The Causes of Intra-Industry Trade between the U.S. and Canada:

Time-series Approach with a Gravity Model

MinKyoung Kim,
Guedae Cho,
and
Won W. Koo*

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*The authors, respectively, a Research Assistant Professor and a Professor,
Center for Agricultural Policy & Trade Studies,
Department of Agricultural and Applied Economics,
North Dakota State University.

mkim@ndsuext.nodak.edu; gcho@ndsuext.nodak.edu; wkoo@ndsuext.nodak.edu

Abstract

This study proposes alternative reasons to explain an asymmetric intra-industry trade for agricultural products between Canada and the United States after the free trade agreement became effective. Using time-series data, a gravity model is developed which enables us to examine the significance of exchange rates and different trade patterns on bilateral trade.

Keywords: Border Effects, Exchange Rates, Gravity model, Intra-industry Trade, National Product Differentiation, Production Differentiation.

Introduction

The Canada-U.S. Free Trade Agreement (CUSTA) became effective in 1989 and the North America Free Trade Agreement (NAFTA) in 1994. The trade agreements resulted in tremendous increase in the trade volume between the U.S. and Canada. However, increases in Canadian exports to the United States have been greater than U.S. exports to Canada especially for agricultural products (Koo and Uhm, 2000). A difference between U.S. exports to Canada and Canadian exports to the U.S. has been relatively minimal before the U.S.-Canada free trade agreement (1980 – 1989). However, Canadian exports of agricultural products to the U.S. have increased much faster than U.S. exports to Canada after CUSTA (1989 - 2000). For example, Canada wheat exports have increased by 523%, while the U.S. exports by only 17% during the post-CUSTA period. An important question is what factors affects the asymmetric trade pattern occurs between the two countries (that is, why Canadian exports to the U.S. increase more than the U.S. exports)? More precisely, why is agricultural trade between the two countries asymmetric, even though they have similar resource endowment and technology?

To explain the trade pattern between the two countries after CUSTA, several studies argue that the exchange rate between the two countries has played an important role (Carter et al., 1990; Kim et al., 2002; Xu and Orden, 2002; Mattson and Koo, 2002).[1] Recently, Kim et al. show that the U.S.-Canada exchange rate has significant impacts on bilateral trade of agricultural products under CUSTA and generates detrimental effects on the U.S. agricultural trade.

Although exchange rates would explain large part of the asymmetric trade pattern between the two countries, there is no significant attempt to answer more fundamental question concerning intra-industry trade between the two countries. Thus, the main objective of this study is to examine alternative reasons why intra-industry trade occurs between the U.S. and Canada by developing an estimation model for the gravity model specification.

Because these two countries have similar resource endowment and technology, classical trade models do not seem to satisfactorily explain their trade pattern. Two alternative models explaining intra-industry trade pattern are suggested in the literature: the product differentiation model (PD) (or home market effects), developed by Krugman (1980) and Helpman and Krugman (1985) and the national product differentiation model (NPD), developed by Armington (1969) and Head and Ries (2001). If firms produce differentiated products with an increasing return to scale in technology, there could be strong demand in a large home market (the U.S. agricultural market), raising domestic production for export by attracting foreign firms. This is called the "home market effect". In this case, trade liberalization reinforces the advantage associated with producing in a large market and exporting to a small market, meaning the U.S. could have more gain from trade liberalization because the size of its market is larger than that of Canada. On the other hand, if products are distinguished by place of production, countries trade each other simply because goods are imperfect substitutes. Thus, the home market effect could be reversed, and the smaller country might be a net exporter. Because firms in a small country have improved access to a large country, trade liberalization enables the firms in Canada to gain more market share from the U.S. agricultural trade.

Several studies, using cross-sectional or panel data analysis, support the home market effects (Harrigan, 1996; Davis and Weinstein, 1999; Head and Ries, 2001; Head, et al., 2002). Feenstra, et al. (2001) examine bilateral export flows for a large sample of OECD countries for several selective years by developing theoretical framework of a gravity model. They find both effects influenced the trade of goods: home market effects for *differentiated* goods and reverse home market effects for relatively *homogenous* goods. However, they considered only a cross-sectional relationship among variables, which generates descriptive statistics between variables, and overlooked dynamic interaction between variables and the internal structure of variables (Glick and Rose, 2000). For example, the 'home market' effect might not be easily captured in the case of the U.S. - Canada bilateral trade if we only consider the cross-sectional relationship because the U.S. has always been a larger market than Canadian.

