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Provincial Pricing Problems: The New PPP?

Exploring Price Volatility and Law of One Price Deviations in Canada

by

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "Provincial Pricing Problems: The New PPP? Exploring Price Volatility and Law of One Price Deviations in Canada" submitted by Timothy Hugh Cowan in partial fulfilment of the requirements for the degree of Master of Arts.

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ABSTRACT

Following a recent trend in research, this thesis explores the failures of the "law of one price" within Canada's borders. To do so, it tracks monthly prices of a disaggregated basket of 70 goods over 13 years, in all 10 Canadian provinces. We quantify the extent of the deviations, and search for the root causes behind them. In general, this thesis finds that the standard tradability of goods argument is not a good explanation, as goods that are not traded actually exhibit lower deviations. Similarly, 'sticky' goods prices do not seem to be at fault either, as price comparisons over a longer time horizon show higher deviations. This thesis does establish that both price volatility and distance between locations matter in establishing law of one price deviations within Canada.

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To my parents.

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PROVINCIAL PRICING PROBLEMS: THE NEW PPP?

The law of one price is a basic tenet of international macroeconomic theory. It asserts that the common-currency price of any good should be equal across countries. In reality, however, this rarely seems to be the case, indicating the presence of market segmentation in the global economy. Recent literature in this area has seen studies focus on price volatility within individual countries, thereby eliminating exchange rate effects and other obstacles to price equalization across countries. This thesis will analyse price volatility within and between Canadian provinces, in a manner similar to that which would be undertaken in an international study. In doing so, comparisons to other single-country studies will be made, and hopefully some comment on the prevailing international theory can be put forth.

Before beginning the study, it is worth reviewing the classic textbook examples of when the law-of-one-price (LOP) does not hold. First, transportation costs can drive a wedge between prices in different locations, not allowing arbitrage to fully equalize prices. Secondly, goods that are not fully transferable or tradable will also not take full advantage of arbitrage. Lastly, slowly adjusting prices can cause a time lag in price correction, which might allow for persistent price discrepancies across locations. This last point is especially true in an international context, as prices in each country are generally 'sticky' in their own currency, whereas the nominal exchange rate adjusts instantaneously. This causes common-currency prices to differ across countries.

After establishing the existence of LOP deviations, this thesis will explore the degree to which they are caused by transportation costs, tradability of goods, and sticky prices between Canadian provinces. It will also seek to determine the extent to which the Canada-US Free Trade Agreement of 1988 and the North American Free Trade Agreement of 1993 impacted law-of-one-price deviations. In essence, it will replicate – and expand in some areas – a study by Engel and Rogers (2001), which uses price data for US cities. This study will use price data on a disaggregated basket of goods from all 10 Canadian provinces to establish and explore law-of-one-price deviations.

The plan of this thesis is as follows. Chapter 2 will survey the literature in this area, and Chapter 3 will discuss the data that will be used for the empirical section of the study. Chapter 4 lays out the calculations and shows the extent of law-of-one-price deviations in Canada, with Chapter 5 exploring the root causes of those deviations. In Chapter 6, the impact of trade agreements on the deviations will be explored. Finally, Chapter 7 will compare results with another similar Canadian study, before the Chapter 8 offers some concluding remarks.

2. Literature Review

Before the main part of this study is undertaken, it is worthwhile to look at the related literature. There are two main aspects of market segmentation that are usually studied: the trade inhibiting effect of international or intranational borders, and the root causes of price discrepancies between locations. The former attempts to quantify the extent to which trade across borders is less than it would or should be in the absence of the border, while the latter explores issues such as distance between locales, tradability of goods, and sticky nominal prices, in determining why the law-of-one-price often fails to hold. There are also two differing ways of testing the degree to which markets are segmented: by measuring trade flows and by measuring prices. The following review of literature offers a mixture of the two goals and the two methods in studying market segmentation.

2.1. The Border Effect.

The area of research that focuses on the trade-dampening effect of international borders was initiated by John McCallum, who attempted to calculate the 'size' of the border between Canada and the United States. McCallum's (1995) study begins by stating the common belief that regional trading blocs such as the European Union and the North American Free Trade Agreement are dramatically decreasing the importance of international borders in trade. He also asserts that the Canada-US border is unique in the world, in that both sides share common language, culture, and institutions. If there is anywhere in the world where a border should not inhibit trade, it is likely that it is the one along the 49th parallel. McCallum's analysis, however, yields exactly the opposite result.

The methodology of the study is to compare the volume of trade between pairs of Canadian provinces, as well as between provinces and states, with the GDP of each region and the distance between each pair of regions. McCallum uses data from each of the 10 Canadian provinces and 30 of the 50 US states. The 30 states used are the largest 20, as well as the 10 that share a border with Canada. The data used is for 1988[1], and his mechanism for the comparison is the 'gravity equation,' which predicts the volume of trade between two regions based upon their relative GDP and the distance between them. The equation includes a 'dummy' variable that takes on a value of 1 for province-to-

[1] It is important to note that this is before the implementation of both the Canada-US Free Trade Agreement of January 1989, and the North American Free Trade Agreement of January 1994.

province trade and 0 for province-to-state trade. (State-to-state trade is not considered in this study.) This variable can then be used to determine the significance of trade within Canada as opposed to across the border.

The most interesting result here is the coefficient on the dummy variable, which, for each of 6 different specifications of the model, was approximately equal to 3. This means that, holding all other variables constant, the *log* of trade volume is about 3 times greater for province-to-province exchange than for state-to-province. By eliminating logs, we are left with McCallum's famous result that interprovincial trade is *22 times greater* than cross-border trade between states and provinces. With this in mind, we can easily understand the title of his paper: "National Borders Matter."

Understanding this result is made easier by illustrating two brief examples. McCallum's findings predict that, in a borderless North America, where volume of trade is determined only by distance and relative GDP through the gravity equation, trade between Ontario and Quebec would be 10 times greater with California than with British Columbia. (California's GDP was about 10 times that of either province in 1988, while the difference in distance from Central Canada to either BC or California is negligible.) In reality it was about one-third in 1988. In addition, McCallum found that BC's exports to Texas should be 50% greater than those to equidistant Ontario, when in fact their trade was nine times greater with Ontario.[2]

McCallum's findings on this subject were and are certainly startling, as well as somewhat controversial. Many authors have undertaken research to explore the robustness of those results. The first of which we will look at is a study by John

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[2] John McCallum (1995), p. 617

Helliwell, which replicates McCallum's analysis, but with a particular focus on Quebec's trading patterns.

Helliwell (1996) follows McCallum in using the same regression equation, albeit with somewhat differing measurements for some variables. He utilizes data from 1988 through 1990, and again focuses on the coefficient of the dummy variable, which signifies interprovincial trade. His results yield 'border effects' of 19.9, 18.7, and 25.0 for the three years individually, and 21.1 for all three years combined.[3] Again, these results come from manipulating the coefficient on the dummy variable measuring province-to-province as opposed to province-to-state trade. The numbers mean that provinces were between 18 and 25 times – and 21.1 times on average – more likely to trade with other provinces than with US states, all other factors being equal. These findings certainly do seem to confirm the earlier McCallum result.

The next step in Helliwell's analysis is to separate out the trade patterns for the province of Quebec. The reasons for doing so are twofold. First, since Quebec is the only province or state that departs from the uniform North American language and culture that everyone assumes leads to increased trade; different results for Quebec may shed some light on the accuracy of that assumption. Secondly, the seemingly ever-looming question of Quebec separation makes the study of its independently determined trade patterns a valid economic question for post-separation North American economy.

In order to separate out Quebec's trade, Helliwell adds in two extra dummy variables, which measure Quebec's trade with other Canadian provinces, and with American states, respectively. When the coefficients on these variables are converted into McCallum-type result, Helliwell asserts that Quebec's trade is 26.8 times greater

[3] John Helliwell (1996), p. 510.

with Canada than with the US when the effect of both variables are factored in. Since this number is larger than McCallum or Helliwell's calculations for the country as a whole, Helliwell concludes that, "Quebec's trading links with the rest of Canada, relative to those with the United States, are at least as strong as they are for other provinces."[4]

Helliwell's final contribution from this paper was to quantify the extent to which these results are counter-intuitive. He reiterates the argument that a continent cohabitated by two countries with a uniform language, culture, and institutional framework, a shared history of low barriers to trade, and a high degree of American ownership in Canada, should rightly cause large volumes of cross-border trade. Helliwell actually surveyed both faculty members and graduating students in economics and political science on the question of "how much trade Canadian provinces do with each other, in comparison with how much they trade with US states of similar economic size and at a similar distance."[5] He reports that the median response was 0.8, with two-thirds of respondents giving answers of between 0.7 and 1.1. In reality, the McCallum-Helliwell analysis gives a radically different answer of something in the low 20s. This, too, is a startling result, in that even people who could be expected to be knowledgeable in this area do not foresee anything remotely close to the results obtained by these studies.

While the United States is far and away Canada's most important trading partner, it is nonetheless a worthwhile pursuit to see if the McCallum-Helliwell border effect holds true between Canada and its other trading partners. This question is pursued by Michael A. Anderson and Stephen L.S. Smith (1999), who also offer some interesting insights into the original McCallum-Helliwell analysis.

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[4] John Helliwell (1996), p. 511.
[5] John Helliwell (1996), p. 513.

Keeping with the original Canada-US relationship for the moment, Anderson and Smith begin with a re-examination of McCallum's initial 1995 study. The authors change the model slightly, in replacing the 'cross-border' dummy variable with two dummies. The first of these is active if the good is an American export to Canada, while the second switches on when the good in question is a Canadian export south of the border. The intent is to establish whether American and Canadian firms have the same viewpoint on the 'size' of the border. The authors' expectations are fulfilled, in that both coefficients are negative – indicating the same trade-diminishing aspect of the border – and that the American coefficient is larger in absolute value. This second result indicates that American firms have less incentive to send their goods across a 'thick' border than do Canadian firms.[6] This is a function of the relative size of the two economies: American firms can much more easily choose not to export, and still find a buyer for their good.

Anderson and Smith also estimate a different specification of the gravity model, and find a border effect of 15.2, which is 31% smaller than the original McCallum result. The point being made is not so much that the McCallum result is wrong and that theirs is right, it is that this type of result can be very sensitive to changes in model specification. In any event, the border effect is still found to be very large and very significant, and in both directions, albeit to different degrees.

Next, the authors attempt to determine whether the border is uniform across Canadian provinces. To do so, they break up the national data set into separate provincial sets. This allows interprovincial trade to be more closely examined, since each transaction now becomes an import for one province and an export for another. In the

[6] Michael A. Anderson and Stephen L.S. Smith (1999), p. 26.

first model, when BC ships lumber to Ontario, this is counted only generally as interprovincial trade. It is now counted as a BC export (within Canada) by the new $D1X$ variable, and an Ontario import (from within Canada) by the $D1M$ variable. Similarly, if BC were to ship its lumber anywhere in the US, this effect would be picked up by XUS dummy. (Imports from the US are left to the constant term.)

Converting the results into the familiar McCallum-type border effect, this method shows that provinces' bias toward interprovincial trade ranges from a high of 49 (Prince Edward Island) to a low of 10 (British Columbia). These results are clarified when the import-export effects discussed above are taken into account. BC is only 4.9 times more likely to export to other provinces than to the US, all else equal, but is 20 times more likely to import from the rest of Canada than from the US. Meanwhile, Ontario is 18 times more likely to import from another province than from the US, again, all else equal, but is an amazing 37 times more likely to export within Canada.[7] This type of result leads to the authors dubbing British Columbia Canada's export platform, while Ontario could be classified as an import platform.

Anderson and Smith do not offer explicit explanations of these findings, but it is not difficult to imagine that this is a result of the types of economies of these two provinces. British Columbia deals heavily in resources, and would understandably find markets in the US, while Ontario is very manufacturing-oriented, and may find it useful to purchase inputs and intermediate goods from south of the border. Nova Scotia, Prince Edward Island, and Newfoundland, meanwhile, all exhibit 'thick borders' in both imports and exports, indicating that those provinces have isolated themselves somewhat from trade with the US.

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[7] Michael A. Anderson and Stephen L.S. Smith (1999), p. 29.

We now turn to Anderson and Smith's discussion of the size of Canada's borders with the rest of the world. Owing to the similarities between Canada and the United States that have been discussed earlier, we would definitely expect to find that the border effects with the rest of the world would be larger than those with the US. The authors tested trade data between Canada and 12 countries including the US, but also comprising a geographically diverse group of important trading partners that made up over 88% of Canada's trade in 1988. Their finding was that the border effect was *the same* or *perhaps smaller* than the same effect between Canada and the United States. This means that, after controlling for the additional distance that must be traversed for goods to leave and enter North America, international borders do not inhibit trade with Canada any more than the US border does.

The authors do offer some insight into the reasoning behind this result. It is possible that, due to the similarities between Canada and the US, similar goods are produced in both countries. This would mean that north-south trade could easily be replaced by east-west trade, whereas the perhaps more specialized products offered by other trading partners would be more difficult to replace.[8]

Anderson and Smith conclude that, while the size of the border may be slightly smaller than McCallum and Helliwell had found, it is still a very significant determinant in North American trade flows. They also showed that the border is viewed in a different way depending upon which side of it a particular agent resides, and that the border with the US differs across provinces, but is more or less the same as it is between Canada and its other trading partners.

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[8] Michael A. Anderson and Stephen L.S. Smith (1999), p. 32.

It is worth noting that not all researchers accept McCallum's result. James E. Anderson and Eric van Wincoop (2001) assert that McCallum used the gravity equation improperly to obtain this result. The argument is that the theoretical development of the gravity model as an explanation for *inter*national trade is inconsistent with its use by McCallum and others as a model for *intra*national trade. In addition, Anderson and van Wincoop argue that the McCallum's shocking result that the Canada-US border reduces trade by a factor of 22 is a function of the small size of the Canadian economy. The authors replicated McCallum's method and specification of the gravity model with 1993 data[9], and found that this number was 16.4 – lower than McCallum's but still significantly large. They also estimated the same number based upon the theoretical gravity equation, and arrived at a border effect of 10.7.[10] When the authors follow McCallum's method, but from a US perspective, they find that the US-Canada border makes state-state trade only 1.5 times greater than state-province trade (controlling for distance and economic size). Again, this goes with the idea that American firms can more easily substitute away from Canadian markets than vice-versa. By any measure, however, the border between Canada and the United States does have a significant impact on trade from a *Canadian* perspective.

One final contribution to the discussion of border effects and distance comes from Helliwell and Geneviève Verdier (2001). The authors boast a new method of measuring distance between areas within a province (or state or country), based upon geographic size, population, and population density. They claim that, on average, this will increase measurements of distance, and therefore indicate more profound border effects.

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[9] Again it is important to note the timing of trade agreements. Although NAFTA was ratified in 1993, it did not come into effect until January 1994.

[10] James E. Anderson and Eric van Wincoop (2001), p. 2.

The authors' new measure of internal distance isolates the urban areas due to their large population density and economic importance. They then mathematically calculate four measures of distance: within cities, between cities, between cities and rural areas, and between rural areas. Each of these average distances is weighted according to the product of each area's population.[11] This gives a measure of the 'population-weighted average internal distance' of the province.

The authors estimate a gravity equation similar to that used in the original McCallum paper and in Helliwell's follow-up. As in those studies, this one uses all 10 Canadian provinces and the same 30 US states, comprising those bordering Canada and her largest trading partners. The key difference in this model is obviously Helliwell and Verdier's new method of measuring distance. A specification of the model using those measures is compared to two other standard measurements of internal distance.[12]

The Helliwell-Verdier measure of distance produces interprovincal border effects that are substantially larger for all provinces than the first measure, but are not significantly different than the second. Taken as a whole, none of the three measures shows significant border effects for the four largest provinces: Ontario, Quebec, British Columbia, and Alberta. The national capital measure showed large border effects for Newfoundland and Prince Edward Island, while the area-based measure gave substantial effects to Newfoundland, Manitoba, and Saskatchewan. Helliwell and Verdier's analysis showed border effects for the four Atlantic provinces as well as Saskatchewan. Overall,

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[11] This means that "within city" measures are multiplied by the square of the city's population, while "city-to-rural" distances are scaled by the product of the city's population and the rural area's population, and so on.

