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National Borders Matter: Canada–U.S. Regional Trade Patterns

By JOHN McCALLUM*

National borders around the world seem to be in a state of flux, with changes occurring in the physical location of borders and perhaps their economic significance as well. Though few economists would agree with Kenichi Ohmae's statement that borders have "effectively disappeared" (1990 p. 172), many have argued that regional trading blocs such as the North American Free Trade Agreement and the European Union are making national borders less important. This paper provides a case study of the impact of the Canada–U.S. border on regional trade patterns. Although the choice of this particular case was dictated by a data source that could be unique to Canada, the Canada–U.S. case may be particularly interesting because the two countries are so similar in terms of culture, language, and institutions. If, as will be seen to be the case, the border separating these two very similar countries exerts a decisive impact on continental trade patterns, then it seems likely, though not proven, that borders separating less similar countries will also have decisive effects on trade patterns.

The methodology of the paper is very simple and derives from a literature including studies by Jan Tinbergen (1962), Hans Linneman (1966), Jeffrey Frankel (1993), and others. These studies use gravity-type equations to examine the determinants of international trade patterns, including the impact of preferential trade blocs. Trade between any two countries is a function of each country's gross domestic product, the

distance between them, and possibly other variables. The effect of a trade bloc on trade patterns is then estimated by appending to the equation a dummy variable set equal to 1 for cases of intrabloc trade and zero for all other cases. This paper makes use of a Statistics Canada data set that includes both interprovincial trade flows and flows between each Canadian province and each state of the United States (it would appear that data on interstate trade flows within the United States do not exist). Whereas the literature just cited uses international trade flows to estimate the impact of multinational trade blocs on trade patterns, this paper uses a combination of sub-national and international trade flows to estimate the impact of the nation state on trade patterns.

The remainder of the paper is organized as follows. Section I presents the basic results using the simplest specification. Section II presents a sensitivity analysis that focuses on specification issues and econometric questions relating to heteroscedasticity and a possible simultaneity problem. The results of these first two sections provide a snapshot of a single year, 1988. Since this is the year in which the Canada–U.S. Free Trade Agreement (FTA) was signed, some might argue that results based on 1988 could change radically as the effects of the FTA, followed by the North American Free Trade Agreement (NAFTA), come into play. While only time will provide a definitive answer to this question, Section III addresses the issue with a brief overview of the evolution of trade patterns and tariff protection over the period 1950–1993.

I. Basic Results

In his survey on the testing of trade theories, Alan Deardorff (1984) commented that despite their "somewhat dubious theoretical

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heritage, gravity models have been extremely successful empirically" (p. 503), and also useful as the basis for tests of other propositions. It is in this spirit that the results of this paper are presented. The simplest version of the estimated equation can be written as follows for any given time period:

$$x_{ij} = a + by_i + cy_j + d \text{ dist}_{ij} + e \text{ DUMMY}_{ij} + u_{ij}$$

where x_{ij} is the logarithm of shipments of goods from region i to region j , y_i and y_j are the logarithms of gross domestic product in regions i and j , dist_{ij} is the logarithm of the distance from i to j , DUMMY_{ij} is a dummy variable equal to 1 for interprovincial trade and 0 for province-to-state trade (it may be recalled that we have no data on interstate trade), and u_{ij} is an error term.

In principle, the data set, described in greater detail in the Data Appendix, consists of imports and exports for each pair of provinces, as well as imports and exports between each of the 10 provinces and each of the 50 states. The data are for 1988, which, as noted above, is the latest year for which the numbers are available. To limit the scope of the operation, it was decided to include only 30 states, defined as the 20 states with the largest population, plus all border states. These 30 states¹ accounted for more than 90 percent of Canada–U.S. trade in 1988. In principle, then, there are 690 observations: $10 \times 9 = 90$ observations for interprovincial trade, as well as $10 \times 30 \times 2 = 600$ observations for province–state trade. In seven cases there was no recorded trade, leaving 683 nonzero observations.