In analyzing the intra-industry trade pattern between the U.S. and Canada, the potential impact of the exchange rate on bilateral trade between the two countries cannot be ignored because an unexpected, large, and prolonged swing of US dollar can exogenously distort purchasing power between the countries and affect the agricultural trade flow. For example, when the U.S. dollar appreciates relative to the Canadian dollar, the U.S. imports raw materials from Canada. A comparative disadvantage exists in the U.S. agricultural sector, relative to the other economic sectors, when the U.S. dollar appreciates. In general, imported inputs are processed for the U.S. domestic consumption rather than for export to Canada. Because exchange rate movements are mainly determined by internationally mobile capital under the floating system, they should be treated as a noise factor distorting a pattern of trade in the short- and medium-run. Thus, it is worth examining the exchange rate effect when analyzing the pattern of agricultural trade between the two countries.

We also examine border effects between the U.S. and Canada by adopting rail rate transportation costs. McCallum (1995) and Anderson and Wincoop (2001) investigate whether national borders matter to bilateral trade between the two countries using a gravity model. They find that there exist significant border effects, generating asymmetric impacts between the two countries. When the border effects are introduced, the assumption that prices are the same over countries is no longer valid. Thus, we incorporate the border effects in our gravity model and examine that this effect can explain the trade pattern in addition to the other two reasons the alternative hypothesis (PD versus NPD) and the exchange rate.

This study proposes alternative reasons for the intra-industry trade pattern between Canada and the United States during the post-CUSTA period (1989-2002). Using time-series data, a gravity model is developed. The gravity model enables us to examine the significance of exchange rate impacts and the alternative intra-industry trading hypothesis (PD and NPD) on bilateral trade. The well-known cointegration analysis developed by Johansen and Juselius (1994) is utilized to estimate the gravity model. We apply SITC 1-digit and SITC 2-digit categories to examine consistency among industries.

The national product differentiation model (NPD) is found to be an appropriate explanation for the U.S. and Canadian agricultural trade pattern for both SITC 1- and 2-digits, while the product differentiation model (PD) is more proper to explain the trade pattern within non-agricultural sectors, such as machinery and manufactured goods when exchange rates and border effects are not introduced in the model. However, exchange rate and border effects significantly explain the trade pattern when they are introduced.

The paper is organized as follows. We briefly introduce the idea of the gravity model and its relation to intra-industry trade pattern, followed by the section of empirical gravity model specification, which incorporates the exchange rate and border effects. Then variable construction and data are discussed, and principal results are presented in result section. The last section summarizes our results.

A Gravity Model and It's Relation to Intra-industry Trade Pattern

Anderson (1979) provides a theoretical foundation for the gravity model specification based on the properties of a Cobb-Douglas and constant elasticity of substitution (CES) expenditure system. Under the assumption that each country is specialized in different product varieties of a final product *k*; that trade is free, so that all countries have identical prices; and that demand is identical and homothetic across countries, the exports *from country i to country j of product k* have 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* using (1), we obtain:

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

Thus,

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

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

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

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) provide the theoretical justification of the gravity model (4) and interpret the estimated coefficients of β and γ for testing intra-industry trade hypotheses, product differentiation (home market effect) (PD) versus national product differentiation (NPD). They derive demand for each differentiated product based on CES utility function and obtain a relationship between the change in GDP of each country and the change in the number of products by differentiating the demand function. They assume that consumption of country *i*'s products in country *j* and prices (c.i.f.) of products are fixed and show that the number of products in a large country will increase by more than the increase in country size, while the number of products in a smaller country decrease. This implies that exports from the larger country to the smaller country 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 monopolistic competition 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 ($\beta > \gamma$), while β should be smaller than that of γ ($\beta < \gamma$) under the national product differentiation hypothesis.

We need to pay attention to country size, which plays major role in explaining intra-industry trade pattern. In monopolistic-competition model, total demand will be higher for the varieties, and a larger market would attract disproportionately more firms to locate in the larger market due to higher profits available. In the national product differentiate model, by contrast, the number of varieties produced in each country is constant and imperfectly substitutes, so that a larger market, which have a larger demand, therefore, becomes a net importer of the good in question.