[12] The two other methods estimate the average internal distance of a country as: one-quarter of the distance between the country's capital city and the capital city of its closest neighbour; and one-quarter of the square-root of the country's geographic area.

the area-measure and the new distance measure show a large own-province trading bias, but the national capital measure does not. Finally, if the provinces are grouped into the four largest and the other six, then the smaller six together show a substantial border effect.[13]

For the purposes of this thesis, the border effects between Canadian provinces found by Helliwell and Verdier and by Anderson and Smith could be useful in explaining deviations from the law-of-one-price between Canadian provinces. If provinces do exhibit own-province trading bias, then markets between provinces will indeed be segmented, and prices can rarely be expected to fully equalize.

2.2. *Measuring Market Segmentation Through Prices*

Most of the preceding literature has focused on the trade-diminishing effect of borders in general, and the Canada-US border in particular, by examining the volume of trade between locations in the same country as well as locations on opposite sides of the border. A 'thick' or trade-diminishing border is cited as evidence of market segmentation between countries. Several recent studies, however, have moved away from the use of trade volumes in determining the existence and the extent of market segmentation.

As perhaps the pre-eminent researchers in this area, Charles Engel and John H. Rogers argue that "trade flows are a problematic measure of the degree of market integration." Since traditional trade theory asserts that trade depends upon such things as factor endowments, even in the absence of any artificial barriers to trade, there is no

[13] John Helliwell and Geneviève Verdier (2001), p. 1038. The 4 largest provinces (Ontario, Quebec, British Columbia, and Alberta) comprise more than 80 percent of Canada's population and GDP. The smaller six are made up of the 4 Atlantic provinces (Nova Scotia, New Brunswick, Newfoundland, and Prince Edward Island) and the 2 Prairie provinces (Manitoba and Saskatchewan).

reason to believe that trade should be "unlimited, or even necessarily…large" in the absence of a border effect.[14]

Instead of raw trade volumes, Engel and Rogers, as well as others, look to the prices of goods and services to determine the level of market integration or segmentation. If the movement of goods between countries were perfectly free, then arbitrage would cause the prices of identical goods to equalize across locations. In reality, however, there are barriers to this free movement of goods. Geographic distance adds in transportation costs, while other structural obstacles, such as exchange rate volatility, or 'man-made' barriers to trade, such as tariffs, can also cause prices to not fully converge.

The first paper on the subject was by Engel (1993) alone, and it looks at price volatility within and between 6 countries over 6 price indexes. In the overwhelming majority of cases – greater than 93% for 5 of the 6 indexes – he finds that "the variance of the relative price within the country for different goods smaller than the variance across countries for the same type of good." Engel gives the example that "the price of a wool shirt relative to a bottle of wine in the United States is less volatile than the price of a wool shirt in the United States relative to the price of a wool shirt in Canada."[15] This is a clear criterion for market segmentation between countries. This thesis will explore a similar question: whether prices of different goods within one Canadian province are less volatile than prices of the same good across all the provinces.

A similar method is employed by Engel and Rogers (1996), who look at prices in cities on either side of the Canada-US border. The data used is 14 disaggregated consumer price indices, ranging from 'Food at Home' to 'Men's and Boy's Apparel', to

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[14] Charles Engel and John H. Rogers (2000), p. 1

[15] Charles Engel (1993), p. 40

'Medical Care', from 23 North American cities (14 in the US and 9 in Canada), dating from June 1978 to December 1994. The authors measure relative price of goods between cities as $P^i_{j,k}$, the log of the price of good *i* in city *j* relative to that price in city *k*. They set out to determine if price volatility – measured by the variance of the $P^i_{j,k}$ variables – increases as does the distance between cities *j* and *k*.

As in previous papers in this review, Engel and Rogers use these regression results to calculate a 'border effect' and a 'distance effect', and indeed find that both factors are significant in determining deviations from the LOP. They convert their border effect into a distance-equivalent, however, and find that it is so pronounced that "in order to generate that much volatility by distance, the cities would have to be 75,000 miles apart."[16] For reference, that is about 3 times the diameter of the Earth. While dominated by the border effect, the authors do find that distance is a significant deterministic factor of volatility. In particular, distance has a large explanatory power when looking at cities in the same country, when there is no border to be traversed.

The authors presently embark on a good discussion of why the border has such a profound effect. Their first consideration is formal trade barriers between countries, but they note that the implementation of the Canada-US Free Trade Agreement did not change the border coefficient.[17] Next, they posit that labour markets may be more homogenous within each country, making wage differentials much more pronounced between cities on opposite sides of the border. An additional specification of the regression equation to include wage differentials again does not seem to change the

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[16] Charles Engel and John H. Rogers (1996), p. 245.
[17] See the review of Engel and Rogers (2000) below for a further discussion on formal trade agreements.

border effect. These two possible explanations fail to give any hint of why the border effect is so large.

Finally, the authors consider a sticky-price argument, in that converting Canadian goods prices into US dollars allows the border effect to include a fluctuating nominal exchange rate. The authors change the measure of relative prices to $(P_f / P)/(P_f^* / P^*)$, where P_f is a US-city price for good *f*, P_f^* is the price of the same good in a Canadian city, and P and P^* are the aggregate price deflators for the American and Canadian city, respectively. This gives the relative *real* price of the good between the two cities and factors out any nominal exchange rate fluctuations. They find that the border effect is still very pronounced, but that the border now accounts for 18.9 percent of the calculated standard deviation as opposed to 33.3 percent before. Some credence then must be given to the sticky price story, but that still leaves a substantial portion of a very large border effect unexplained.

One final contribution of the 1996 paper is that Engel and Rogers posit the idea that distance may not matter beyond some upper endpoint. They choose an arbitrary value of 1700 miles, and determine that there is no effect of additional distance on volatility.[18] A similar idea will be utilized in this study.

The result of a 75,000-mile border between Canada and the US is tremendously surprising, given the geographic proximity and close economic ties between the two countries. A worthwhile investigation, then, is to determine the 'size' of the border between other countries as a basis for comparison. David C. Parsley and Shang-Jin Wei (2001) tackle the issue of the imaginary border between the United States and Japan. In

[18] Charles Engel and John H. Rogers (1996), p. 243

addition to calculating the border effect, they also briefly analyse law-of-one-price deviations within and between the countries.

Their data consists of price data for 27 commodities that can be reasonably compared across 96 cities in the US and Japan, over 88 quarters (from the beginning of 1976 to the end of 1997). They use a benchmark city in each country, and calculate relative prices between those benchmarks and all other cities in both countries.

The first exploration of the results was a comparison of the US-only city pairs, the Japan-only city pairs, and the cross-country city pairs, using 1985 results. The authors found a low dispersion in prices within each country, but more pronounced deviations between the two countries. This gave evidence that Japanese prices were high relative to those in America, as well as indicating that LOP failures are more pronounced between the United States and Japan than within each country individually.[19]

This exercise was repeated using 1990 data, and the authors found that the cross-country dispersion had increased, indicating that Japanese prices had risen even more relative to American prices, and that LOP deviations between the two countries had become more severe. This is taken as preliminary evidence that deviations do not in fact decline over time, although the authors hasten to mention that such a conclusion made from just two snapshots in time could be misleading.

Turning now to the size of the border between Japan and the US, Parsley and Wei attempt to determine if the 75,000 miles that empirically separate Canada and the US is extremely high, or if it is in fact the norm. To do so, they estimate an equation similar to that in the previous Engel-Rogers (1996) paper, which measures the effect of distance and of the border on the 'real exchange rate' between cities, measured by their price data.

[19] David C. Parsley and Shang-Jin Wei (2001), p. 92.

Using the coefficients from these regression results, the authors calculated an Engel-Rogers-type border effect of roughly 6.5 *trillion* miles, which they note is about 70,000 times the distance from the Earth to the Sun or 130 million times around Earth.[20] If the old Engel-Rogers (1996) border estimate was mind-boggling, this one seems absolutely incomprehensible. By any measure, however, the simple act of crossing a border has a greater effect on price dispersion than can be accounted for by distance alone.

It has been established that there are failures of the law-of-one price between Canada and the United States. Another Engel and Rogers study (2000) analyses price volatility between US cities and Canadian provinces, but attempts to find more qualitative reasons for LOP discrepancies. First, the existence of market segmentation allows for the concept of pricing to market, and second, each country exhibits national markets established "by tradition, by national distribution networks, and [by] national marketing campaigns."[21] They argue that, even in the absence of the standard sticky-price argument, these factors would cause deviations between the countries. It is possible that Canada might exhibit similar 'regional markets' that allow for pricing to market and contribute to price discrepancies within Canada.

The authors also attempt to determine whether or not trade agreements – specifically the Canada-US Free Trade Agreement (CUSFTA) of 1988 – lessen the amount of the price discrepancies between the two countries. They note that Helliwell (1998) found that "the bias in trade between Canadian provinces (relative to trade between provinces and US states) fell significantly after the free-trade agreement."

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[20] David C. Parsley and Shang-Jin Wei (2001), p. 97.
[21] Charles Engel and John H. Rogers (2000), p. 4.

Further, they argue that, "if indeed trade restrictions were a chief obstacle to market integration, then we should see prices moving more closely together after the free-trade agreement then before."[22]

They segment their dataset into three periods: pre-CUSFTA, a transition period, and full implementation of CUSFTA. The authors did in fact see a reduction of about 20% in the border effect from the first period to the last. This would seem to indicate that a lessening of trade restrictions was lessening LOP deviations. However, this was matched by a similar reduction (approximately 20%) of the coefficient on distance.

The conclusion drawn by Engel and Rogers is that, while markets are indeed becoming more integrated over this time period – they credit increased efficiencies in transportation, communication, and marketing – it seems as though this is not because of the free-trade agreement. This thesis will attempt to determine if deviations within Canada were significantly impacted by various trade agreements.

2.3. Single-Country Studies

Changing focus from a cross-country to a within-one-country type of analysis enables the researcher to reduce the effect of any artificial trade barriers, as well as any exchange rate effects. In theory, a single country's economy should be more homogeneous and should be more conducive to the law-of-one-price holding.

With this in mind, an earlier study by Parsley and Wei (1996) studies the prices of 51 commodities over 48 US cities in an effort to determine an "upper bound estimate of the rate of convergence to Purchasing Power Parity (PPP)."[23] These findings, they argue,

[22] Charles Engel and John H. Rogers (2000), p. 3.
[23] David C. Parsley and Shang-Jin Wei (1996), p. 1211.

are important in confirming or denying any models on foreign exchange rates or broader open-economy macro models, given that conventional wisdom on the validity of PPP has "run the full gamut – from fairly high, to nearly zero, and now, back to positive but slow."

Parsley and Wei segment their sample into three distinct groups: perishables (15), non-perishables (26), and services (10). They then calculate the pre-tax price differential between commodity k at time t in city i and city j as follows:

$$Q_{ij,k,t} = \ln(P_{i,k,t} / P_{j,k,t}) \qquad (5)$$

Using New Orleans as benchmark city j, they then calculate $Q_{ij,k,t}$ for each of the other 47 cities, and for all 51 goods, using quarterly price data from the beginning of 1975 to the end of 1992.[24] Clearly, the law-of one-price predicts that these values should be zero, although this may not always be the case for a variety of reasons previously discussed.

The major test of this study is whether or not the first-difference price differentials follow a random walk, which would indicate that any deviation from PPP would be permanent – the prices would never again permanently equalize. The alternative hypothesis here is that the differentials follow a zero-mean, stationary AR(1) process. Again breaking their results into three groups, Parsley and Wei are able to reject the null in 20 of 26 cases (at the 5% level) for non-perishables, 10 of 15 cases (at the 1% level) for perishables, and in 4 of the 10 cases (again at the 1% level) for services.

The significance here is that for the vast majority of goods, including the perishable goods and the services – which might normally be considered non-tradable –

[24] David C. Parsley and Shang-Jin Wei (1996), p. 1213, 1215. The authors also tested New York as a benchmark city, and found this distinction made no significant difference to the results.

price differentials "are disciplined not to wander away from zero indefinitely."[25] The authors are quick to point out, however, that this does not necessarily contravene the prevailing wisdom about non-traded goods having more persistent deviations from the law of one price. To comment further, a second issue must be explored: speed of convergence.

After the results of the previous test, the authors assume that the price differentials in fact are stationary and take on a zero-mean AR(1) process, and further argue that rate of convergence depends the magnitude of the coefficient on the price differentials in their previous regression. A benchmark rate of convergence was then calculated for each group by calculating the implied half-life of the deviations for good in each group with the median coefficient. The results give half-lives of approximately 5 quarters for non-perishables, 4 quarters for perishables, and 15 quarters for services.[26]

These results illustrate the fact that, while deviations may be no larger for non-traded goods, convergence to PPP does take substantially more time for the services sector. Nonetheless, these estimates of convergence rates are much lower than in other studies, which are typically in the range of 3 to 5 years, even for traded goods.

Another study built upon the same data set as Parsley and Wei (1996), and also using price data from US cities, is Paul G.J. O'Connell and Wei (2002). These authors also find that relative prices across American cities are stationary, with the notable exceptions of some services, especially health care. A slightly different approach also sees the authors group their goods – admittedly "coarsely" – as follows: not locally-produced (national name-brands); may be locally produced (perishable food items); and

[25] David C. Parsley and Shang-Jin Wei (1996), p. 1220.
[26] David C. Parsley and Shang-Jin Wei, p. 1222.

locally produced (services as well as chain-food such as McDonald's). With these definitions in mind, they find that the LOP holds for around 40 percent of non-locally produced goods, and for the basic staples in the may be locally produced category. Deviations of 5 to 10 percent were common for the remainder of goods in the sample. Finally, they found that, in general, large deviations dissipated much more quickly than did small differences, although there were differences within and between each grouping of goods.[27]

The two remaining studies in this review are the most relevant to this thesis. Janet Ceglowski (2003) embarks on a similar investigation of LOP deviations between 25 Canadian cities, and attempts to ascertain the role of distance and provincial borders in creating those deviations. Meanwhile, Engel and Rogers (2001) provided a template of sorts for this thesis, by looking at deviations from parity amongst 29 US cites, employing many of the same techniques that will be used here.

Let us deal with the Ceglowski (2003) study first. Commenting that recent work on international issues had turned to single-country – mostly US – case studies, Ceglowski asserts that a Canadian comparison would "both broaden understanding of intranational price behaviour in general and provide a context in which to evaluation the findings for the US."[28] Her study took bi-annual averages of actual retail prices for 45 goods in 25 Canadian cities over the time period from 1976 to 1993. Using retail prices, rather than indexes, is important in that it allows for the testing of both absolute and relative price parity, as well as avoiding a possible aggregation bias.

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[27] Paul G.J. O'Connell and Shang-Jin Wei (2002), p. 51
[28] Janet Ceglowski (2003), p. 374.

The measure of price deviations in this study was the relative price $rp_{ijkt} = \ln(p_{ikt} / p_{jkt})$, where p_{ikt} and p_{jkt} are the prices of good *k* in cities *i* and *j*, respectively, at time *t*. Again, under the LOP, these measures would be zero. Failing that, they give the percentage deviation from absolute price parity. These deviations were, on average, roughly 12 percent, with individual good averages ranging from just under 10 to somewhat greater than 20 percent. Some individual city-to-city measures, however, were in fact zero, while others were greater than 100 percent. The author also measured the volatility of these relative prices, given by the standard deviation of the *rp* measures. In general, there was a positive relationship between the volatility of the relative price series and the mean absolute deviations.[29]

Turning now to the preliminary results, Ceglowski notes that, while deviations do exist over the short-run, this does not necessarily mean that longer-run convergence is not possible. She applies standard unit-root test to the logged relative prices, and found strong evidence in favour of rejecting that hypothesis. This, she argues, is generally regarded as evidence that relative prices are stationary and will converge in the long run.

