Abstract
This paper provides an empirical analysis of the comparative evolution of intranational and international trade in the Canadian provinces since 1981. We establish a striking empirical fact, the “L curve,” that characterizes the comparative evolution of intranational (interprovincial) and international trade shares to GDP between 1981 and 2000. The analysis casts doubt on the pure diversion hypothesis, common in trade models such as the structural gravity model of Anderson and van Wincoop (2003) that was used recently to revisit the Canada–U.S. border effect. International trade appears to complement rather than substitute for interprovincial trade. More research is needed to completely solve the border puzzle.

Keywords: trade diversion, FTA, border effect

JEL classification: F10, F15
1. Introduction

The orientation of regional trade links in Canada has undergone a major shift in the last 15 years when north-south trade with its U.S. neighbor started to boom and grew at a much faster pace than the traditional east-west interprovincial trade channel. This fact has already been noted in the border-effect literature that scrutinized Canadian trade data, following McCallum’s (1995) empirical analysis of the detailed data on Canadian interprovincial and province-state trade. Between 1988 and 2000, the Canada–U.S. border effect had decreased from an initial 22 number to around 8 (Coulombe 2002).

In this paper we document the change in orientation of Canadian regional trade links with an empirical analysis of aggregate data for interprovincial and international trade. These data are available from Statistics Canada on an annual time-series basis for the 10 Canadian provinces for the 1981–2000 period. We first establish a striking stylized fact, the “L curve,” in Section 2. Time-series evidence reveals an important structural shock that occurred around 1991 in provincial trade patterns. The analysis allows a new perspective regarding the effect of the Free Trade Agreement (FTA) on the relationship between interprovincial and international trade in Canada. The relative decline of Canadian interprovincial trade’s share to GDP is a phenomenon that preceded the expansion of north-south international trade between Canada and the United States. The share of interprovincial trade to GDP was decreasing steadily and significantly throughout the 1981–1991 period, whereas the share of Canadian international trade to GDP was roughly steady. A significant structural break in the relationship between interprovincial and international trade occurred in 1991–1992. Since 1991, Canadian international trade has boomed and the value of interprovincial trade has started to grow at the same long-run rate as the GDP.

In Section 3, we use a pooled time-series cross-sectional (cross-provinces) framework for analyzing the statistical relationship between interprovincial and international trade. We focus on the trade diversion hypothesis, which is critical in many trade models. For example, the theoretical gravity model used by Anderson and van Wincoop (2003) to revisit the Canada–U.S. border effect is based on the pure trade diversion hypothesis. In their structural trade model, the effect of trade barriers is restricted to the re-orientation of trade flows between international and intranational trade channels. Our empirical analysis suggests that this hypothesis is strongly
rejected by the facts. For the Canadian regional economies, international trade appears to complement rather than substitute for interprovincial trade.

2. The L curve

We focus on the comparative evolution of the international and interprovincial trade shares to GDP \( INTS \) and \( IPTS \) respectively:\(^1\)

\[
INTS = \frac{\text{international imports + international exports}}{\text{GDP}}
\]
\[
IPTS = \frac{\text{interprovincial imports + interprovincial exports}}{\text{GDP}}
\]

The idiosyncratic relative evolution of the two time series for Canada as a whole is best illustrated by the following scatter diagram (Figure 1) that links interprovincial and international trade shares of goods and services.

[Figure 1 here]

The scatter observations are linked by a line to illustrate the evolution over time. The historical evolution starts at the south-east of the diagram and ends at the north-west. The evolution of the two trade shares in the scatter clearly exemplifies two different periods: (1) between 1981 and 1991, the share of interprovincial trade to GDP falls continuously and (relatively) steadily and slowly while the share of international trade to GDP is roughly constant; (2) between 1992 and 2000, the share of interprovincial trade to GDP is roughly constant while the share of international trade to GDP increases continuously and steadily. Obviously the relationship between the two trade share variables has been disrupted around 1991–1992 by an important structural break. We call this stylized fact the L curve to describe the L shape of the scatter.

