of product level output data. Unfortunately, neither UNIDO nor BACI provide data on agricultural and mining output. Therefore, we use two additional data sources: the United Nations Food and Agriculture Organization (FAOSTAT) web page provides data on agricultural output, and the Energy Information Administration provides official energy statistics on the value of fuel production (including oil, natural gas, and coal) for the world.

We experiment with several distance variables based on different approaches in the calculation of internal as well as bilateral distances. Detailed description of the different distance variables that we have created is available upon request.[55] Here we just describe the distance variable that we have chosen to use in our main estimations.[56] To calculate bilateral distances we adopt the procedure from Mayer and Zignago (2006), which is based on Head and Mayer (2000). We use the following formula to generate weighted distances: $d_{ij} = \sum_{k \in i} \frac{pop_k}{pop_i} \sum_{l \in j} \frac{pop_l}{pop_j} d_{kl}$ where pop_k is the population of agglomeration k in trading partner i, and pop_l is the population of agglomeration l in trading partner j.[57] To calculate

[54] As in the case of interprovincial trade, data on the same five commodities is missing in the original tables for the years before 1996. We interpolate those values.

[55] Head and Mayer (2000) provide a nice summary and discussion of the alternative approaches of distance calculations.

[56] Our results are pretty robust to the choice of alternative distance measures.

[57] Head and Mayer (2000) propose the use of GDP shares rather than population shares as weights in the distance formula. Even though using GDP shares is the better approach, data availability did not allow us to use it in our analysis.

population weights, we take the biggest 20 agglomerations (in terms of population) in each trading partner when the partner is a province, a territory, or a state, and the biggest 50 cities when the partner is ROW.[58] Finally, d_{kl} is the distance between agglomeration k and agglomeration l, measured in kilometers, and calculated by the Great Circle Distance Formula.[59] All data on latitude, longitude, and population is from the World Gazetteer web page. A very appealing argument for the use of this particular approach in calculating the distances for our analysis is that the same procedure is applied when we calculate internal distances and bilateral distances. In addition, and what is especially important for us, this procedure allows us to also consistently aggregate the distances between any given partner and the rest of the world.

Finally, we generate dummy variables to pick up contiguous borders and the presence or absence of provincial or international border, as well as the effects of the implementation of the Agreement on Internal Trade (AIT). We assign a value of one to the dummy variable capturing contiguity when the two trading partners share a common border. We also generate a dummy variable to capture the presence of provincial border, which takes a value of one for internal trade, that is when the province trades with itself. Next, we assign a value of one to a dummy variable when the two trading partners are from the same country in order to capture the effect of an international border.

Appendix C: Trade Costs by Product

IMR's. Our findings indicate that Agricultural Products, Chemical Products, Petroleum and Coal Products and Fuels have consistently high relative inward multilateral resistances across almost all provinces and territories. On the other hand, Leather, Rubber and Plastic Products, Printing and Publishing Products, Transportation Products, and Textile Products have consistently low relative IMR indexes across different provinces and territories.

[58] In the few instances, where data was not available for 20 agglomerations within a single trading partner, we take only the cities for which data is available.

[59] Following Mayer and Zignago (2006), we use 32.19 kilometers as inner-city distance.

A natural explanation for such findings could be industry concentration: On the one hand, Agriculture, Fuels, and Petroleum and Coal Products are all resource industries with high concentration in certain regions. On the other hand, Printing and Publishing Industry is considered the most widely dispersed Canadian manufacturing industry. Industry concentration does not explain the low inward multilateral resistance in the Textile and Apparel industry, which is mainly concentrated in Ontario and Quebec. Through intensive capital investment over the last several decades, the Canadian Textile and Apparel industry has gained efficiency and has become more and more competitive on the world market. A big proportion of domestic demand is met by domestic production, which naturally translates into lower trade costs for the Canadian Consumer.

OMR's. We find that Textile Products, Printing and Publishing Products, and Non-metallic Mineral Products are always the three commodity categories with highest outward trade costs regardless of the province or territory in question, while Fuels, Machinery, Electrical Products, Petroleum and Coal Products, and Chemical Products are consistently among those with lowest OMR indexes. World competition is a natural candidate to explain our findings: Given, Canadian resources, Fuels and Petroleum and Coal Products are among the products for which Canada has clear advantage on the world market, while at the same time, it faces fierce competition in sectors such as Textile Products. In both cases we draw intuition from Proposition 1 that in the special case of uniform inter-regional trade costs, the OMR is decreasing in supply share.

