# INTERNATIONAL TRADE AND THE BORDER EFFECT BETWEEN CANADA AND UNITED STATES

by

Fei Huang

Bachelor of Business Administration, Trent University, 2013

A Report Submitted in Partial Fulfilment of the Requirements for the Degree of

Master of Arts

in the Graduate Academic Unit of Economics

Supervisor: Mehmet Dalkir, PhD, Dept. of Economics

Examining Board: Mike Farnworth, PhD, Dept. of Economics

Tony Myatt, PhD, Dept. of Economics

This report is accepted by the Dean of Graduate Studies

THE UNIVERSITY OF NEW BRUNSWICK

January, 2016

**Abstract**

The trade relationship between Canada and the United States is intense under the North American Free Trade Agreement (NAFTA). Canada and the U.S. are mutually the largest trade partners. However, McCallum (1995) stated that trade between provinces is about 20 times larger than trade between any particular province and state. The national border has significant effects on the trade between Canada and the United States. This study follows McCallum's methodology to explore how border effects changed from 1991 to 2011. Border effects between Canada and the U.S. is declining with the development of economy and policy change. Moreover, New Brunswick surprisingly has lower border effect with states of the U.S. compared to other provinces of Canada.

**Acknowledgement**

It is a genuine pleasure to express my deep thanks and gratitude to my supervisor Dr. Mehmet Dalkir, Department of Economics, University of New Brunswick. I am grateful for his constant guidance and encouragement. Without his help this master report would not have been possible.

I would like thank to the examining board, Dr. Mike Farnworth and Dr. Tony Myatt, Department of Economics, University of New Brunswick. Their comments are very important for me to improve quality of the paper.

I also thank to every professor who teach me. I learn a lot from their courses. In addition, a thank go to my friends and family who are always support me.

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## CHAPTER I：Introduction

Canada and the United States are two of most developed countries in the world. These two countries have cooperated in terms of trading the output of many industries. Canada and the United States have the longest international border and they are the second and fourth geographically largest countries. Thirteen States of the U.S. and eight Canadian provinces and territories of Canada are located along the border between these countries. There are no significant geographical barriers such as a mountain range or a dessert, between their landmass so it provides suitable conditions for transportation and consequently for international trade. Moreover, Canada and the U.S. have similar cultures and English is the most common language spoken in the both countries.

In 1988, Canada and the U.S. signed The Free Trade Agreement (FTA). This agreement eliminated a large number of trade restrictions and barriers in stages over a ten-year period. It significantly increased cross-border trade and improved the economies of the two countries. With the development of cooperation and its economy, new trade partner Mexico joined the agreement in 1994. During this same year, FTA was replaced by the North American Free Trade Agreement (NAFTA). The main targets of the free trade agreement include decreasing barriers to trade in goods and services, facilitating conditions for fair competition within the free trade area, and liberalizing conditions for investment within free trade area. In 2014, Canada exported 403 billion Canadian Dollars worth of

goods and services to the U.S., which accounts for 77% of total Canadian international trade. During the same year, the U.S. exported 344 billion Canadian dollars worth of goods and services to Canada, which accounted 19 % of total international trade for the United States. The U.S. and Canada are mutually their biggest international trade partners.

Based on the above background information, Canada and the U.S. have good conditions for cross-border trade on many aspects such as geography, economy, culture similarity, language, and economic policy. The trade volume between Canada and the U.S. is much higher in comparison to their trade with other countries. However, it is surprising that the Canada-U.S. trade and the internal trade within their respective regions are significantly different. McCallum (1995) states that, "other things equal, trade between provinces is more than 20 times larger than the trade between a province and a state". Under NAFTA, international border between the two countries is less restrictive, and so the Canada-U.S. trade should not be much different in comparison to the inter-provincial trade. Therefore, the indication is that trade restrictions at the border between two countries still has significant effects on the cross-border trade.

In this paper, we investigate the significance of the border effect between Canada and the U.S., and how the border effect changed during the 20 years between 1991 and 2011. Particularly, we estimate the New Brunswick border effect as well. Our model is based on the Gravity Model. The model predicts the bilateral trade base on economic size and distance. McCallum (1995) developed the Gravity model by adding a border dummy

variable that is the key variable to indicate the border effect between Canada and US. In this report, we apply difference-in-difference method as sensitivity test as well. There are four subsequent sections in this report: literature review, methodology, empirical results, and policy implications.

## CHAPTER II: Literature review

McCallum (1995) states that the national borderline matters significantly with regard to trade between Canada and the United States. In his article, McCallum uses a standard gravity model to examine trade between Canadian provinces and the U.S. states. He included a dummy variable to indicate if the trade is from one particular province to one other. As mentioned in the introduction, the author finds that, holding other relevant variables constant, trade between two Canadian provinces is more than twenty times larger than trade between that same province and ant particular U.S. state. Obstfeld and Rogoff (2000) point out the six puzzles of international macroeconomics. Home bias is one of six puzzles mentioned. Obstfeld and Rogoff (2000) also discuss whether the plausible trade costs combined with standard estimates of elasticity of substitution across imports and exports can explain the puzzle.

The topic of border effects and North American economic interaction has been studied for a long time. Coulombe (2006) summarizes studies that explore this topic. There are two

main parts in his study. The first part is a review and discussion of the study of Anderson and van Wincoop (2001). In the second part, Coulombe's estimates on border effects for Canada and the ten provinces with a sample spanning the years 1981-200. Coulombe (2006) found that the border effect on goods trade is declining from 1981 to 2001.

Chen, Rus, and Sen (2012) published a study that focuses on the changes of border effects before and after 9/11 attacks. They build an industry level panel data set from 1992 to 2005. Before 9/11, the border effect was declining since North American Free Trade Agreement (NAFTA) that implemented in 1995. After the 9/11, the flow of goods across the Canada\U.S. border slow down because the U.S. government significantly increased resources devoted to the border security. In addition to this main result, the authors reference the sources for each data set they examine and especially for the provinces-to-provinces trade and provinces-to-states trade, which was beneficial during preparation of this manuscript.

Wall (2000) finds that the border has significant effect on the volume of trade between the U.S. and Canada. In addition, this paper considered the heterogeneity bias. They use two different models: general gravity model, and heterogeneous gravity model. The home bias ratio increased over 40% when heterogeneous gravity model replaced standard gravity model. The home bias on flow from the U.S. to Canada becomes smaller than that of flows from Canada to the United States.

Query (2014) considers a case where the border effect is heterogeneous across states

and provinces. One potential reason for economically large regions to have smaller border effects is that the cost of crossing the U.S.-Canada border is fixed. The authors estimate a Gravity model and include the importer market size and population density as determinants of border effects. They conclude that a 10% increase in the market size of an importing country would increase cross-border trade by 2.6%.

Yi (2013) argue that border effect is problematic in the standard gravity models, because the border effect is only consistent with high elasticities of substitution between goods and/or high-unobserved national border barriers. In order to analyze the problem of border effect, the author introduces vertical specialization, which occurs when regions specialize only in particular stages of a good's production sequences. Vertical specialization magnifies the effects of border barriers such as tariffs that can potentially explain the border effects.

Baier and Bergstand (2004) explore the question: "do free trade agreements actually increase members' international trade?" They use the gravity model to examine the effects of free trade agreements. Their answer is affirmative. Overall, this article contributes to the literature in two ways: on the one hand, it uncovers the positive effect of free trade agreements on international trade. In my paper, the border effect changes after Canada and the United States signed the North American Free Trade Agreement. The authors' conclusion is similar to my findings. On the other hand, this article discusses the problem of endogeneity and how to statistically account for this. The sources of endogeneity bias

include omitted variables, simultaneity, and measurement errors. Those problems may be statistically accounted for using instrumental variable, control-function, and/or panel data techniques. In my paper, I consider the endogeneity bias as well.

Helliwell (1996) follows the method of McCallum to investigate whether national borders matter for Quebec's trade. The author examines 1988, 1989, 1990 data to estimate the border effect for Canada and Quebec separately. The estimates of border effect for Canada in 1988 is 19.9[1], which is slightly smaller than McCallum's finding. The estimates of border effect for Quebec are 14.3, 14.2 and 16.2 respectively for 1988, 1989 and 1990. The border effect for Quebec is also significant. In addition to this result, the paper provides a methodology to test border effect for one specific province. Application of this method to New Brunswick's case is quite possible. I examine the border effect for New Brunswick follow Helliwell's method.

Wei (1996) provides a definition of home bias and estimates the home bias ratio for OECD countries from 1982 to 1994. Generally, he found that intra-national trade is two and a half times higher than international trade among OECD countries during this period. The result is smaller than the estimate of McCallum, but the home bias or border effect is still significant. Moreover, from 1982 to 1994, the home bias ratio is slowly decreasing and the effect of the regional trade bloc on home bias is significant.

[1] Other things equal, trade between provinces is more than 19.9 times larger than the trade between a province and a state

Anderson and Wincoop (2001) take an important step forward for the theory of border effect. They discuss McCallum (1995) findings and point out that this paper omits terms related to remoteness and multilateral resistance. They extend McCallum's model by adding resistance term. After controlling for size and distance, the paper concludes that the national border makes the trade between Canada and the U.S. decline by approximately 44%.

