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Asymmetric Pattern of Intra-industry Trade Between the United States and Canada

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Abstract

This study proposes alternative rationales to explain an asymmetric intra-industry trade pattern between the United States and Canada after the free trade agreement became effective. Using time-series data, a gravity equation is developed which enables us to examine the impacts of relative market size, exchange rates, and transportation costs on bilateral trade. It is found that these three effects have to be taken together in order to explain the asymmetric intra-industry trade pattern. Exchange rate impacts on bilateral trade are found to the most significant, indicating that U.S. dollar appreciation causes a more asymmetric trade pattern for agricultural goods than for large-scale manufacturing goods.

Keywords: border effects, exchange rates, gravity equation, intra-industry trade, national product differentiation model, production differentiation model

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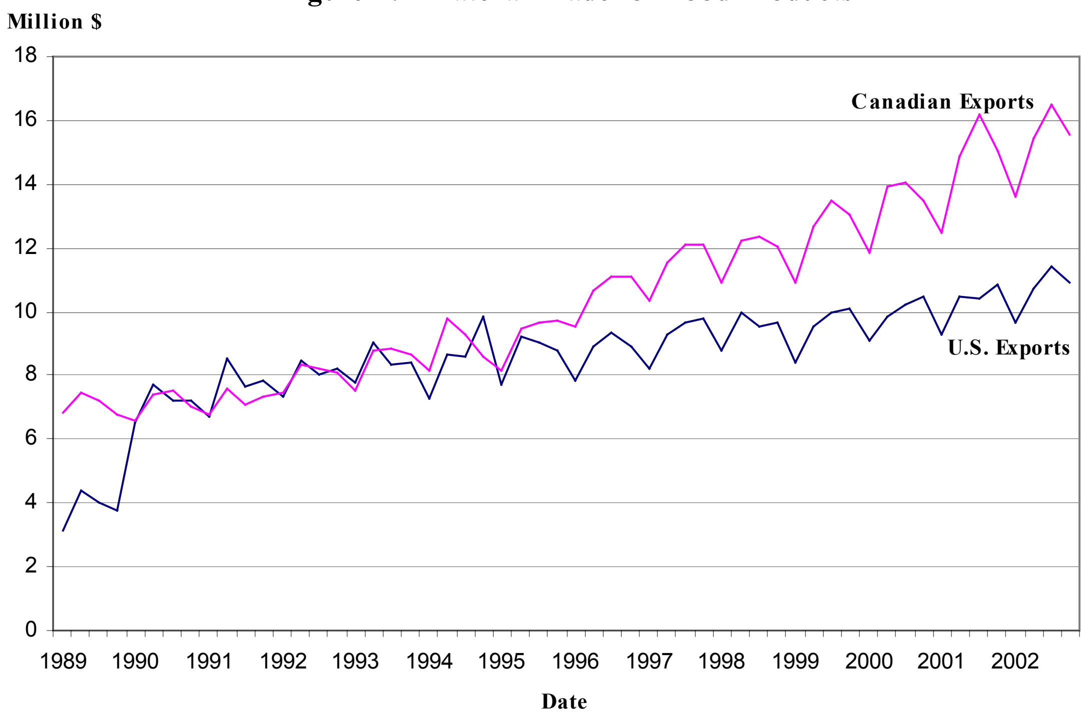
INTRODUCTION[1]

The Canada-U.S. Free Trade Agreement (CUSTA) became effective in 1989 and was incorporated into the North America Free Trade Agreement (NAFTA) in 1994. While the trade agreements resulted in a tremendous increase in the trade volume between the United States and Canada, the volume did not increase proportionately between the two countries. For instance, Canadian exports to the United Sates for food products have increased almost twice as fast as U.S. exports to Canada (Figure 1). Why do the two countries trade similar products with each other in increasingly *different proportions* after the implementation of CUSTA? Because these two countries have similar resource endowments and technology, classical trade models based on comparative advantage do not seem to explain their trade pattern well. There are three potential explanations suggested in the literature: relative market size, exchange rates, and border effects.

Figure 1. Bilateral Trade for Food Products



Quarterly SITC 1-digit U.S. exports to Canada and Canadian exports to the United States are collected by the U.S. International Trade Commission. Values are represented in U.S. dollars. For the period of 1989 - 2002, Canadian exports to the United States for food products increased by 17%, while U.S. exports to Canada increased by 9%.

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[1] We are grateful to Hamid Beladi for valuable comments about this paper.