The simplest versions of this equation are reported in the first two rows of Table 1. Row 1 is the Canada-only version of the

equation, with 90 observations and no dummy variable. Row 2 includes the U.S. observations and the dummy variable, for a total of 683 observations. It can be seen that this simple model has considerable explanatory power and that the elasticities of exports with respect to own GDP, importing-region GDP, and distance are respectively 1.3, 1.0, and -1.5 according to the first equation. These numbers are of similar magnitude in the second equation. The estimated coefficient on the distance variable is substantially larger than the estimated coefficients from the international studies referred to earlier, which tend to be less than 1 in absolute value. One possible explanation of this difference rests on the fact that water transport is much cheaper than other modes of transport and that, whereas most global trade is transported by water, most North American trade goes by air and land. More interestingly, the second regression implies that, other things equal, trade between two provinces is more than 20 times larger than trade between a province and a state [$\exp(3.09) = 22$]. The range of this estimate, plus or minus two standard errors, is 17–29.

Table 2 sets out both the actual regional pattern of trade flows and the pattern that the regression equations would predict for a borderless North America (minus Mexico). For Canada as a whole in 1988, shipments of goods by destination were as follows: own province, 44 percent; other provinces, 23 percent; United States, 24 percent; and rest of the world, 9 percent. East–west interprovincial shipments, then, were of very similar value to north–south exports to the United States. As just seen, the gravity-model equation predicts a radically different distribution of this trade in a borderless world. If, for purposes of illustration, one assumes that the sum of the east–west and north–south trade remains a constant 47 percent of total shipments, then the prediction for a borderless world is that interprovincial trade should account for 4 percent of shipments rather than 23 percent, while shipments to the United States should account for 43 percent of shipments rather than 24 percent. The table presents this

¹The thirty states are Alabama, Arizona, California, Florida, Georgia, Idaho, Illinois, Indiana, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Montana, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Ohio, Pennsylvania, Tennessee, Texas, Vermont, Virginia, Washington, and Wisconsin.

TABLE 1—SENSITIVITY TESTS: ECONOMETRIC ISSUES

Independent variable	Equation						
	1	2	3	4	5	6	7
$x_{ij} = a + by_i + cy_j + d \text{ dist}_{ij} + e \text{ DUMMY}_{ij}$							
y_i	1.30 (0.06)	1.21 (0.03)	1.15 (0.04)	1.20 (0.03)	1.24 (0.03)	1.20 (0.03)	1.36 (0.04)
y_j	0.96 (0.06)	1.06 (0.03)	1.03 (0.04)	1.07 (0.03)	1.09 (0.03)	1.05 (0.03)	1.19 (0.04)
dist_{ij}	-1.52 (0.10)	-1.42 (0.06)	-1.23 (0.07)	-1.34 (0.06)	-1.46 (0.06)	-1.43 (0.06)	-1.48 (0.07)
DUMMY_{ij}		3.09 (0.13)	3.11 (0.16)	3.09 (0.13)	3.16 (0.13)	3.08 (0.13)	3.07 (0.14)
Estimation method:	OLS	OLS	OLS	OLS	OLS	IV	OLS
Number of observations:	90	683	462	683	690	683	683
Standard error:	0.80	1.10	0.97	1.07	1.13	1.11	1.15
Adjusted R^2 :	0.890	0.811	0.801	0.887	0.820	0.811	0.797

Notes: Standard errors are given in parentheses. Definitions of the equations are as follows:

Equation 1: Basic equation, Canada only;

Equation 2: Basic equation, Canada + United States;

Equation 3: Sample includes only jurisdictions with GDP exceeding \$10 billion;

Equation 4: Regression weighted by $y_i + y_j$;

Equation 5: Seven observations of zero trade set equal to minimum values;

Equation 6: Logarithms of population, pop_i and pop_j , used as instruments for y_i and y_j ;

Equation 7: Regression estimated by ordinary least squares, but with population variables replacing income variables.

same information for each of Canada's five regions.²

Since experience suggests that people regard these numbers as unbelievably large, it might be useful to illustrate the findings with a map and two examples. Figure 1 provides what might be called an economic map of North America. Each black circle represents a province, and each white circle represents a state. The mid-point of each circle is the "central place" of the province or state (described in the Data Appendix), while the area of each circle is proportional to gross domestic product of the jurisdiction in question. The ten circles spread out across the northern part of the continent tend to be small and distant from each other in comparison with the larger, more numer-

ous, and less distant circles that constitute the American states. Hence the gravity-model prediction that Canadian trade should be overwhelmingly north-south is not surprising.

Turning now to the examples, a borderless gravity model predicts that Ontario and Quebec should export about ten times as much to California as to British Columbia. The distances are inconsequentially different, and California's GDP is more than ten times that of British Columbia. In fact, in 1988 both Quebec and Ontario exported more than three times as much to British Columbia as to California. A second example: in 1988 British Columbia exported about nine times as much to Ontario (\$1.4 billion) as to Texas (\$155 million), but in a borderless world British Columbia's exports to Texas should be about 50-percent greater than her exports to Ontario. The distances are the same, and the gross domestic product of Texas is 50-percent greater than that of Ontario.