The question of convergence now comes up naturally, so Ceglowski follows Parsley and Wei (1996) in calculating implied half-lives of the deviations. She finds that the mean value is 0.55 years, with half-lives for most goods being under 1 year. This is much lower than previous estimates of 4 to 5 quarters by Parsley and Wei (1996) and 1.83 years by Culver and Papell (1999).[30]

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[29] Janet Ceglowski (2003), p. 376.
[30] Recall that Parley and Wei found half-lives of 4 quarters for perishable goods, 5 quarters for non-perishables, and 15 quarters for services, using US data. Ceglowski only considers food and basic household items, not services. Culver and Papell used Canadian city-level CPI data.

Finally, Ceglowski turns to the issue of a distance effect and a border effect. Using a benchmark city (Toronto), she compared the size and the persistence of deviations to the quickest road distance between each city and Toronto. She found a positive distance effect for 30 of the 45 goods, with about half of those findings being significant. When transportation costs are taken into account, allowing for a band of no-arbitrage around prices, this evidence states that "both the width of the band and the size of the long-run prices disparity could depend on the distance between cities."[31]

The next test got rid of the benchmark city, thus comparing absolute price deviations between all city pairs with distances between all cities. The regression also included a dummy variable for each city, and found that distance was positive and significant for all goods. The same test was repeated with the addition of a provincial dummy variable that took on the value 1 when two cities were in different provinces. The addition of the provincial dummy reduced the distance effect for most goods, indicating that at least some of the deviations that had been attributed to a distance effect were in fact owing to the crossing of provincial borders.

The coefficient on the provincial dummy variable was used, as in previous studies, to calculate an interprovincial border effect for all goods that had both the distance and the border effect significant. The border effect for some goods was once again astronomical, but the pooled estimate pitted the value at 4880 miles. This means cities on opposite sides of a provincial border trade as though there is an additional 4880 miles of distance between them. This seems noteworthy, until previous estimates of the size of the Canada-US border are considered. While significant, it seems as though

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[31] Janet Ceglowski (2003), p. 382.

Canada's interprovincial borders are not nearly as trade inhibiting as her border with the United States.

It is still worthwhile, however, to offer some explanation of the observed border effect. Ceglowski theorizes that differing provincial taxation and regulatory structures may contribute, especially for provincially regulated commodities such as milk.[32] This also fits neatly with the theory of historical trading patterns and networks contributing to LOP failures. If provincial trading links are stronger than national ones, as Engel and Rogers (2000) claim is true for links within one country as opposed to those across national borders, then deviations between provinces could be borne out in large border effects. Finally, Ceglowski tests the theory that prices depend on the relative distance from cities to a "central or core location," with the closer city taking advantage of lower freight costs and offering lower prices.[33] She tests this theory, again using Toronto as the central location, and finds that relative distance from Toronto is in fact a significant factor.

The final study in this review is the Engel and Rogers (2001) paper that provided a template of sorts for this study. This paper mirrored previous Engel-Rogers efforts, by looking at price volatility by city, but this time using monthly price data for an expanded basket of 43 goods for 29 US-only cities, over the time period from December 1986 to June 1996. They seek to test the "proportional law of one price," as their data is in price index form. To do so, they utilize, as a measure of price volatility, the standard deviation of $\Delta p_{xt}^{m} - \Delta p_{yt}^{n}$. In words, this is a measure of the overall spread between first-difference

[32] Prices in the data set were inclusive of all taxes, making provincial tax structures a possible contributing factor. It should be noted, too, that the border effect for milk in this study is 2.07×10^{25}, far higher even than any estimate of the Canada-US border effect.

[33] Janet Ceglowski (2003), p. 390.

log-prices of good *x* in location *m* and the first-difference log-price of good *y* in location *n*, at time *t*.[34] These calculations were repeated using 24th-difference log-prices, meaning that the prices being compared were 2 years apart rather than 1 month. The longer time horizon should allow prices to equalize more fully.

The authors used Engel's (1993) notion of comparing price volatility for similar goods across cities to that of all goods within a particular city. This was done through the r_{jk} calculations, which are replicated using our Canadian data in this study. The actual results obtained by Engel and Rogers will be presented alongside ours – in Chapter 4 – as a basis for comparison, but their general finding for the US data was that "law-of-one-price deviations are not as important for locations within the United States as compared to deviations among countries."[35]

The Engel-Rogers study went on to focus on the denominators of the r_{jk} calculations – the actual LOP deviations – in an effort to seek out root causes of those observed deviations. These included distance between cities, tradability of goods, and price stickiness. They conclude that the most significant contributors to law-of-one-price failures are distance and nominal price volatility.[36] Many similar techniques will be employed in this thesis, and results will be compared in an effort to determine if price behaviour is similar in Canada and in the United States.

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[34] Charles Engel and John H. Rogers (2001), p. 2.
[35] Charles Engel and John H. Rogers, p. 6.
[36] Charles Engel and John H. Rogers, p. 14.

3. The Data

The data used in this study are monthly price indexes from a basket of 70 disaggregated goods from all 10 Canadian provinces over the period from December 1984 until December 1997. The source of this official data is Statistics Canada's CANSIM internet archive. The dataset actually dates back to September 1978, but seems to have been expanded in December 1984, as many more goods are tracked from that point on. In order to work with the largest possible number of goods, the sample period for this study begins in December 1984.

Several prices were eliminated from the dataset due to being commodity index-type prices. For example, the broad categories of 'Food', 'Food Purchased from Stores', and 'Meat' were all eliminated, while individual prices of six different types of meats were included. On the other hand, some goods were included under their broader product index heading. An example of this is 'Fresh Vegetables' being left in the sample, while the specific prices of 'Lettuce', 'Tomatoes', et cetera, were removed. This reduced the number of goods in the sample while keeping a high level of disaggregation. In addition, some goods in the original dataset were excluded because of either not being included in every province's dataset. The measure of energy in the sample is the index of 'Water, Fuel, and Electricity', since different provinces had different subsections under that category. The sample also includes, but is not limited to, the following categories: clothing, housing and household items, automobile purchases and expenses, public transit, recreation, and education. The result was the most disaggregated, most uniform across the provinces, and most complete sample possible, given the original data.

As was mentioned above, a major portion of this study will look at the effect of transportation costs on trade and price volatility. To do so, we will determine whether a greater distance between provinces increases law-of-one-price deviations between those two provinces. The measure of distance between provinces is taken to be the distance by road between each of the provinces' largest cities – Vancouver, Calgary, Regina, Winnipeg, Toronto, Montreal, Saint John, Halifax, Charlottetown, and St. John's.[37] The actual distances can be found in Table 3, while a discussion of the robustness of this method of measuring and testing distance is available in Appendix A.

In the set-up of this study, each of the goods was classified as either traded or non-traded. This classification was largely a judgement call based on the rule of thumb that goods are traded while services are not. Some goods also seem to be non-transferable, however, such as 'Prescribed Medicines' and 'Food Purchased from Restaurants', and thus were classified as non-traded. As was mentioned in the opening, theory tells us that the law-of-one-price should not hold as well for non-traded goods. Part of this study will be to determine if deviations from the law-of-one-price are larger for non-traded goods in Canada.

In order to determine the possible effect of sticky prices, the price deviations themselves were calculated using both 1-month differences and 24-month differences. The 24th difference simply means that we compare the price data for each month with the same month two years later. The longer time lag should allow for prices to adjust more fully, and therefore should provide for lower law-of-one-price deviations. It is also worth

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[37] The source for the distance data is the Driving Distance on http://www.mapquest.ca. It could be argued that most goods travel by rail. However, in much of the country, railway lines run alongside the Trans-Canada Highway, making road distance a good proxy.

noting that this time-lag is equivalent to 8 quarters, which is longer than most of the estimated half-lives of price deviations mentioned earlier.

4. Empirical Results

The measure of price volatility used in this study, as in Engel-Rogers (2001) is the standard deviation of $\Delta p_{xt}^{m} - \Delta p_{yt}^{n}$, where p_{xt}^{m} is the (log) price of good x in province m at time t, and p_{yt}^{n} the (log) price of good y in province n at time t. We also define $\Delta p_{xt}^{m} = p_{xt}^{m} - p_{x,t-1}^{m}$ as the first difference log-price of good x in province m between time periods t-1 and t. In words, $sd(\Delta p_{xt}^{m} - \Delta p_{yt}^{n})$ is a measure of the overall spread between first-difference log-prices of good x in location m and the first-difference log-price of good y in location n, at time t. Again, these calculations were repeating using 24th difference prices,[38] and were conducted for all pairs of goods in the same location (meaning that $m = n$ while x and y vary) as well as for the prices of the same good in different locations ($x = y$ while m and n change).

It is worth noting at this time that this study will be testing the "proportional," rather than the "absolute" law of one price, since our price data is in index form. Our measure of volatility will pick up deviations from the proportional law-of-one-price unless prices in different locations move together, in which case the standard deviation of $\Delta p_{xt}^{m} - \Delta p_{yt}^{n}$ will be zero. In this case, the absolute law-of-one-price would be violated – as price discrepancies do exist – but the proportional law-of-one-price does in fact hold.

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[38] For clarity of notation, the following formula will be used when referring exclusively to 24th differences: $\Delta_{24} p_{xt}^{m} - \Delta_{24} p_{yt}^{n}$, where $\Delta_{24} p_{xt}^{m} = p_{xt}^{m} - p_{x,t-24}^{m}$.

We are now ready for the first empirical investigation of this thesis, which follows Engel and Rogers (2001) measure of volatility of all goods prices in the same location relative to one good's price across locations. This is accomplished through the following calculation:[39]

$$r_{jk} = \frac{\frac{1}{69}\sum_{i=1,i\neq j}^{70} sd(\Delta p_{jt}^{k} - \Delta p_{it}^{k})}{\frac{1}{9}\sum_{m=1,m\neq j}^{10} sd(\Delta p_{jt}^{k} - \Delta p_{jt}^{m})} \qquad (1)$$

for each good $j = 1,\ldots,70$ and each location $k = 1,\ldots,10$; where $sd(\cdot)$ denotes standard deviation.

The numerator of equation (1) measures the price volatility of goods within each province. That is, the numerator of each r_{jk} value gives the average of the standard deviations of the difference between the price of good *j* and the price of every other good in province *k*. The denominator, meanwhile, gives a measure of the volatility of the price of good *j* across the provinces. This measures the volatility of deviations from the law-of-one-price.

Recall from the Engel (1993) study, that this type of analysis gives results such as the comment that "the price of a wool shirt relative to a bottle of wine in the United States is less volatile than the price of a wool shirt in the United States relative to the price of a wool shirt in Canada."[40] For a similar statement to be made between Canadian provinces, these r_{jk} values would have to be less than 1. In fact, Engel and Rogers (2001) argue that, in order to replicate the earlier, international findings by Engel (1993), their r_{jk} values would have to be in the order of 0.15.

[39] Charles Engel and John H. Rogers (2001), p. 6
[40] Charles Engel (1993), p. 40

Clearly this is not the case, as indicated by the average r_{jk} values for each good, summarized in Table 1. These results show that, in general, the average volatility of each good *within* each province is larger than the average volatility of that good *between* the provinces, as is indicated by r_{jk} values that are, on average, larger than 1.

The calculations were carried out using both 1st-difference and 24th-difference prices. The 70-good average here is 1.83 using 1st-difference prices and 1.85 using 24th-differences, as compared to 2.03 and 1.75 for Engel and Rogers.[41]

It is quite clear that both the Engel-Rogers (2001) findings for American cities and these results for Canadian provinces yield much higher results than the earlier, international study by Engel (1993). It is not likely that either intra-province or intra-city price volatility – the numerators – are extremely high with respect to the intra-country volatility from the Engel (1993) study. This leaves the conclusion that these higher r_{jk} values arise from lower denominators; that is, from lower cross-province price volatility. The conclusion here is that that volatility and law-of-one-price deviations between Canadian provinces are lower than would be expected between countries.

Another interesting way to view these results is by looking at the differences between traded and non-traded goods. We expect that the law-of-one-price will not hold as well for non-traded goods. This does not appear to be the case, however. As was mentioned above, lower r_{jk} values indicate higher volatility, approaching what can be observed between countries. Table 1 indicates that the average r_{jk} value for non-traded goods is 2.59 using 1st-difference prices, compared to 1.55 for traded goods. This rather

[41] Charles Engel and John H. Rogers (2001), p. 3. It is important to note that Engel and Rogers use a CPI-equivalent weighted average, whereas the results in this thesis use a straightforward mean average.

large difference is reduced when 24th-differences are used (1.91 and 1.82, respectively). It does seem, however, that the non-traded goods exhibit less deviation from the law-of-one-price than do the traded goods – which is the opposite of what we would expect. The Engel-Rogers study exhibited the exact same phenomenon, and it is one that will be studied in more depth in the next chapter.

The comparison between 1st-difference and 24th-difference pricing is also interesting. If short-term price stickiness is a factor in law-of-one-price deviations, then deviations should be lower when measuring price changes over a longer time period. Lower law-of-one-price deviations, in this case, mean higher r_{jk} values. In the Canadian study, the overall average r_{jk} value did increase, but only slightly. In fact, the good-specific r_{jk} increased in 49 of the 70 goods. In the Engel-Rogers study, the average value actually decreased over the longer timeframe. These results give little credence to the idea that sticky short-run prices might contribute to volatility.

This preliminary exercise seems to indicate that deviations from the law-of-one-price are not as large within Canada as they are across international borders. These deviations do exist, however, and the remainder of this thesis will focus on the underlying reasons for these discrepancies.

5. Where Do Deviations Come From?

In order to determine the cause of deviations from the law-of-one-price, we must recall the textbook reasons for the failure of the law: sticky nominal prices, transport costs, and tradability of goods. The presence of slow-adjusting elements in the economy, such as wage contracts, can cause additional costs that must be included in goods prices.

Such items are quite likely to vary across locations, causing goods prices to differ as well. Similarly, additional post-production costs – the most obvious being transport costs – may exist to bring products to market, creating a 'no-arbitrage' band around prices that prevents full equalization. Finally, if goods are not easily transferable, then agents cannot take advantage of arbitrage opportunities arising from price differences, and those price differences may persist.

To analyse the causes of law-of-one-price deviations, we will look to the deviations themselves. Recall that the average deviation from the LOP for good j between province k and all other provinces is given by the denominator of the r_{jk} calculation. Since we have such calculations for every good and every province, we can determine the average LOP deviations for each good across all provinces. These results are presented in Table 2. It should be noted that all deviations were multiplied by 100, in order to compare with Engel and Rogers (2001).

We begin by noting the difference in deviations between traded and non-traded goods. These discrepancies offer commentary on the tradability of goods argument, which will arise throughout the sections that deal specifically with the effects of sticky prices and transportation costs.

The most striking result here is that the average deviations are much lower for non-traded goods, once again going against the prevailing theory. When using 1st-difference prices, the average deviations for the 19 non-traded goods is 1.74, while for the 51 traded goods it is 2.79, for an overall average of 2.50. In fact, of the 10 goods with the highest law-of-one-price deviations, only one – 'Automobile Registrations' – is non-traded. Meanwhile, of the 10 goods with lowest deviations, 7 are non-traded.[42] Engel and Rogers (2001) find similar results, again contradicting the theory.

5.1. Sticky Prices

The difference in average deviations between traded and non-traded goods is reduced as we move to 24th-difference prices, but only because deviations for all goods increase dramatically. In fact, deviations increase for all goods, with the lowest increase being 'Women's Clothing' at 53.4 percent, the largest being 'Homeowner's Insurance' at 511.5 percent. The average increase for the 70 goods was over 192 percent.

This is yet another instance of the facts contradicting the theory, as price adjustments over a 2-year period should eliminate any sticky price effect and lead to lower – not higher – deviations. It seems as though this exercise indicates that neither tradability of goods nor short-run price stickiness are important in determining the cause of law-of-one-price deviations in Canada.