Based on *relative market size* (or *income*), two distinctive models (*product differentiation* and *national product differentiation*) have been developed to explain asymmetric intra-industry trade patterns and to forecast asymmetric effects of trade liberalization on trade flows between different-sized countries (Armington, 1969; Krugman, 1980; Helpman and Krugman, 1985; Harrigan, 1996; Davis and Weinstein, 1999; Feenstra, et al., 2001; Head and Ries, 2001; Head, Mayer, and Ries, 2002). [2] Krugman (1980) and Helpman and Krugman (1985) developed the *product differentiation* model (or *home market effect*), which states that intra-industry trade occurs because people favor variety of a product. On the other hand, Armington (1969) argued that countries trade with each other because goods are imperfect substitutes and suggested the *national product differentiation* model. While the *product differentiation* model explains the trade pattern for differentiated goods and states that a larger country gains more from trade liberalization (Harrigan 1996; Davis and Weinstein, 1999; Feenstra, et al., 2001; Head and Ries, 2001), the *national product differentiation* model is more appropriate to describe trade patterns for relatively homogeneous goods and states that a smaller country has improved access to a larger country due to a free trade agreement (Feenstra, et al., 2001).

The effect of market size is an important principle to explain the trade pattern. However, two more concerns should be addressed to fully understand the trade pattern. First, the market sizes of different countries (usually measured in GDP) are converted into one currency, incorporating exchange rate impacts. Exchange rate movements are recognized as one of the influential factors affecting trade flow between countries under the floating exchange rate regime. In their theoretical papers, Krugman and Baldwin (1987) and Baldwin and Krugman (1989) emphasized the importance of exchange rate impact on trade flows and theorized the hysteresis effect of exchange rates. Empirical studies found that exchange rate movements exercise considerable influence over the trade flow between the United States and Canada (Backus, 1986; Carter, et al., 1990; Kim, et al., 2002; Xu and Orden, 2002). These studies indicate that the potential impact of the exchange rate on bilateral trade between the two countries cannot be ignored because a large and persistent real appreciation of the U.S. dollar relative to the Canadian dollar can exogenously affect *relative prices* between countries, resulting in a certain impact on bilateral trade flows.

The second concern is a border effect, such as transportation costs and tariffs, which is not dealt with in the analysis of the home market effect. All countries have identical prices if free trade is assumed. However, when transportation costs and/or tariffs are introduced in international trade, trade is no longer free and the prices are no longer identical. Thus, the pattern of trade is more complex when border effects exist. Although they found different degrees of border effects on Canadian exports to the United States, both McCallum (1995) and Anderson and Wincoop (2001) claimed that border effects are asymmetric depending on the size of countries: the smaller

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[2] The *product differentiation* model demonstrates that if firms produce differentiated products with an increasing return to scale in technology, a strong demand in a larger country raises domestic production for export by attracting foreign firms to locate and produce in the country. In this case, trade liberalization reinforces the advantage associated with producing in a large market and exporting to a small market, meaning that the United States, which experienced higher income growth than Canada during the post-CUSTA period, could have more to gain from trade liberalization. On the other hand, if products are distinguished by place of production, then the *national product differentiation* model explains trade patterns. A larger demand in the larger country causes more imports from a smaller country, and hence the smaller country becomes a net exporter. Thus, if this model can explain the trade pattern, firms in Canada will have improved access to the United States due to trade liberalization and gain market share in the United States.

country, Canada, would experience a much larger impact of the border existence (tariffs) than the United States.

In fact, all three of the factors simultaneously affect the trade pattern between the United States and Canada, and they dynamically interact with each other through relative prices between the two countries. For example, exchange rate movements directly and/or indirectly influence the relative market size (or income) and cause relative prices to change. These relative prices are also influenced by changes in transportation costs. Thus, it is possible for changes in exchange rates and transportation costs to overwhelm the (reversed) home market effect if only the relative market size is used to analyze the U.S. – Canada trade pattern.

In spite of this intricate relationship among the three factors (relative market size, exchange rates, and transportation costs), there has been no empirical study, to the best of our knowledge, that has examined the simultaneous impacts of these three factors on the asymmetric intra-industry trade pattern. Therefore, the aim of this study is to explain the asymmetric trade pattern between the United States and Canada during the post-CUSTA period (1989-2002) by investigating the impacts of plausible rationales on U.S. – Canada bilateral trade. More specifically, this study suggests a plausible explanation for the difference in trade patterns between relatively homogeneous goods (agricultural products) and differentiated goods (large-scale manufacturing products).

Using time-series data, a gravity equation is developed to investigate the impacts of those factors on bilateral trade between the two countries. Proper specification of a gravity equation is an important issue (Matyas, 1997; Egger, 2000; Glick and Rose, 2002). Previous literature examined the trade pattern by using cross-sectional data, answering the question, "How are pertinent variables related to the trade pattern?". It has not been possible, however, to obtain the answer to "What is the impact of changes in the variable over time?" (Glick and Rose, 2002). Because the United States has always been a larger market than Canada, it is difficult to examine the impact of relative income movements on the U.S. – Canada trade pattern over time if only the cross-sectional relationship is considered. Dynamic interaction among variables over time and the internal structure of variables are overlooked in cross-sectional analysis. In addition, the impact of a large and persistent appreciation of the U.S. dollar relative to the Canadian dollar cannot be captured if cross-sectional data are used. Thus, time-series data should be used in a gravity equation to obtain the respective impacts of market size, exchange rate, and transportation costs. The well-known cointegration analysis developed by Engel and Granger (1987) is utilized to estimate the gravity equation.