## CHAPTER III: Data Description and Methods

### 3.1 Data

The dataset consists of five series: trade value between each province, trade value between provinces and states, GDP of provinces, GDP of states and distance between locations. Province-to-province data is obtained from CANSIM survey tables[2], Statistics Canada. The data covers the years 1992 to 2011 for each province and territory of Canada. The province-to-state export and import figures are obtained from Trade Data Online[3], Statistics Canada. This data is available from 1990 to 2014 for each Canadian province and each United State. The GDP of each province and state are from Statistics Canada and the U.S. Census Bureau respectively. The distance data collected from the website of

[2] CANSIM is Statistics Canada's key socioeconomic database. It provides a fast and easy access for a large range of latest statistics available in Canada.

[3] Trade Data Online is the database of Statistic Canada and it provides custom-based statistics on international trade.

DistanceFromTo. It includes the straight distance and driving distance for each provinces and states. In order to make a strong balanced panel dataset, the range of data has chosen from year 1992 to year 2011, a series of 20 years. In addition, all the export values, import values, and GDP values are measured with current Canadian dollars.

McCallum (1995) examines 10 provinces because the economic size of Canadian territories are relatively small and there is negligible trade volume between the territories and provinces, and states. Out of the 10 provinces, eight of them are located along the national border. For the United States, the dataset includes 30 states[4] which are relatively large and along the Canada/U.S. border line. Trade between these provinces and states are accounted for a vast majority of Canada-U.S. trade. This sample consists of 7,800 observations: each province can trade with 39 possible locations. Since there are 10 provinces that given 390 observations. And we have that for 20 years, giving us 390*20=7,800[5]. In the database, some observations are zero. According to "A Practical Guide to Trade Policy Analysis by World Trade Organization", there exist two methods to deal with the zero-trade flows. One can either drop zero observation or assume that the dollar value of trade is a very small number. If the zero observations are randomly distributed, the first method will be applicable. However, in this case zero trade value is probably associated with long distance and high bilateral trade cost. If we just drop the zero

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

[5] Between the states and provinces, imports and exports, are time different series

observations, the result may be inconsistent. Therefore, the second method is applied and zero observations are treated as if a small amount of trade tool place.

## 3.2 Model

### 3.2.1 Theoretical model: gravity model

In 1962, Tinbergen point out the size of trade between two countries could be approximated by the gravity equation. In Newtonian theory of gravity, planets are attracted to each other depending on their mass and proximity. Similarly, in the gravity model of trade, bilateral trade depends on trade partners' economic size (GDP) and proximity (distance). According to Coulumbe (2006), the gravity model is represented by the following equation:

$$\text{trade(ij)} = \frac{AY(i)^b Y(j)^c}{dist(ij)^d} \qquad (1)$$

where b and c are income elasticities of trade and d is distance elasticity. Other variables may enter the equation in multiplicative form represented by coefficient A. The equation usually transformed to the following linear equation.

$$\ln trade(ij) = \beta_0 + \beta_1 \ ln \ Y_i + \beta_2 \ ln \ Y_j - \beta_3 \ ln \ dist_{ij} + \varepsilon_{ij} \qquad (2)$$

Therefore, the standard method to estimate gravity model is to take natural logarithms for all variables to obtain a log-linear equation that could be estimated by linear regression.

3.2.2 Regression model

The regression model is based on McCallum (1995). McCallum used a simple regression model to estimate the border effect between the U.S. and Canada by adding a border dummy variable into the gravity equation.

$$\ln trade(ij) = \beta_0 + \beta_1 \ln Y_i + \beta_2 \ ln \ Y_j + \beta_3 \ ln \ dist_{ij} + \beta_4 \ Dummy_{ij} + \varepsilon_{ij} \qquad (3)$$

where trade(ij) is trade flow from the origin i to the destination j and it is the dependent variable in the model. $Y_i$ and $Y_j$ are the GDP figures for trade partners i and j respectively. Independent variable $dist_{ij}$ is the distance between i and j. Border dummy is the binary variable that is equal to 1 if the trade is inter-provincial and 0 if the trade is a cross the border trade between Canada and the U.S.

McCallum（1995）examines cross-sectional data for a particular year. The sample examined below is a 20-year long panel data set. The panel equation estimate is.

$$\ln trade(ijt) = \beta_0 + \beta_1 \ln \mathrm{GDP}_{it} + \beta_2 ln \ GDP_{jt} + \beta_3 \ ln \ dist_{ij} + \beta_4 dummy_{ij} + \varepsilon_{ijt} \qquad (4)$$

The $dummy_{ij}$ is the key variable that indicates the border effect between Canada and the United States. We also expect the effect of this indicator variable on trade to change through the years from 1992 to 2011. Chen, Rus, and Sen (2012) propose two methods to estimate this equation. One is using OLS to estimate the border effects with a separate regression for each year. The other method proposed is a difference-in-differences

specification that condition border effect estimates through year specific dummies. For the first method, we estimate equation (4) to and predict border effect separately for each year from 1992 to 2011.

The second method is the "difference-in-differences" method. For this purpose, we add the interaction terms for border dummies and year dummies to the equation in order to estimate change of border effect from 1992 to 2011. According to Chen, Rus and Sen (2012) the equation described as follows, and it is applied to the existing panel dataset.

$$\ln trade(ijt) = \beta_0 + \beta_1 \ln \mathrm{GDP}_{it} + \beta_2 ln\ GDP_{jt} + \beta_3\ ln\ dist_{ijt} + \beta_4\ dummy_{ij} + \beta_5(dummy * year1993_t) + \beta_6(dummy * year1994_t) + \cdots\cdots + \beta_{23}(dummy * year2011_t) + \sum_i exporter_i + \sum_t year_t + \varepsilon_{ij} \qquad (5)$$

where $\beta_4$ is the border effect of 1992, and from $\beta_5$ to $\beta_{23}$ are the incremental border effect for each year. The estimates of $\beta_5$ to $\beta_{23}$ are termed the "difference-in-difference" estimator and measures the exogenous effects of the change on the dependent variable y. It shows the change of estimates during the particular period of time. Moreover, the dummy variables of exporters and year dummies are included as well. $\sum_i exporter_i$ represents dummies of exporters' GDP. $\sum_t year_t$ is the summation of estimates of specific years.

While McCallum and Helliwell's publications are based on the OLS method, the difference-in-differences method could be a sensitivity test to check whether the results are consistent among two different methods.

In order to estimate the specific border effect between New Brunswick and the United States, we use the same method to estimate the border effect for New Brunswick base on the trade flow data between New Brunswick and each state of U.S.

## CHAPTER IV: Results

### 4.1 Canada-the U.S. trade

#### 4.1.1 Descriptive Statistics

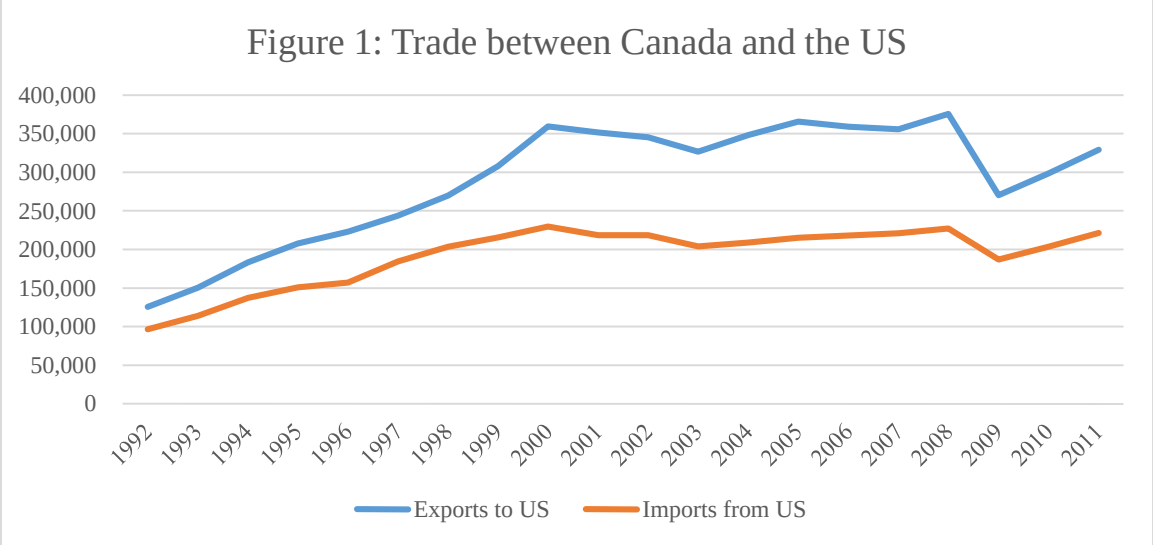



Figure 1 shows the trend of imports and exports between Canada and the U.S. for the 20 years under consideration. Overall, exports and imports have a similar trend. They simultaneously increase or decrease at each specific period. From 1992 to 2000, exports and imports were growing up significantly. The exports in this period increased from 125,670 million Canadian dollars to 359,289 million, which is about a three-fold growth.