The dramatic increase in deviations as we move to the longer time horizon is intriguing. If price equalization is indeed at work, then the longer timeline should allow prices to adjust, and we should witness a lessening of deviations. This is the essence of the 'sticky prices' argument for why the LOP may fail over the short-run. It is possible, however, that there is simply too much going on during that 24-month period to allow for prices to come together. If prices are not sticky, but in fact are extremely volatile, then we might expect to see deviations actually increase over time.

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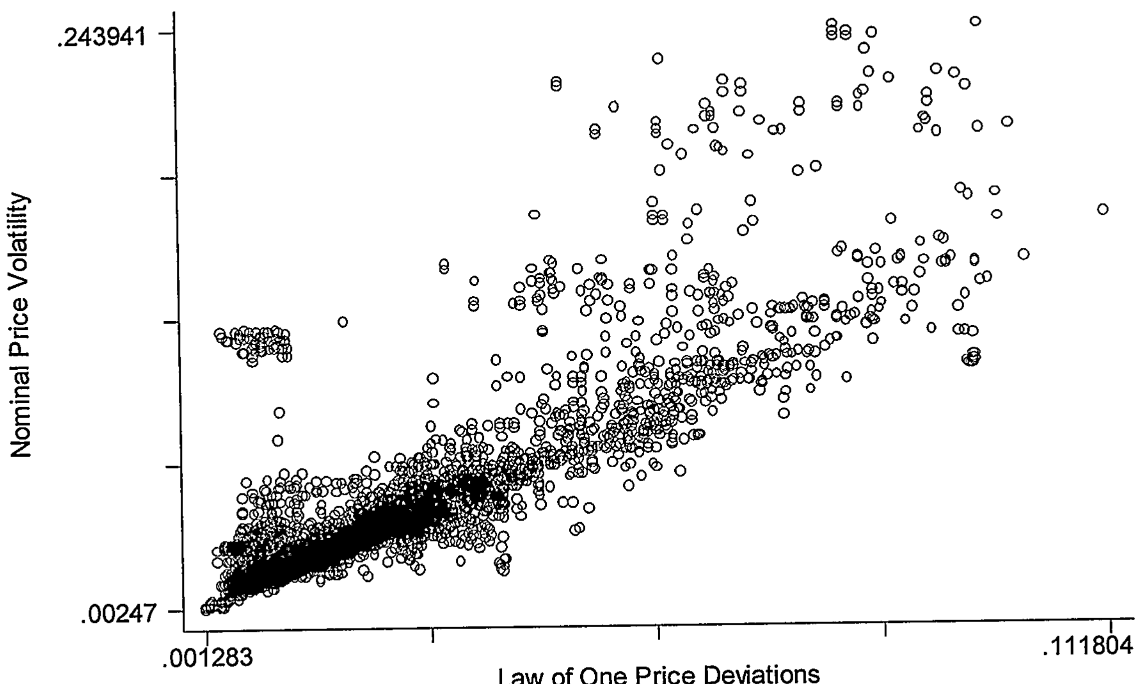
[42] The 10 goods with the lowest deviations are: 'Rented Accommodations' [N], 'Purchase of Automobiles', 'Owned Accommodation' [N], 'Food Purchased from Restaurants' [N], 'Recreation', 'Household Operations', 'Health Care Services' [N], 'Replacement Costs (housing)' [N], 'Personal Care Services' [N], and 'Served Alcohol' [N]. [N] indicates a Non-Traded Good.

Engel and Rogers (2001) set out to test this hypothesis, by comparing deviations from the LOP to price volatility in individual goods. They attempted to find a relationship between the deviations and the sum of the individual measures of price volatility. For example, the average deviation between prices of 'Fresh & Frozen Beef' between Alberta and British Columbia is 0.044753, while the deviation of the price of that good in Alberta is 0.041317 and in BC is 0.032197, for a sum of 0.073514. When this is repeated for all 10 provinces and all 70 goods, we have 6300 observations, which are plotted in Figure 1 below.



Law of One Price Deviations vs Nominal Price Volatility

Figure 1

This illustration shows that, for the most part, cross-province deviations are low when price volatility in those provinces is also low. As price volatility increases, so too do LOP deviations. As Engel and Rogers (2001) point out, another way to interpret these findings is by recalling the statistical formula for variance:

$$\mathrm{var}(\Delta p_{jt}^{m} - \Delta p_{jt}^{n}) = \mathrm{var}(\Delta p_{jt}^{m}) + \mathrm{var}(\Delta p_{jt}^{n}) - 2\,\mathrm{cov}(\Delta p_{jt}^{m}, \Delta p_{jt}^{n}) \qquad (2)$$

In essence, our graph plots everything in equation 2 except the covariance term. This shows that deviations – represented by the left side the equation – can be low in one of two ways. Either the volatility of the individual goods prices could be low (with their covariance also being low), or the volatility could be high (with their covariance also being high).

The graph shows that most points are clustered near the origin and close to the imaginary 45-degree line. This shows that, as with Engel and Rogers, the first explanation is true here.[43] As deviations increase, however, the majority of points seem to fall beneath the 45-degree line, indicating a small, positive covariance between the prices in across locations. Overall, it seems as though nominal price volatility is more important than price stickiness in establishing LOP deviations.

5.2. Transportation Costs

We will now attempt to ascertain if transportation costs are a determining factor in establishing deviations. If transportation costs are large, then they can drive a wedge between the prices of goods in different locations, not allowing full price convergence. This would seem to be a particularly important issue for Canada, owing to the enormous geographic size of the country. While the cost of transportation might not inhibit trade between Ontario and Quebec, or any other neighbouring provinces, it makes sense that it might come into play in determining the nature of trade between British Columbia and

[43] Charles Engel and John H. Rogers (2001), p. 11. If the latter of the two explanations were true, then we would see points on the graph in Figure 1 that were high in Nominal Volatility (the vertical axis), while being low in LOP Deviations (the horizontal), which does not seem to be the case.

Nova Scotia. Indeed, the distance between some Canadian provinces is likely far greater than between some countries in an international study.

To determine whether distance matters, we need to know whether a larger distance between provinces indicates larger price deviations between those provinces. More succinctly, the question is whether or not $sd(\Delta p_{jt}^{k} - \Delta p_{jt}^{m})$ increases with the distance between provinces k and m for every good j. As was mentioned in the introduction of the thesis, the distance between provinces is being estimated by the road distance between the largest cities in each province. Again, a list of cities and distances is given in Table 3, while an expanded discussion of distance occurs in Appendix A, which shows that the results below are robust to alternate measures of distance.

A simple regression measures the effect of distance between provinces – the independent variable – on an intercept and average price volatility between provinces – the dependent variable. There are 45 observations for each of the 70 regressions.[44] The regression results are given in Table 4a. Most significantly, the table shows that for 54 of the 70 goods, increased distance between provinces does correspond to increased price deviations. In addition, for the 23 goods in which the relationship was significantly different than zero (at the 5% level), none of the significant coefficients were negative. For comparative purposes, Engel and Rogers (2001) found 30 of 43 positive coefficients, 24 of which were significant.

In addition, Table 4a shows that there is very little difference between the average effect of distance between traded and non-traded goods. Once again, we would expect distance to have more of an effect on traded goods, since distance is thought to be one of

[44] For each of the 10 provinces, there are 9 pairs of distance and volatility, corresponding to the 9 other provinces. This gives 90 observations, but in so doing counts every observation twice. There are 45 unique observations for each of the 70 regressions.

the major causes of price discrepancies between locations for traded goods. If non-traded goods are truly not traded, then distance between trading partners should have no bearing on LOP deviations. This may be further evidence that tradability of goods is not in fact a major influence on deviations. All in all, however, these results seem to indicate that distance between Canadian provinces, like distance between US cities, is an important factor in determining the extent to which the law-of-one-price holds.

A logical corollary of this analysis is to explore the question of whether there is some point beyond which the effect of distance is lessened. In similar fashion to Engel and Rogers (1996), we have chosen to treat all distances beyond 2215 kilometres equal. This seemingly arbitrary choice was made because this is the distance by road between Vancouver on the west coast and Winnipeg, the major centre closest to the geographic centre of Canada. In actuality, looking at the distances in Table 3, we see that Vancouver to Winnipeg is about one-third of the way across the country. Winnipeg to Montreal (2202 km) and Montreal to St. John's (2454) are also approximately equal to that one-third distance.

The idea here is that, if firms in British Columbia were willing to ship product as far east as Winnipeg, then perhaps the additional cost of shipping to Central or Atlantic Canada would be negligible. Other provinces, too, may be willing to ship goods further if they would go so far as 2215 kilometres. The choice of an actual distance is less important then the idea that there is some point past which additional distance does not matter. If this rather innocuous hypothesis – which, for lack of a better name, we will call the Winnipeg Effect – is indeed true, then we should see coefficients of similar magnitudes in this model as in the previous.

To explore the Winnipeg Effect, the earlier regressions were duplicated, with all distances above 2215km being treated as equal. The results from this model are presented in Table 4b, along with an additional column measuring the difference in coefficients from one model (Table 4a) to the other. Remembering that increased distance is supposed to contribute to increased volatility and deviations, we see that this model actually has 2 fewer positive coefficients, but does find 9 fewer coefficients to be significant at the 5% level. The final column in Table 4b shows that in many cases the coefficients did not change a great deal. On average, coefficients in the Winnipeg Effect model were larger by 1.78 – with 30 coefficients increasing and 40 decreasing – which is hardly significant when we recall that all coefficients were multiplied by 10^4. Standard errors, however, were also increased by average of 2.53 (with these measures again being multiplied by 10^4), while average adjusted R^2 decreased by about 0.02.

Overall, there are mixed results for the Winnipeg Effect hypothesis. It did not seem to change much at all in terms of the size of coefficients, standard errors, or overall fit of the model as indicated by the adjusted R^2. However, it appears that for some goods, distance is a less significant contributor to deviations when the longer distances are factored out. Nonetheless, this does give some evidence toward the fact that, past some distance – that is not necessarily 2215 kilometres – the effect of additional distance of law-of-one-price deviations is negligible. This was the same conclusion that Engel and Rogers (1996) came to with their arbitrary boundary of 1700 miles.[45]

As expected in a country the size of Canada, the distance between two points is significant in determining the extent to which they are able to 'trade away' price

[45] Charles Engel and John H. Rogers (1996), p. 243.

differentials. Appendix A shows that these results are robust to alternate measures of distance.

6. The Effect of Trade Agreements

A global trend throughout the 1980s and 1990s was a move toward trade liberalization. This includes bilateral trade agreements between nations, moves toward multilateral tariff reduction through mechanisms such as the GATT and WTO, and regional trade agreements or trading blocs such as the EU, NAFTA, or Mercosur. This study analyses prices within Canada, a country that has certainly followed this trend of trade liberalization, and also a country that relies extremely heavily on trade with the United States. It is therefore an interesting pursuit to ascertain what, if any, effect this trade liberalization has had upon this study's measures of deviations from the law of one price.

This will be done by looking at the differences in LOP deviations under Canada's various trade agreements. Specifically, we will replicate the earlier analyses of this thesis as Canada moved from essentially no major trade agreements to the Canada-United States Free Trade Agreement of 1988 (CUSFTA), and subsequently into the North American Free Trade Agreement of 1993 (NAFTA).

Interestingly enough, there seem to be two contradictory, yet equally plausible scenarios at work here. In the first case, the creation of a larger, continental market for goods could cause greater price equalization across the three countries involved – Canada, the US, and Mexico. If convergence toward the law-of-one-price occurred across North America, then our Canadian provincial price data should show a lessening of law-of-one-price deviations as prices equalize under the new trade agreements. Conversely, it is easy to imagine that free trade – a "thinner" border in McCallum's terms – between Canada and the US in particular would allow provinces to substitute east-west trade for north-south trade with US states. It is possible that – in the absence of artificial barriers to trade – more convenient and cost-effective trade routes exist between provinces and states than between pairs of provinces. If trade volumes between provinces did in fact decrease, then this would, at least theoretically, result in an increase in LOP deviations between provinces.

In order to explore this question, the original data set was segmented into three parts. The first time period, the one without any major trade agreements, stems from the beginning of the sample period until the implementation of the CUSFTA (December 1984 to December 1988). The second period spans the life of the CUSFTA (January 1989 to December 1993), while the third begins with NAFTA and ends as the sample period ends (January 1994 to December 1997).

The analysis replicates the earlier exploration of law-of-one-price deviations from Chapter 4. Table 5a reports the average LOP deviations by good for the three time periods in question, using first-difference log-prices. These are the denominators from the original r_{jk} calculations in Chapter 4, calculated over the three time periods. Since we are using first-difference pricing, there is a 'transition' month between each time period. That is, the last entry of the 'Before CUSFTA' group is the difference between November and December 1988, prices. The first entry of the 'CUSFTA' period, then, is the difference between December 1988, and January 1989, when the CUSFTA actually came into effect. The sample size of these three periods is 48, 48, and 59 months, respectively.

As before, the same analysis was undertaken using 24^{th}-difference pricing. These results are presented in Table 5b. This method, however, creates larger 'transition' periods, since entries are calculated using prices 24 months apart. For example, prices from December 1986 are matched up with prices from December 1988. In this case, both months are contained within the 'Before CUSFTA' period, but this is the last entry for which that is the case. The next 24^{th}-difference price compares January 1987 to January 1989, which straddles the first and second time periods. For that reason, this will be the first entry in a new period entitled 'Transition Period 1'. The same logic is applied to fit the data into the following time periods: 'CUSFTA', 'Transistion Period 2', and 'NAFTA'. It is perhaps simplest to view each of the three original time periods as containing only price information *wholly contained* in that time period. All entries that straddle two time periods are included in the appropriate 'transition period'. The five time periods have sample sizes of 25, 24, 17, 24, and 32 entries respectively.

For both the 1^{st}-difference and the 24^{th}-difference pricing, the most noteworthy of the results is once again the difference in the size of the deviations for traded goods as opposed to the non-traded goods or the overall average. In the 3 cases shown in Table 5a, and 4 of the 5 in Table 5b, the deviations for traded goods are substantially higher than those of the non-traded goods. In the only other case, 'Transition Period 1' in Table 5b, the two are almost exactly equal. This is the same result that was found in Chapter 4, when dealing with the entire sample. Once again, this is against the prevailing theory, as trading presents arbitrage opportunities, which are theoretically supposed to drive prices together.

When looking at the individual goods, we see once again that the same 5 goods have the lowest overall deviations in every time period, as well as in the full sample average. These goods are: 'Rented Accommodations', 'Purchase of Automobiles', 'Owned Accommodation', 'Food Purchased from Restaurants', and 'Recreation'. Three of these five goods are classified as non-traded, while the broad category of 'Recreation' as well as 'Purchase of Automobiles' would not be very highly traded. This is another example of the prevailing theory being contradicted by the empirical results.

Meanwhile, the goods with the highest LOP deviations all fall into the food and beverage category. 'Fresh & Frozen Poultry', 'Fresh Fruit', 'Fresh Vegetables', 'Fresh & Frozen Pork', and 'Non-Alcoholic Beverages' all exhibit high deviations. While all these goods are classified as traded, it is difficult to imagine a thriving trade in British Columbia Peaches for New Brunswick Blueberries, for example. This gives slightly greater credence to the theory that, in the absence of trading opportunities, prices will never fully equalize across locations.

The results concerning traded and non-traded goods match quite closely with Engel and Rogers (2001). They found that the ten goods which deviated the most from the LOP were all traded goods, while only two of the ten which exhibited the lowest deviations were non-traded. The results here contradict the theory, but are not without precedent.

Another result here is that we once again we see that the deviations under 24th-difference pricing are much higher than under 1st-difference, although not as much as under the full sample. It seems yet again that the longer time-horizon, which should allow for more complete price convergence, actually increases deviations. In Chapter 4, it was postulated that nominal price volatility, rather than price-stickiness, could in fact be responsible for these deviations.

This leads to the central question of this chapter: Do trade agreements inhibit or propagate LOP deviations? The empirical results show that, on average and in the particular case of traded goods, deviations do increase in each successive time period. The average deviations under 1st-difference pricing increased 8.9 percent from the first period to the last, while when using the 24th-difference measure, that number was 16 percent. For traded goods in particular, deviations rose by 16 and 26 percent, respectively. For non-traded goods, however, deviations decrease in general, by 21 percent under 1st-differences and 11 percent under 24th-differences. The only exception to these general results is the CUSFTA time period in the 24th-difference analysis, which showed by far the lowest level of deviations in all cases.