When only relative market size is examined, the *product differentiation* model and the *national product differentiation* model are found to explain bilateral trade patterns for large-scale manufacturing goods and agricultural products, respectively. This result is consistent with findings by Feenstra, et al. (2001) and Head and Ries (2001). However, when the three factors are examined concurrently, the joint movements of the factors have to be taken into account in order to explain the trade pattern. The U.S. dollar appreciation relative to the Canadian dollar is found to impede increases in U.S. exports to Canada, and causes more asymmetric bilateral trade for agricultural products than for large-scale manufacturing goods.

The paper is organized as follows. We briefly introduce the idea of the gravity equation and its relation to the intra-industry trade pattern in the second section. The next section explains an empirical gravity equation specification, and data. Principal results are then presented. The last section summarizes our results.

GRAVITY EQUATION AND ITS RELATION TO INTRA-INDUSTRY TRADE PATTERN

The gravity equation is a popular formulation for statistical analyses of bilateral trade flows between countries. It can be thought of as a short-hand representation of supply (GDP of i^{th} country who exports) and demand (GDP of j^{th} country who imports). The gravity equation is known to produce a reliable result: the elasticities of trade are consistently signed correctly, economically large, and statistically significant, so that the equation explains a reasonable proportion of the cross-country variation in trade (Rose, 2000). Leamer and Levinsohn (1995) described the gravity equation as one producing 'some of the clearest and most robust empirical findings in economics'.

Although it has performed well in practice, the gravity equation has suffered from a lack of a theoretical foundation. There have been several attempts to derive the gravity equation formally (Feenstra, et al., 1998; Bacchetta and Van Wincoop, 2000; Evenett and Keller, 2002). Anderson (1979) provided a theoretical foundation for the gravity equation specification based on the properties of a Cobb-Douglas and constant elasticity of substitution (CES) expenditure system. Under the assumptions that (1) each country specializes in different varieties of a final product *k*, (2) trade is free, so that all countries have identical prices, and (3) demand is identical and homothetic across countries, the exports *from country i to country j of product k* have the following relationship:

$$X_{ij}^k = \theta_j y_i^k , \tag{1}$$

where $\theta_j = Y_j / Y_w$, which is country *j*'s share of world expenditure or GDP (Y_w), and Y_j is country *j*'s real GDP, implying market size. X_{ij} is exports from country *i* to *j* and y_i^k denotes country *i*'s production of good *k*. The total GDP in each country is measured by $Y_i = \sum_{k=1}^{n} y_i^k$ and $Y_w = \sum_{i=1}^{C} Y_i$, where *C* denotes number of countries. Then, summing all products *k*, (1) becomes:

$$X_{ij} = \sum_k X_{ij}^k = \theta_j \sum_k y_i^k = \theta_j Y_i = Y_i \frac{Y_j}{Y_w} . \tag{2}$$

Thus,

$$X_{ij} = \frac{1}{Y_w} Y_i Y_j . \tag{3}$$

This is a conventional gravity equation, stating that the bilateral exports from country *i* to country *j* are proportional to the product of their GDP's. Taking a natural logarithm of both sides, the empirical model of (3) becomes:

$$\ln X_{ij} = \alpha + \beta \cdot \ln Y_i + \gamma \cdot \ln Y_j + \delta \cdot Z_{ij} + \eta_{ij}, \quad (4)$$

where $\alpha = (-\ln Y_w)$ and Z_{ij} is a vector of time-invariant variables such as distance and border effects.

Feenstra *et. al.* (1998; 2001) provided the theoretical justification to interpret the coefficients of β and γ in the gravity equation (4) for testing intra-industry trade hypotheses, the *product differentiation* (*home market effect*) versus the *national product differentiation* (*reversed home market effect*). Assuming fixed consumption of country *i*'s products in country *j* and prices (c.i.f.) of products, they derived demand for each differentiated product based on the CES utility function and constructed a relationship between the change in GDP of each country and the change in the number of products by differentiating the demand function. Because total demand will be higher for the product varieties in a larger market, foreign firms will be enticed by higher available profits to locate in the larger market. Equation (4) implies that exports from the larger country (*i*) to the smaller country (*j*) will increase in proportion to the number of products, and as a result, the larger country becomes a net exporter of the differentiated good to the smaller country. Thus, if the *product differentiation* model is proper to explain the pattern of intra-industry trade between countries, the estimated coefficient of β should be greater than that of γ ($\beta > \gamma$). However, the estimated coefficient of β should be smaller than that of γ ($\beta < \gamma$) under the *national product differentiation*, stating that the number of varieties produced in each country is constant and imperfectly substitutable. A larger market, therefore, becomes a net importer of the good in question.