Empirical Model Derivation

The gravity model (4) is, in general, utilized in cross-sectional analysis (Bergstands 1985, 1989; Feenstra et al. 2001), whose results should be differently interpreted from the one used in time-series analysis. As mentioned in (Glick and Rose, 2002), cross-sectional analysis is likely to answer the question of "*how* are relative market sizes (GDP) of countries related to the intra-industry trade pattern?" However, time-series analysis should be conducted when the impact of change in relative market sizes of countries on the trade pattern is of interest (*what* is the impact?). This is critical differentiation between the two analyses when explaining the U.S. and Canada bilateral trade pattern because the time-series analysis is likely to answer a policy question such as the impact of free trade agreement, which the cross-sectional analysis cannot answer (Glick and Rose). Since the U.S. has always been a larger country than Canada, ignoring dynamic interaction between the two countries (when the cross-sectional analysis is utilized) may generate biased home market effect, which may lead to improper policy implication of bilateral trade.

As confirmed in Kim, et al., 2002, the U.S. dollar appreciation relative to Canadian dollar significantly affect the U.S.-Canada bilateral trade over time, indicating the alternative models of testing intra-industry trade pattern may overshadow the impact of change in the exchange rate if the cross-sectional analysis is employed. Thus, this study differentiates the gravity model into the two hypotheses, the market size (production differentiation and national production differentiation) and the exchange rate to compare which can explain the bilateral trade better.

McCallum (1995) investigates whether national borders still matter for the U.S. and Canada bilateral trade using a gravity model, including border indicators. When there are border effects, such as transportation costs or tariffs, then it is no longer the case that prices are the same across countries. Several studies found high border effects among countries (especially OECD countries) such as Wall (2000), Anderson and Wincoop (2001), Redding and Venables (2000), Rose and Wincoop (2001). McCallum finds stunningly high border effects between the U.S. and

Canada (around 22% of border effects). Anderson and Wincoop (2001) and Feenstra, et al. (1998; 2001) argue that

"*…border effects have an asymmetric effect on countries of different size and have a larger effect on small countries*."

But they criticize the border effects between the two countries should be around 11% and suggest the unbiased justification of the gravity model with price indexes for both exporting and importing countries. However, the price indexes are unobservable.[2]

Thus, we modify the conventional gravity model (4) more to incorporate the exchange rate impact and border effect as well as the impact of change in relative market sizes. To derive an empirical model fitted to time-series analysis, we first rewrite (2) according to the gravity model developed in Anderson and Wincoop (2001) as follows:

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

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. Then, the exchange rate impact can be separated out as follows:

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

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

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

where ρ_i includes (1-σ). For export from country *j* to *i* is then,

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

where $\tilde{X}_{jit}$ is export from country *j* to country *i*, denominated in the importer's currency. Feenstra *et. al*. show that $\alpha_i > \beta_i$ and $\alpha_j < \beta_j$ under the product differentiation hypothesis and the signs are reversed ($\alpha_i < \beta_i$ and $\alpha_j > \beta_j$)under the national product differentiation hypothesis.

There are three distinct problems in estimating (7) and (8). First, the world income (Y_w) is not available in higher frequency. 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 model. However, it varies over time in a time-series analysis, which affects the share of relative income of a country. For instance, even if the income of an importing country increases compared to last period, the share of income can decrease if world income increase faster than that of an importing country resulting in less imports. Therefore, without the variable $(\ln Y_w)$, the estimated coefficients could be significantly different from unity and sometimes it can be negative in a time-series analysis.[3] Second, there is the high cost of estimating the unobserved price indexes (p_i and P_j) because it needs a custom programming to estimate the price indexes. Third one is the well known nonstationarity of variables. Without properly treating non-stationary problem, the estimation results could be biased due to spurious regression problem. To avoid possible misleading results due to these problems, we subtract (8) from (7) to have

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

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

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

where $\vartheta_1 = (\alpha_i - \beta_i)$, $\vartheta_2 = 2\gamma$, $\vartheta_3 = (\rho_i - \rho_j)$, and ε_t is an error term. Under product differentiation hypothesis, $\vartheta_1 > 0$, while $\vartheta_1 < 0$ under the national production differentiation hypothesis. 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 asymmetric border effect between the two countries, especially the impact is greater to Canada, then $\vartheta_3 < 0$ ($\rho_i < \rho_j$) when *i* is the U.S. and *j* is Canada.

Because exchange rate movement is an important determinant of the 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 a model without exchange rate impact and border effects. Then (10) becomes

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

Variable Construction and Data

SITC 1- and SITC 2-digit data, which are bilaterally traded between the U.S. and Canada, are collected from U.S. International Trade Commission. These variables are quarterly from 1989:I to 2002:IV, which are sorted out after harmonized system.