\(^1\) See Section 3.3 for data sources.
Analysis of the scatter of the 10 provinces’ trade shares\textsuperscript{2} indicates that the typical L shape characterizing the aggregate relationship between interprovincial and international openness appears to be driven by the two large central provinces of Quebec and Ontario (Figure 2). In the two core provinces, trade patterns evolve similarly and mimic the Canadian pattern. However, the comparative evolution of trade links is different in the periphery. In Atlantic Canada, both international and interprovincial trade shares decrease substantially during the 1981–1991 period. Thereafter, the international trade share expands and interprovincial trade grows roughly at the same rate as GDP. There are few common patterns in trade link evolution across the four Western provinces. Saskatchewan and British Columbia are the only two Canadian provinces that did not experience a noticeable decrease in their interprovincial trade share during the 1981–1990 period. After 1992 for Manitoba, and 1993 for Saskatchewan and British Columbia, both international and interprovincial trade shares increase. During the whole 1981-2000 period, the decrease in interprovincial trade shares in these three provinces is not substantial.

[Figure 2 here]

The overall picture is different for Alberta (Figure 3). The major oil-producing province is the only province for which the scatter suggests a negative relationship between the evolution of the international and interprovincial trade shares. Alberta, in fact, is the only province for which the time-series evolution of the two trade shares is negatively correlated (-0.11) in first difference during the whole period. For the other provinces, correlations are positive and vary from 0.20 for Ontario to 0.61 for Quebec and 0.72 for Newfoundland. This key information illustrates clearly that from a time-series basis, the trade diversion hypothesis—that the increase in international trade might have been at the expense of interprovincial trade—might be valuable only for Alberta. We return to this point below.

[Figure 3 here]

\textsuperscript{2} To save space, most of the scatters for the 10 Canadian provinces and for the disaggregation between goods and services are not shown in this paper. They can be found in the research paper version that may be downloaded from the Industry Canada web site.
Furthermore, analysis of the comparative evolution of international and interprovincial trade share indicators differs strikingly for goods and for services (Figure 4). For goods, the relationship between international and interprovincial trade shares follows the same L curve shape as total trade. For services, the scatter for trade is completely different. Overall, both international and interprovincial trade in services tend to grow at a faster rate than GDP for the whole period. However, the expansion of interprovincial trade in services occurs in the 1994–2000 period while the expansion of international trade in services is mainly in the 1981–1994 period.

[Figure 4 here]

To summarize, the L curve is shaped by the evolution of the trade of goods in the two big central provinces of Ontario and Quebec. In 2000, these two provinces account for 70 per cent of Canada’s total international trade.

3. Intranational and international trade: substitute or complement?

3.1 Gravity with gravitas and the diversion hypothesis

The L curve raises many questions regarding the economics of Canadian trade patterns. Why was the interprovincial trade share falling in the 1980s? Why was interprovincial trade constant in the 1990s while international trade was rising? Why did a sharp break in trade patterns occur in the early 1990s? What is the role of FTA in shaping the L curve? Answering all these questions requires the use of detailed sectorial data and econometric testing of alternative structural models of trade. Of course this task goes well beyond the scope of this paper. In this section, we focus on one single important economic issue—the trade diversion hypothesis—that appears to be in conflict with the straightforward message that emerges from analysis of the L-shape curve.

Empirical testing of trade diversion versus trade creation following changes in trade barriers has been a subject of study in economics for a long time (Balassa 1967). The diversion hypothesis plays an important role in recent economic analyses of Canadian trade patterns. Pure trade
diversion (one-for-one) between interprovincial trade and province-state trade is a central hypothesis in the structural gravity model of trade of Anderson and van Wincoop (2003), used to revisit the Canada–U.S. border effect literature. Anderson and van Wincoop’s (2003) model is based on the theoretical gravity model of trade, first developed by Anderson (1979). One of the key elements of the modeling, also at the center of many trade models, is the assumption that each regional economy is endowed with a fixed supply of a differentiated good. This good is traded either intranationally or internationally. Naturally, the effect of trade barriers in this framework is to divert international trade toward the national market.