The imports doubled in these years as well. After 2000, exports and imports were declining until 2003 and fluctuating up and down during 2007 and 2008. There is a sharp decline between 2008 and 2009. The exports changed from 375,480 million to 270,090 million which is about a 100,000 million decrease. Imports also dropped massively. After 2009, both exports and imports started to grow up.

### 4.1.2 Regression result

Table 1 shows the regression results for each year from 1992 to 2011 based on equation (3). Overall, from the corresponding p-values, all variables are significant at 1%. R-square for each regression is above 0.8.

The independent variables GDP of exporter and GDP of importer are highly positively correlated with the dependent variable. This indicates that the higher the GDP the more trade flow between the trade partners. The coefficient of distance is negative as expected. In the gravity model, distance is significantly associated with transportation cost. Generally, the trade cost will be higher with the increase of distance. Therefore, the longer the distance between two locations, the lower the trade between these locations.

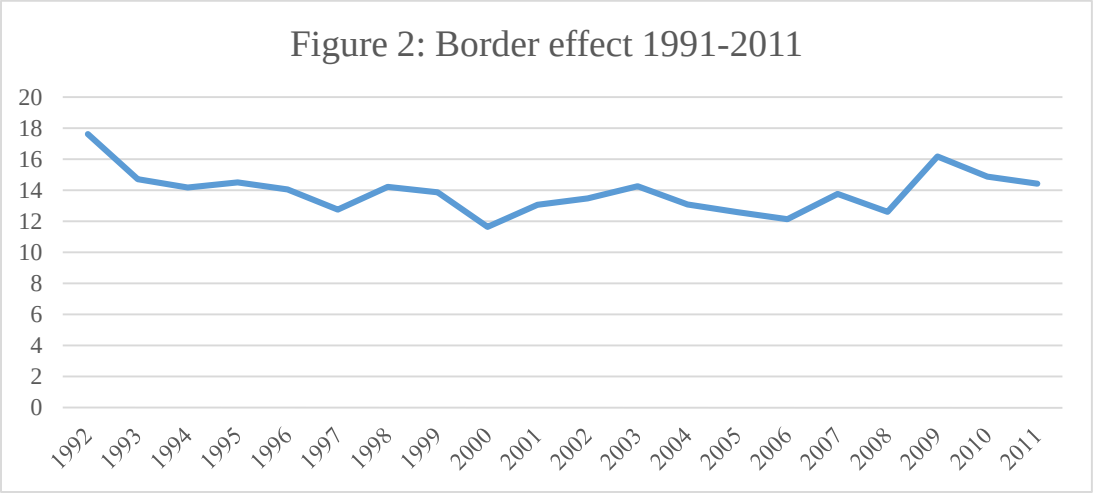



Table 2, in addition to dummy for border in Table 1, includes expected value of the year specific dummy for each year. Overall, the border effect is still large and it is above 10 for each year. Furthermore, Figure 2 shows the trend of change for the border effect between Canada and the United States. In 1992, the border effect is 17.61, which means that the inter-province trade is 17.61 times more than province-state trade. The number we get is lower than the estimate of McCallum: 22 based on older data. The border effect decreases from 1991 to 1997. The signing of North American Free Trade Agreement (NAFTA) in 1994 may be a factor in the decrease of the border effect. The border effect hit a low point in 2000 which is 11.64; the lowest level in 20 years. However, after this year the border effect grew until 2004. According to Chen, Rus, and Ren (2012), after the tragedy in 2001, the level of border security is highly increased. The cost of cross border trade increased with that change. From 2004 to 2008 the border effect fluctuates around 13 but it significantly increased to 16.7 in 2009. After this year, the border effect keeps decreasing.

**Table 1** **Regression Result-Canada and the U.S.**

| **year** | **1992** | **1993** | **1994** | **1995** | **1996** |
|---|---|---|---|---|---|
| | Coef. | Coef. | Coef. | Coef. | Coef. |
| lgdp_exporter | 1.32 | 1.25 | 1.25 | 1.26 | 1.27 |
| lgdp_importer | 0.98 | 0.97 | 0.96 | 0.99 | 0.98 |
| ldist | -1.35 | -1.33 | -1.34 | -1.34 | -1.37 |
| border | 2.87 | 2.69 | 2.65 | 2.67 | 2.64 |
| _cons | -11.00 | -10.21 | -10.02 | -10.53 | -10.33 |
| **year** | **1997** | **1998** | **1999** | **2000** | **2001** |
| | Coef. | Coef. | Coef. | Coef. | Coef. |
| lgdp_exporter | 1.24 | 1.25 | 1.24 | 1.19 | 1.18 |
| lgdp_importer | 0.93 | 0.97 | 0.96 | 0.93 | 0.93 |
| ldist | -1.40 | -1.39 | -1.39 | -1.36 | -1.35 |
| border | 2.55 | 2.65 | 2.63 | 2.45 | 2.57 |
| _cons | -9.25 | -9.92 | -9.77 | -9.09 | -9.10 |
| **year** | **2002** | **2003** | **2004** | **2005** | **2006** |
| | Coef. | Coef. | Coef. | Coef. | Coef. |
| lgdp_exporter | 1.18 | 1.20 | 1.19 | 1.18 | 1.15 |
| lgdp_importer | 0.90 | 0.93 | 0.92 | 0.95 | 0.97 |
| ldist | -1.35 | -1.35 | -1.34 | -1.41 | -1.44 |
| border | 2.60 | 2.66 | 2.57 | 2.53 | 2.50 |
| _cons | -8.97 | -9.53 | -9.32 | -9.21 | -8.86 |
| **year** | **2007** | **2008** | **2009** | **2010** | **2011** |
| | Coef. | Coef. | Coef. | Coef. | Coef. |
| lgdp_exporter | 1.16 | 1.14 | 1.11 | 1.15 | 1.15 |
| lgdp_importer | 0.95 | 0.93 | 0.95 | 0.95 | 0.98 |
| ldist | -1.36 | -1.38 | -1.33 | -1.37 | -1.41 |
| border | 2.62 | 2.54 | 2.78 | 2.70 | 2.67 |
| _cons | -9.34 | -8.75 | -9.22 | -9.29 | -9.41 |

**Table 2** **Border effect: Canada and the U.S.**

| Year | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|---|
| Border dummy | 2.87 | 2.69 | 2.65 | 2.67 | 2.64 | 2.55 | 2.65 | 2.63 | 2.45 | 2.57 |
| Border effect[6] | 17.61 | 14.72 | 14.18 | 14.51 | 14.05 | 12.76 | 14.21 | 13.86 | 11.64 | 13.07 |
| **Year** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** |
| Border dummy | 2.60 | 2.66 | 2.57 | 2.53 | 2.50 | 2.62 | 2.54 | 2.78 | 2.70 | 2.67 |
| Border effect | 13.48 | 14.25 | 13.09 | 12.58 | 12.13 | 13.77 | 12.62 | 16.17 | 14.87 | 14.42 |

Note: Border dummy is the estimate of border dummy variable, which is an estimate of $\beta_4$ in the equation (3) for this table.

Border effect is the expected value of border dummy. For instance, in 1992 the border dummy is 2.87 and then the border effect is EXP (2.87) =17.61.



[6] Border effect is the expected value of border dummy

## 4.2 Trade of New Brunswick

New Brunswick is one of three maritime provinces and it has 513 kilometres of national border with the United States. According to Wall (2000), the difference between inter-province trade and international trade is very significant if the distance is controlled for. Table 3 shows descriptive statistics of trade for New Brunswick. The left hand columns show New Brunswick' trade with 6 provinces as percentage of their GDP. The right hand columns show New Brunswick's trade with 6 states that are near or on the Canadian border as percentage of state's GDP in millions of Canadian dollars. If the border effect did not matter, the difference between the left hand side and the right hand side should not be large.