EMPIRICAL MODEL

Because our interest lies in investigating the impact of alternative rationales on the U.S.-Canada trade pattern, the gravity equation (4) is modified to incorporate the exchange rate impact and border effect as well as the impact of change in relative market sizes. To derive an empirical gravity equation, fitted to time-series data, we first rewrite (3) according to the gravity equation suggested by Anderson and Wincoop (2001) as follows:

$$X_{ijt} = \frac{Y_{it} Y_{jt}}{Y_{wt}} \left(\frac{T_{ijt}}{p_{it} P_{jt}} \right)^{1-\sigma}, \quad (5)$$

where T_{ij} is transaction costs from country *i* to country *j*, σ is a substitution rate of the product *k*, and p_i and P_j are local and general price indexes of country *i* and *j*, respectively. The exchange rate impact can be separated out as follows:

$$X_{ijt} = Y_{it} \left(\tilde{Y}_{jt} \cdot S_t / Y_{wt} \right) \left(T_{ijt} / p_{it} P_{jt} \right)^{1-\sigma}, \quad (6)$$

where S_t is a exchange rate, and $\tilde{Y}_{jt}$ is the income of the importing country denominated in the importer's currency. Taking logarithms from both sides of (6), export from country *i* to country *j* can be expressed as follows:

$$\ln X_{ijt} = \alpha_i \ln Y_{it} + \beta_i \ln \tilde{Y}_{jt} + \gamma_i \ln S_t - \delta_i \ln Y_{wt} + \rho_i \ln T_{ijt} - (1-\sigma)(\ln p_{it} + \ln P_{jt}), \quad (7)$$

where ρ_i includes (1-σ). Equation (7) can be rewritten for export from country *j* to *i* as

$$\ln \tilde{X}_{jit} = \alpha_j \ln Y_{it} + \beta_j \ln \tilde{Y}_{jt} - \gamma_j \ln S_t - \delta_j \ln Y_{wt} + \rho_j \ln T_{jit} - (1-\sigma)(\ln p_{it} + \ln P_{jt}), (8)$$

where $\tilde{X}_{jit}$ is export from country *j* to country *i*, denominated in the importer's currency. Similar to Feenstra *et. al*. (2001), $\alpha_i > \beta_i$ in (7) and $\alpha_j < \beta_j$ in (8) imply that the product differentiation model explains trade patterns, while $\alpha_i < \beta_i$ in (7) and $\alpha_j > \beta_j$ in (8) means that the national product differentiation model describes trade patterns.

There are three distinct problems of directly estimating (7) and (8). First is the low frequency of available world income data (Y_w). In a cross-sectional analysis, the world income is fixed at any given period *t*, and as a result, Y_w is treated as a constant term in a gravity equation. However, world income varies over time in a time-series analysis, which affects the income share of a country. For instance, even if the income of an importing country increases, the share of income can decrease if world income increases faster than that of an importing country, resulting in fewer imports. Therefore, without the variable $(\ln Y_w)$, the estimated coefficients could be significantly different from unity and can be sometimes negative in a time-series analysis.[3] The second issue is the high cost of estimating the unobserved price indexes (p_i and P_j), which requires a custom programming. The third problem is the well-known nonstationarity of variables. Without properly treating the non-stationarity, the estimation results could be biased due to a spurious regression problem (Granger and Newbold, 1974; Phillips, 1986). To avoid possible misleading results due to these problems, we subtract (8) from (7), resulting in:

$$\ln X_{ijt} - \ln \tilde{X}_{jit} = (\alpha_i - \alpha_j) \ln Y_{it} - (\beta_j - \beta_i) \ln \tilde{Y}_{jt} + (\gamma_i + \gamma_j) \ln S_t - (\delta_i - \delta_j) \ln Y_{wt} + (\rho_i - \rho_j) \ln T_t . (9)$$

Under the symmetric assumption of the usual gravity equation ($\alpha_i = \beta_j$, $\alpha_j = \beta_i$, $\gamma_i = \gamma_j$, and $\delta_i = \delta_j$)[4], (9) becomes

$$\ln X_{ijt} - \ln \tilde{X}_{jit} = \vartheta_1 (\ln Y_{it} - \ln \tilde{Y}_{jt}) + \vartheta_2 \ln S_t + \vartheta_3 \ln T_t + \varepsilon_t , \quad (10)$$

where the dependent variable represents net trade flows, $\vartheta_1 = (\alpha_i - \beta_i)$, $\vartheta_2 = 2\gamma$, $\vartheta_3 = (\rho_i - \rho_j)$, and ε_t is an error term. Under the home market effect, $\vartheta_1 > 0$, while $\vartheta_1 < 0$ under the reversed home market effect. We expect $\vartheta_2 < 0$ for the negative impact of the U.S. dollar appreciation on U.S. exports to Canada. As mentioned in Anderson and Wincoop (2001), if there is an

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[3] In many empirical models with panel data, researchers include a time-specific fixed effect into the model, which is expected to be able to capture the effect of the variation of world income. With this, they can mitigate this misspecification problem.