Gravity Implied Trade Costs. We find wide variability of implied trade costs across commodities: Mineral Products and Mining have significantly higher values, while Electrical Products and Chemical Products are among the commodities with low implied values. While we find no clear trend in the time evolution of gravity trade costs at the commodity level, the share-weighted index suggests an increase in costs over time for some categories such as Mineral Products and Printing and Publishing Products. In contrast, outward multilateral resistance indexes fall over time at the product level.

DTC's. We find some differences and some similarities between the distributions of OMR's and provincial domestic trade costs to Canada when we compare them at the commodity level. On the one hand, our results indicate that, just like in the case of OMR's, Printing and Publishing Products and Non-metallic Mineral Products are among the commodity categories with highest DTCC's, while Electrical Products and Chemical Products are consistently among the products with lowest DTCC's. On the other hand, we find that the some commodities such Textiles, which are subject to high OMR, experience relatively low domestic Canadian trade costs, while other products such as Petroleum and Coal Products, which have relatively low outward multilateral resistance, are subject to significant DTCC's. Finally, our mean comparison tests indicate that Fuels is the only category for which OMR's are not significantly different than the DTCC's.

Appendix D: Proof of Propositions

Proof of Proposition 1 Assume a *uniform* international trade cost $t > 1$ on all trades across borders, while internal trade (from j to j) assumed to be frictionless, $t_{jj} = 1$. Take a representative good, so the subscript k is suppressed. It then eases notation slightly to move the location indexes from the superscript to the subscript position. Let s_j denote country j's share of world shipments (at delivered prices) of the generic good, while b_i denotes the expenditure share of country i on the generic good.

The system of equations that determine P_i, Π_i for all i, j is given by:

$$P_j^{1-\sigma} = t^{1-\sigma}\bar{h} + (1 - t^{1-\sigma})s_j/\Pi_j^{1-\sigma} \tag{16}$$

$$\Pi_i^{1-\sigma} = t^{1-\sigma}\bar{h}' + (1 - t^{1-\sigma})b_i/P_i^{1-\sigma}. \tag{17}$$

Here, $\bar{h} = \sum_i s_i \Pi_i^{\sigma-1}$ and $\bar{h}' = \sum_j P_j^{\sigma-1} b_j$. Recognizing that $\bar{h} = \sum_j (\beta_j \widetilde{p}_j)^{1-\sigma}$, its value is given by the general equilibrium solution. Multiply both sides of (16) by $\Pi_i^{1-\sigma}$ and multiply both sides of (17) by $P_i^{1-\sigma}$. Use the resulting equality to solve

$$\Pi_i^{1-\sigma} = P_i^{1-\sigma}\frac{\bar{h}'}{\bar{h}} + \frac{(1-t^{1-\sigma})(b_i - s_i)}{\bar{h}t^{1-\sigma}}.$$

Then substitute into (16) and extract the positive root[60] of the resulting quadratic equation in the transform $P_i^{1-\sigma}$. Impose the normalization $\bar{h} = \bar{h}'$.[61] Then:

$$2P_i^{1-\sigma} = \gamma_i + [\gamma_i^2 + 4(1-t^{1-\sigma})b_i]^{1/2} \tag{18}$$

where

$$\gamma_i = \bar{h}t^{1-\sigma} - \frac{(1-t^{1-\sigma})(b_i - s_i)}{\bar{h}t^{1-\sigma}}.$$

At this solution

$$2\Pi_i^{1-\sigma} = \bar{h}t^{1-\sigma} + [\gamma_i^2 + 4(1-t^{1-\sigma})b_i]^{1/2}.$$

Multilateral resistance (inward and outward) is unambiguously decreasing in supply share s_i at equilibrium and unambiguously increasing in expenditure share b_i in equilibrium. It is unambiguously increasing in the net import share $b_i - s_i$ for given expenditure shares.

The solution for $\bar{h} = \bar{h}'$ is implicit in the next expression, obtained from using the definition of $\bar{h}$ and the preceding solution for Π_i,

$$\bar{h} = 2\sum_i s_i[\bar{h}t^{1-\sigma} + (\gamma_i^2 + 4(1-t^{1-\sigma})b_i)^{1/2}]^{-1},$$

where γ_i is given as a function of $\bar{h}$ above.

Proof of Proposition 2 Under the equal shares condition (5)-(6) implies

$$\Pi_i^{1-\sigma} = \frac{1}{n}\sum_j (t_{ij}/P_j)^{1-\sigma}$$

[60] The positive root of the quadratic is necessary for P to be positive.