The key finding of Anderson and van Wincoop (2003) is that McCallum-type border effect estimates are non-symmetrical. McCallum’s (1995) finding—that typical weighted (by size and distance) trade between two Canadian provinces was 22 times larger than weighted trade between a Canadian province and a U.S. state—was recognized by Obstfeld and Rogoff (2000) as one of the trade puzzles. Anderson and van Wincoop (2003) demonstrate that, for a given degree of trade diversion generated by the common border, a McCallum-type border effect is about 10 times greater when measured with Canadian interprovincial trade data than with U.S. interstate trade data. According to Anderson and van Wincoop (2003), this important bias follows mainly from the small size of the Canadian economy compared with that of the United States. This new finding is critical for the general interpretation of border effects. It indicates that border effect estimates do contain information that is extremely hard to interpret at the cross-sectional (cross-country) level.

Anderson and van Wincoop (2003) also use the structural gravity model for comparative statics analysis. They estimate that the effect of removing the trade barriers between Canada and the United States would be to increase Canada–U.S. trade by 44 per cent. This estimate was based on a McCallum-type border effect of 16 in 1993. Coulombe (2002) extrapolates from Anderson and van Wincoop’s (2003) results and shows that eliminating trade barriers between Canada and the United States will generate a 25 per cent increase (post-2001) in Canada–U.S. cross-border trade. What bilateral resistance remains between the two countries is so low that it could be largely explained, for example, by the fact that Canada and the United States are not using the same
currency. As documented in Frankel and Rose (2002), the adoption of a common currency by the
two countries might certainly lead to a 25 per cent increase in trade flows.

In the problem under study, the diversion hypothesis implies that intranational trade is a substitute
for international trade. For example, if interprovincial trade was artificially stimulated by the
Canadian tariff structure with a resulting trade diversion, removing tariffs (as has been the case in
the period under study) will generate an increase in international trade at the expense of
interprovincial trade. In this section, by pooling time-series and cross-sectional information
contained in the evolution of provincial trade patterns since 1981, we show that the underlying
pure trade diversion hypothesis used in the modeling of Anderson and van Wincoop (2003) is
clearly rejected by Canadian facts. This point is important for the border effect literature since
from the start, Canadian regional trade databases have been at the center of border effect studies
using official intranational trade data.

The diversion hypothesis is also an important element in the interpretation of the effects of FTA
on Canadian trade patterns. The FTA is the obvious institutional change that was likely to affect
the orientation of provincial trade patterns in Canada. The FTA gradually eliminated and reduced
tariff (and non-tariff) trade barriers between Canada and the United States from January 1, 1989,
to January 1, 1998. The Canada–U.S. Free Trade Agreement was extended to Mexico on January
1, 1994, with the North American Free Trade Agreement (NAFTA). During this period, Canada
experienced a spectacular increase in its trade with its southern neighbor. A decrease in the
relative importance of interprovincial trade in the 1988–1996 period has been documented and
analyzed in Helliwell, Lee, and Messinger (1999). Based on evidence from industry-level data on
commodity trade and tariffs, they conclude that part of the relative decline in interprovincial trade
might be attributed to FTA. We will show in this section that the underlying time-series and
cross-sectional information contained in Canadian provincial data casts doubt on this
interpretation of the effect of FTA.

3.2 Empirical investigation
Even though the L curve gives a clear hint about the rejection of the diversion hypothesis, the curve’s idiosyncratic profile is not a sufficient argument. The information contained in the L curve deals only with the time-series evolution of aggregate trade flows. In this section, we test the prediction of trade diversion by making the best use of the information contained in the pooled time-series and cross-sectional data for the interprovincial and international trade share of the 10 Canadian provinces in the 1981–2000 sample.