X_{ijt}^{k} is the real export value of country *i* to country *j* in year *t* for sector *k*, where *k* refers to specific export sectors, 0:food and live animal, 1: Beverages and Tobacco, 2: Crude Materials, 3: Mineral Fuels, 4: Animal and Vegetable Oils, Fats and Waxes, 5: Chemical Products, 6: Manufactured Goods, 7: Machinery and Transport Equipment for SITC 1-digit (8 and 9 are excluded because they include miscellaneous and other goods, which are not exactly identified in bilateral trade flow). Fifty-six categories of SITC 2-digit are selected according to the categories of SITC 1-digit, but the results are partly reported (25 categories) for economic reason. 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 nominal exchange rates between the US and Canada (S_t) is obtained from the Economic Research Service (ERS) in the United States Department of Agriculture (USDA). Because the exchange rate represents Canadian dollar per a unit of U.S. dollar, an increase in the index represents an appreciation of the US dollar.

Because the U.S. and Canada free trade agreement 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 shipment.

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 the U.S. dollar, and converted into the respective country's currencies using the nominal exchange rates (S_t). These values are deflated by the consumer price index of each country (1982-84=100), which are obtained from the Bureau of Labor Statistics (BLS) and CANSIMII database, respectively. When running the regression, country *i* is designated as the U.S. and country *j* as Canada

Unit Root Test

We test nonstationarity of the individual time series using the Augmented Dickey-Fuller test (ADF) and the Philips-Perron test (PP) with the 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 due to low power of distinguishing slow mean reverting from nonstationarity.[5] The results of these tests indicate that the variables contain unit root for most of variables in both SITC 1- and 2-digits, meaning that these variables are not mean reverting but become *I*(1), stationary, at a 95% significance level. The results are abbreviated for economic reason.

Results

Although the ordinary least squares (OLS) estimator is super-consistent (Engle and Granger, 1987) in estimating the long-run relationships among non-stationary variables, it is not efficient because it does not include the short-run dynamic adjustment of variables. Johansen's cointegration analysis (1994) is utilized in this study to have efficient long-run relationship. 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 exist one cointegrating relationship among variables for each categories (0 to 7) of SITC 1-digit and for both Models (10) and (11).

The estimation results for SITC 1-digit are presented in Table 1. The first two columns display the estimated coefficients of relative market size in Models (10) and (11), respectivley. In addition to the sign of coefficients for the relative market size in both models, we expect that the coefficients may lie between 0.38 and 0.5 for differentiated goods and between –0.41 and -0.21 for homogeneous goods according to the results of Feenstra *et al*.[6]

When the exchange rate and border effects are not considered (the first column), the coefficients of the categories of 0 (food and live animals) and of 4 (animal and vegetable oils, fats and waxes) are found to be negative. The coefficient of category 4 (oils) is significant and –0.386 that lies in the range Feesntra *et al* estimated. The rest of coefficients are positive and lie between 0.212 (machinery) and 0.468 (manufacture goods). However, the coefficients of categories 1 (beverage and tobacco) and 2 (crude materials) are outlying the range, which may be inflated by factors, such as exchange rates and border effects. If agricultural products are *relatively homogeneous* to manufacturing and machinery products, these results are accordance with the results of Feenstar *et al*, and indicate that the national product differentiation model explains the pattern of the U.S.-Canada bilateral trade for food and oils (categories 0 and 4), while the product differentiation model (or home market effect) is proper to explain the rest of categories.

The coefficients of the relative market size become smaller when the exchange rate and border effects are considered, and some of them become not significantly different from zero (the second column of Table 2). For relatively homogeneous goods (food and live animals, and animal and vegetable oils, fats, and waxes), the estimated coefficients of the relative market size are –0.179 and –0.197, respectively, and they are 0.208, 0.109, and 0.113, respectively, for differentiated goods (crude materials, manufactured goods, and machinery), indicating that both the national product differentiation and product differentiation (home market effect) models explain the intra-industry trade pattern for the respective products. However, change in exchange rate seems to explain the intra-industry trade more properly than the relative market size. As the U.S. dollar appreciates, the relative U.S. exports to Canadian exports significantly decrease for all products, but the degree of exchange rate impacts varies across products and ranges from -1.265 (-2.530/2) to –0.424 (-0.847/2) except -1.743 (-3.485/2) for the product of mineral fuels, which seems inflated due to unidentified factors.