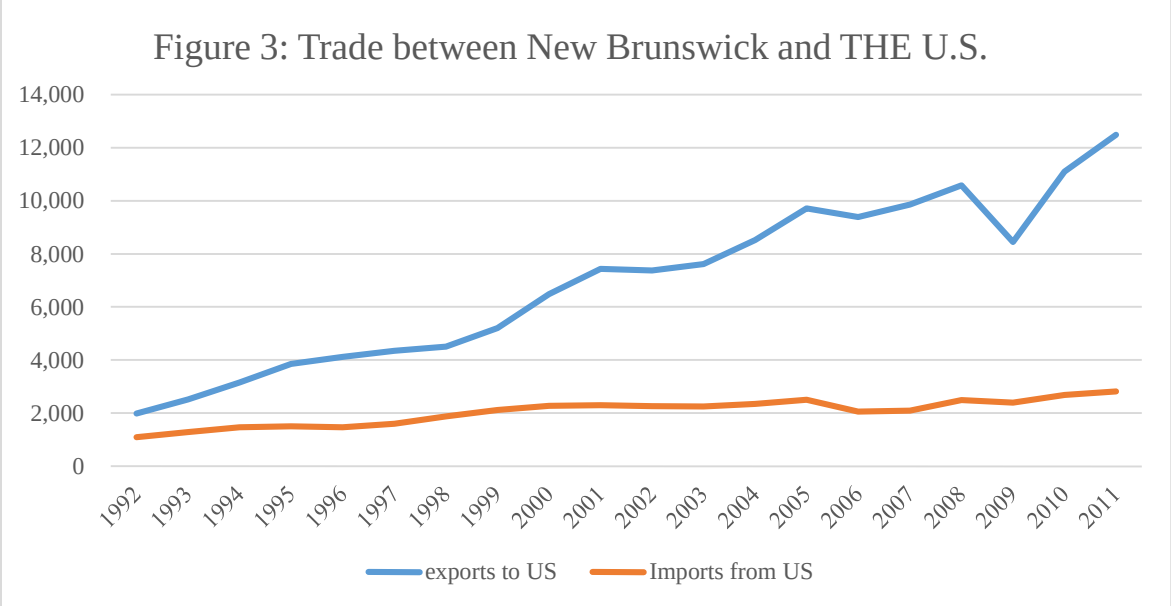
**Table 3 Trade of New Brunswick, 2011 (millions of CAD)**

| **Regions** | Export | GDP | % as GDP | **Regions** | Export | GDP | % as GDP |
|---|---|---|---|---|---|---|---|
| **Quebec** | 4,829 | 345,732 | 1.40% | **Massachusetts** | 1,171 | 412653 | 0.28% |
| **Nova Scotia** | 1,692 | 38,349 | 4.41% | **Maine** | 1,121 | 52007 | 2.16% |
| **PEI** | 645 | 5,409 | 11.92 % | **New Hampshire** | 6,524 | 64246 | 10.16 % |
| **Ontario** | 1901 | 658,635 | 0.29% | **New York** | 483 | 1234073 | 0.04% |
| **Alberta** | 1061 | 299,142 | 0.35% | **Montana** | 4 | 40193 | 0.01% |
| **British Columbia** | 386 | 217,460 | 0.18% | **Washington** | 31 | 372444 | 0.01% |

### 4.2.1 Descriptive statistics

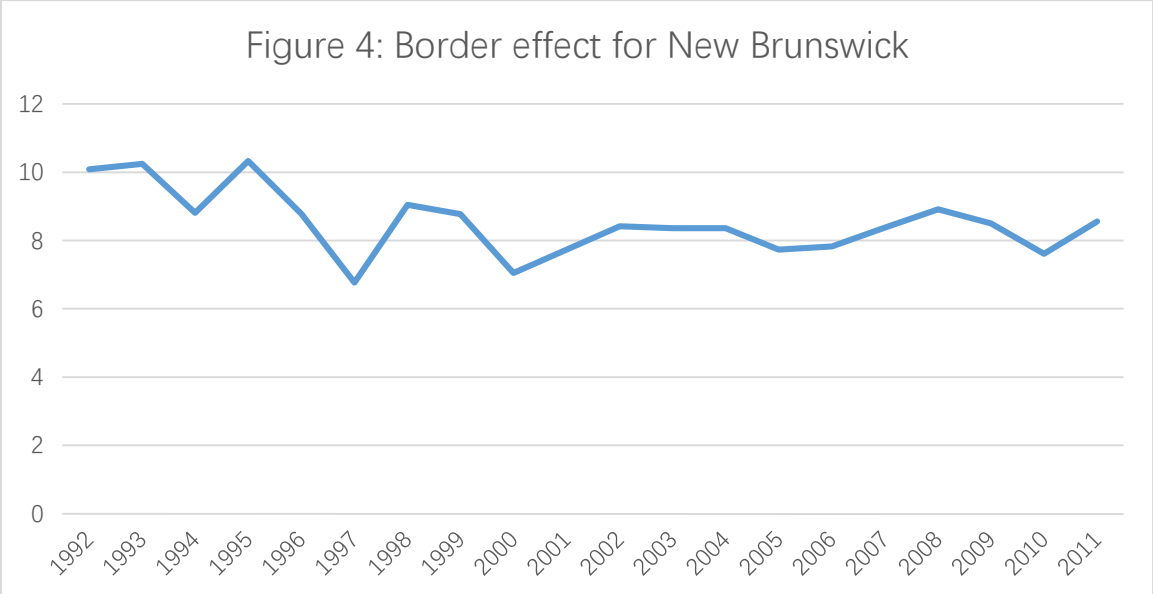
In order to exam the specific border effect for New Brunswick, we apply the same method using solely the data from New Brunswick. Figure 3 shows that the import and

export trends for New Brunswick are different with the lines we get from Figure 1 for Canada. Exports kept increasing from 1992 to 2008 and the approximate difference is a significant 8,000 million dollars. Similar to the overall Canadian situation, exports faced a sharp decrease in 2008. The exports from New Brunswick to the U.S. reduced from 10,000 million to 8,000 million and which is approximately a 20% fall in one year. After this year, exports start climbing again and growing fast. Exports increased to 12,500 million dollars at the end of 2011. As for imports, the change is quite small compared to exports. From 1992 to 2011, the imports from the U.S. to New Brunswick increased from 1,288 million to 2,818 million which is just a 1,530 million change over 20 years. Therefore, New Brunswick is running trade surplus with the U.S. and the trade balance has been growing larger over the last 20 years.



4.2.2 Regression result for trade of New Brunswick

Table 4 shows the New Brunswick trade regression results for each year. We get similar estimates for the independent variable such as exporter's GDP and importer's GDP compared to the result from Table 1 which shows the result for Canada overall. The distance parameter estimate is negative which is expected. Table 5 report the border dummy variable parameter estimates from 1992 to 2011 and the associated border effect. Surprisingly, the border effect for New Brunswick is smaller than the border effect for overall Canada. The average border effect is 8.52 for New Brunswick and 13.9 for Canada.




In figure 4, the border effect changes significantly from 1992 to 2000. It peaks at 10.33 in 1994 and then decrease to 6.77 in 1997. After 2000, the border effect grew to 8.42 and remains close to this level for the rest of the period.

**Table 4** **Regression result: New Brunswick and the U.S.**

| year | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|
| | Coef. | Coef. | Coef. | Coef. | Coef. |
| lgdp_exporter | 1.12 | 1.14 | 1.11 | 1.14 | 1.17 |
| lgdp_importer | 0.91 | 1.02 | 0.99 | 1.04 | 1.00 |
| ldist | -1.32 | -1.33 | -1.34 | -1.38 | -1.42 |
| border | 2.31 | 2.33 | 2.18 | 2.33 | 2.17 |
| _cons | -8.03 | -9.29 | -8.53 | -9.18 | -8.75 |
| **year** | **1997** | **1998** | **1999** | **2000** | **2001** |
| | Coef. | Coef. | Coef. | Coef. | Coef. |
| lgdp_exporter | 1.20 | 1.18 | 1.18 | 1.07 | 1.01 |
| lgdp_importer | 0.93 | 0.99 | 0.98 | 0.88 | 0.89 |
| ldist | -1.51 | -1.48 | -1.45 | -1.34 | -1.37 |
| border | 1.91 | 2.20 | 2.17 | 1.95 | 2.05 |
| _cons | -7.44 | -8.43 | -8.52 | -6.93 | -6.44 |
| **year** | **2002** | **2003** | **2004** | **2005** | **2006** |
| | Coef. | Coef. | Coef. | Coef. | Coef. |
| lgdp_exporter | 1.05 | 1.07 | 1.06 | 1.07 | 1.12 |
| lgdp_importer | 0.90 | 0.87 | 0.85 | 0.85 | 0.87 |
| ldist | -1.37 | -1.33 | -1.30 | -1.38 | -1.45 |
| border | 2.13 | 2.12 | 2.12 | 2.05 | 2.06 |
| _cons | -7.05 | -7.08 | -7.05 | -6.62 | -6.87 |
| **year** | **2007** | **2008** | **2009** | **2010** | **2011** |
| | Coef. | Coef. | Coef. | Coef. | Coef. |
| lgdp_exporter | 1.12 | 1.07 | 1.07 | 1.02 | 1.08 |
| lgdp_importer | 0.85 | 0.85 | 0.82 | 0.80 | 0.91 |
| ldist | -1.35 | -1.33 | -1.27 | -1.24 | -1.31 |
| border | 2.13 | 2.19 | 2.14 | 2.03 | 2.15 |
| _cons | -7.30 | -6.91 | -7.12 | -6.53 | -7.86 |

**Table 5** **Border effect: New Brunswick and the U.S.**

| **year** | **1992** | **1993** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** |
|---|---|---|---|---|---|---|---|---|---|---|
| border dummy | 2.31 | 2.33 | 2.18 | 2.33 | 2.17 | 1.91 | 2.20 | 2.17 | 1.95 | 2.05 |
| Border effect | 10.09 | 10.24 | 8.81 | 10.33 | 8.79 | 6.77 | 9.05 | 8.78 | 7.05 | 7.73 |
| **year** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** |
| border dummy | 2.13 | 2.12 | 2.12 | 2.05 | 2.06 | 2.13 | 2.19 | 2.14 | 2.03 | 2.15 |
| Border effect | 8.42 | 8.36 | 8.36 | 7.74 | 7.83 | 8.38 | 8.91 | 8.50 | 7.62 | 8.56 |

## 4.3 Sensitivity analysis

### 4.3.1 Difference-in-Difference method

In the previous chapter, the estimates of the border effect by OLS model are based on McCallum's methodology. Now we use difference-in-difference method to run the regression. Unit root test is applied to check whether the variable is stationary before we run the regression. Base on Fisher type augmented Dickey-Fuller tests, the dependent variable ln (trade flow) is significant at 1% level, which means it is stationary[7]. The independent variables ln (importer GDP) is significant but it has a judgement for the independent variable ln (exporter GDP), which will be explained in the limitation part.