On a time-series basis, for one single province, trade diversion implies that an increase in the international trade share is accompanied by a decrease in the interprovincial trade share. We will test for the contemporaneous relationship between the two trade variables and look at a possible Granger causality between the two. From a cross-sectional point of view, the diversion hypothesis implies that provinces with a higher international trade share have a lower interprovincial trade share. This is a key prediction of the endowment economy of Anderson and van Wincoop (2003) in which international trade is a substitute one-for-one for intranational trade. We pool both types of information in an empirical set-up where appropriate measures are gradually taken into account in order to tackle the econometric problems encountered with this type of analysis: various forms of heteroscedasticity, fixed effects, structural breaks, and auto-correlation. The cross-sectional information is best captured when the relationship between the two trade shares is tested in levels. The time-series information emerges from the empirical analysis in first differences.

The analysis is carried out in two steps. First, we combine the pooled time-series cross-sectional (across provinces) information for the 10 Canadian provinces in the 1981–2000 sample to analyze the contemporaneous relationship between international and interprovincial trade shares. Second, we will test the Granger causality between these two variables to determine if there is a causal relationship between them.

The results of seven diversion regressions are displayed in Table 1. Interprovincial trade shares are used as the dependent variable. In the first two regressions, the hypothesis is tested on the levels of the IPTS and INTS variables:
\[ IPTS_{i,t} = \beta_1 \times INTS_{i,t} \left[ + \beta_2 \times BR91 \right] + \beta_3 \times FE_i + \epsilon_{i,t}. \]  

In the following three regressions, the hypothesis is tested on the first difference \(d(IPTS)\) and \(d(INTS)\):
\[ d(IPTS)_{i,t} = \beta_4 \times d(INTS)_{i,t} + \beta_5 \times FE_i + \epsilon_{i,t}. \]

Finally, in regressions (6) and (7), we replace the \(INTS\) and the \(d(INTS)\) variables with international trade share estimates (\(USTS\), and \(d(USTS)\)) between Canadian provinces and the United States only:
\[ IPTS_{i,t} = \beta_6 \times USTS_{i,t} + \beta_7 \times FE_i + \epsilon_{i,t}. \]
\[ d(IPTS)_{i,t} = \beta_8 \times d(USTS)_{i,t} + \beta_9 \times FE_i + \epsilon_{i,t}. \]

The diversion hypothesis implies that the parameter estimates for the international trade variables \(\hat{\beta}_1, \hat{\beta}_4, \hat{\beta}_6, \) and \(\hat{\beta}_8\) are significantly different from zero and negative. In the seven regressions, we used fixed effects (\(FE\)) to model the fact that the Canadian provinces follow different trends in the evolution of interprovincial trade shares.

[Table 1 here]

In the first three regressions, we estimated the system using seemingly unrelated regression (SUR), which is the least restricted framework here as it corrects for both contemporaneous correlation and cross-sectional heteroscedasticity. For the last four regressions with subsamples, it was not possible to use SUR due to the limited number of time-series observations. For these four subsample regressions, we used iterated feasible generalized least squares (IFGLS) to account for cross-sectional heteroscedasticity.

In the first column, the diversion hypothesis is tested in level following a straightforward approach that mimics a cross-section econometric approach by abstracting from time-series consideration. For this first econometric set-up, we ignore the important structural break that
occurred around 1991 in the relationship between international and interprovincial trade shares (depicted in the L curve) and we do not correct for auto-correlation. The effect of international trade on interprovincial trade shares is negative, substantial, and extremely significant (at the 1 per cent level) and the regression has a high R-squared of 0.87. This exercise illustrates the danger of testing the diversion hypothesis by comparing interprovincial and international trade for two dates (such as 1988 before FTA and 1996 after FTA as in Helliwell, Lee, and Messinger [1999]) without taking the 1991 structural brake into consideration.

Due to the time-series dimension of the actual analysis, the results depicted for the first regression post an important warning. The very low Durbin-Watson statistic (0.32) is clear evidence of positive serial correlation in the residuals. As documented and explained in Granger and Newbold (1974) and Phillips (1986), the use of non-stationary data in econometrics might result in spurious regressions. A spurious regression will typically produce a very high R-squared and a very low Durbin-Watson. As a practical rule of thumb, a Durbin-Watson statistic that is lower than the R-squared is evidence of a spurious regression.