[4] Many studies assume this symmetric condition when they use panel data with a gravity model (e.g., Rose, 1998; Glick and Rose, 2000). Hence, we do not believe the assumption is so strong.

asymmetric border effect between the two countries, especially if the impact is greater to Canada, then $\vartheta_3 < 0$ ($\rho_i < \rho_j$) when *i* is the United States and *j* is Canada.

Because exchange rate movement is an important determinant of relative income, the coefficient of the relative income movement may be inflated due to the impact of change in the exchange rate. Thus, we also estimate an equation without exchange rate impact and border effects. Then, (10) becomes

$$\ln X_{ijt} - \ln X_{jit} = \vartheta_1'(\ln Y_{it} - \ln Y_{jt}) + u_t . \quad (11)$$

To estimate (10) and (11), SITC 1- and SITC 2-digit products, which are bilaterally traded between the United States and Canada, are collected from the U.S. International Trade Commission. These variables are recorded quarterly from 1989:I to 2002:IV, and are sorted under the harmonized system.

X_{ijt}^{k} is the real export value of country *i* to country *j* in year *t* for product *k*, where *k* refers to five groups of exported products classified at the SITC 1-digit level: (1) Food and Live Animal Products, (2) Animal and Vegetable Oils, Fats, and Waxes, (3) Chemical Products, (4) Manufactured Goods, and (5) Machinery and Transport Equipment. To confirm the robustness of the estimated results, SITC 2-digit products are also examined. Fifty-six categories of products at the SITC 2-digit level are selected, but the results are only reported for economic reason.[5] The income variables of both countries (Y_t^{us} and Y_t^{can}) are collected from the Bureau of Economic Analysis (BEA) in the U.S. Department of Commerce (USDC). Monthly data were converted to quarterly data for consistency. The exchange rates between the United States and Canada (S_t) are obtained from the Economic Research Service (ERS) in the U.S. Department of Agriculture (USDA). Because the exchange rate is denoted as the Canadian dollar per the U.S. dollar, an increase in the index represents an appreciation of the US dollar.

Because CUSTA became effective after 1989, border effects, such as tariffs, do not exist. Transportation costs might be the best proxy to represent the border effect. Rail rates (cents/ton mile) are obtained from the Public Use of Waybill, which contains 99% of Canada to U.S. rail shipments.

The variables in (10) are constructed as follows. The nominal value of exports (X_{ij} and $\tilde{X}_{ji}$) and GDP (Y_i and $\tilde{Y}_j$) are originally collected in terms of the U.S. dollar and converted into the respective country's currency using the exchange rates (S_t). These values are deflated by the consumer price index of each country (1982-84=100), obtained from the Bureau of Labor Statistics (BLS) and the CANSIMII database.

[5] Full results are available from authors.

RESULTS

We first test nonstationarity of the individual time series using the Augmented Dickey-Fuller test (ADF) and the Philips-Perron test (PP) with intercept and trend to avoid possible problems caused by heteroskedasticity in the variables. In addition, the stationarity test based on the LR test (χ^2) is conducted to distinguish slow mean reverting process from nonstationarity.[6] The results of these tests indicate that most variables contain unit roots, meaning that these variables are not mean reverting but become *I*(1), stationary, at a 95% significance level.

For SITC 1-digit, the null hypothesis of zero cointegration was rejected for all cases by the maximum eigenvalue and the trace tests at 95%, indicating there exists one cointegrating relationship among variables for each SITC 1-digit product. The estimation results are presented in Table 1. The first two columns display the estimated coefficients of the relative market size, ϑ_1 and ϑ_1', in Models (10) and (11), respectively. It is expected that the coefficients lie between 0.38 and 0.5 for differentiated goods and between –0.41 and -0.21 for homogeneous goods, in accordance with the results of Feenstra *et al*.[7]

Table 1. Intra-industry Trade Pattern Estimation using Different Models (10) and (11)

	Relative Market Size		$\ln S_t$	$\ln T_t$	Time Trend	
Products	ϑ_1' in (11)	ϑ_1 in (10)	ϑ_2 in (10)	ϑ_3 in (10)	Model (11)	Model (10)
Food	-0.284 (0.182)	**-0.179** (0.042)	**-1.465** (0.320)	**-0.171** (0.087)	**-0.009** (0.002)	**-0.011** (0.002)
Oils	**-0.386** (0.081)	**-0.197** (0.034)	**-2.204** (0.688)	-0.281 (0.315)	**0.021** (0.003)	**0.056** (0.010)
Chemicals	0.043 (0.031)	0.021 (0.063)	**-1.887** (0.478)	0.105 (0.120)	**0.003** (0.001)	0.001 (0.004)
Manufacture	**0.468** (0.176)	**0.109** (0.032)	**-2.036** (0.210)	**-0.077** (0.037)	-	**0.006** (0.002)
Machinery	**0.212**[a] (0.116)	**0.113** (0.041)	**-0.847** (0.196)	**-0.097**[a] (0.051)	**-0.004** (0.001)	0.005 (0.003)