[61] Another normalization modifies the parameters of the solution slightly without changing the qualitative results.

while

$$P_j^{1-\sigma} = \frac{1}{n}\sum_i (t_{ij}/\Pi_i)^{1-\sigma} + \sum_i (t_{ij}/\Pi_i)^{1-\sigma}(Y_i/Y - 1/n).$$

Here, n is the number of regions. If supply share are also equal to $1/n$ then $P_i = \Pi_i$. Now allow a small amount of specialization in supply. The preceding equation at given Π's is the sum of an average and a covariance that is positive on the hypothesis that supply shares on average will rise as bilateral trade costs to j fall. This force pushes P_j downward, below the given Π_j. In the first equation above, this downward movement of P_j pushes Π_i upward. So specialization tends to drive the Π's above the P's.

Proof of Proposition 3 Let $CHB = \{CHB_i\}$. Let p denote the vector of proportional rates of change in $\{P_j^{\sigma-1}\}$ and let π denote the vector of proportional rates of change in $\{\Pi_i^{\sigma-1}\}$. Let a circumflex denote a percentage change.

The results of differentiation of (5)-(6) at constant t's are

$$-\widehat{p} \;=\; W'(\widehat{s} + \widehat{\pi}) \tag{19}$$

$$-\widehat{\pi} \;=\; \Omega(\widehat{b} + \widehat{p}); \tag{20}$$

where $\Omega = \{\omega_{ij}\}, W = \{W_{ij}\}$ and $\omega_{ij} = t_{ij}^{1-\sigma}P_j^{\sigma-1}b_j/\sum_j t_{ij}^{1-\sigma}P_j^{\sigma-1}b_j$ and $W_{ij} = t_{ij}^{1-\sigma}\Pi_i^{\sigma-1}s_i/\sum_i t_{ij}^{1-\sigma}\Pi_i^{\sigma-1}s_i$. Note that $\Omega\iota = \iota = W'\iota$. Adding together the two preceding equations,

$$\widehat{CHB} = \widehat{p} + \widehat{\pi} = -W'\widehat{s} - \Omega\widehat{b} - W'\widehat{\pi} - \Omega\widehat{p}. \tag{21}$$

Average CHB is given by $\iota'\widehat{CHB} = -\iota'W'\widehat{s} - \iota'\Omega\widehat{b}$ using the normalization $\iota'W'\widehat{\pi} + \iota'\Omega\widehat{p} = 0'$. Assumption M means that $W'\widehat{s} > 0$ and $\Omega\widehat{b} > 0.\|$

Recalling that $\iota'ds = \iota'db = 0$, the assumption means that changes in supply shares s_i are positively correlated with $(t_{ij}/\Pi_i)^{1-\sigma}$ for each destination j while changes in expenditure shares b_j are positively correlated with $(t_{ij}/P_j)^{1-\sigma}$ for each origin i, trade cost bill reducing behavior.

The normalization used in proving Proposition 3 is natural due to the indeterminacy property of the equilibrium system for multilateral resistance: at an equilibrium p^0, π^0 for given shares and trade costs, λp^0 and $(1/\lambda)\pi^0$ are also solutions for any finite $\lambda > 0$. The normalization is automatically satisfied in the neighborhood of equilibrium for changes in λ at given shares and t's.

The preceding structure yields an interpretation of our finding that Π's fall. When P's are almost constant over time, (19) implies that $\widehat{\pi} = -\widehat{s}$, changes in Π's are driven by specialization. (20) combined with (19) gives a deeper version of this interpretation. Normalize so that the first element of $\widehat{p}$ is equal to zero. Let a subscript $n-1$ denote the various matrix and vector constructions that delete the corresponding elements. Then solve (20) for $\widehat{p}_{n-1} = -(I_{n-1} - (W'\Omega)_{n-1})^{-1}(W'_{n-1}\widehat{s}_{n-1} - \Omega_{n-1}\widehat{b}_{n-1})$. Note that $(I_{n-1} - (W'\Omega)_{n-1})^{-1} = I_{n-1} + (W'\Omega)_{n-1} + (W'\Omega)^2_{n-1} + \cdots$ is a positive matrix. $(W'_{n-1}\widehat{s}_{n-1} - \Omega_{n-1}\widehat{b}_{n-1})$ is a difference between two positive numbers under Assumption M, driving $\widehat{p}$ toward zero. In particular, $(W'_{n-1}\widehat{s}_{n-1} - \Omega_{n-1}\widehat{b}_{n-1}) \rightarrow 0 \Rightarrow \widehat{p} \rightarrow 0$. Then $\widehat{\pi} = -\Omega\widehat{b} < 0$ under Assumption M, and $\widehat{\pi}_i = -\omega_{i1}\widehat{b}_1 - \sum_{j=2}^{n} W_{ij}\widehat{s}_j; i = 2, ..., n$ and $\widehat{\pi}_1 = \sum_i \omega_{1i}\widehat{b}_i$. In this sense, changes in Π's are driven by specialization.