The next sixr regressions use two alternative approaches to tackle the econometric problems of the first diversion regression. In regression (2), we continue to estimate the diversion hypothesis with the levels of the IPTS and INTS variables. However, we explicitly model the structural brake by introducing a time dummy $BR91$ for the 10 provinces that takes the value zero prior to 1991 and one thereafter. We also correct for serial correlation with a common (for all provinces) AR(1) in the regression. The result regarding the diversion hypothesis is reversed! International openness now has a positive and significant effect (at the 5 per cent level) on interprovincial trade shares. The $BR91$ break variable is negative and significant at the 1 per cent level. The standard error of regression is much lower than in the first regression, the R-squared is 0.98, and the Durbin-Watson is close to 2. Obviously regression (2) provides a much better fit than regression (1).

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3 The general direction of the results (rejection of the diversion hypothesis) is not altered if the time dummy is modeled as a shock to the parameter of the INTS variable.
Two supplementary points are worth mentioning regarding the econometric results of regression (2). First, the negative value of the 1991 break does not imply that FTA had a negative effect on interprovincial trade. The reason for the negative value is that the $INTS$ variable grows faster after 1991 and the effect of $INTS$ on interprovincial trade is positive. The total effect of the changing trade patterns after 1991 on interprovincial trade shares will be best viewed with the following three regressions in first differences. Second, the parameter estimates for the fixed effects are indicators of the relative interprovincial trade shares across the Canadian provinces. It is interesting that the three provinces with a lower dependence on interprovincial openness are Ontario, British Columbia, and Quebec. In Beine and Coulombe’s study (2003), those three provinces show a business cycle that is more correlated with the U.S. business cycle.

In regressions (3), (4), and (5), we use a straightforward approach to tackle the issue of non-stationarity by taking the first difference of both trade variables. In regression (3), the system is estimated for the entire 1981–2000 period. We repeated the same regression setting for the two subsamples 1981–1991 and 1991–2000, which are divided by the date of the structural break for the relationship between the levels of the two trade variables.

For the three diversion regressions using first differences, the diversion hypothesis is strongly rejected with a positive, substantial, and significant (at the 1 per cent level) effect of the change in the international trade shares on the change of interprovincial trade shares. Interestingly, the effect is stronger after 1991 than before. A 100 per cent point increase in international trade translates into a 17.5 per cent and 26.4 per cent point increase in interprovincial trade before and after 1991, respectively.4

In the first difference set-up, fixed-effect parameters estimate annual growth long-run trends in interprovincial trade shares, using the assumption that there is no change in international trade shares. The point estimates are not all statistically different from zero. They are, however, all negative and some of them are very significant. For Ontario and Quebec, the long-lasting decrease in interprovincial trade is significant at the 1 per cent level. For Newfoundland, the

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4 The word “translates” is appropriate here give the a-theoretical approach of the econometric analysis.
The decrease is significant at the 5 per cent level. For Alberta, the decrease is significant at the 1 per cent level in the 1991–2000 period only.

Canadian provinces’ international trade data that are available in the 1981–2000 sample refer to exports and imports to all countries. The United States is by far the most important trading partner of Canada. Between 1990 and 2000, the share of Canada’s trade with the United States has increased from 70 per cent to 76 per cent of its trade with all countries. Data on trade between Canadian provinces and the United States could be computed on a basis that is consistent with the previous data for the 10 Canadian provinces in the 1990–2000 sample. For regressions (6) and (7) in Table (1), we replace the \textit{INTS} and the \textit{d(INTS)} variables by the \textit{USTS} and the \textit{d(USTS)} variables that refer to the trade share (to GDP) between the United States and Canadian provinces. The results for both regressions in levels (regression [6]) and first-differences (regression [7]) are very comparable with the findings from the total trade database.

Having now established a positive statistical relationship between international and interprovincial trade in light of the 1981–2000 cross-sectional and time-series information, we attempt in the last empirical step of this section to ascertain if there are causality links between the two trade channels. Of course, the following Granger causality exercise has to be viewed with great caution since the number of time-series observations at our disposal is very limited. We have to split the sample into two periods (1981–1991 and 1991–2000) because Granger causality tests would suffer from a serious bias if performed over a period during which a structural break in the relation was observed between the two variables under study. Given the limited number of time-series observations, we have to restrict our study to a one-year lag.