Transportation costs, which represent the border effects between the two countries, are also found to determine the intra-industry trade (the forth column of Table 1). Asymmetric response of the intra-industry trade to change in transportation costs is confirmed. Although direct comparison with the result of Anderson and Wincoop (2001) is not possible because they used tariff indicators for border effects, our results of the negative coefficients indicate that change in transportation costs more significantly affect the Canadian exports to the U.S. than U.S. exports to Canada. They lie between –0.171 and –0.077 except the products of beverage and tobacco, and mineral oils whose coefficients are outlying around 1.5. Manufactured goods and machinery are least influenced products by change in transportation costs, while food and live animals are more likely affected by the transportation costs except beverage and fuels.

Intra-industry trade pattern for the *relatively homogenous products* (agricultural products: food and live animals, and animal and vegetable oils, fats, and waxes) are well explained by both the national product differentiation models and the exchange rate. This result indicates that agricultural products produced in the U.S. are recognized as different products from those in Canada. This is mainly due to the fact that the agricultural sector has *relatively* constant economy of scale, and as a result, the U.S. cannot locate foreign firms, and large demand in the U.S. market causes more imports from Canada. In addition, demanding more imports from Canada is accelerated by the unfavorable movement of the U.S. dollar. An appreciation of the U.S. dollar generates more purchasing power of the U.S., and hence more demanding imports from Canada. The appreciation may cause a comparative disadvantage for the U.S. agricultural sector because a large portion of imports from Canada is raw materials that are processed for the U.S. domestic consumption rather than for exports to Canada.

Meanwhile, the product differentiation model (home market effects) is proper to explain intra-industry trade for three differentiated products, crude materials, manufactured goods, and machinery and transportation equipment. Thus, these products are not differentiated on the basis of country of origin, but rather differentiated based on production technology and consumers preferences of varieties (the “love of variety” as called in Dixit and Stiglitz (1977)). Since increasing return to scale exists for these products, the U.S. attracts foreign firms to locate and to produce varieties of these products. However, overall of the differentiated goods are more likely explained by both the exchange rate and border effects rather than the home market effect. An appreciation of the U.S. dollar generates more purchasing power for consumers to imports more varieties of products and also captivates foreign firms located in the U.S. market to sell many varieties of products at higher prices, causing scale effects for firms. Both U.S. dollar appreciation and lower transportation costs may affect plant scale of firms to expand their output, generating inward foreign direct investment for large-scale sectors.

We also examine the intra-industry trade patterns for SITC 2-digits, bilaterally traded between the U.S. and Canada, because of substitutability of products. For example, under the category 0 of SITC 1-digit (food and live animals), there are several sub-products, which seems not substitutable, such as meat and cereal, and more specific products may have different trade pattern than the one using SITC 1-digit. According to the results of using SITC 1, the results of three distinct products (food and live animals; manufactured goods; and machinery and transport equipment) of SITC 2-digit are presented Tables 2 to 4.[7]

Overall, the three reasons, the two alternative models (PD versus NPD), exchange rate, and border impacts, are proper to explain the asymmetric intra-industry trade for food and live animals between the U.S. and Canada (Table 2). Five products out of nine are well explained by the national product differentiation model. However, the exchange rate explains the trade pattern more than the national product differentiation model. The exchange rate impacts on more specific products (SITC 2) are larger than the one on the aggregate products of food and live animals (SITC 1), ranging from –1.336 (-2.672/2) for fish to –0.599 (-1.199/2) for sugar. Thus, increase in purchasing power of consumers due to the appreciation of the U.S. dollar is more proper to explain why Canada exports to the U.S. more than the U.S. exports to Canada for the agricultural products. The trade pattern for six specific products is explained by change in transportation cost as in Table 2. The coefficients of transportation costs (ϑ_3 in Table 2) are negative but the magnitude is much larger than those in Table 1 (from –1.645 to –0.643 in Table 2 versus –0.171 in Table 1). Thus, increase in transportation costs influences Canada exports to the U.S. more significantly than the U.S., indicating that higher prices of those products due to increase in transportation costs may cause less purchasing power of the U.S. consumers for those specific products produced in Canada.