Model (10) $\ln X_{ijt} - \ln \tilde{X}_{jit} = \vartheta_1(\ln Y_{it} - \ln \tilde{Y}_{jt}) + \vartheta_2 \ln S_t + \vartheta_3 \ln T_t + \varepsilon_t$, and

Model (11) $\ln X_{ijt} - \ln X_{jit} = \vartheta_1'(\ln Y_{it} - \ln Y_{jt}) + u_t$, where subscripts *i* and *j* indicate the United States and Canada, respectively, for both models. Numbers in parentheses are standard errors. Bold numbers indicate significance at 95% (two-tailed test). a indicates significance at 90%.

Food: Food and Live Animal products
Oils: Animal and Vegetable Oils, Fats, and Waxes
Chemicals: Chemical Products
Manufacture: Manufactured goods
Machinery: Machinery and Transport Equipment

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[6] See Johansen and Juselius (1992) and Juselius and MacDonald (2000) for the LR test.

[7] These ranges are obtained by subtracting the coefficients of importing country's GDP from exporting country's GDP, presented in Table 2 in Feenstra et al (2001).

Consistent Finding with Previous Literature

When the exchange rate and border effects are *not* considered (ϑ_1' in (11); the first column of Table 1), the coefficients of food and oil products are found to be negative, indicating that the national product differentiation model explains the U.S.–Canada trade pattern for these products better than the product differentiation model. However, only the coefficient for oil products (-0.386) is significant, meaning that, as U.S. income increases 1% relative to Canadian income, U.S. exports of oils to Canada decrease 0.386% relative to Canadian exports to the United States. For large-scale manufacturing products such as chemicals, manufactures, and machinery, the coefficients are positive and lie between 0.212 (machinery) and 0.468 (manufacture goods). If agricultural products are *relatively homogeneous* to manufacturing and machinery products, these results are in accordance with the results of Feenstra *et al*, and indicate that the national product differentiation model explains the pattern of U.S.-Canada bilateral trade for food and oil products, while the product differentiation model (or home market effect) is proper to explain the rest of the categories.

The Importance of Exchange Rates and Transportation Costs

When the exchange rate and transportation costs are introduced in the model (10), all three rationales explain the asymmetric trade pattern reasonably well, but the exchange rate is found to be the most significant. All coefficients of relative market size become smaller when the exchange rate and transportation costs are considered (ϑ_1 in Table 1), and the estimated coefficients are –0.179 and –0.197, respectively, for relatively homogeneous goods (food and oils) and 0.109 and 0.113, respectively, for differentiated goods (manufactured goods, and machinery). For the exchange rate impact, all the coefficients are significant and the magnitudes are much greater than those for the relative market sizes (ϑ_2 in Table 1). U.S. exports of food and oil products to Canada decrease by 0.733% (-1.465/2) and 1.102% (-2.204/2), respectively, due to a 1% appreciation of the U.S. dollar, while they decline by 0.944% (-1.887/2), 1.018% (-2.036/2), and 0.424% (0.847/2), respectively, for chemicals, manufactures, and machinery.

Changes in transportation costs, which represent the border effects between the two countries, are also found to cause an asymmetric response in the intra-industry trade (ϑ_3 in Table 1). Although it is not possible to directly compare results with findings of Anderson and Wincoop (2001) due to the fact that they used tariff indicators for border effects, our results of the *negative* coefficients indicate that changes in transportation costs negatively affect the Canadian exports to the United States more than U.S. exports to Canada, supporting their results. The coefficients lie between –0.171 and –0.077. Food products are more affected by changes in transportation costs (-0.171), while manufactured goods and machinery are least influenced (-0.077 and –0.097, respectively). This is mainly due to a difference in the mode of transportation. For example, because of the nature of agricultural commodities, they might require a speedy delivery and/or a different type of delivery relative to large-scale manufacturing products.

Our finding indicates that relative market size is not the only explanation for the asymmetric trade pattern. Rather, the joint movements of all three rationales can explain the asymmetric trade pattern during the post-CUSTA period. For the *relatively homogenous products* (food and oil products), the trade pattern is well-explained by the reversed home market effect. That is, agricultural products produced in the United States are recognized as different products from those produced in Canada because of the following reasons. First, agricultural production is characterized by both *relatively* constant return to scale and intensive use of immobile land. Second, consumer preference and production practices, stemming from weather conditions and soil types, are different across countries. As a result, the United States cannot attract foreign firms, and relatively higher income growth in the United States during the post-CUSTA period causes more than proportionate imports from Canada. The appreciation of the U.S. dollar further hinders U.S. exports of agricultural products to Canada by directly distorting relative commodity prices between the two countries and by increasing U.S. purchasing power. As a result, the U.S. dollar appreciation relative to the Canadian dollar intensifies demands for Canadian products in the United States. However, the negative coefficient of transportation costs (-0.171) indicates that an increase in transportation costs partially discourages Canadian exports to the United States, supporting the results of McCallum (1995) and Anderson and Wincoop (2001).