[Table 2 here]

Results for the 1991–2000 period are presented in Table 2 for Canada and the two big central provinces of Ontario and Quebec. Interestingly, the null hypothesis of non-Granger causality is rejected for both relationships (\textit{INTS} not causing \textit{IPTS}, and the reverse) for the aggregate trade data of both Canada and Quebec. Evidence is mixed for Ontario since the null hypothesis cannot be rejected for one relationship. Overall, the results suggest some evidence of a simultaneous (and
positive, given the results of Table 1) causality between international trade and interprovincial trade in Canada over the 1991–2000 sample.\(^5\)

### 3.3 A discussion on data and robustness analysis

The trade and GDP data used to compute the $INTS$ and $IPTS$ variables are nominal data and come from the Gross Domestic Product, Expenditure-Based matrices of Statistics Canada’s CANSIM database.\(^6\) Canadian provinces’ trade shares with the United States (regressions [6] and [7] in Table 1) are Statistics Canada data computed by the authors from data extracted from Trade Data Online on Industry Canada’s web site, <www.strategis.ic.gc.ca/sc_mrkti/tdst/tdo/tdo.php#tag>.

We computed the share of total trade with the United States to total trade with all countries for the 10 provinces for all years in the 1990–2000 sample and multiplied these shares by the $INTS$ variables to obtain the $USTS$.

For robustness analysis, in this section we also use real GDP data that are deflated using (chained) provincial GDP deflators from the Gross Domestic Product at 1997 Prices.\(^7\) Since our trade variables are measured as ratio to GDP, all variables are real, whether they come from the nominal or real database. The difference between the two sets of variables is intrinsically related to regional terms of trade and to the specific composition of regional GDP. With the set of GDP and trade data computed from the nominal database, variations in trade shares include variations in terms of trade; these variations, however, are partly excluded from variables computed from the real data set.

A good example to illustrate the difference between the two databases is the effect of an oil shock on Alberta. An increase in the relative price of oil will expand the output and export measures of Alberta in the nominal GDP data set because the relative value of oil produced in Alberta and

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\(^5\) Results for the Granger causality are very similar when we use the $USTS$ and the $IPTS$ variables as in regressions (6) and (7) in Table 1.

\(^6\) CANSIM I Matrix 9023 for Alberta and following numbers for the other provinces

\(^7\) Table 3840002, CANSIM II series v15855886, 905, 906, 908, and 909 for Alberta and corresponding numbers for the other provinces
exported abroad has increased. This regional terms-of-trade effect will be partly eliminated from the data set based on real GDP as only real flows (volume of oil) are computed with this database. The chained-price index used by Statistics Canada to produce provincial real data will partly account for changes in terms of trade because the increase in the price of oil will increase the weight of oil in GDP and trade flows.

The evolution of interprovincial and international trade shares computed from trade and output data from the real database does not display the same L shape as the evolution observed for Canada as a whole, for Ontario, and for Quebec. This result indicates that the evolution of terms of trade, including exchange rate changes, plays a key role in shaping the idiosyncratic L-type evolution in the scatter of the two trade channels.

However, the overall results (a strong rejection of the diversion hypothesis) are robust when the same empirical methodology is applied to the trade data coming from the real database. Results reported in Table 3 have very much in common with those displayed in Table 1, with one exception. The result for the pooled estimation in levels for equation (2) still displays significant auto-correlation even after the 1991 brake was added and after it was corrected for auto-correlation in the same way as in Table 1. The reason for this is that the introduction of a break in 1991 is not appropriate for the data coming from the real database since their scatter does not display an L shape.