Table 6 shows the regression result based on equation (5). Overall, the border effect changed from 16.78 to 13.81 for year 1992 to 2011. From 1992 to 1997, the border effect has been decreasing. After 1997, it started to increase but significantly dropped from 13.72 to 11.94 from 1999 to 2000. From 2000 on, the border effect increased to 14.61 in 2003 and then declined to 11.97 in 2006. After that year, the border effect started to fluctuate significantly increasing between 2008 and 2009. Finally, the border effect started to decrease starting from 2009.

The results in Figure 2 (OLS) and Figure 5 (difference-in-differences) are similar although the methods are quite different. The similarity is not only for the estimate of the

[7] See the result of Stata in the appendix

border effect, but also for the tendency of change. For instance, the trends of border effect are decreasing from 1992 and 1997 in both Figure 2 and Figure 5. The border effects that estimated by two different methods reach the lowest points in 2000. Furthermore, in Figure 5 the change of the border effect is significant between 2008 and 2009, which is the same tendency we observe in Figure 2 that estimated by regular linear regression.

Besides the estimates of border dummies, other parameter estimates are in the Appendix, Table 11. The Alberta, British Columbia, Ontario and Manitoba parameter estimates are significantly higher than other provinces. It means the provinces of Alberta, British Columbia, Ontario and Manitoba have more exports to U.S than other provinces.

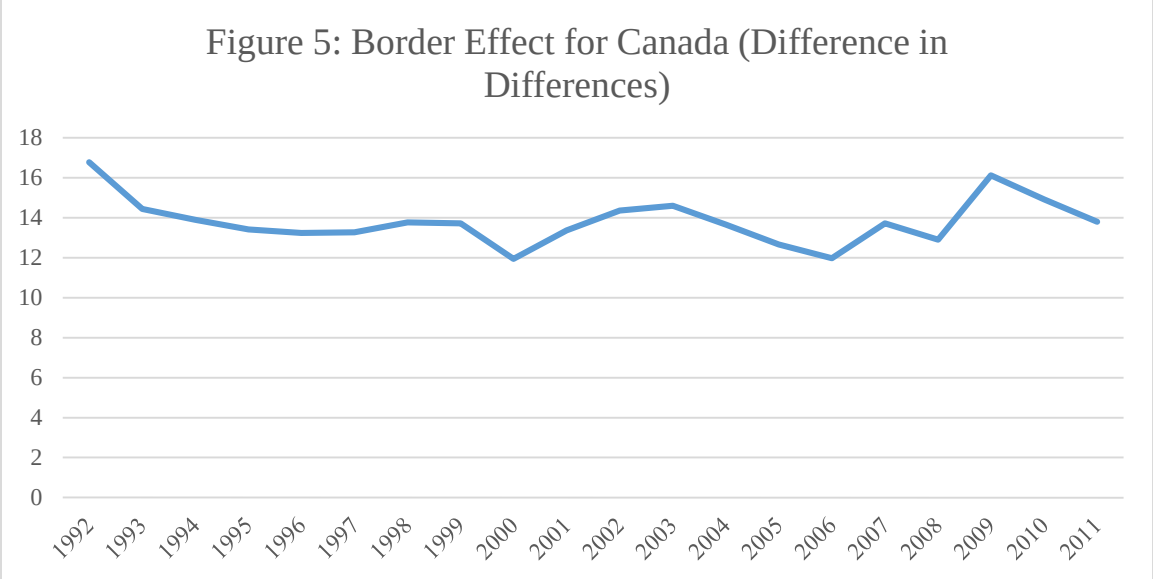


**Table 6** **Regression result: Canada and the U.S. (difference in difference method)**

| year | Overall | | 1993 | | 1994 | | 1995 | | 1996 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coef. | P>z | Coef. | P>z | Coef. | P>z | Coef. | P>z | Coef. | P>z |
| border dummy | 2.82 | 0.00 | -0.15 | 0.05 | -0.19 | 0.02 | -0.23 | 0.00 | -0.24 | 0.00 |
| lgdp_exporter | 0.88 | 0.00 | | | | | | | | |
| lgdp_importer | 0.95 | 0.00 | | | | | | | | |
| ldist | -1.41 | 0.00 | | | | | | | | |
| **year** | **1997** | | **1998** | | **1999** | | **2000** | | **2001** | |
| | Coef. | P>z | Coef. | P>z | Coef. | P>z | Coef. | P>z | Coef. | P>z |
| border dummy | -0.24 | 0.00 | -0.20 | 0.01 | -0.21 | 0.01 | -0.34 | 0.00 | -0.23 | 0.00 |
| **year** | **2002** | | **2003** | | **2004** | | **2005** | | **2006** | |
| | Coef. | P>z | Coef. | P>z | Coef. | P>z | Coef. | P>z | Coef. | P>z |
| border dummy | -0.16 | 0.05 | -0.14 | 0.07 | -0.21 | 0.01 | -0.28 | 0.00 | -0.34 | 0.00 |
| **year** | **2007** | | **2008** | | **2009** | | **2010** | | **2011** | |
| | Coef. | P>z | Coef. | P>z | Coef. | P>z | Coef. | P>z | 2011 | P>z |
| border dummy | -0.20 | 0.01 | -0.27 | 0.00 | -0.04 | 0.58 | -0.12 | 0.13 | -0.20 | 0.01 |

**Table 7** **Border effect for Canada ( Difference in differences)**

| year | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|---|
| border dummy | 2.82 | 2.67 | 2.63 | 2.59 | 2.58 | 2.58 | 2.62 | 2.61 | 2.48 | 2.59 |
| border effect | 16.78 | 14.44 | 13.89 | 13.41 | 13.25 | 13.28 | 13.77 | 13.72 | 11.94 | 13.37 |
| **year** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** |
| border dummy | 2.66 | 2.68 | 2.61 | 2.54 | 2.48 | 2.62 | 2.55 | 2.78 | 2.70 | 2.62 |
| border effect | 14.37 | 14.61 | 13.66 | 12.67 | 11.97 | 13.72 | 12.91 | 16.13 | 14.92 | 13.81 |

### 4.3.2 Adjustment for Distance

With regard to the international trade between Canada and the U.S., trucking is the main mode of transportation. Based on the report of Transport Canada (2011), road transportation accounts for about 45% of total value for the Canada's export to the U.S., and 73% of total value for the imports from the United States. Since distance matter, I replaced the straight distance by driving distance in order to identify whether the change impacts the border effects differently. Table 8 shows that the log trucking distance coefficient estimates remains negative. The numbers are smaller than Table 1 and the possible reason may be that the driving distance is always longer than the straight distance between two places. In addition, for the result of border dummy, the coefficients are very similar with the previous estimates and the border effect is still significant. The change of distance does not change the border effect significantly.

Because the relationship between distance and trade flow is probably non-linear, Table 9 reports the regression results arrived at after including distance squared. The coefficient of the distance becomes much smaller compared to the result in Table 1 and it is definitely negative. Again this modification does not have a significant influence on the border effect.