²These numbers are based on the Canada-only regression, but the results are virtually identical when based on the second reported regression, which includes U.S. variables.

TABLE 2—CANADIAN SHIPMENTS OF GOODS BY DESTINATION, 1988

Origin	Shipments (\$ billion)	Destination (percentage of total shipments)			
		Own province	Other provinces	United States	Rest of world
Canada	387	44	23 [4]	24 [43]	9
Atlantic provinces	18	37	29 [12]	19 [36]	15
Quebec	85	47	27 [6]	19 [40]	7
Ontario	179	45	21 [3]	29 [47]	5
Prairie provinces	67	41	28 [9]	18 [37]	13
British Columbia	37	43	13 [2]	19 [30]	25

Note: Figures in brackets are predictions based on the gravity model.

Source: Statistics Canada (1989a,b, 1992).

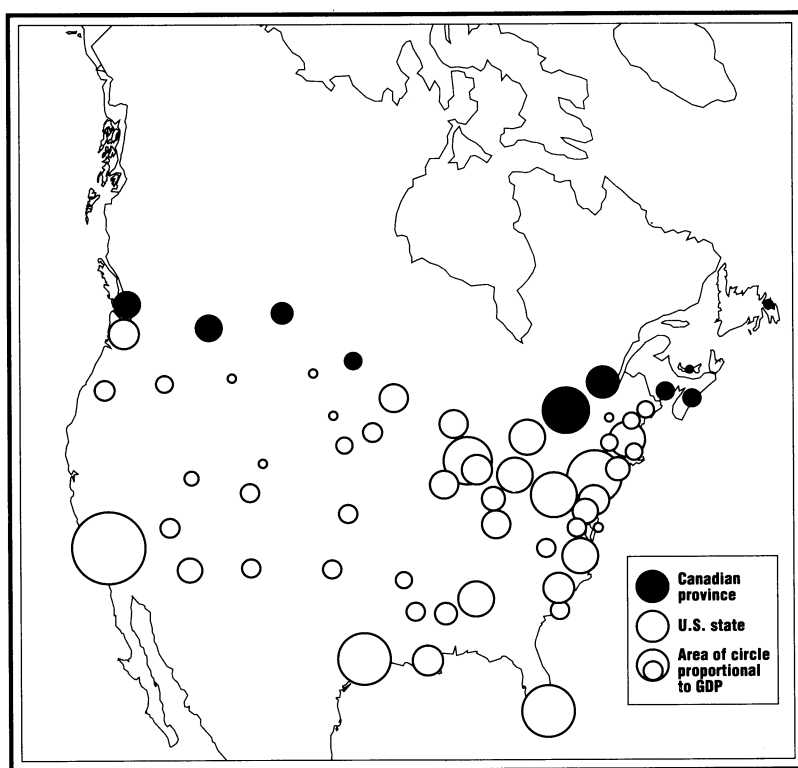


FIGURE 1. ECONOMIC MAP OF NORTH AMERICA

Before proceeding to the sensitivity tests, it is worth noting that my 22-to-1 result is much bigger than the corresponding numbers that Frankel (1993) obtains for the trade-generating impact of regional blocs. He runs regressions at five-year intervals from 1965 to 1990 and finds that the effects of the various regional groupings on total trade reach maximum levels as follows: Western Hemisphere, 2.8 to 1 in 1990; East Asia Economic Community, 5.8 to 1 in 1970; Pacific Rim countries, 6.4 to 1 in 1985; European Community, 3.1 to 1 in 1985.³ My result is also in the spirit of Paul Krugman's (1991) comparison of the degree of economic integration of the states of the United States with that of the countries of the European Union. However, the differences reported in this paper are greater by several orders of magnitude than the differences reported by Krugman (1991).