The case of the CUSFTA is perplexing. The 24th-difference analysis seems to be better suited to pick up the true effect of each trade agreement, as it allows for an adjustment period surrounding each one's implementation. The numbers would indicate, then, that deviations drop significantly with the CUSFTA, then increase even more so with NAFTA (except in the case of non-traded goods). It is not likely that the added inclusion of Mexico into the trading bloc would cause such a substantive difference in the deviations. Of course, NAFTA is much more than CUSFTA extended to include Mexico. It would seem that, all else equal, either the specific nature of the NAFTA agreement contributed to increased deviations within Canada, or the trade agreements had nothing at all to do with any changes in the LOP deviations.

This thesis has shown that there are law-of-one-price deviations between Canadian provinces, and these deviations certainly do persist even as Canada liberalizes trade and enters into larger regional trade agreements. So, do trade agreements increase or decrease these deviations? If there is a general rule-of-thumb that emanates from this analysis, it is that trade agreements increase law-of-one-price deviations substantially for traded goods, while to a lesser extent decrease those deviations in non-traded goods.

While this is true on average, only 13 of the 51 traded goods and 6 of the 19 non-traded goods truly exhibit this pattern. Nevertheless, it would seem to be consistent with the second hypothesis put forth at the beginning of this chapter. That is, that the "thinner" border would cause substitution away from east-west or province-to-province trade and toward north-south or province-to-state trade.

Of course, it is still possible that trade agreements have in fact nothing to do with LOP deviations in Canada. Recall that Engel and Rogers (2000) found a 20 percent reduction in the border effect between Canada and the United States when studying similar time periods. However, they saw corresponding reductions in the distance effect, and concluded that the catalyst was a general increase in efficiency rather than the trade agreements themselves. Further study into the impact of trade agreements on prices and trade patterns within Canada would be worthwhile.

7. Comparing to Other Canadian Results

The recent study by Ceglowski (2003) was similar to this one in that it explored root causes of LOP deviations between Canadian cities. The approach and method of the two studies do differ, but it is worthwhile to compare methodology and results between the two.

First of all, Ceglowski's measure of relative prices is $rp_{ijkt} = \ln(p_{ikt} / p_{jkt})$, which allowed her to present results as a percentage deviation from parity. She found that the average deviation was 12 percent, with a good deal of variability over all the goods. Our results are more raw and perhaps less intuitive, as they give actual numerical deviations. The average actual deviation from was 0.025 – reported in the tables as 2.50 – with less variance about that mean.

Ceglowski then explored the persistence of the observed deviations, calculating half-lives to be under one year for most goods, while this thesis explored the issues of tradability of goods and price stickiness versus price volatility as root causes of LOP deviations.

Where the two studies do intersect is on the issue of distance as a determining factor for LOP deviations. Ceglowski's first investigation measured the effect of the distance between each city and Toronto, finding a positive relationship with deviations for 30 of her 45 goods (67%), with about half of those being significant (33% overall). This study found a positive effect for 57 of 70 goods (81%), with 38 of those being significant (54%). Overall, these results seem to indicate that distance was a greater contributing factor in establishing deviations.

Insofar as the magnitude of the distance effect, it is difficult to compare the two sets of results, owing to different measures of both distance and of deviations. The average size of coefficient in Ceglowski's study was 0.024, meaning that, all else equal, a city one mile farther away from Toronto would have LOP deviations 0.024 percent larger. The corresponding number for this study was 0.0016, which indicates that if the largest cities in two provinces were one *kilometre* farther apart, the actual numerical price deviation between those two provinces would be that much higher. Again, these results are difficult to compare, but indicate in both cases that distance is likely the largest single explanation of observed deviations.

The two studies differ in how they proceeded with the exploration of distance. This study tested the Winnipeg Effect hypothesis, and considered alternative measures of distance (see Appendix A), while Ceglowski calculated an interprovincial border effect.

The set-up of the Ceglowski study – by using several cities in each province – allowed for the calculation of a border effect between provinces. A simple dummy variable that 'switches on' when prices between cities outside of the same province are being compared will capture this information. For our study, every comparison of prices is an interprovincial comparison, thus not allowing a similar endeavour.

It would be possible to measure the effect of 'regional borders' within Canada. That is, to determine whether prices the West, the Prairies, Central Canada, and Atlantic Canada differ more than can be explained by their geographic distance apart. However, if this did give border effects similar to those found by Ceglowski and others, it would do so by a rather artificial and arbitrary method. Given the importance of politics between regions in Canada, however, further research into 'regional borders' may be warranted.

8. Conclusions

This study has explored deviations from the law-of-one-price between the provinces of Canada. It has been shown that these deviations are not as prevalent in Canada as can be observed between countries, but are still present. Further investigations seemed to indicate that basic theoretical reasons for the law-of-one-price to break down – such as tradability of goods and short-run price stickiness – do not seem to cause these deviations. Indeed, deviations seem to be less for non-traded goods than for those that are traded, while they tend to increase rather than decrease as a longer time horizon is studied. Evidence does suggest a link between the deviations and simple price volatility, however the most concrete causal relationship that was uncovered was that distance matters in establishing law-of-one-price discrepancies. Not surprisingly for a country the size of Canada, it was shown that the price deviations increase as the provinces in question become farther apart.

The study also examined the effect of the Canada-US Free Trade Agreement and of the North American Free Trade Agreement on law-of-one-price deviations in Canada. The results of that effort were not completely clear, but seemed to indicate, on average, that the trade agreements caused increased price discrepancies within Canada. It is possible that this is due to north-south trade replacing east-west trade as barriers are eliminated. Further research on the impact of trade agreements is warranted.

In general, it is unsurprising that the economic, cultural, and geographic diversity of Canada would lead to some sort of market segmentation as is indicated by the failure of the law-of-one-price within our borders. Hopefully this study provided some level of insight into the precise reasons behind this failure.

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Table 1
Ratio of Intra-province Price Variability to Cross-Province Law-of-One-Price Deviations

Good	Std. Dev. Of 1st Difference*	Std. Dev. Of 24th Difference**
Fresh & Frozen Beef	0.98	1.26
Fresh & Frozen Pork	0.93	1.22
Fresh & Frozen Poultry	0.86	1.01
Fresh & Frozen Chicken	0.83	0.96
Processed Meat	1.39	1.94
Fish	1.19	1.88
Fresh Milk	1.61	1.58
Butter	1.20	1.27
Cheese	1.94	2.36
Eggs	0.88	1.12
Bakery Products	1.30	1.65
Other Cereal & Grain Products	1.23	1.37
Fresh Fruit	1.03	1.29
Preserved Fruit, Fruit Preparations	1.26	1.59
Vegetables, Vegetable Preparations	1.43	1.48
Fresh Vegetables	1.43	1.42
Preserved Vegetables, Vegetable Preparations	1.29	1.48
Sugar, Confectionary	0.91	1.47
Fats, Oils	1.19	1.73
Coffee, Tea	1.15	2.40
Non-Alcoholic Beverages	0.86	0.93
Food Purchased from Restaurants [N]	3.97	3.06
Rented Accommodations [N]	8.80	4.51
Owned Accommodation [N]	3.99	2.19
Replacement Costs [N]	2.74	1.16
Property Tax (incl. Special charges) [N]	2.29	1.41
Homeowner's Insurance [N]	1.92	1.11
Homeowners Maintenance and Repairs [N]	1.12	1.34
Water, Fuel, Electricity	1.48	1.62
Household Operations	3.11	2.66
Telephone	1.92	1.68
Child Care, Domestic Services [N]	2.33	1.57
Household Chemical Products	1.28	1.32
Paper, Plastic, Foil	1.57	1.75
Other Household Goods & Services	2.08	1.86
Furniture	1.17	1.49
Household Textiles	1.03	1.40
Household Equipment	1.86	2.85
Household Appliances	2.08	3.00
Kitchen Utensils, Tableware, Flatware	1.02	1.32
Women's Clothing	1.30	1.89
Men's Clothing	1.30	1.79
Children's Clothing	1.28	1.84
Footwear	1.26	1.76
Clothing Accessories, Jewelry	1.28	1.54

Table 1

Ratio of Intra-province Price Variability to Cross-Province Law-of-One-Price Deviations

Good	Std. Dev. Of 1st Difference*	Std. Dev. Of 24th Difference**
Clothing Material, Notions, Services	2.23	1.91
Purchase of Automobiles	5.03	5.54
Operation of Automobiles	1.43	1.59
Gasoline	1.03	1.48
Automobile Parts, Maintenance and Repairs [N]	2.10	1.92
Other Automobile Operating Expenses	2.35	2.40
Automobile Insurance Premiums [N]	1.23	1.03
Automobile Registration Fees [N]	0.66	0.75
Taxi and Other Local Commuter Transit [N]	0.68	1.27
Inter-City Transit [N]	2.86	3.76
Prescribed Medicines [N]	2.22	1.01
Non-Prescribed Medicines	1.30	1.59
Health Care Services [N]	3.01	2.28
Personal Care Supplies and Equipment	1.73	2.08
Personal Care Services [N]	2.44	1.99
Recreation	3.52	4.21
Education [N]	2.45	1.34
Tuition [N]	2.05	2.76
Reading Materials and Other Print Matter	2.05	1.92
Served Alcohol [N]	2.39	1.92
Alcohol Bought in Stores	2.24	2.12
Beer	1.70	1.72
Wine	1.59	1.40
Liquor	1.75	2.12
Cigarettes	1.29	1.62
70-Good Average	**1.83**	**1.85**
Non-traded Goods Average (19 goods)	**2.59**	**1.91**
Traded Goods Average (51 goods)	**1.55**	**1.82**

Notes:

* Average r_{jk} values for each good across provinces, using 1^{st} difference log-prices. This measures relative price volatility of goods within each province to that of each good across provinces.

** As above, but using 24^{th} difference log-prices.

[N] indicates that this good is Non-Traded. All other goods are assumed to be Traded.

Table 2

Average Law-of-One-Price Deviations by Good

Good	1st Differences	24th Differences
Fresh & Frozen Beef	4.11	7.97
Fresh & Frozen Pork	5.90	10.50
Fresh & Frozen Poultry	6.23	11.61
Fresh & Frozen Chicken	7.63	13.98
Processed Meat	2.18	4.70
Fish	1.68	4.88
Fresh Milk	1.71	4.82
Butter	2.54	6.46
Cheese	1.27	3.07
Eggs	4.46	9.72
Bakery Products	2.29	4.46
Other Cereal & Grain Products	2.43	6.24
Fresh Fruit	6.32	10.38
Preserved Fruit, Fruit Preparations	2.36	5.69
Vegetables, Vegetable Preparations	5.17	8.52
Fresh Vegetables	7.43	11.51
Preserved Vegetables, Vegetable Preparations	2.30	5.60
Sugar, Confectionary	4.73	9.87
Fats, Oils	2.53	6.23
Coffee, Tea	3.26	8.13
Non-Alcoholic Beverages	8.24	14.02
Food Purchased from Restaurants [N]	0.59	2.27
Rented Accommodations [N]	0.26	1.54
Owned Accommodation [N]	0.57	3.39
Replacement Costs [N]	0.88	7.58
Property Tax (incl. Special charges) [N]	1.29	5.79
Homeowner's Insurance [N]	1.33	8.12
Homeowners Maintenance and Repairs [N]	3.05	6.08
Water, Fuel, Electricity	1.91	6.15
Household Operations	0.73	2.55
Telephone	1.35	5.81
Child Care, Domestic Services [N]	1.05	4.94
Household Chemical Products	2.22	6.32
Paper, Plastic, Foil	1.68	5.48
Other Household Goods & Services	1.20	3.90
Furniture	2.68	4.89
Household Textiles	3.33	5.51
Household Equipment	1.39	2.45
Household Appliances	1.17	2.27
Kitchen Utensils, Tableware, Flatware	3.53	6.70
Women's Clothing	2.47	3.79
Men's Clothing	2.38	4.05
Children's Clothing	2.50	4.17
Footwear	2.60	4.21
Clothing Accessories, Jewelry	2.35	4.92

Table 2

Average Law-of-One-Price Deviations by Good

Good	1st Differences	24th Differences
Clothing Material, Notions, Services	1.11	3.68
Purchase of Automobiles	0.56	1.58
Operation of Automobiles	2.02	5.60
Gasoline	4.03	8.70
Automobile Parts, Maintenance and Repairs [N]	1.33	4.22
Other Automobile Operating Expenses	1.33	4.22
Automobile Insurance Premiums [N]	2.38	9.23
Automobile Registration Fees [N]	5.90	18.87
Taxi and Other Local Commuter Transit [N]	4.26	7.08
Inter-City Transit [N]	2.16	4.38
Prescribed Medicines [N]	1.82	11.07
Non-Prescribed Medicines	2.16	5.80
Health Care Services [N]	0.85	3.16
Personal Care Supplies and Equipment	1.48	3.44
Personal Care Services [N]	1.00	3.68
Recreation	0.68	1.58
Education [N]	1.31	6.68
Tuition [N]	1.92	3.86
Reading Materials and Other Print Matter	1.24	3.86
Served Alcohol [N]	1.03	3.93
Alcohol Bought in Stores	1.08	3.51
Beer	1.50	4.55
Wine	1.67	6.32
Liquor	1.47	3.52
Cigarettes	3.55	14.83
70-Good Average	**2.50**	**6.12**
Non-traded Goods Average	**1.74**	**6.10**
Traded Goods Average	**2.79**	**6.13**

Notes:
Average LOP deviations are the average of the denominators from the r_{jk} calculations (x100). This is the average standard deviation of a good's relative price across provinces, using either 1st or 24th difference log-prices. If prices were perfectly equalized across provinces, these numbers would be zero.