**Table 8** **Regression Result-Canada and the U.S.(modified by distance)**

| year | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|
| | Coef. | Coef. | Coef. | Coef. | 1996 |
| lgdp_exporter | 1.30 | 1.23 | 1.23 | 1.24 | 1.25 |
| lgdp_importer | 0.95 | 0.94 | 0.94 | 0.97 | 0.96 |
| ldist_truck | -1.36 | -1.34 | -1.36 | -1.36 | -1.39 |
| border | 2.92 | 2.74 | 2.70 | 2.72 | 2.69 |
| _cons | -10.11 | -9.35 | -9.13 | -9.61 | -9.37 |
| **year** | **1997** | **1998** | **1999** | **2000** | **2001** |
| | Coef. | Coef. | Coef. | 2000 | 2001 |
| lgdp_exporter | 1.22 | 1.23 | 1.22 | 1.18 | 1.16 |
| lgdp_importer | 0.91 | 0.94 | 0.93 | 0.91 | 0.91 |
| ldist_truck | -1.41 | -1.41 | -1.41 | -1.38 | -1.38 |
| border | 2.60 | 2.70 | 2.68 | 2.50 | 2.62 |
| _cons | -8.30 | -8.96 | -8.80 | -8.15 | -8.07 |
| **year** | **2002** | **2003** | **2004** | **2005** | **2006** |
| | Coef. | Coef. | Coef. | Coef. | Coef. |
| lgdp_exporter | 1.17 | 1.19 | 1.17 | 1.17 | 1.14 |
| lgdp_importer | 0.88 | 0.90 | 0.90 | 0.92 | 0.94 |
| ldist_truck | -1.37 | -1.38 | -1.36 | -1.43 | -1.47 |
| border | 2.65 | 2.70 | 2.62 | 2.59 | 2.55 |
| _cons | -8.01 | -8.55 | -8.41 | -8.20 | -7.82 |
| **year** | **2007** | **2008** | **2009** | **2010** | **2011** |
| | Coef. | Coef. | Coef. | Coef. | Coef. |
| lgdp_exporter | 1.22 | 1.12 | 1.10 | 1.13 | 1.13 |
| lgdp_importer | 0.91 | 0.91 | 0.93 | 0.92 | 0.96 |
| ldist_truck | -1.41 | -1.40 | -1.36 | -1.39 | -1.44 |
| border | 2.60 | 2.59 | 2.84 | 2.76 | 2.73 |
| _cons | -8.30 | -7.75 | -8.23 | -8.32 | -8.36 |

**Table 9** **Regression Result-Canada and the U.S.(modified by distance_square)**

| **year** | **1992** | **1993** | **1994** | **1995** | **1996** |
|---|---|---|---|---|---|
| | Coef. | Coef. | Coef. | Coef. | Coef. |
| lgdp_exporter | 1.32 | 1.25 | 1.25 | 1.26 | 1.27 |
| lgdp_importer | 0.98 | 0.97 | 0.96 | 0.99 | 0.98 |
| ldist_square | -0.67 | -0.66 | -0.67 | -0.67 | -0.69 |
| border | 2.87 | 2.69 | 2.65 | 2.67 | 2.64 |
| _cons | -11.00 | -10.21 | -10.02 | -10.53 | -10.33 |
| **year** | **1997** | **1998** | **1999** | **2000** | **2001** |
| | Coef. | Coef. | Coef. | Coef. | Coef. |
| lgdp_exporter | 1.24 | 1.25 | 1.24 | 1.19 | 1.18 |
| lgdp_importer | 0.93 | 0.97 | 0.96 | 0.93 | 0.93 |
| ldist_square | -0.70 | -0.70 | -0.69 | -0.68 | -0.68 |
| border | 2.55 | 2.65 | 2.63 | 2.45 | 2.57 |
| _cons | -9.25 | -9.92 | -9.77 | -9.09 | -9.10 |
| **year** | **2002** | **2003** | **2004** | **2005** | **2006** |
| | Coef. | Coef. | Coef. | Coef. | Coef. |
| lgdp_exporter | 1.18 | 1.20 | 1.19 | 1.18 | 1.15 |
| lgdp_importer | 0.90 | 0.93 | 0.92 | 0.95 | 0.97 |
| ldist_square | -0.68 | -0.68 | -0.67 | -0.70 | -0.72 |
| border | 2.60 | 2.66 | 2.57 | 2.53 | 2.50 |
| _cons | -8.97 | -9.53 | -9.32 | -9.21 | -8.86 |
| **year** | **2007** | **2008** | **2009** | **2010** | **2011** |
| | Coef. | Coef. | Coef. | Coef. | Coef. |
| lgdp_exporter | 1.16 | 1.14 | 1.11 | 1.15 | 1.15 |
| lgdp_importer | 0.95 | 0.93 | 0.95 | 0.95 | 0.98 |
| ldist_square | -0.68 | -0.69 | -0.67 | -0.69 | -0.71 |
| border | 2.62 | 2.54 | 2.78 | 2.70 | 2.67 |
| _cons | -9.34 | -8.75 | -9.22 | -9.29 | -9.41 |

4.3.3 Endogeneity of GDP

With regard to equation (3), an endogeneity problem may exist because the dependent variable export is already included in the independent variable GDP. According to McCallum (1995), it is applicable to replace the log GDP with log population. The model then becomes:

$$\ln trade(ij) = a + b \ln pop_i + c \ \ ln \ \ \text{pop}_j - d \ \ ln \ \ dist_{ij} + eDUMMY_{ij} + \varepsilon_{ij} \qquad (6)$$

where $\text{pop}_i$ is the population of location i and $\text{pop}_j$ is the population of location j. Other variables remain the same as in the equation (3).

Table 10 reports the equation (5) regression results. All independent variables are all significant at 1%. The log population coefficient estimates are positive that indicate the trade flow increased with higher population size of exporter and importer. The coefficient of distance remains negative as expected. For border effect, the coefficient is lower than in Table 1 but the change is not significant. For example, the border coefficient estimates in Table 1 are 2.87, 2.69 and 2.65 respectively for the years 1992, 1993 and 1994. For these same years, the coefficients are 2.74, 2.48 and 2.38 respectively in Table 10. The border dummy coefficients did not change significantly with the introduction of instrumental variables. Furthermore, the border dummy parameter estimate decreases from 2.87 to 2.65 in three years in comparison to Table 1, and from 2.74 to 2.36 from Table 10. In summary the trend of change remains the same and coefficients all decease simultaneously over the

**Table 10** **Regression Result-Canada and the U.S.(modified by popylation)**

| **year** | **1992** | **1993** | **1994** | **1995** | **1996** |
|---|---|---|---|---|---|
| | Coef. | Coef. | Coef. | Coef. | Coef. |
| lpop_exporter | 1.44 | 1.37 | 1.38 | 1.38 | 1.38 |
| lpop_importer | 1.06 | 1.04 | 1.04 | 1.07 | 1.06 |
| ldist | -1.36 | -1.32 | -1.33 | -1.33 | -1.37 |
| border | 2.73 | 2.48 | 2.38 | 2.39 | 2.34 |
| _cons | -22.47 | -21.18 | -20.96 | -21.45 | -21.00 |
| **year** | **1997** | **1998** | **1999** | **2000** | **2001** |
| | Coef. | Coef. | Coef. | Coef. | Coef. |
| lpop_exporter | 1.36 | 1.37 | 1.35 | 1.30 | 1.29 |
| lpop_importer | 1.02 | 1.06 | 1.05 | 1.02 | 1.02 |
| ldist | -1.40 | -1.40 | -1.39 | -1.35 | -1.35 |
| border | 2.23 | 2.25 | 2.23 | 2.13 | 2.21 |
| _cons | -19.92 | -20.46 | -20.05 | -19.02 | -18.83 |
| **year** | **2002** | **2003** | **2004** | **2005** | **2006** |
| | Coef. | Coef. | Coef. | Coef. | Coef. |
| lpop_exporter | 1.30 | 1.30 | 1.28 | 1.27 | 1.23 |
| lpop_importer | 1.02 | 0.99 | 0.99 | 1.01 | 1.02 |
| ldist | -1.35 | -1.32 | -1.31 | -1.34 | -1.36 |
| border | 2.13 | 2.39 | 2.38 | 2.41 | 2.44 |
| _cons | -19.02 | -18.89 | -18.54 | -18.61 | -18.01 |
| **year** | **2007** | **2008** | **2009** | **2010** | **2011** |
| | Coef. | Coef. | Coef. | Coef. | Coef. |
| lpop_exporter | 1.22 | 1.19 | 1.16 | 1.19 | 1.19 |
| lpop_importer | 1.00 | 0.97 | 0.99 | 0.98 | 1.01 |
| ldist | -1.28 | -1.28 | -1.29 | -1.31 | -1.33 |
| border | 2.64 | 2.59 | 2.73 | 2.76 | 2.79 |
| _cons | -18.20 | -17.15 | -17.16 | -17.35 | -17.50 |

years.

4.3.4 Multilateral resistance term (MTR) and remoteness

As mentioned in the literature review, some economists discuss variables that McCallum (1995) omits. Anderson and Wincoop (2003) modify the analysis in McCallum (1995) by adding a multilateral resistance term (MTR). The trade cost between country i and county j is not just the single cost of bilateral trade. If goods are exported from country i to country j, not only the average trade cost of importer j with other trading partners, but also the average cost of exporter i with their trading partners should be considered. However, MTRs as price indices cannot be observed. The easier way to control multilateral resistance term is adding the proxy variable, which is the "remoteness variable" into the model. The equation of remoteness based on Anderson and Wincoop(2003) is

$$\mathrm{REM}_i = \sum_{m \neq j} d_{im}/y_m$$

This variable is intended to account for the average distance of region i from all trading partners other than j. Where $y_m$ is partner traders' shares of total GDP. McCallum's regression then becomes

$$\ln trade(ijt) = \beta_0 + \beta_1 \ln \mathrm{GDP}_{it} + \beta_2 ln\ \ GDP_{jt} + \beta_3\ \ ln\ \ dist_{ij} + \beta_4 DUMMY_{ij} +$$

$$\beta_5\ \ REM_i + \beta_6\ \ REM_j + \varepsilon_{ijt} \qquad (7)$$

After adding the remoteness variable, McCallum's result changes. According to Chen, Rus and Sen (2012), the border effect becomes smaller after adding the proxy variable but

change is not significant. For instance, they estimated the border effects as 10.80 and 10.38 in 1992 before and after adding the remoteness respectively. Moreover, their finding is consistent with other publications in the literature. Therefore, estimation of border effect by adding remoteness variable, has not been considered here.