II. Sensitivity Tests

Tables 1 and 3 set out alternative regressions designed to deal with potential problems of econometrics and specification. In all there are 11 regressions reported in the two tables combined, and these are labeled equations 1–11. Equations 1 and 2 are the basic regressions that were reported in the text above. Equations 3–5 deal with the possibility of heteroscedasticity: equation 3 includes only the larger jurisdictions, defined as states or provinces with GDP exceeding \$10 billion; equation 4, following the example of Frankel and Shang-Jin Wei (1993), is a weighted regression, with weights defined as the logarithm of the product of the GDP's (i.e., the regression is weighted by $y_i + y_j$); and equation 5, following Linnemann (1966) and Zhen Kun Wang and L. Alan Winters (1992), substitutes min-

imal trade flow values for cases where recorded trade values are zero.⁴

A second possible econometric problem arises from the fact that the dependent variable (exports) is a component of one of the regressors (GDP). Hence, by an accounting identity, the included regressor is going to be correlated with the disturbance term. Accordingly, equation 6 uses the logarithms of the corresponding populations as instruments for the GDP variables, while equation 7 replaces the logarithms of GDP with the logarithms of population.⁵ As can be seen from Table 1 all of the coefficients and standard errors of the seven equations are remarkably stable. In particular, the estimated coefficient on $DUMMY_{ij}$ lies in the range 3.07–3.16 with standard errors between 0.13 and 0.16.

The remaining four regressions, labeled equations 8–11 and reported in Table 3, test alternative, more complicated specifications. Equation 8 enters distance in logarithmic form as before, but also as a natural number (DIST) and the square of DIST. There is a modest increase in explanatory power but no significant effect on the coefficient on $DUMMY_{ij}$. Next, equation 9 tests for province-specific constant terms and province-specific coefficients on $DUMMY_{ij}$. The former are indicators of the overall volume of each province's exports (given GDP, distance, etc.), while the latter are indicators of the degree to which each province's trade is biased toward exports to other provinces. It can be seen that British Columbia and Alberta have significantly above-average constant terms (i.e., more trade), while British Columbia and Newfoundland have significantly below-average coefficients on $DUMMY_{ij}$ (i.e., proportionally less east–west trade as compared with other provinces). The other provinces did not diverge significantly from each other. Other things equal, province-to-province

³These numbers, which correspond to my 22-to-1 figure, are taken from Frankel's (1993) table 2. For example, he reports a coefficient of 1.04 on the Western Hemisphere dummy variable in 1990. The figure reported in the text is $\exp(1.04) = 2.8$.

⁴This last adjustment is not likely to be very important in the present context, since only seven of the 690 trade flows were recorded as zero.

⁵A regression of the logarithms of the GDP's on the logarithm of the populations yields an R^2 of 0.99.

TABLE 3—SENSITIVITY TESTS: SPECIFICATION ISSUES

Independent variable	Equation			
	8	9	10	11
Constant	-1.37 (1.82)	-3.24 (0.70)	-3.06 (0.72)	-3.31 (1.80)
Constant (British Columbia)		1.08 (0.21)	1.16 (0.20)	1.21 (0.21)
Constant (Alberta)		0.63 (0.18)	0.29 (0.20)	0.32 (0.21)
y_i	1.21 (0.03)	1.18 (0.03)	1.18 (0.03)	1.22 (0.04)
y_j	1.06 (0.03)	1.03 (0.03)	1.03 (0.03)	1.05 (0.04)
dist_{ij}	-2.00 (0.33)	-1.48 (0.06)	-1.54 (0.06)	-1.63 (0.33)
DIST_{ij}	0.0016 (0.0007)			0.0005 (0.0007)
DIST_{ij}^2	-3.7×10^{-7} (1.4×10^{-7})			-1.7×10^{-7} (1.4×10^{-7})
DUMMY_{ij}	3.11 (0.13)	3.22 (0.14)	3.21 (0.14)	3.30 (0.15)
DUMMY (British Columbia)		-1.39 (0.43)	-1.38 (0.43)	-1.35 (0.44)
DUMMY (Newfoundland)		-1.18 (0.38)	-1.13 (0.38)	-1.02 (0.39)
PRIM_{ij}			2.87 (0.89)	2.60 (0.92)
MFG_{ij}			0.58 (0.75)	0.72 (0.80)
Estimation method:	OLS	OLS	OLS	IV
Number of observations:	683	683	683	690
Standard error:	1.10	1.07	1.07	1.09
Adjusted R^2 :	0.81	0.82	0.82	0.83

Note: Standard errors are given in parentheses.

trade is now six times greater than province-to-state trade for British Columbia, eight times greater for Newfoundland, and 25 times greater for the other eight provinces. It is perhaps natural that the east-west trade bias should be weakest for Newfoundland and British Columbia, the provinces on the two extremities of the country. Also, it is interesting to note that, in spite of linguistic differences, the estimates for Quebec were consistently close to the national average.