U.S. exports to Canada of large-scale manufacturing products, such as manufactures and machinery, are reasonably well-explained by changes in the relative market size, indicating that these products are differentiated based on production technology and consumer preferences for variety (the "love of variety" as it is called in Dixit and Stiglitz (1977)). Since there is increasing return to scale for these products, the United States attracts foreign firms to locate within the country and to produce varieties of these products. However, the relative increase in U.S. exports to Canada is hindered by the U.S. dollar appreciation relative to the Canadian dollar. A 1% appreciation of the U.S. dollar generates detrimental impacts on U.S. exports to Canada for chemical, manufacture, and machinery products by 0.944%, 1.018%, and 0.424%, respectively.

Note that the sizes of exchange rate impacts are similar between agricultural products and large-scale manufacturing products. According to the hysteresis model by Baldwin (1988) and Baldwin and Krugman (1989), only huge exchange rate shocks (either appreciation or depreciation) induces new entry (exit) of firms that sell their products in the domestic market (e.g. Japanese cars made in the United States). Thus, if the U.S. dollar appreciation relative to the Canadian dollar during the post-CUSTA period was substantial enough to attract Canadian firms to enter the U.S. manufacturing market, the exchange rate impact on bilateral trade of large-scale manufacturing products would be smaller than that on trade of food and oil products. Thus, comparable exchange rate effects on bilateral trade for both agricultural and large-scale manufacturing products indicates that the size of U.S. dollar appreciation during the post-CUSTA period was not enough to induce new Canadian entry into the U.S. market. Rather, the real appreciation of the U.S. dollar affects the relative price of the commodities, causing increased demand for Canadian manufacturing products in the United States.

Consistency Across Products

The asymmetric intra-industry trade pattern for SITC 2-digit products is also analyzed to examine consistency over trading product categories (SITC 1- and 2-digits).[8] Because the sub-products of each SITC 1-digit product, such as meat and cereal, are not easily substitutable, the sub-products may have a different trade pattern than the SITC 1-digit product. SITC 2-digit products are selected based on the results of Table 1 (sub-products of food, manufacture, and machinery products), and the results are presented in Tables 2 and 3.[9]

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[8] Because of data availability, we were not able to expand the time period of the data set to test robustness of the result.

[9] The rest of the results are available on request.

Overall, the results in Tables 2 and 3 confirm the finding in Table 1: all three rationales, the relative market size, the exchange rate, and border impacts, are suitable to explain the asymmetric intra-industry trade between the United States and Canada. The reversed home market effect is found to explain the trade pattern for five agricultural products (ϑ_1 in Table 2). However, the exchange rate impact explains the asymmetric trade pattern more significantly than the relative income (the exchange rate impact is significant for all products except coffee and tea products). The exchange rate impacts on bilateral trade of the sub-products (SITC 2) are larger than the impact on aggregate food product trade (SITC 1), ranging from –1.336 (-2.672/2) for fish to –0.599 (-1.199/2) for sugar. Larger border impacts on bilateral trade for the sub-products are also found (ϑ_3 in Table 2 versus ϑ_3 in Table 1: from –1.645 to –0.643 in Table 2 versus -0.171 in Table 1). Increases in transportation costs yield more significant detrimental effects on Canadian exports to the United States than on U.S. exports to Canada.

Table 2. Intra-industry Trade Pattern for Agricultural Products using SITC 2-digits

Sub-products	Market Size (ϑ_1)	$\ln S_t$ (ϑ_2)	$\ln T_t$ (ϑ_3)	Trend
Live animals	0.135 (0.347)	**-2.196** (0.826)	**-0.887** (0.382)	0.034 (0.020)
Meat	**-0.258** (0.046)	**-1.457** (0.609)	-0.437 (0.279)	**-0.037** (0.007)
Dairy production	**-0.168** (0.069)	**-1.384** (0.161)	**-0.645**[a] (0.232)	**-0.048** (0.020)
Fish	**-0.144** (0.023)	**-2.672** (0.898)	0.058 (0.270)	**-0.041** (0.007)
Cereals	**-0.390** (0.102)	**-2.316** (0.284)	-0.040 (0.102)	**0.024** (0.002)
Vegetables & fruits	**-0.294** (0.147)	**-2.502** (0.823)	**-0.643** (0.270)	**-0.025** (0.012)
Sugars	-0.192 (0.240)	**-1.199** (0.632)	**-0.421** (0.176)	-0.005 (0.006)
Coffee & tea	-0.374 (0.286)	0.204 (0.838)	**-0.506** (0.248)	0.018 (0.011)
Feed for animals	-0.130 (0.312)	**-1.915** (0.776)	**-0.365** (0.115)	-0.003 (0.007)

These results are obtained by running Model (10). Numbers in parentheses are standard errors.
Bold numbers indicate significance at 95% (two-tailed test). a indicates significance at 90%.