### 4.3.5 Linear model

The regression model that I use in this study is log-log model. In order to test whether the log-log model and linear model are different, I use linear model to estimate the border effect as well. After regression, the coefficient of border dummy variable is extremely large[8]. For the result of log-log model, the border effect is the expected value of the coefficient of border dummy. The expected value is the reversing the log in the log-log model, and it is not necessary for the linear model.

## CHAPTER V: Policy implications

5.1 Border effect persistence

Border effect is related to many factors such as political barriers, distance, culture and language differences, and so on. According to Nitsch and Wolf (2009), the specific reasons that cause border effect are hard to identify. They state that there are three hypotheses to

[8] see the regression result in the Appendix

test the origins of border effect: “political barriers” hypothesis, “fundamentals” hypothesis and “artefact” hypothesis. For the first hypothesis, border effect is mainly caused by the political barriers such as tariffs, different national standards, and different currencies. These barriers can be quickly removed. For the second hypothesis, border effect is endogenous and it is related to the cultural, linguistic, social, business networks, and geographical factors. Under this hypothesis, border effect may slowly deteriote, but does not vanish completely. The third hypothesis is related to the finding of Anderson and Wincoop. Trade costs are highly nonlinear, and distance and trade costs are difficult to measure properly. The border effect may be overestimated. In short, in our case Canada and the U.S. do not have significant barriers such as language, culture, and geography under the second hypothesis. Therefore, if government of Canada or the New Brunswick provincial government want to remove the border effect, policy change might be a proper way to go.

## 5.2 Canadian perspective

There is no doubt that globalization has developed rapidly in the past few decades and it will be continually progress in the future. Canada is one of the most developed countries and has integrated with trading partners and the world economy. McCallum (1995) found the inter-provincial trade of Canada is about 20 times more than cross border trade between the U.S. and Canada based on 1988 data. The border effect was significant at that time. However, with the new existing free trade agreements and foreign policies, the border

effect is diminishing during the last 25 years. Those trade agreements and policies that relate to transportation, foreign investment, tariffs, and border security have had significant effects to eliminate barriers such as deceasing trade costs, and increasing efficiency to cross the border. My result reflects the significant change of the border effect after NAFTA.

The border effect of 2011 is the most recent year in my data set. The border effect of that year is 14.2, which is still significant. It indicates the trade flows between provinces is still much higher than that between provinces and states. However, the overall trend of border effect is decreasing. Based on my finding and the potential trade opportunities, we can predict that the border effect will continue to diminish in the future. First, with the development of globalization, transportation may become more efficient and the transportation cost may decline. Second, the world is becoming more and more open, that means the differences of culture and languages will no longer stand as barriers for the international trade. Last but most importantly, the government of Canada has strategies to open new markets, and create new businesses between Canada and its trading partners. Governments are encouraged to seek further opportunities of cooperation. For instance, Trans Pacific Partnership (TPP) is a trade agreement among 12 pacific rim countries. Canada has considered the free trade agreement with Trans-Pacific partners. According to Global Affairs Canada, the TPP is the largest free trade agreement in the world history. It will promote the economy and enhance the role of Canada in Asia-Pacific. It is estimated that this region will achieve half of the global GDP by 2050. Therefore, with those factors

the border effect will be likely decrease in the next few decades.

## 5.3 New Brunswick perspective

According to Lambert (2013), the average annual growth of export from 2007 to 2012 for New Brunswick is 5.7%, which is much higher than the rate for overall Canada (0.2%). The import growth rates are 12% and 2.6% for New Brunswick and Canada respectively. New Brunswick's international trade is continually growing and the relationship between New Brunswick and the U.S. is expanding. However, the exports from New Brunswick to the U.S. involves a relatively narrow range of goods. According to Kukucha (2008), the biggest part of export is non-crude petroleum and the second part and the third parts are lumber and crustaceans (crabs and lobster). In 1997 the percentage weight of those three items are 29.9%, 12.7% and 3.2% respectively. In 2006 the percentages changed to 57.7%, 4.0% and 3.4% respectively. The proportion of non-crude petroleum is increasing fast and it is dramatically bigger than proportions of other products. Although New Brunswick has lower border effect and higher increase rate of export than the overall Canada, the government of New Brunswick still need to promote international trade and attempt to improve the diversity of traded items.

Compared to New Brunswick, some provinces such as British Columbia and Alberta already have strategies for foreign trade and those strategies can be indicators or references for the government of New Brunswick. For British Columbia, the Asia-Pacific Initiative

started as early as 1997. According to Asia-Pacific Initiative Annual Report 2009-2010, the initiative includes five priority strategies. “First, building a global identity for Canada’s Pacific Gateway. Second, strengthen B.C.’s trade and investment relationships. Third, develop a world-class supply chain and gateway infrastructure. Fourth, develop and attract a labour force. Last, position B.C. as North America’s Asia-Pacific destination”. Through those strategies British Columbia expected the stronger international trade and a better relationship with Asian countries such as China, India, Japan and South Korea. Alberta has the similar strategies that are meant to stimulate international trade with the U.S. and other partners. According to Alberta’s International Strategy 2013, there are four strategic objectives. “First, diversify markets to expand the economy. Second, build Alberta’s reputation as a global citizen. Third, prepare Albertans for success in the global community. Fourth, prioritize and integrate government actions to take advantage of international opportunities”. These Alberta strategic objectives are meant to maintain the growth and improvement on the international trade and relationship.

Even though New Brunswick has a smaller economy and smaller population compared to British Columbia and Alberta, the government of New Brunswick should concentrate on promoting the economy based on the province’s own advantages. Department of Intergovernmental Affairs of New Brunswick has three objectives for New Brunswick’s international strategy. The first one is to develop economic relations with trading partners (especially with the U.S.) by encouraging international trade, increasing

international investment and improve tourism industry. The second objective is to strengthen human capital such as providing suitable environment for immigrants and improving New Brunswicker's skills and knowledge. The third one is developing partnerships and networks with federal government, trading partners, national and international organizations in order to exploit opportunities.

## 5.4 Limitation and further discussion

The major limitation for this study is lack of reliable data. We only have the data from 1992 to 2011 that is for twenty years' data for trade flows from province to province and from province to state. The trade flows from states to states are not available for every year over this period. If we have had the data, we will be able to estimate the border effect for the United States and compare it with the result of Canada. Anderson and Winoop (2001) state that the border effects for the U.S. is much smaller than that of Canada. The possible explanation is the smaller size of the Canadian economy. However, the data that the author use is cross sectional data rather than a panel. Therefore, at this point we can only focus on the border effect over 20 years' and from Canada's perspective.

There is another limitation about data. It is hard to answer why the border effect is so big at this stage. The data used in this study is province and state level trade flows data. If the data of specific industry and product level data were available, it would be possible to explore which industry or product have had significant impact on the border effect.

The unit root test we apply is the Fisher type test base on the augmented Dicky-Fuller test. The data series taken independently may still be non-stationary, but with 20 data points for each GDP and trade series, it is hard to determine that.

## CHAPTER VI: Conclusion

In conclusion, this study follows McCullum (1995) and based on the gravity model to estimate the border effects between Canada and the U.S. through a period of 20 years. The border effect for Canada overall is declining. The border effect is 17.61 in 1992 and it decreased to 14.42 in 2011. There are significant fluctuations during this period. According to Chen, Rus, and Sen (2012), the significant changes are likely related to the introduction of NAFTA and the 9/11 tragedy. The result of this study is consistent with their finding. In addition to the overall Canadian border effect, the New Brunswick's border effects is estimated. Compared to overall Canada, the New Brunswick's border effect is lower. The border effect is 10.05 in 1992 and it declined to 8.56 in 2011. Although the border effect for New Brunswick is lower, the government still needs to continually develop international trade with the U.S. and other partners, and also improve the diversity of the trade.

The trade relations of provinces are closer than the trade between provinces and states. However, we predict that border effect will become smaller in the future with the

development of globalization and the new free trade agreements such as Trans-Pacific Partnership. However, border effect absorbs the effect of the missing variables real exchange rate and the transportation costs. Given the high fluctuations in the exchange rate and the oil prices since 1992, the border effect still seems to be quite flat. The exact border effect is difficult to be measured completely. With the development of globalization, Canada will have more opportunities to develop its economy and play a more and more important role in the world.