For the manufactured and machinery products, the product differentiation model explains the trade pattern as well as do the exchange rate and transportation costs, consistent with the results using SITC 1-digit (Tables 3 and 4). For manufactured goods, the impacts of the relative market size (ϑ_1) and the exchange rats (ϑ_2) on more detailed products are not very different from the one on the aggregate products (SITC 1). For example, ϑ_1 and $\frac{1}{2}\vartheta_2$ for detailed manufactured products (SITC 2)range between 0.131 and 0.253 and between –1.261 and –0.399, respectively, (in Table 3), while they are 0.109 and –1.018, respectively, for aggregate products (in Table 1). However, the border effects (ϑ_3) on detailed products are different from the one on aggregate products. For aggregate products (SITC 1), the effects are negative, implying that a smaller country, Canada, has a larger impact of change in transportation costs. However, positive coefficients are found when SITC 2-digit is used, implying the U.S. has more impacts due to unfavorable movements of transportation costs, when more specific products are examined. For example, change in transportation costs affect exports of leather manufactures (category 61), cork and wood (category 63), and paper (category 64) in the U.S. rather than

Canada by showing positive coefficients, 0.337, 0.183, and 0.143, respectively, while other detailed products show consistency with one using SITC 1. Similar results also occur to machinery products. Electrical machinery products (category 77) in Table 4 shows positive coefficient of transportation costs, 0.204. For these products, foreign firms located in the U.S. face higher prices due to increase in transportation costs, generating detrimental effects on the U.S. exports to Canada.

Conclusion

After the Canada-US Free Trade Agreement (CUSTA), the increase has been greater for Canadian exports to the United States than U.S. exports to Canada especially for agricultural products (Koo and Uhm, 2000). There are some suggested reasons to explain this trade pattern, such as role of exchange rate and role of Canadian Wheat Board. In the presented paper, we try to find alternative and more fundamental reasons to explain the pattern of agriculture trade between Canada and the United States during the post-CUSTA period.

In analyzing the intra-industry trade pattern between the U.S. and Canada, dynamic interaction among variables should not be ignored, which can answer the question of impact of change in relative market size, exchange rates, and border effects. We develop an empirical model to examine the time-series relationships within the gravity model specification. All three reasons, the product differentiation versus national product differentiation models, exchange rates, and border effects, are proper to explain the trade pattern. However, the exchange rate impact is found to be most significant factor, affecting bilateral trade between the two countries.

In addition to the exchange rate impacts, we find that pattern of trade of large-scale manufacturing sector is well explained by the product differentiation model, while, in the case of the agricultural sector, the national product differentiation model is appropriate. Considering the fact that the U.S. market is larger market than Canadian market, the results implies that large-scale manufacturing industries in the U.S. will have gains from the trade liberalization through the economies of scale, while U.S. agriculture and food processing sectors will have loss due to the liberalization as well as unfavorable movements of the U.S. dollar.

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Notes

[1] Also, Schmitz and Koo (1996) emphasize that Canadian Wheat Board would play a significant role stimulating increase in Canadian exports to the United States. Boarder effect is also analyzed to explain bilateral trade pattern but there is no significant result for agricultural product, specially, between the U.S. and Canada.

[2] Bergstrand (1985; 1989) and Baier and Bergstrand (2001) use general price indexes in each country, while Anderson and Wincoop (2001) made custom programming to calculate the indexes. Harrigan (1996), Hummels 1999), Redding and Venables (2000) and Rose and Wincoop (2001) used fixed effects to take account of the unobserved price indexes.

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

[4] In fact, many studies assume this symmetric condition when they used a panel data with a gravity model (i.e., Rose, 1998; Glick and Rose, 2000 more). Therefore, we do not believe the assumption is so strong.

[5] See Johansen and Juselius (1992), Juselius and MacDonald (2000b), and Kim and Koo (2002) for the LR test of Unit Root.

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

[7] The rest of results are available on request.

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

	Relative Market Size		$\ln S_t$	$\ln T_t$	Time Trend	
	ϑ_1' in (11)	ϑ_1 in (10)	ϑ_2 in (10)	ϑ_3 in (10)	Model (11)	Model (10)
0: 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)
1: Beverage	**0.887** (0.412)	-0.329 (0.816)	**-2.530** (0.834)	**-1.488** (0.250)	**-0.014** (0.005)	**0.040** (0.011)
2: Crude	**0.790** (0.350)	**0.208** (0.065)	**-1.328** (0.443)	**-0.136** (0.073)	-	**0.011** (0.003)
3: Fuels	**0.378** (0.025)	0.139 (0.808)	**-3.485** (1.431)	**-1.541** (0.459)	-	**0.047** (0.020)
4: 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)
5: 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)
6: Manufacture	**0.468** (0.176)	**0.109** (0.032)	**-2.036** (0.210)	**-0.077** (0.037)	-	**0.006** (0.002)
7: 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 U.S. 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%.