For the manufacturing products, the product differentiation model explains the trade pattern, as do the exchange rate and transportation costs, consistent with the results using the SITC 1-digit (Table 3). The impacts of the relative market size (ϑ_1) and the exchange rates (ϑ_2) on the sub-products (SITC 2) are not very different from those on the aggregate products (SITC 1). However, the border effects (ϑ_3) on sub-products are different from those on aggregate products. For aggregate products (SITC 1), the effects are negative, implying that a smaller country (Canada) is more affected by change in transportation costs. However, positive coefficients are found when the SITC 2-digit is used, implying that the United States is more affected by unfavorable movements of transportation costs when more specific products are examined. For example, change in transportation costs affect leather manufactures, cork and wood, and paper in the United States by showing positive coefficients, 0.337, 0.183, and 0.143, respectively, while the other detailed products are consistent with SITC 1. For these products, foreign firms located in the United States face higher prices due to an increase in transportation costs, generating detrimental effects on the U.S. exports to Canada.

Table 3. Intra-industry Trade Pattern for Manufacturing Products using SITC 2-digits

Sub-products	Market Size (ϑ_1)	$\ln S_t$ (ϑ_2)	$\ln T_t$ (ϑ_3)	Trend
Leather	**0.179** (0.082)	**-1.936** (0.713)	**0.337** (0.177)	**-0.023** (0.008)
Rubber	**0.131** (0.039)	**-1.494** (0.265)	**-0.324** (0.074)	**-0.007** (0.002)
Cork & wood	**0.175** (0.073)	**-1.522** (0.253)	**0.183** (0.055)	0.012 (0.007)
Paper	**0.158** (0.049)	**-0.798** (0.367)	**0.143** (0.069)	**-0.009** (0.003)
Textile yarn	**0.181** (0.076)	**-2.001** (0.395)	**-0.264** (0.119)	-0.008 (0.006)
Nonmetallic mineral	0.150 (0.110)	**-2.056** (0.856)	0.191 (0.218)	0.009 (0.006)
Iron & steel	**0.253** (0.033)	**-2.359** (0.638)	**-0.851** (0.186)	**0.036** (0.011)
Nonferrous metals	**0.163** (0.030)	**-1.064** (0.224)	**-0.196** (0.067)	**0.010** (0.002)
Metals	0.159 (0.363)	**-2.522** (0.268)	0.058 (0.103)	-

Numbers in parentheses are standard errors.
Bold numbers indicate significance at 95% (two-tailed test). a indicates significance at 90%.

CONCLUDING REMARKS

Since the Canada-U.S. Free Trade Agreement (CUSTA) was implemented, the rate of increase in Canadian exports to the United States has been greater than U.S. exports to Canada. Three alternative causes are examined, namely, relative market size, the exchange rate between the United States and Canada, and transportation costs, to explain the asymmetric pattern of intra-industry trade between Canada and the United States during the post-CUSTA period. In analyzing the intra-industry trade pattern between the two countries, dynamic interaction among the three rationales should not be ignored. We developed a model to examine the time-series relationships within the gravity equation specification.

When relative market size is examined alone, which is used as a benchmark to compare results, the product differentiation model and the national product differentiation model are found to be appropriate to explain bilateral trade patterns for large-scale manufacturing goods and agricultural products, respectively. This result is consistent with one by Feenstra, et al. (2001) and Head and Ries (2001). By considering time-variant behavior of the three rationales in the model, however, relative market size is not the only factor causing the asymmetric trade pattern between the two countries. Rather, the joint movements of relative market size, the exchange rate, and border effects explain the asymmetric bilateral trade pattern under the CUSTA. The exchange rate impact is found to be the most significant factor, instigating asymmetric bilateral trade between the two countries.

The *product differentiation* model is proper to explain the trade pattern for large-scale manufacturing goods, demonstrating that the United States has an advantage in accessing the Canadian market due to trade liberalization. However, the U.S. dollar appreciation impedes an increase in U.S. exports, while an increase in transportation costs harms the Canadian exports. By contrast, the *national product differentiation* model is proper to explain the trade pattern for agricultural products, meaning that Canada has an advantage in accessing the U.S. market. Moreover, the U.S. dollar appreciation generates favorable conditions for Canada to export more agricultural products to the United States, though an increase in transportation costs has a negative impact on Canadian exports to the United States. Overall, Canadian exports of agricultural products grow significantly faster than U.S. exports do.

Considering the fact that U.S. income growth rates have been greater than those in Canada during the recent decades, the results imply that large-scale U.S. manufacturing industries gain from trade under CUSTA, while the U.S. agricultural and food processing sectors do not benefit from the higher income growth rate and are harmed by unfavorable movements of the U.S. dollar under CUSTA.

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