Table 3
Distances Between the Largest Cities in Each Province in Canada (in Kilometres)

	Calgary	Vancouver	Winnipeg	Saint John	St. John's	Halifax	Toronto	Charlottetown	Montreal	Regina
Calgary (Alberta)	-	900	1315	4403	5974	4744	3276	4674	3529	751
Vancouver (British Columbia)	900	-	2215	5303	6874	5644	4397	5575	4923	1651
Winnipeg (Manitoba)	1315	2215	-	3076	4647	3417	1949	3347	2202	580
Saint John (New Brunswick)	4403	5303	3076	-	1615	385	1401	316	883	3668
St. John's (Newfoundland)	5974	6874	4647	1615	-	1406	2972	1363	2454	5239
Halifax (Nova Scotia)	4744	5644	3417	385	1406	-	1742	231	1224	4009
Toronto (Ontario)	3276	4397	1949	1401	2972	1742	-	1673	542	2541
Charlottetown (Prince Edward Island)	4674	5575	3347	316	1363	231	1673	-	1155	3940
Montreal (Quebec)	3529	4923	2202	883	2454	1224	542	1155	-	2794
Regina (Saskatchewan)	751	1651	580	3668	5239	4009	2541	3940	2794	-

The source for these distances is the "Driving Distances" section on on http://www.mapquest.ca

Table 4a

Effects of Distance Between Provinces on Law-of-One-Price Deviations

Good	Log-Distance	Standard Error	Adj. R^2
Fresh & Frozen Beef	40.65 *	10.37	0.2461
Fresh & Frozen Pork	22.58	13.08	0.0431
Fresh & Frozen Poultry	32.04 *	12.56	0.1113
Fresh & Frozen Chicken	35.98 *	17.47	0.0686
Processed Meat	7.17	4.70	0.0294
Fish	3.17	3.76	-0.0066
Fresh Milk	8.95	9.83	-0.0039
Butter	20.80	11.56	0.0484
Cheese	3.00	2.86	0.0022
Eggs	3.00	2.86	0.0022
Bakery Products	9.94 *	4.76	0.0710
Other Cereal & Grain Products	19.60 *	3.99	0.3451
Fresh Fruit	6.01 *	13.94	0.2856
Preserved Fruit, Fruit Preparations	21.10 *	4.46	0.2374
Vegetables, Vegetable Preparations	75.09 *	11.18	0.5004
Fresh Vegetables	106.38 *	15.77	0.5028
Preserved Vegetables, Vegetable Preparations	12.72 *	4.22	0.1553
Sugar, Confectionary	-8.89	14.52	-0.0144
Fats, Oils	0.97	6.45	-0.0227
Coffee, Tea	6.08	7.67	-0.0085
Non-Alcoholic Beverages	40.16 *	19.87	0.0665
Food Purchased from Restaurants [N]	0.68	2.49	-0.0215
Rented Accommodations [N]	-1.20	1.69	-0.0115
Owned Accommodation [N]	0.51	1.37	-0.0199
Replacement Costs [N]	8.17 *	3.44	0.0952
Property Tax (incl. Special charges) [N]	-0.33	6.90	-0.0232
Homeowner's Insurance [N]	10.87	6.29	0.0432
Homeowners Maintenance and Repairs [N]	-9.96	6.91	0.0239
Water, Fuel, Electricity	14.37 *	5.68	0.1097
Household Operations	2.74 *	1.22	0.0851
Telephone	6.43	4.14	0.0310
Child Care, Domestic Services	8.91 *	4.31	0.0694
Household Chemical Products	5.03	6.99	-0.0111
Paper, Plastic, Foil	5.08	4.37	0.0790
Other Household Goods & Services	5.18	3.51	0.0260
Furniture	-4.65	10.11	-0.0183
Household Textiles	-5.09	8.06	-0.0139
Household Equipment	16.57	10.32	0.3460
Household Appliances	-4.71	0.54	0.0171
Kitchen Utensils, Tableware, Flatware	-9.43	9.00	0.0022
Women's Clothing	-3.68	10.42	-0.0203
Men's Clothing	-7.18	10.08	-0.0113
Children's Clothing	-3.29	7.49	-0.0187
Footwear	-2.53	7.77	-0.0207
Clothing Accessories, Jewelry	7.70	5.75	0.0178

Table 4a

Effects of Distance Between Provinces on Law-of-One-Price Deviations

Good	Log-Distance	Standard Error	Adj. R^2
Clothing Material, Notions, Services	10.12	5.23	0.0586
Purchase of Automobiles	5.58 *	2.61	0.0747
Operation of Automobiles	28.52 *	7.04	0.2591
Gasoline	54.07 *	19.37	0.1337
Automobile Parts, Maintenance and Repairs [N]	54.07 *	19.37	0.1337
Other Automobile Operating Expenses	37.02	19.09	0.0590
Automobile Insurance Premiums [N]	23.03	11.62	0.0624
Automobile Registration Fees [N]	-0.36	13.15	-0.0232
Taxi and Other Local Commuter Transit [N]	-5.72	9.80	-0.0152
Inter-City Transit [N]	68.42 *	32.32	0.0733
Prescribed Medicines [N]	29.28	55.61	-0.0167
Non-Prescribed Medicines	-8.59	5.68	0.0284
Health Care Services [N]	7.58	6.27	0.0104
Personal Care Supplies and Equipment	-3.08	3.83	-0.0081
Personal Care Services [N]	4.96	2.69	0.0518
Recreation	9.52 *	1.72	0.4015
Education [N]	4.30	12.23	-0.0203
Tuition [N]	8.56	21.40	-0.0195
Reading Materials and Other Print Matter	15.46 *	6.93	0.0829
Served Alcohol [N]	-2.73	3.20	-0.0062
Alcohol Bought in Stores	4.03	3.30	0.0112
Beer	0.51	3.00	-0.0226
Wine	4.55	4.47	0.0008
Liquor	10.28 *	4.73	0.0782
Cigarettes	-1.75	18.94	-0.0231
70-Good Average	**12.35**		
Non-traded Goods Average (19 goods)	**11.00**		
Traded Goods Average (51 goods)	**12.85**		
Number of Positive Coefficients	**54**		
Number of Significant Coefficients	**23**		

Notes:

This table reports the results of 70 separate regressions, one for each good. In each case, the independent variable is the log-distance between provinces, while the dependent variable is the average price volatility between provinces for that good. There are 45 observations for each regression.

The log-distance coefficients and standard errors have been multiplied by 10^4.

The distance between provinces is estimated as the distance by road between each of the cities of: Vancouver, Calgary, Regina, Winnipeg, Toronto, Montreal, Saint John, Halifax, Charlottetown, and St. John's. Source: http://www.mapquest.ca

* The log-distance variable was significant at the 5% level in this regression.

Table 4b

How Much Distance is Too Much Distance?

Good	Log-Distance	Standard Error	Adj. R^2	Diff. In Coeff.
Fresh & Frozen Beef	49.89 *	13.29	0.2294	9.24
Fresh & Frozen Pork	20.71	16.84	0.0115	-1.87
Fresh & Frozen Poultry	31.06	16.40	0.0555	-0.98
Fresh & Frozen Chicken	29.59	22.76	0.0154	-6.39
Processed Meat	10.66	5.89	0.0491	3.49
Fish	5.36	4.74	0.0064	2.19
Fresh Milk	14.97	12.36	0.0105	6.01
Butter	20.78	14.86	0.0213	-0.02
Cheese	2.77	3.64	-0.0097	-0.23
Eggs	2.77	3.64	-0.0097	-0.23
Bakery Products	8.80	6.18	0.0228	-1.14
Other Cereal & Grain Products	20.10 *	5.52	0.218	0.50
Fresh Fruit	68.77 *	18.36	0.2285	62.76
Preserved Fruit, Fruit Preparations	22.59 *	6.05	0.2271	1.49
Vegetables, Vegetable Preparations	86.07 *	15.46	0.4053	10.99
Fresh Vegetables	120.90 *	21.95	0.4	14.52
Preserved Vegetables, Vegetable Preparations	12.91 *	5.55	0.0912	0.19
Sugar, Confectionary	-17.92	18.27	-0.0009	-9.03
Fats, Oils	3.42	8.15	-0.0191	2.46
Coffee, Tea	4.98	9.75	-0.0171	-1.10
Non-Alcoholic Beverages	54.52 *	25.00	0.0787	14.36
Food Purchased from Restaurants [N]	-0.08	3.15	-0.0232	-0.76
Rented Accommodations [N]	-1.51	2.14	-0.0116	-0.31
Owned Accommodation [N]	-0.11	1.73	-0.0232	-0.62
Replacement Costs [N]	9.29 *	4.42	0.0722	1.12
Property Tax (incl. Special charges) [N]	-1.11	8.74	-0.0229	-0.78
Homeowner's Insurance [N]	12.96	8.00	0.0355	2.09
Homeowners Maintenance and Repairs [N]	-15.24	8.66	0.0455	-5.28
Water, Fuel, Electricity	12.21	7.49	0.0363	-2.16
Household Operations	2.74	1.57	0.0441	0.00
Telephone	8.22	5.24	0.0321	1.80
Child Care, Domestic Services	7.22	5.61	0.0146	-1.69
Household Chemical Products	7.52	8.84	-0.0063	2.49
Paper, Plastic, Foil	1.63	5.62	-0.0213	-3.45
Other Household Goods & Services	2.76	4.54	-0.0145	-2.41
Furniture	-7.15	12.80	-0.0159	-2.50
Household Textiles	-8.98	10.17	-0.005	-3.89
Household Equipment	11.14	13.36	-0.007	-5.43
Household Appliances	-5.94	4.49	0.0168	-1.23
Kitchen Utensils, Tableware, Flatware	-11.67	11.41	0.001	-2.25
Women's Clothing	-12.03	13.10	-0.0036	-8.35
Men's Clothing	-16.03	.12.609	0.0138	-8.84
Children's Clothing	-8.25	9.43	-0.0054	-4.96
Footwear	-10.11	9.74	0.0017	-7.58
Clothing Accessories, Jewelry	8.85	7.31	0.0105	1.15

Table 4b

How Much Distance is Too Much Distance?

Good	Log-Distance	Standard Error	Adj. R^2	Diff. In Coeff.
Clothing Material, Notions, Services	8.22	6.80	0.0104	-1.90
Purchase of Automobiles	4.61	3.41	0.0185	-0.97
Operation of Automobiles	37.65 *	8.78	0.2833	9.13
Gasoline	79.83 *	23.74	0.1898	25.76
Automobile Parts, Maintenance and Repairs [N]	79.83 *	23.74	0.1898	25.76
Other Automobile Operating Expenses	29.43	24.82	0.0091	-7.59
Automobile Insurance Premiums [N]	31.71 *	14.60	0.0779	8.68
Automobile Registration Fees [N]	5.70	16.64	-0.0205	6.05
Taxi and Other Local Commuter Transit [N]	-13.91	12.29	-0.0064	-8.19
Inter-City Transit [N]	57.88	42.12	0.0198	-10.54
Prescribed Medicines [N]	43.47	70.04	-0.0143	14.19
Non-Prescribed Medicines	-11.67	7.17	0.0362	-3.09
Health Care Services [N]	3.31	8.07	-0.0193	-4.27
Personal Care Supplies and Equipment	-4.09	4.85	-0.0066	-1.01
Personal Care Services [N]	2.89	3.51	-0.0074	-2.08
Recreation	10.83 *	2.33	0.3196	1.32
Education [N]	9.45	15.45	-0.0144	5.15
Tuition [N]	18.76	27.02	-0.0119	10.20
Reading Materials and Other Print Matter	13.56	9.04	0.0276	-1.90
Served Alcohol [N]	-5.73	3.99	0.0236	-3.00
Alcohol Bought in Stores	4.00	4.20	-0.022	-0.03
Beer	1.14	3.80	-0.0211	0.63
Wine	6.32	5.65	0.0057	1.78
Liquor	9.01	6.16	0.0253	-1.27
Cigarettes	6.82	23.98	-0.0213	8.57
70-Good Average	**14.13**		**Average Difference in Coefficients**	**1.78**
Non-traded Goods Average (19 goods)	**12.88**			
Traded Goods Average (51 goods)	**14.59**			
Number of Positive Coefficients	**52**		**Number of Larger Coefficients**	**30**
Number of Significant Coefficients	**14**			

Notes:

This table reports the results of 70 separate regressions, one for each good. In each case, the independent variable is the log-distance between provinces, however any all distances above 2215 km (the distance by Road between Vancouver and Winnipeg) are taken as equal. The dependent variable is the average price volatility between provinces for that good. There are 45 observations for each regression.

The log-distance coefficients and standard errors have been multiplied by 10^4.

The distance between provinces is estimated as the distance by road between each of the cities of: Vancouver, Calgary, Regina, Winnipeg, Toronto, Montreal, Saint John, Halifax, Charlottetown, and St. John's. Source: http://www.mapquest.ca

The 4th column measures the Difference in Coefficients between the previous model, summarized in Table 4a, and this one. A positive number here means that the coefficient increased due to the specification of this model.

* The log-distance variable was significant at the 5% level in this regression.

Table 5a

LOP Deviations and Trade Agreements (1st Differences)

Good	Standard Deviation of 1st Difference*			
	Before CUSTA (1984-1988)**	Under CUSTA (1989-1993)**	Under NAFTA (1994-1997)**	Full-Sample Deviations (from Table 2)
Fresh & Frozen Beef	3.53	3.88	4.57	4.11
Fresh & Frozen Pork	4.86	6.02	6.37	5.90
Fresh & Frozen Poultry	5.86	5.50	6.82	6.23
Fresh & Frozen Chicken	7.20	6.58	8.42	7.63
Processed Meat	2.25	2.15	2.09	2.18
Fish	1.32	1.68	1.89	1.68
Fresh Milk	1.55	1.48	1.86	1.71
Butter	1.72	2.25	3.02	2.54
Cheese	1.06	1.19	1.47	1.27
Eggs	4.35	4.10	4.68	4.46
Bakery Products	1.88	2.02	2.71	2.29
Other Cereal & Grain Products	2.07	2.40	2.63	2.43
Fresh Fruit	6.06	6.83	5.96	6.32
Preserved Fruit, Fruit Preparations	1.84	2.39	2.65	2.36
Vegetables, Vegetable Preparations	4.60	5.44	5.32	5.17
Fresh Vegetables	7.02	7.89	7.31	7.43
Preserved Vegetables, Vegetable Preparations	1.67	1.98	2.86	2.30
Sugar, Confectionary	4.82	4.45	4.66	4.73
Fats, Oils	2.31	2.33	2.75	2.53
Coffee, Tea	2.96	2.77	3.75	3.26
Non-Alcoholic Beverages	8.24	9.41	6.77	8.24
Food Purchased from Restaurants [N]	0.51	0.58	0.55	0.59
Rented Accommodations [N]	0.36	0.23	0.12	0.26
Owned Accommodation [N]	0.54	0.66	0.47	0.57
Replacement Costs [N]	0.75	0.94	0.74	0.88
Property Tax (incl. Special charges) [N]	1.40	1.46	0.73	1.29
Homeowner's Insurance [N]	1.62	0.98	1.09	1.33
Homeowners Maintenance and Repairs [N]	2.55	3.61	2.86	3.05
Water, Fuel, Electricity	1.75	1.93	1.84	1.91
Household Operations	0.68	0.70	0.76	0.73
Telephone	1.25	1.28	1.30	1.35
Child Care, Domestic Services [N]	1.09	1.20	0.80	1.05
Household Chemical Products	1.69	1.96	2.67	2.22
Paper, Plastic, Foil	1.57	1.59	1.77	1.68
Other Household Goods & Services	1.14	1.12	1.26	1.20
Furniture	3.03	2.78	2.17	2.68
Household Textiles	2.72	3.59	3.50	3.33
Household Equipment	1.11	1.27	1.65	1.39
Household Appliances	1.02	1.24	1.20	1.17
Kitchen Utensils, Tableware, Flatware	2.98	3.19	4.06	3.53
Women's Clothing	1.63	2.28	3.06	2.47
Men's Clothing	1.78	2.24	2.82	2.38
Children's Clothing	1.40	2.06	3.32	2.50
Footwear	1.96	2.52	3.03	2.60
Clothing Accessories, Jewelry	2.07	2.42	2.43	2.35

Table 5a

LOP Deviations and Trade Agreements (1st Differences)

Good	Before CUSTA (1984-1988)**	Under CUSTA (1989-1993)**	Under NAFTA (1994-1997)**	Full-Sample Deviations (from Table 2)
	Standard Deviation of 1st Difference*			
Clothing Material, Notions, Services	0.95	1.11	1.18	1.11
Purchase of Automobiles	0.59	0.52	0.52	0.56
Operation of Automobiles	1.89	2.37	1.66	2.02
Gasoline	3.56	4.87	3.30	4.03
Automobile Parts, Maintenance and Repairs [N]	1.43	1.33	1.19	1.33
Other Automobile Operating Expenses	1.43	1.33	1.19	1.33
Automobile Insurance Premiums [N]	2.73	2.09	1.97	2.38
Automobile Registration Fees [N]	3.26	4.49	3.75	5.90
Taxi and Other Local Commuter Transit [N]	2.28	2.35	1.67	4.26
Inter-City Transit [N]	2.18	1.57	1.45	2.16
Prescribed Medicines [N]	4.31	1.01	0.89	1.82
Non-Prescribed Medicines	2.06	2.31	2.05	2.16
Health Care Services [N]	0.90	0.98	0.62	0.85
Personal Care Supplies and Equipment	1.27	1.68	1.44	1.48
Personal Care Services [N]	0.96	0.97	1.00	1.00
Recreation	0.68	0.64	0.70	0.68
Education [N]	0.70	1.62	1.16	1.31
Tuition [N]	1.02	2.49	1.50	1.92
Reading Materials and Other Print Matter	1.12	1.35	1.21	1.24
Served Alcohol [N]	1.14	0.88	0.97	1.03
Alcohol Bought in Stores	1.17	1.12	0.91	1.08
Beer	1.89	1.47	1.02	1.50
Wine	2.07	1.35	1.43	1.67
Liquor	1.22	1.45	1.60	1.47
Cigarettes	2.70	2.64	4.12	3.55
70-Good Average	**2.25**	**2.41**	**2.45**	**2.50**
Non-traded Goods Average (19 goods)	**1.56**	**1.55**	**1.24**	**1.74**
Traded Goods Average (51 goods)	**2.50**	**2.73**	**2.90**	**2.79**

Notes:

* As in Table 2a, this gives average LOP deviations for each good across provinces, using 1st difference log-prices.