[Table 3 here]

The results in Table 1 regarding the diversion hypothesis are also robust to many alternative econometric set-ups. For example, following the Granger causality analysis, one could think of modeling the relationship between international openness and interprovincial openness using the following dynamic regression set-up:

\[
IPTS_{i,t} = \gamma_1 \times IPTS_{i,t-1} + \gamma_2 \times INTS_{i,t-1} + \gamma_3 \times BR91 + \gamma_4 FE_i + \epsilon_{i,t},
\]

In this dynamic set-up, using correction for serial correlation and IFGLS estimation, the point estimate for the lagged international openness variable is positive and significant at the 1 per cent
level. Furthermore, we get the same result regarding the rejection of the diversion hypothesis when the trade share variables are expressed as logarithmic deviations from the cross-sectional sample mean.

4. **Conclusion**

Analysis of the relationship between Canadian provincial trade data presented in this paper suggests that the pure trade diversion hypothesis is clearly rejected by the Canadian experience. Overall, we found that the decline of the relative importance of interprovincial trade in Canada is a phenomenon that preceded the expansion of international trade links. From an economic policy point of view, this result indicates that strong intranational economic linkages are not threatened by increased international openness. Both trade channels, intranational and international, even appear to complement each other.

The rejection of the pure diversion hypothesis is important from the point of view of trade theory since that hypothesis is now the natural starting point in trade models used to analyze the effect of trade barriers. Consequently, the solution to the border effect puzzle proposed by Anderson and van Wincoop (2003) suffers a serious setback since trade diversion is at the core of their insightful explanation of McCallum’s (1995) spectacular number. For example, their comparative statics result—that removing the border will increase Canada–U.S. trade by only 44 per cent—is based on the assumption that an increase of one unit of trade with the United States is matched one-for-one by a decrease in interprovincial trade. This result has to be viewed with great care since our empirical investigation indicates that the underlying assumption is clearly rejected by the facts. Our analysis suggests that more research is needed to provide a theoretical foundation for the gravity equation that could solve the Canada–U.S. border puzzle. The solution should take into account that, for Canadian regional economies, international trade appears to complement rather than substitute for interprovincial trade.

Anderson and van Wincoop (2003, p. 189) conclude their paper by identifying the endowment economy assumption as one limitation of their model. The modeling of a complementary
relationship between intranational and international trade necessitates going beyond the usual assumption made in trade theory that each region is endowed with a fixed supply of a single differentiated final good.
Reference List


Figure 1. The L curve
Figure 2. Ontario, goods and services
Figure 3. Alberta, goods and services
Figure 4. Goods vs services -- Canada
Table 1. Estimation results for the diversion hypothesis

<table>
<thead>
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<th>Dependent variable</th>
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<th>(4)</th>
<th>(5)</th>
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<td>1.97</td>
<td>1.77</td>
<td>1.92</td>
<td>1.77</td>
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<td>Panel observations</td>
<td>200</td>
<td>190</td>
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<td>100</td>
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<td></td>
</tr>
</tbody>
</table>

Notes: See notes at end of Table 2 for details on estimation techniques.
Table 2. Pairwise Granger causality tests: interprovincial and international openness

<table>
<thead>
<tr>
<th>Null hypothesis</th>
<th>F-Statistic</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTS (Canada) does not Granger cause IPTS (Canada)</td>
<td>6.8</td>
<td>0.035</td>
</tr>
<tr>
<td>IPTS (Canada) does not Granger cause INTS (Canada)</td>
<td>14.02</td>
<td>0.007</td>
</tr>
<tr>
<td>INTS (Quebec) does not Granger cause IPTS (Quebec)</td>
<td>7.08</td>
<td>0.032</td>
</tr>
<tr>
<td>IPTS (Quebec) does not Granger cause INTS (Quebec)</td>
<td>11.57</td>
<td>0.011</td>
</tr>
<tr>
<td>INTS (Ontario) does not Granger cause IPTS (Ontario)</td>
<td>1.3</td>
<td>0.292</td>
</tr>
<tr>
<td>IPTS (Ontario) does not Granger cause INTS (Ontario)</td>
<td>8.82</td>
<td>0.021</td>
</tr>
</tbody>
</table>

Note for Table 2: Sample 1991–2000; 10 time-series observations, one lag.