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

SITC 2	Market Size (ϑ_1)	$\ln S_t$ (ϑ_2)	$\ln T_t$ (ϑ_3)	Trend
00: live animals	0.135 (0.347)	**-2.196** (0.826)	**-1.287** (0.482)	0.034 (0.020)
01: meat	**-0.258** (0.046)	**-1.457** (0.609)	-0.437 (0.279)	**-0.037** (0.007)
02: dairy production	**-0.168** (0.069)	**-1.384** (0.161)	**-1.645**[a] (0.832)	**-0.048** (0.020)
03: fish	**-0.144** (0.023)	**-2.672** (0.898)	0.058 (0.270)	**-0.041** (0.007)
04: cereals	**-0.390** (0.102)	**-2.316** (0.284)	-0.040 (0.102)	**0.024** (0.002)
05: vegetables & fruits	**-0.294** (0.147)	**-2.502** (0.823)	**-0.643** (0.270)	**-0.025** (0.012)
06: sugars	-0.192 (0.240)	**-1.199** (0.632)	**-0.821** (0.176)	-0.005 (0.006)
07: coffee & tea	-0.374 (0.286)	0.204 (0.838)	**-0.706** (0.248)	0.018 (0.011)
08: feed for animals	-0.130 (0.312)	**-1.915** (0.776)	**-0.965** (0.315)	-0.003 (0.007)

These results are obtained by running Model (10). Numbers in parentheses are standard errors.

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

SITC 2	Market Size (ϑ_1)	$\ln S_t$ (ϑ_2)	$\ln T_t$ (ϑ_3)	Trend
61: leather	**0.179** (0.082)	**-1.936** (0.713)	**0.337** (0.177)	**-0.023** (0.008)
62: rubber	**0.131** (0.039)	**-1.494** (0.265)	**-0.324** (0.074)	**-0.007** (0.002)
63: cork & wood	**0.175** (0.073)	**-1.522** (0.253)	**0.183** (0.055)	0.012 (0.007)
64: paper	**0.158** (0.049)	**-0.798** (0.367)	**0.143** (0.069)	**-0.009** (0.003)
65: textile yarn	**0.181** (0.076)	**-2.001** (0.395)	**-0.264** (0.119)	-0.008 (0.006)
66: nonmetallic mineral	0.150 (0.110)	**-2.056** (0.856)	0.191 (0.218)	0.009 (0.006)
67: iron & steel	**0.253** (0.033)	**-2.359** (0.638)	**-0.851** (0.186)	**0.036** (0.011)
68 nonferrous metals	**0.163** (0.030)	**-1.064** (0.224)	**-0.196** (0.067)	**0.010** (0.002)
69: metals	0.159 (0.363)	**-2.522** (0.268)	0.058 (0.103)	-

Numbers in parentheses are standard errors.

Table 4: Intra-industry Trade Pattern for Machinery Products using SITC 2-digits

SITC 2	Market Size (ϑ_1)	$\ln S_t$ (ϑ_2)	$\ln T_t$ (ϑ_3)	Trend
71: power generating machinery	0.120 (0.171)	**-1.520**[a] (0.787)	-0.207 (0.276)	-0.001 (0.012)
73: metalworking	**0.224** (0.037)	**-1.524** (0.653)	**0.368**[a] (0.186)	**-0.026** (0.004)
74: general industrial	**0.149** (0.031)	**-1.755** (0.270)	**-0.274** (0.079)	**-0.010** (0.002)
75: office	**0.183** (0.035)	**-1.841** (0.346)	0.737 (0.610)	**0.067** (0.013)
77: electrical	**0.175** (0.020)	**-1.657** (0.357)	**0.204**[a] (0.106)	**-0.021** (0.002)
78: road vehicles	**0.103** (0.045)	**-0.434**[a] (0.221)	**-0.259** (0.110)	**-0.006** (0.003)
79: transport equipment	**0.128**[a] (0.067)	-0.994 (0.602)	**-0.518** (0.191)	**-0.008** (0.004)

Numbers in parentheses are standard errors.