** Deviations are given for three separate time periods: The period of the sample without any formal trade agreements (December 1984-December 1988); the timespan of the Canada-US Free Trade Agreement (CUSTA, January 1989-December 1993); and from the implementation of the North American Free Trade Agreement (NAFTA) until the end of the sample period (January 1994-December 1997). The final column gives the full-sample results from Table 2, for comparative purposes.

Table 5b

LOP Deviations and Trade Agreements (24th Differences)

Good	Standard Deviation of 24th Difference*					
	Before CUSTA**	Transition Period 1**	Under CUSTA**	Transition Period 2**	Under NAFTA**	Full-Sample Deviations (from Table 2)
Fresh & Frozen Beef	6.19	5.80	4.22	5.96	6.76	7.97
Fresh & Frozen Pork	8.98	8.21	7.41	9.76	8.71	10.50
Fresh & Frozen Poultry	9.04	7.74	6.03	7.98	11.75	11.61
Fresh & Frozen Chicken	11.03	9.33	7.20	9.48	14.85	13.98
Processed Meat	4.09	3.20	2.67	3.40	3.85	4.70
Fish	3.87	3.70	2.60	3.18	3.27	4.88
Fresh Milk	3.52	2.81	2.91	3.72	4.37	4.82
Butter	3.48	4.79	4.12	3.86	6.26	6.46
Cheese	2.05	1.54	1.92	2.08	2.87	3.07
Eggs	5.96	7.86	6.59	7.98	9.25	9.72
Bakery Products	3.04	2.97	3.10	3.79	4.00	4.46
Other Cereal & Grain Products	5.34	4.22	4.08	4.23	4.51	6.24
Fresh Fruit	8.45	9.22	8.39	8.00	9.55	10.38
Preserved Fruit, Fruit Preparations	3.67	3.53	3.24	4.01	5.41	5.69
Vegetables, Vegetable Preparations	6.12	5.96	5.84	7.25	8.34	8.52
Fresh Vegetables	8.82	8.24	8.14	10.05	11.11	11.51
Preserved Vegetables, Vegetable Preparations	4.18	3.74	2.68	3.61	5.06	5.60
Sugar, Confectionary	9.33	8.07	7.82	6.75	8.53	9.87
Fats, Oils	5.05	4.84	3.58	4.22	5.56	6.23
Coffee, Tea	5.52	4.78	3.74	5.54	8.22	8.13
Non-Alcoholic Beverages	10.95	12.92	12.70	11.06	10.57	14.02
Food Purchased from Restaurants [N]	1.26	1.00	1.26	1.53	1.89	2.27
Rented Accommodations [N]	0.79	1.04	0.57	0.57	0.40	1.54
Owned Accommodation [N]	1.67	1.78	1.45	1.63	1.56	3.39
Replacement Costs [N]	2.88	4.09	2.88	3.12	2.52	7.58
Property Tax (incl. Special charges) [N]	4.21	4.05	2.68	3.72	3.37	5.79
Homeowner's Insurance [N]	4.59	4.64	2.98	3.58	3.65	8.12
Homeowners Maintenance and Repairs [N]	3.42	5.03	4.48	5.35	5.11	6.08
Water, Fuel, Electricity	4.38	4.51	3.86	3.83	4.83	6.15
Household Operations	1.78	1.65	1.24	1.42	2.09	2.55
Telephone	3.43	4.02	2.59	2.67	4.03	5.81
Child Care, Domestic Services [N]	2.77	2.68	2.30	2.54	2.75	4.94
Household Chemical Products	4.24	3.22	3.29	4.12	5.94	6.32
Paper, Plastic, Foil	2.86	2.58	2.14	3.80	5.79	5.48
Other Household Goods & Services	2.62	2.24	2.00	2.41	3.10	3.90
Furniture	3.22	4.37	4.04	4.32	3.58	4.89
Household Textiles	3.38	3.86	3.96	5.05	5.20	5.51
Household Equipment	1.60	1.54	1.60	2.31	2.55	2.45
Household Appliances	1.67	1.59	1.82	1.99	2.30	2.27
Kitchen Utensils, Tableware, Flatware	4.22	5.09	4.88	5.43	6.82	6.70
Women's Clothing	2.05	1.82	2.30	3.03	3.98	3.79
Men's Clothing	2.14	2.39	3.08	3.53	4.26	4.05
Children's Clothing	1.66	1.75	2.86	3.22	4.61	4.17
Footwear	2.64	2.64	3.04	3.33	4.69	4.21
Clothing Accessories, Jewelry	2.84	4.02	3.01	3.35	4.33	4.92

Table 5b

LOP Deviations and Trade Agreements (24th Differences)

Good	Before CUSTA**	Transition Period 1**	Under CUSTA**	Transition Period 2**	Under NAFTA**	Full-Sample Deviations (from Table 2)
	Standard Deviation of 24th Difference*					
Clothing Material, Notions, Services	1.78	2.34	2.02	2.19	2.82	3.68
Purchase of Automobiles	1.29	0.99	0.92	1.23	1.29	1.58
Operation of Automobiles	4.41	3.92	4.01	4.92	3.19	5.60
Gasoline	6.20	7.38	7.55	8.54	5.90	8.70
Automobile Parts, Maintenance and Repairs [N]	3.70	3.26	3.06	2.67	2.76	4.22
Other Automobile Operating Expenses	3.70	3.26	3.06	2.67	2.76	4.22
Automobile Insurance Premiums [N]	9.91	7.32	3.57	6.03	4.69	9.23
Automobile Registration Fees [N]	9.94	9.75	9.81	15.03	13.88	18.87
Taxi and Other Local Commuter Transit [N]	5.59	4.77	5.97	4.57	5.57	7.08
Inter-City Transit [N]	4.86	4.67	2.15	2.38	2.85	4.38
Prescribed Medicines [N]	12.90	11.59	1.67	1.98	2.99	11.07
Non-Prescribed Medicines	3.40	3.87	3.64	3.88	3.48	5.80
Health Care Services [N]	2.12	2.16	1.79	1.70	1.78	3.16
Personal Care Supplies and Equipment	2.16	2.56	2.33	2.67	2.44	3.44
Personal Care Services [N]	2.36	2.05	1.68	2.60	2.77	3.68
Recreation	1.16	1.01	0.77	1.11	1.20	1.58
Education [N]	1.67	3.34	3.26	4.58	3.99	6.68
Tuition [N]	2.25	5.48	4.95	6.86	5.07	3.86
Reading Materials and Other Print Matter	1.85	2.13	1.99	2.76	3.42	3.86
Served Alcohol [N]	2.28	2.30	1.66	2.51	2.93	3.93
Alcohol Bought in Stores	2.15	2.42	1.58	2.48	2.74	3.51
Beer	2.80	3.27	2.67	3.27	3.48	4.55
Wine	5.37	4.80	2.39	2.89	4.50	6.32
Liquor	2.85	1.76	1.96	2.65	3.08	3.52
Cigarettes	6.64	6.30	5.64	11.74	15.76	14.83
70-Good Average	**4.26**	**4.25**	**3.62**	**4.37**	**4.96**	**6.12**
Non-traded Goods Average (19 goods)	**4.17**	**4.26**	**3.06**	**3.84**	**3.71**	**6.10**
Traded Goods Average (51 goods)	**4.30**	**4.25**	**3.83**	**4.56**	**5.43**	**6.13**

Notes:

* As in Table 2b, this gives average LOP deviations for each good across provinces, using 24th difference log-prices.

** Deviations are given for five separate time periods: The period of the sample without any formal trade agreements; the transition to the Canada-US Free Trade Agreement (CUSTA); the timespan of CUSTA; the transition period to the North American Free Trade Agreement (NAFTA); and from the implementation of NAFTA until the end of the sample period. The final column gives the results from Table 2, for comparative purposes.

Appendix A: Robustness Tests for Distance Measurements

One of the major endeavours of the paper was to explore the effect of the distance on law-of-one-price deviations. The distance calculations for that test were the actual driving distances available from www.mapquest.ca. This chapter will test the robustness of those results by presenting two alternative ways of measuring distance. The first will be the great-circle air distance between the largest cities in each province, available from www.indo.com/distance. The second measure will be the number of provincial borders that need to be crossed to facilitate trade between two provinces.

This test of distance uses the 'great-circle' air distance, again between the largest cities in each province. The distances themselves are listed in Table 6, while results from the replication of the earlier exercise are presented in Table 7. Comparing to the results that used road distance, we see 1 less positive coefficient (53), but 2 more significant coefficients (38), and once again none of the significant ones show a negative effect between distance and deviations. Secondly, we see that in this case there is a substantial difference between the size of the distance effect for traded and non-traded goods. In the earlier analysis, we saw that there was almost no difference in the effect of distance between the traded and non-traded categories. This result is more what we might expect to see, since distance between locations should have no bearing on a good that is not traded between those locations.

Finally, and most importantly, we see that there is very little difference in the size of the coefficients when moving from road distance to great-circle distance. On average, the coefficients were larger by 1.17, with nearly 50 of the 70 goods showing a difference in coefficients less than 5 (in absolute value). These results are extremely small given that all coefficients were multiplied by 10^4. Only 4 goods, 'Processed Meat', 'Fresh Fruit', 'Taxi and Other Local Commuter Transit', and 'Inter-City Transit' showed a substantial difference. In general, it seems that there was little difference in measuring distance by road or by great circle air distance.

The Winnipeg Effect was also tested using great-circle distance, and those results are shown in Table 8. In this case, the benchmark distance is 1869 kilometres, which is the air distance between Vancouver and Winnipeg. For reference, this is again approximately one-third of the way across the country, as Winnipeg to Montreal is 1825 and Montreal to St. John's is 1613 km. The results again show not a large difference in magnitude of coefficients from the just completed analysis using great-circle distance, shown in Table 6. There were the same number of positive coefficients (53), but 13 fewer significant ones (12), and adjusted R^2 values dropped slightly, from an average of .058 to an average of .035. Very similar results were obtained when testing the Winnipeg Effect using road distance. Again, the results are mixed. The size of the correlation and the fit of the model did not change much, but the number of significant coefficients did decrease. All in all, however, the great-circle model seems to fit approximately as well as did the road distance model.

We will now utilize a different method of testing distance. This time, we will find out whether the number of borders that must be crossed to facilitate trade between two provinces is a good indicator of the magnitude of law-of-one-price deviations. In essence, this model treats all provinces as being the same size, and simply counts the number of borders between them. This is very straightforward except for in the Atlantic provinces. The assumption that will be made here is that all goods into and out of Prince

Edward Island must cross the Confederation Bridge and go through New Brunswick. Similarly, we imagine that all shipments to and from Newfoundland must go through Nova Scotia, discounting the shared border between Quebec and Labrador, as it lies in a very unpopulated area. All other provinces line up nicely from east to west, making the counting of borders trivial.

The results are tabulated in Table 9, and are striking. First of all, there are 63 positive coefficients, 33 of which are significant. Both of these numbers are far and away greater than earlier measures of a distance effect. Again, none of the significant coefficients are negative. Furthermore, the distance effect for both traded and non-traded goods are somewhat lower than in the earlier models. In fact, the effect for non-traded goods is substantially lower at 3.28. Since this shows a low distance effect for non-traded goods, this result finally shows some correlation between the facts and the theory in the tradability of goods issue. For that reason above all others, this model appears to work the best.

Unfortunately, every other piece of information we have seen concerning traded versus non-traded goods is that they have no bearing on LOP deviations. In addition, the R^2 for this model was the highest – 0.091 as compared to 0.068 for road distance and 0.058 for great-circle distance. This indicates that this model perhaps does not fit the data as well as the other measures.

One final comment on the border-counting model is that this is the closest we come in this study to calculating an actual border effect. The nature of our data does not allow for the possibility of calculating a border effects in terms of amount of trade forgone as in McCallum (1995) and Helliwell (1996) or a distance-equivalent of the border as in Engel-Rogers (1996), Parsley-Wei (2001), or Ceglowski (2003). This is because there is no variable that can isolate the difference between *inter*provincial and *intra*provincial trade. Given the nature of our data, every trade is by definition an *inter*provincial trade, and no border effect can be factored out.

Our results do show, however, that, for the traded goods, the act of crossing a border increases deviations by 6.87 (remembering that all measures were multiplied by 10^4). This is a nicely intuitive result. For each additional border goods cross, deviations increase by that amount, all else being equal.

The three different methods of measuring distance produced slightly different results, but all point to the fact that distance is indeed one of the leading causes of law-of-one-price deviations.

Table 6

Distances Between the Largest Cities in Each Province in Canada (in Kilometres)

	Calgary	Vancouver	Winnipeg	Saint John	St. John's	Halifax	Toronto	Charlottetown	Montreal	Regina
Calgary (Alberta)	-	673	1208	3568	4375	3768	2719	3716	3029	678
Vancouver (British Columbia)	673	-	1869	4238	5046	4439	3366	4389	3694	1339
Winnipeg (Manitoba)	1208	1869	-	2379	3250	2581	1518	2544	1825	530
Saint John (New Brunswick)	3568	4238	2379	-	1039	202	1081	242	596	2903
St. John's (Newfoundland)	4375	5046	3250	1039	-	885	2112	802	1613	3745
Halifax (Nova Scotia)	3768	4439	2581	202	885	-	1266	178	792	3104
Toronto (Ontario)	2719	3366	1518	1081	2112	1266	-	1310	503	2041
Charlottetown (Prince Edward Island)	3716	4389	2544	242	802	178	1310	-	815	3061
Montreal (Quebec)	3029	3694	1825	596	1613	792	503	815	-	2355
Regina (Saskatchewan)	678	1339	530	2903	3745	3104	2041	3061	2355	-

The source for these distances is the "Great Circle Formula" on http://indo.com/distance.