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## Appendix

| **Table 11** | **Full Regression result: Canada and US (difference in difference method)** | | |
|---|---|---|---|
| Dependent Variable | Coef. | Std. Err. | P>z |
| ldist | -1.409677 | 0.0616742 | 0 |
| lgdp_importer | 0.9452391 | 0.032687 | 0 |
| lgdp_exporter | 0.881264 | 0.0626411 | 0 |
| border | 2.823815 | 0.1187907 | 0 |
| border*1993 | -0.1535044 | 0.0789067 | 0.052 |
| border*1994 | -0.1927055 | 0.078995 | 0.015 |
| border*1995 | -0.2278582 | 0.079011 | 0.004 |
| border*1996 | -0.2400538 | 0.079046 | 0.002 |
| border*1997 | -0.2377875 | 0.0792556 | 0.003 |
| border*1998 | -0.2012373 | 0.079566 | 0.011 |
| border*1999 | -0.2051559 | 0.0795487 | 0.01 |
| border*2000 | -0.3439053 | 0.0794108 | 0 |
| border*2001 | -0.2307454 | 0.0795947 | 0.004 |
| border*2002 | -0.1587363 | 0.0796083 | 0.046 |
| border*2003 | -0.1423864 | 0.079135 | 0.072 |
| border*2004 | -0.2093197 | 0.0789723 | 0.008 |
| border*2005 | -0.2846712 | 0.0788668 | 0 |
| border*2006 | -0.3410664 | 0.0788403 | 0 |
| border*2007 | -0.2048763 | 0.0788956 | 0.009 |
| border*2008 | -0.2661211 | 0.0789878 | 0.001 |
| border*2009 | -0.0433239 | 0.0788502 | 0.583 |
| border*2010 | -0.1209381 | 0.0790245 | 0.126 |
| border*2011 | -0.1985854 | 0.0792191 | 0.012 |
| exporter_AB | 0.5529856 | 0.2000969 | 0.006 |
| exporter_BC | 0.4370452 | 0.1986708 | 0.028 |
| exporter_MB | 0.2849552 | 0.179179 | 0.112 |
| exporter_NB | 0.0009296 | 0.1826998 | 0.996 |
| exporter_NL | -0.9573424 | 0.1874031 | 0 |
| exporter_NS | -0.6262764 | 0.1804425 | 0.001 |
| exporter_ON | 0.4181845 | 0.2392227 | 0.08 |

| | | | |
|---|---|---|---|
| exporter_PE | -1.102202 | 0.2321651 | 0 |
| exporter_QC | -0.0554217 | 0.2143696 | 0.796 |
| exporter_SK | 0 | (omitted) | |
| year_1993 | 0.1134165 | 0.038274 | 0.003 |
| year_1994 | 0.1504225 | 0.0392258 | 0 |
| year_1995 | 0.181641 | 0.0402546 | 0 |
| year_1996 | 0.1525205 | 0.0412904 | 0 |
| year_1997 | 0.1269783 | 0.0430011 | 0.003 |
| year_1998 | 0.0620582 | 0.0453554 | 0.171 |
| year_1999 | 0.0375676 | 0.0477756 | 0.432 |
| year_2000 | 0.1174222 | 0.0512584 | 0.022 |
| year_2001 | 0.0061692 | 0.053183 | 0.908 |
| year_2002 | -0.107853 | 0.0556205 | 0.052 |
| year_2003 | -0.1581529 | 0.0566802 | 0.005 |
| year_2004 | -0.1366611 | 0.0591673 | 0.021 |
| year_2005 | -0.1529584 | 0.0618306 | 0.013 |
| year_2006 | -0.1520039 | 0.0644037 | 0.018 |
| year_2007 | -0.1735794 | 0.0671887 | 0.01 |
| year_2008 | -0.1581843 | 0.0704683 | 0.025 |
| year_2009 | -0.3576315 | 0.0684818 | 0 |
| year_2010 | -0.3372121 | 0.0707373 | 0 |
| year_2011 | -0.3030792 | 0.074281 | 0 |
| _cons | -5.565835 | 0.8535818 | 0 |

**Unit Root Test**

These are the Fisher-type unit-root test for time series variables based on augmented Dickey-Fuller tests.

| **Unit Root Test: ln (trade flow)** | | | |
|---|---|---|---|
| Ho: All panels contain unit roots | | | |
| Ha: At least one panel is stationary | | | |
| | | Statistic | p-value |
| Inverse chi-squared(780) | P | 1754.462 | 0 |
| Inverse normal | Z | -14.2742 | 0 |
| Inverse logit t(1954) | L* | -16.7095 | 0 |
| Modified inv. chi-squared | Pm | 24.6719 | 0 |

| **Unit Root Test: ln(exporter GDP)** | | | |
|---|---|---|---|
| Ho: All panels contain unit roots | | | |
| Ha: At least one panel is stationary | | | |
| | | Statistic | p-value |
| Inverse chi-squared(780) | P | 147.0879 | 1 |
| Inverse normal | Z | 24.2357 | 1 |
| Inverse logit t(1954) | L* | -23.7296 | 1 |
| Modified inv. chi-squared | Pm | -16.0244 | 1 |

| **Unit Root Test: ln(importer GDP)** | | | |
|---|---|---|---|
| Ho: All panels contain unit roots | | | |
| Ha: At least one panel is stationary | | | |
| | | Statistic | p-value |
| Inverse chi-squared(780) | P | 4761.7303 | 0 |
| Inverse normal | Z | -43.6028 | 0 |
| Inverse logit t(1954) | L* | -59.1323 | 0 |
| Modified inv. chi-squared | Pm | 98.5327 | 0 |

**Table 12** **Regression Result-Canada and US (linear model)**

| year | 1992 | | 1993 | | 1994 | | 1995 | | 1996 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coef. | P>t | Coef. | P>t | Coef. | P>t | Coef. | P>t | Coef. | P>t |
| gdp_exporter | 0.01 | 0.00 | 0.02 | 0.00 | 0.02 | 0.00 | 0.02 | 0.00 | 0.02 | 0.00 |
| gdp_importer | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| dist | -0.38 | 0.00 | -0.47 | 0.00 | -0.54 | 0.00 | -0.59 | 0.00 | -0.62 | 0.00 |
| border | 1228.50 | 0.00 | 1235.63 | 0.00 | 1244.65 | 0.00 | 1278.14 | 0.00 | 1346.98 | 0.00 |
| _cons | -136.52 | 0.00 | -72.36 | 0.00 | -66.13 | 0.00 | -26.10 | 0.00 | -33.20 | 0.00 |
| **year** | **1997** | | **1998** | | **1999** | | **2000** | | **2001** | |
| | Coef. | P>t | Coef. | P>t | Coef. | P>t | Coef. | P>t | Coef. | P>t |
| gdp_exporter | 0.02 | 0.00 | 0.02 | 0.00 | 0.02 | 0.00 | 0.02 | 0.00 | 0.02 | 0.00 |
| gdp_importer | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| dist | -0.70 | 0.00 | -0.74 | 0.00 | -0.80 | 0.00 | -0.88 | 0.00 | -0.83 | 0.00 |
| border | 1441.92 | 0.00 | 1439.18 | 0.00 | 1562.30 | 0.00 | 1724.93 | 0.00 | 1850.90 | 0.00 |
| _cons | -28.55 | 0.00 | -81.51 | 0.00 | -129.31 | 0.00 | -52.39 | 0.00 | -102.27 | 0.00 |
| **year** | **2002** | | **2003** | | **2004** | | **2005** | | **2006** | |
| | Coef. | P>t | Coef. | P>t | Coef. | P>t | Coef. | P>t | Coef. | P>t |
| gdp_exporter | 0.02 | 0.00 | 0.02 | 0.00 | 0.02 | 0.00 | 0.02 | 0.00 | 0.02 | 0.00 |
| gdp_importer | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| dist | -0.83 | 0.00 | -0.79 | 0.00 | -0.85 | 0.00 | -0.89 | 0.00 | -0.90 | 0.00 |
| border | 1887.26 | 0.00 | 2073.81 | 0.00 | 2154.52 | 0.00 | 2244.09 | 0.00 | 2433.65 | 0.00 |
| _cons | -86.22 | 0.00 | -134.14 | 0.00 | -65.52 | 0.00 | 2.92 | 0.00 | -23.35 | 0.00 |
| **year** | **2007** | | **2008** | | **2009** | | **2010** | | **2011** | |
| | Coef. | P>t | Coef. | P>t | Coef. | P>t | Coef. | P>t | Coef. | P>t |
| gdp_exporter | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 |
| gdp_importer | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| dist | -0.89 | 0.00 | -0.92 | 0.00 | -0.72 | 0.00 | -0.81 | 0.00 | -0.90 | 0.00 |
| border | 2623.51 | 0.00 | 2712.52 | 0.00 | 2912.48 | 0.00 | 3003.00 | 0.00 | 3088.79 | 0.00 |
| _cons | -82.23 | 0.00 | 18.80 | 0.00 | -222.98 | 0.00 | -196.24 | 0.00 | -43.65 | 0.00 |

**Curriculum Vitae**

Fei Huang

Post-secondary education:

Master of Art in Economics, University of New Brunswick

Master Report, “International Trade and the Border Effect Between Canada and United States”.

January 2014-Januaary 2016

Bachelor of Business of Administration, Trent University, Ontario, Canada.

September 2012-August 2014

Business School, Shandong Jianzhu University, China.

September 2010-Agust 2012