The next step was to incorporate variables reflecting differences in comparative

advantage or resource endowments as reflected in different structures of production. The variable PRIM_{ij} is defined as $\text{abs}(\text{prim}_i - \text{prim}_j)$, where "abs" denotes the absolute value and prim_i is the ratio of primary-sector production (agriculture, mining, forestry, fishing) to GDP in jurisdiction i . Similarly, the variable MFG_{ij} is defined as $\text{abs}(\text{mfg}_i - \text{mfg}_j)$, where mfg_i is the ratio of manufacturing-sector production to GDP in jurisdiction i . The absolute values of these differences in sectoral shares of GDP are indicators of the degree to which the structure of production differs between any two jurisdic-

tions. Standard trade theory would predict a positive relation between trade and the degree to which structures of production are different. Equation 9 indicates that this prediction is supported empirically, although the addition of these variables has little effect on the other parameter estimates and adds little to the overall explanatory power of the regression. Finally, equation 11 combines the various extensions by including all of the additional variables, estimating the regression with instrumental variables, and including the seven observations with zero reported trade. Again, one sees that the results remain robust.

Other estimated regressions (not reported) incorporated interaction terms between $DUMMY_{ij}$ and the other explanatory variables or the squares of y_i , y_j , and $dist_{ij}$. Also, two explanatory variables used by Frankel (1993) were included but found not to be statistically significant. These are a dummy variable that is set equal to 1 when two jurisdictions are adjacent and a per capita income variable. The latter is intended to capture a positive relation between the extent of trade and stage of development. However, differences in stage of development or per capita income across North American provinces and states are much less than differences across a global sample of countries.⁶ In none of these cases was there any significant effect on the coefficient on $DUMMY_{ij}$. Finally, and with the help of my colleague Marc Gaudry, I ran a series of more sophisticated specification and heteroscedasticity tests. The technique is described in Gaudry (1993). The results are available to the interested reader upon request, but they yielded no significant difference in terms of the coefficient on $DUMMY_{ij}$.

⁶It should be observed that one cannot both use population as an instrument for GDP and test the hypothesis that trade is affected by both aggregate and per capita GDP. A partial consolation is that other researchers who have used instrumental variables in similar contexts have found that this correction makes no difference to their results (see David Hummels and James Levinsohn, 1993).

III. Trade Patterns over Time: FTA and NAFTA

The analysis to this point has been a snapshot of the year 1988, which happens to be the year in which the Canada–U.S. Free Trade Agreement (FTA) was signed. It is conceivable, then, that the apparently decisive impact of the Canada–U.S. border on continental trade patterns in 1988 will diminish rapidly as the integrating effects of the FTA and NAFTA come into play. If this were the case, then the basic finding reported in this paper would quickly vanish. To investigate this issue, it may be useful to observe longer-run trends, including trends over the six years that have passed since the signing of the FTA. Since the detailed information on interprovincial and international trade is available only for the years 1984–1988, we consider a longer time series on international trade only.

Figure 2 plots Canada–U.S. trade (average of merchandise exports and imports) as a percentage of GDP over the period 1950–1993, as well as an admittedly crude indicator of the level of tariff protection (import duties as a percentage of the value of merchandise imports). In Canada, as in most other industrialized countries, protection has trended downward since the early 1960's, while international trade shares have trended upward beginning around the same time. Indeed, the simple correlation coefficient between our measures of tariff protection and trade shares over the period 1950–1993 is -0.91 .

The evidence to date suggests that the effects of continental free trade could turn out to be relatively modest, or if not modest, at least gradual. On the one hand, to the extent that the rising trade share has been driven by reduced tariff protection, the impact of free trade will be quite modest, because tariff protection is already low and does not have a great deal further to fall before reaching zero. On the other hand, the post-1988 increase in the trade share is certainly no greater than would have been predicted on the basis of either earlier trends or the rate of tariff protection shown