Table 7

Effects of Distance Between Provinces on Law-of-One-Price Deviations

Good	Log-Distance	Standard Error	Adj. R^2	Diff. In Coeff.
Fresh & Frozen Beef	41.24 *	10.78	0.2366	0.59
Fresh & Frozen Pork	27.42 *	13.32	0.0684	4.84
Fresh & Frozen Poultry	32.58 *	13.00	0.1072	0.55
Fresh & Frozen Chicken	37.60 *	18.02	0.0708	1.62
Processed Meat	64.35	4.88	0.0165	57.18
Fish	3.92	3.87	0.0006	0.75
Fresh Milk	8.45	10.17	-0.0071	-0.50
Butter	18.00	12.08	0.0270	-2.80
Cheese	4.26	2.92	0.0250	1.26
Eggs	4.26	2.92	0.0250	1.26
Bakery Products	12.01 *	4.82	0.1058	2.07
Other Cereal & Grain Products	19.67 *	4.18	0.3244	0.07
Fresh Fruit	63.59 *	14.25	0.3007	57.58
Preserved Fruit, Fruit Preparations	21.27 *	4.66	0.3107	0.17
Vegetables, Vegetable Preparations	78.35 *	11.43	0.5112	3.27
Fresh Vegetables	112.01 *	15.95	0.5234	5.63
Preserved Vegetables, Vegetable Preparations	12.64 *	4.39	0.1419	-0.08
Sugar, Confectionary	-4.16	15.05	-0.0214	4.73
Fats, Oils	1.50	6.66	-0.0220	0.54
Coffee, Tea	7.13	7.90	-0.0042	1.05
Non-Alcoholic Beverages	35.68	20.78	0.0424	-4.48
Food Purchased from Restaurants [N]	0.55	2.57	-0.0222	-0.13
Rented Accommodations [N]	-0.92	1.75	-0.0167	0.28
Owned Accommodation [N]	0.98	1.41	-0.0118	0.47
Replacement Costs [N]	8.99 *	3.53	0.1110	0.82
Property Tax (incl. Special charges) [N]	0.25	7.13	-0.2320	0.57
Homeowner's Insurance [N]	12.54	6.44	0.0596	1.67
Homeowners Maintenance and Repairs [N]	-7.03	7.23	-0.0013	2.93
Water, Fuel, Electricity	13.83 *	5.93	0.0914	-0.54
Household Operations	3.00 *	1.25	0.0981	0.26
Telephone	6.06	4.30	0.0220	-0.37
Child Care, Domestic Services	9.47 *	4.43	0.0749	0.56
Household Chemical Products	4.59	7.23	-0.0138	-0.44
Paper, Plastic, Foil	6.88	4.47	0.0302	1.80
Other Household Goods & Services	6.12	3.60	0.0414	0.95
Furniture	-1.34	10.47	-0.0229	3.31
Household Textiles	-1.73	8.36	-0.0222	3.36
Household Equipment	17.79	10.64	0.0393	1.22
Household Appliances	-3.73	3.69	0.0005	0.98
Kitchen Utensils, Tableware, Flatware	-8.41	9.33	-0.0043	1.02
Women's Clothing	-1.30	10.78	-0.0229	2.38
Men's Clothing	-5.70	10.43	-0.0162	1.49
Children's Clothing	-2.26	7.75	-0.0212	1.04
Footwear	0.15	8.04	-0.0232	2.68
Clothing Accessories, Jewelry	7.53	5.95	0.0135	-0.17

Table 7

Effects of Distance Between Provinces on Law-of-One-Price Deviations

Good	Log-Distance	Standard Error	Adj. R^2	Diff. In Coeff.
Clothing Material, Notions, Services	11.28 *	5.36	0.0721	1.16
Purchase of Automobiles	5.79 *	2.70	0.0757	0.21
Operation of Automobiles	25.81 *	7.59	0.1936	-2.71
Gasoline	47.28 *	20.52	0.0893	-6.78
Automobile Parts, Maintenance and Repairs [N]	37.67 *	19.74	0.0566	-16.40
Other Automobile Operating Expenses	21.34 *	12.11	0.0457	-15.68
Automobile Insurance Premiums [N]	-0.26	13.58	-0.0232	-23.29
Automobile Registration Fees [N]	-4.28	10.14	-0.0190	-3.93
Taxi and Other Local Commuter Transit [N]	69.95 *	33.42	0.0714	75.67
Inter-City Transit [N]	17.12	57.56	-0.0212	-51.30
Prescribed Medicines [N]	-7.93	5.90	0.0180	-37.21
Non-Prescribed Medicines	8.61	6.46	0.0174	17.20
Health Care Services [N]	-2.92	3.96	-0.0105	-10.50
Personal Care Supplies and Equipment	5.28	2.77	0.0566	8.36
Personal Care Services [N]	10.17 *	1.73	0.4316	5.21
Recreation	3.55	12.64	-0.0214	-5.97
Education [N]	6.77	22.12	-0.0210	2.47
Tuition [N]	15.99 *	7.16	0.0832	7.43
Reading Materials and Other Print Matter	-2.14	3.31	-0.0134	-17.59
Served Alcohol [N]	3.47	3.42	0.0007	6.20
Alcohol Bought in Stores	-0.14	3.10	-0.0232	-4.17
Beer	3.34	4.64	-0.0111	2.83
Wine	9.92 *	4.92	0.0653	5.38
Liquor	-0.30	19.57	-0.0233	-10.58
Cigarettes	-7.37	14.94	-0.0086	-5.62
70-Good Average	**13.52**		**Average Difference in Coefficients**	**1.17**
Non-traded Goods Average (19 goods)	**8.98**			
Traded Goods Average (51 goods)	**15.21**			
Number of Positive Coefficients	**53**			
Number of Significant Coefficients	**25**			

Notes:

This table reports the results of 70 separate regressions, one for each good. In each case, the independent variable is the log-distance between provinces, while the dependent variable is the price volatility between provinces for that good. There are 45 observations for each regression.

The log-distance coefficients and standard errors have been multiplied by 10^4.

The last column shows the difference in the magnitude of the coefficients between this measure of distance on the previous (using road distance). A positive number here means that the coefficient increased under this measure of distance.

The distance between provinces is estimated as the distance between each of the cities of: Vancouver, Calgary, Regina, Winnipeg, Toronto, Montreal, Saint John, Halifax, Charlottetown, and St. John's. The distance calculations are based on the great circle formula available at http://www.indo.com/distance

* The log-distance variable was significant at the 5% level in this regression.

Table 8

How Much Distance is Too Much Distance?

Good	Log-Distance	Standard Error	Adj. R^2	Diff. In Coeff.
Fresh & Frozen Beef	49.53 *	15.62	0.1706	4.89
Fresh & Frozen Pork	28.13	18.94	0.0267	0.18
Fresh & Frozen Poultry	33.63	18.66	0.0486	-0.89
Fresh & Frozen Chicken	31.08	25.87	0.0100	-11.66
Processed Meat	11.72	6.69	0.0460	6.97
Fish	6.18	5.37	0.0074	3.32
Fresh Milk	14.63	14.07	0.0245	7.46
Butter	18.73	16.98	0.0049	-7.68
Cheese	4.00	4.11	-0.0013	-0.54
Eggs	4.00	4.11	-0.0013	-0.54
Bakery Products	12.02	6.93	0.0436	-1.46
Other Cereal & Grain Products	21.75 *	6.34	0.1967	-1.01
Fresh Fruit	75.31 *	21.03	0.2117	8.21
Preserved Fruit, Fruit Preparations	22.12 *	7.14	0.1636	-3.40
Vegetables, Vegetable Preparations	94.57 *	17.90	0.3794	18.94
Fresh Vegetables	130.31 *	25.71	0.3594	20.33
Preserved Vegetables, Vegetable Preparations	14.20 *	6.31	0.0846	-1.42
Sugar, Confectionary	-9.18	20.89	-0.0187	-5.75
Fats, Oils	0.74	9.26	-0.0231	-2.60
Coffee, Tea	6.38	11.05	-0.0154	-2.24
Non-Alcoholic Beverages	44.26	29.09	0.0290	-1.97
Food Purchased from Restaurants [N]	-0.61	3.57	-0.0226	-1.89
Rented Accommodations [N]	-0.84	2.44	-0.0204	0.96
Owned Accommodation [N]	0.25	1.97	-0.0229	-0.97
Replacement Costs [N]	10.09	5.03	0.0643	1.26
Property Tax (incl. Special charges) [N]	-3.18	9.90	-0.0208	-5.50
Homeowner's Insurance [N]	12.92	9.14	0.0222	2.06
Homeowners Maintenance and Repairs [N]	-13.31	9.96	-0.1750	-7.06
Water, Fuel, Electricity	10.67	8.60	0.0122	-7.05
Household Operations	2.52	1.81	0.0212	-1.11
Telephone	7.94	5.99	0.0169	0.78
Child Care, Domestic Services	8.61	6.35	0.0187	-1.76
Household Chemical Products	6.15	10.06	-0.0144	-2.10
Paper, Plastic, Foil	2.70	6.37	-0.0190	-5.10
Other Household Goods & Services	2.68	5.15	-0.0169	-4.77
Furniture	-10.47	14.47	-0.0110	-9.37
Household Textiles	-8.84	11.56	-0.0095	-7.42
Household Equipment	13.70	15.12	-0.0041	-5.83
Household Appliances	-6.71	5.09	0.0165	-3.08
Kitchen Utensils, Tableware, Flatware	-15.55	12.88	0.0103	-7.24
Women's Clothing	-12.88	14.86	-0.0067	-13.37
Men's Clothing	-16.97	14.33	0.0091	-14.50
Children's Clothing	-7.14	10.73	-0.0128	-6.42
Footwear	-0.95	11.09	-0.0060	-2.36
Clothing Accessories, Jewelry	8.88	8.32	0.0032	0.00

Table 8

How Much Distance is Too Much Distance?

Good	Log-Distance	Standard Error	Adj. R^2	Diff. In Coeff.
Clothing Material, Notions, Services	9.73	7.69	0.0134	-2.41
Purchase of Automobiles	5.01	3.87	0.0150	-1.38
Operation of Automobiles	37.39 *	10.43	0.2121	8.82
Gasoline	77.07 *	27.86	0.1313	25.01
Automobile Parts, Maintenance and Repairs [N]	77.07 *	27.86	0.1313	25.01
Other Automobile Operating Expenses	35.31	28.08	0.0130	-6.66
Automobile Insurance Premiums [N]	34.82 *	16.60	0.0717	11.88
Automobile Registration Fees [N]	3.29	18.88	-0.0225	7.82
Taxi and Other Local Commuter Transit [N]	-12.86	14.00	-0.0035	-11.81
Inter-City Transit [N]	71.09	47.56	0.0273	-3.73
Prescribed Medicines [N]	35.71	79.94	-0.0185	9.02
Non-Prescribed Medicines	-14.61	8.07	0.0493	-8.79
Health Care Services [N]	4.89	9.13	-0.0165	-5.38
Personal Care Supplies and Equipment	-5.26	5.49	-0.0019	-3.55
Personal Care Services [N]	2.70	3.99	-0.0125	-3.15
Recreation	11.56 *	2.71	0.2807	1.51
Education [N]	12.85	17.48	-0.0106	16.91
Tuition [N]	24.61	30.56	-0.0081	31.09
Reading Materials and Other Print Matter	15.95	10.23	0.0316	-1.37
Served Alcohol [N]	-6.59	4.52	0.0250	-5.10
Alcohol Bought in Stores	2.76	4.80	-0.0155	-1.94
Beer	0.06	4.31	-0.0233	-0.51
Wine	4.00	6.47	-0.0142	-0.35
Liquor	9.71	7.00	0.0206	-1.58
Cigarettes	20.09	27.03	-0.0103	27.47
70-Good Average	**15.14**		**Average Difference in Coefficients**	**0.49**
Non-traded Goods Average (19 goods)	**13.76**			
Traded Goods Average (51 goods)	**15.66**			
Number of Positive Coefficients	**53**			
Number of Significant Coefficients	**12**			

Notes:

This table reports the results of 70 separate regressions, one for each good. In each case, the independent variable is the log-distance between provinces, however any all distances above 1869km (the direct "great circle" distance between Vancouver and Winnipeg) are taken as equal. The dependent variable is the price volatility between provinces for that good. There are 45 observations for each regression.

The log-distance coefficients and standard errors have been multiplied by 10^4.

The distance between provinces is estimated as the distance between each of the cities of: Vancouver, Calgary, Regina, Winnipeg, Toronto, Montreal, Saint John, Halifax, Charlottetown, and St. John's. The distance calculations are based on the great circle formula available at http://www.indo.com/distance

The 4^{th} column measures the Difference in Coefficients between the previous model, summarized in Table 7 and this one. A positive number here means that the coefficient increased as a result of this model's specification.

* The log-distance variable was significant at the 5% level in this regression.

Table 9

Number of Borders Crossed and Law of One Price Deviations

Good	Borders	Standard Error	Adj. R^2
Fresh & Frozen Beef	16.52 *	5.15	0.1747
Fresh & Frozen Pork	16.83 *	5.88	0.1407
Fresh & Frozen Poultry	17.21 *	5.83	0.1495
Fresh & Frozen Chicken	24.32 *	7.85	0.1634
Processed Meat	0.84	2.28	-0.0201
Fish	1.01	1.79	-0.0158
Fresh Milk	0.88	4.70	-0.0224
Butter	9.76	5.49	0.0469
Cheese	2.93 *	1.30	0.0850
Eggs	2.93 *	1.30	0.0850
Bakery Products	7.18 *	2.10	0.1958
Other Cereal & Grain Products	9.70 *	1.84	0.3776
Fresh Fruit	29.77 *	6.48	0.3136
Preserved Fruit, Fruit Preparations	10.32 *	2.08	0.3493
Vegetables, Vegetable Preparations	34.29 *	5.50	0.4623
Fresh Vegetables	51.91 *	7.24	0.5339
Preserved Vegetables, Vegetable Preparations	6.76 *	1.95	0.2011
Sugar, Confectionary	5.71	6.86	-0.0070
Fats, Oils	1.71	3.05	-0.0158
Coffee, Tea	6.50	3.53	0.0518
Non-Alcoholic Beverages	16.52	9.53	0.0436
Food Purchased from Restaurants [N]	1.11	1.17	-0.0037
Rented Accommodations [N]	-0.31	0.80	-0.0198
Owned Accommodation [N]	1.06	0.63	0.0406
Replacement Costs [N]	4.46 *	1.60	0.1338
Property Tax (incl. Special charges) [N]	1.60	3.26	-0.0176
Homeowner's Insurance [N]	6.52 *	2.92	0.0831
Homeowners Maintenance and Repairs [N]	0.43	3.36	-0.0229
Water, Fuel, Electricity	10.80 *	2.37	0.3098
Household Operations	2.17 *	5.12	0.2778
Telephone	2.02	1.99	0.0007
Child Care, Domestic Services	5.57 *	1.97	0.1377
Household Chemical Products	3.33	3.30	0.0004
Paper, Plastic, Foil	6.81 *	1.83	0.2256
Other Household Goods & Services	5.52 *	1.48	0.2260
Furniture	5.44	4.73	0.0072
Household Textiles	3.70	3.80	-0.0011
Household Equipment	12.14 *	4.69	0.1148
Household Appliances	0.14	1.72	-0.0231
Kitchen Utensils, Tableware, Flatware	2.69	4.30	-0.0140
Women's Clothing	9.42 *	4.74	0.0629
Men's Clothing	6.32	4.71	0.0179
Children's Clothing	4.58	3.49	0.0162
Footwear	7.82 *	3.49	0.0835
Clothing Accessories, Jewelry	5.50 *	2.65	0.0696

Table 9

Number of Borders Crossed and Law of One Price Deviations

Good	Borders	Standard Error	Adj. R^2
Clothing Material, Notions, Services	6.84 *	2.37	0.1433
Purchase of Automobiles	3.73 *	1.17	0.1712
Operation of Automobiles	6.53	3.80	0.0425
Gasoline	7.49	9.92	-0.0099
Automobile Parts, Maintenance and Repairs [N]	7.49	9.92	-0.0099
Other Automobile Operating Expenses	21.08 *	8.88	0.0954
Automobile Insurance Premiums [N]	3.18	5.74	-0.0160
Automobile Registration Fees [N]	-3.30	6.22	-0.0166
Taxi and Other Local Commuter Transit [N]	3.46	4.64	-0.0102
Inter-City Transit [N]	37.10 *	15.08	0.1030
Prescribed Medicines [N]	-8.09	26.42	-0.0210
Non-Prescribed Medicines	0.47	2.76	-0.0226
Health Care Services [N]	6.55 *	2.85	0.0885
Personal Care Supplies and Equipment	0.76	1.83	-0.0191
Personal Care Services [N]	4.56 *	1.13	0.2593
Recreation	4.81 *	0.78	0.4593
Education [N]	-3.80	5.78	-0.0131
Tuition [N]	-7.17	10.11	-0.0114
Reading Materials and Other Print Matter	8.85 *	3.23	0.1144
Served Alcohol [N]	1.89	1.50	0.0132
Alcohol Bought in Stores	1.71	1.57	0.0044
Beer	-0.22	1.42	-0.0227
Wine	0.36	2.14	-0.0226
Liquor	5.08 *	2.23	0.0869
Cigarettes	-10.80	8.83	0.0112
70-Good Average	**6.87**		
Non-traded Goods Average (19 goods)	**3.28**		
Traded Goods Average (51 goods)	**8.21**		
Number of Positive Coefficients	**63**		
Number of Significant Coefficients	**33**		

Notes:

This table reports the results of 70 separate regressions, one for each good. In each case, the independent variable is the number of borders that must be crossed to trade goods between two specific provinces, while the dependent variable is the price volatility between provinces for that good. There are 45 observations for each good.

The log-distance coefficients and standard errors have been multiplied by 10^4.

* The log-distance variable was significant at the 5% level in this regression.