Notes for Tables 1 and 3:
- IFGLS are iterated feasible generalized least-squares estimations using cross-section weighted regressions to account for cross-sectional heteroscedasticity.
- The ***, **, and * indicate that the null hypothesis could be rejected at 1 per cent, 5 per cent, and 10 per cent critical levels, respectively.
- White heteroscedasticity-consistent standard error (between brackets) (HCCME) allows for asymptotically valid inferences in the presence of heteroscedasticity.
- SUR is seemingly unrelated regression; standard error (between brackets) are not HCCME with SUR. Reported R-squared, S.E. of regression, and DW stat for SUR are from the unweighted statistics.
- AR-correction is correction for auto-correlation.
- The 10 Canadian provinces, and their associated fixed effects (FE) are, from east to west: Newfoundland (NF), Nova Scotia (NS), Prince Edward Island (PE), New Brunswick (NB), Ontario (ON), Quebec (QU), Manitoba (MA), Saskatchewan (SA), Alberta (AL), and British Columbia (BC).
Table 3. Estimation results for the diversion hypothesis using real trade and GDP database

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>SUR</td>
<td>SUR</td>
<td>SUR</td>
<td>IFGLS</td>
<td>IFGLS</td>
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<tr>
<td>INTS</td>
<td>-0.157*** (0.04)</td>
<td>0.097*** (0.012)</td>
<td>0.236*** (0.026)</td>
<td>0.201*** (0.057)</td>
<td>0.190*** (0.049)</td>
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<tr>
<td>d(INTS)</td>
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<td></td>
</tr>
<tr>
<td>BR91</td>
<td></td>
<td>-0.0056** (0.003)</td>
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</tr>
<tr>
<td>AL-FE</td>
<td>0.62*** 0.48***</td>
<td>-0.016** -0.018</td>
<td>-0.015*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BC-FE</td>
<td>0.42*** 0.29***</td>
<td>-0.003 -0.002</td>
<td>-0.005**</td>
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<tr>
<td>MA-FE</td>
<td>0.65*** 0.55***</td>
<td>-0.003 -0.008*</td>
<td>0.001</td>
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<tr>
<td>NB-FE</td>
<td>0.80*** 0.65***</td>
<td>-0.008 -0.006</td>
<td>-0.010**</td>
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</tr>
<tr>
<td>NF-FE</td>
<td>0.67*** 0.53***</td>
<td>-0.013** -0.015**</td>
<td>-0.010*</td>
<td></td>
<td></td>
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<tr>
<td>NS-FE</td>
<td>0.67*** 0.54***</td>
<td>-0.011 -0.012</td>
<td>-0.009***</td>
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<td></td>
</tr>
<tr>
<td>ON-FE</td>
<td>0.45*** 0.27***</td>
<td>-0.014** -0.012***</td>
<td>-0.015***</td>
<td>-0.015***</td>
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</tr>
<tr>
<td>PE-FE</td>
<td>0.87*** 0.78***</td>
<td>-0.013 -0.015</td>
<td>-0.009</td>
<td></td>
<td></td>
</tr>
<tr>
<td>QU-FE</td>
<td>0.51*** 0.36***</td>
<td>-0.010** -0.007***</td>
<td>-0.013***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SA-FE</td>
<td>0.70*** 0.56***</td>
<td>-0.006 -0.008</td>
<td>-0.007***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AR-correction</td>
<td>NO</td>
<td>YES</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>S.E. of regression</td>
<td>0.038</td>
<td>0.027</td>
<td>0.024</td>
<td>0.031</td>
<td>0.017</td>
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<tr>
<td>R-squared</td>
<td>0.94</td>
<td>0.97</td>
<td>0.13</td>
<td>0.12</td>
<td>0.19</td>
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<tr>
<td>Durbin-Watson</td>
<td>0.56</td>
<td>0.83</td>
<td>1.84</td>
<td>1.69</td>
<td>2.09</td>
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<tr>
<td>Panel observations</td>
<td>200</td>
<td>190</td>
<td>190</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Notes: See notes at end of Table 2 for details on estimation techniques.