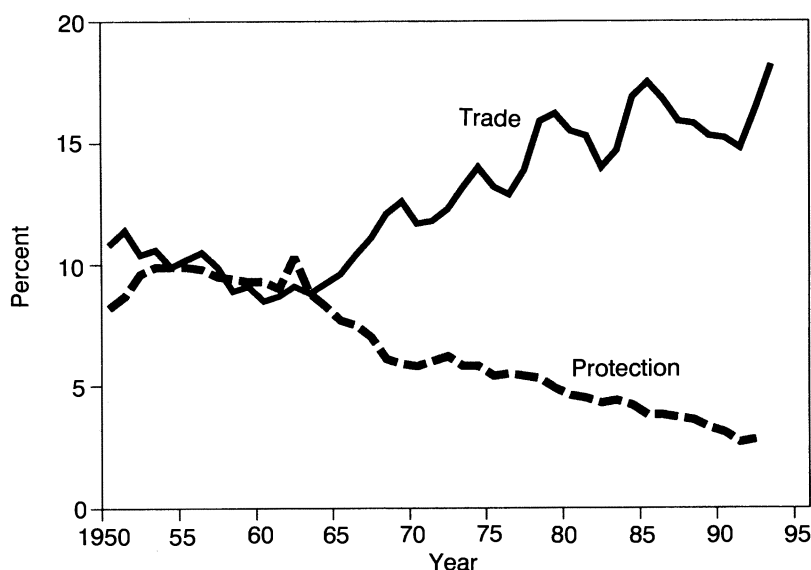


FIGURE 2. CANADA-U.S. TRADE AND CANADIAN TARIFF PROTECTION

Notes: Canada-U.S. trade is defined as the average of Canada's merchandise imports from and exports to the United States as a percentage of Canadian GDP. Protection is defined as Canadian custom import duties as a percentage of merchandise imports. Data for 1993 are for the first six months of the year.

Source: Canadian Socio-Economic Information Management System (CANISM).

in Figure 2.⁷ Although this prognosis could turn out to be wrong for a number of possible reasons (e.g., diminished nontariff barriers associated with NAFTA, a role for countervailing short-term factors in the early 1990's, psychological effects of NAFTA), it is certainly not a foregone conclusion that NAFTA will lead to a radical shift in Canadian trade patterns over the next decade or so.

IV. Conclusions

Whatever the reasons may be and whatever the future may hold, the fact that even

the relatively innocuous Canada-U.S. border continues to have a decisive effect on continental trade patterns suggests that national borders in general continue to matter. That is the basic message of this paper.

DATA APPENDIX

The fundamental data source for this paper is the matrix of interprovincial trade produced by the Input-Output Division of Statistics Canada (*Interprovincial and International Trade Flows of Goods, 1984-1988*, Technical Series No. 49, June 1992). For each of the years 1984-1988 and for a variety of commodity groupings, this document provides estimates of shipments from each province to each other province, as well as shipments between each province and the rest of the world (imports and exports). To generate the dependent variable of the regressions, these data were combined with a second data source providing estimates of exports from each province to each state, as well as imports into each province from each state (Statistics Canada, *Merchandise Trade—Exports, 1988*, Catalogue No. 65-202 and *Merchandise Trade—Imports, 1988*, Catalogue No. 65-203). This second data source was used to determine the shares of each province's aggregate exports that went to the

⁷The trend increases in the trade share, in percentage points per decade, were as follows: 1963-1973, 4.1; 1973-1988, 2.3; 1988-1993, 0.4. Alternatively, if one regresses the trade-share variable on a constant, its own lagged value, the rate of tariff protection, and a dummy variable for the period 1989-1993, then the coefficient on the dummy variable is -0.07, with a standard error of 0.44.

United States and to each state, as well as the shares of each province's aggregate imports that came from the United States and from each state. These export and import shares were then applied to the aggregate export and import figures taken from the first source. As noted in the text, all reported regressions were based on a sample of 30 states.

Shipments are valued at producer prices or "factory-gate prices." In principle, to quote from the basic data source for this study, "the point of origin is where the good is produced or removed from inventories of producers, wholesalers and retailers. ... The point of final destination is where goods are purchased for final consumption or for use in the production of other commodities or added to inventories" (Statistics Canada, 1992 p. 3). However, as the document acknowledges, for want of precise information, the actual estimates do not always accord with the theoretical definitions.

Turning now to the data on provincial and state gross domestic product (GDP), both aggregate and sectoral provincial data are from the Statistics Canada publication *Provincial Economic Accounts* (1991, 13-213P). State data are from the U.S. Department of Commerce's *Survey of Current Business* (December 1991, pp. 47-50).

With regard to distances, in most cases distances were measured from the single, principal city of the province or state. Exceptionally, the central point of a jurisdiction was defined as an average (weighted by population) of the longitudes and latitudes of two or more cities (e.g., in California, San Francisco and Los Angeles).

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