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DETERMINING THE EFFECT OF NAFTA ON THE NORTH AMERICAN SWEET  
POTATO MARKET

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## **Determining the Effect of NAFTA on the North American Sweet Potato Market**

***Abstract:** In order to analyze the effect of NAFTA on the North American sweet potato market, this study uses both observable trade data such as trade volumes and home prices and unobservable trade data such as imported prices and non-tariff trade costs. The unobservable trade data are estimated by the model used in this study. Unlike previous studies, this study confirms that the degree of integration in the North American sweet potato markets is relatively low because the three individual sweet potato markets are mostly dominated by their own product and the difference between home and imported prices in each NAFTA member country have increased from pre-NAFTA to post-NAFTA levels. Two counterfactual analyses confirm that low levels of market integration may be due to high non-tariff trade costs.*

*Key words:* NAFTA, Sweet Potatoes, Non-Tariff Trade Cost, Trade Creation, and Trade Diversion.

The North American Free Trade Agreement (NAFTA) facilitated agricultural trade among three North American countries (Zahniser et. al., 2015; and Zahniser and Crag, 2009). Sweet potato trade among NAFTA's member countries has grown remarkably since NAFTA was implemented in 1994. For example, the trade volume of sweet potatoes among the three North American countries has increased by more than 500%, from 44 million pounds in 1994 to 270 million pounds in 2011. As previous studies indicated (Balassa, 1961; Barichello et al., 1991; de Janvry, 1996; Gould, 1998; Grennes, 1991; Jayasinghe and Sarker, 2008; and Robbins, 2014), NAFTA has helped to raise the level of integration among North America's sweet potato markets.

However, sweet potato prices in the three North American countries are still significantly different. For example, average prices of sweet potatoes in post-NAFTA between 1994 and 2011 are \$0.175 per pound in the United States, \$0.483 per pound in Canada, and \$0.102 per pound in

Mexico. Furthermore, trade data suggests that there might be a much greater difference between prices of imported and locally grown sweet potatoes.

In empirical analyses, however, researchers face practical difficulties because some trade data are unobservable, such as non-tariff trade costs and final prices of goods consumed in the importing country and produced in the exporting country (Anderson and van Wincoop, 2004; Eaton and Kortum, 2002; Khan and Kalirajan, 2011; and Waugh, 2010). This is what motivates this study. Using the North American sweet potato market, this study shows how unobservable trade data can be obtained and in order to determine the effect of NAFTA on the North American sweet potato market. In describing the effect of NAFTA on the North American sweet potato market, this study focuses on 1) the effect of NAFTA on trade creation and diversion, and 2) the effect of non-tariff trade costs on price divergence.

In order to achieve these goals, this study adopts assumptions accepted by previous studies as follows: 1) the North American sweet potato consumer has a specific structure of utility which determines quantity demanded at a specific price level; 2) the trade costs, which represent the difference between the marginal cost in the exporting country and the price paid by the consumer in the importing country, consist of observable costs (tariffs) and unobservable costs (non-tariff trade costs); 3) factors of production are immobile between countries, implying that each of the member countries produces sweet potatoes using their own resources; and 4) there is a unique elasticity of substitution representing the quantity relationship given home and imported prices.

Based on these assumptions, this study proceeds as follows. In the next section, we develop a model in which the imported price is defined by consumer preference, total factor productivity, production costs, observable and unobservable trade costs, home prices, factor

prices, and expenditures. In section three, we briefly describe the North American sweet potato market. Data and estimated parameters are discussed in the fourth section. Empirical results follow in the next section. Finally, the paper concludes with future research recommendations.

## **Theoretical Framework**

### ***Demand Conditions***

NAFTA provides increased opportunities to North American consumers in choosing food products originating from different sources. As North American sweet potato consumers recognize differentiated sweet potatoes sourced from different origins, consumers' choice to maximize utility can be formulated by Dixit and Stiglitz's CES utility function as follows:

$$(1) \quad u_i = \left[ \sum_{j=1}^n q_{ij}^{\frac{\sigma}{\sigma-1}} \right]^{\frac{\sigma-1}{\sigma}},$$

where  $q_{ij}$  represents sweet potatoes consumed in country  $i$  and produced in country  $j$  and

$\sigma = 1 - \sigma^*$  where  $\sigma^*$  is elasticity of substitution (Dixit and Stiglitz, 1977; Solow, 1956; Tomeck and Robinson, 2003; and Varian, 1992).

Total expenditures by the consumer in country  $i$  on origin-differentiated sweet potatoes can be summarized as follows:

$$(2) \quad \sum_{j=1}^n p_{ij} q_{ij} = M_i,$$

where  $p_{ij}$  represents a price in country  $i$  coming from country  $j$  and  $M_i$  is total expenditure on sweet potatoes in country  $i$ .

This study defines quantity and price as follows:  $q_{ij}$  which is produced in country  $j$  and consumed in country  $i$  is the imported quantity of sweet potatoes,  $q_{ii}$  (or  $q_{jj}$ ) which is produced

in country  $i$  (or  $j$ ) consumption of domestic sweet potatoes,  $p_{ii}$  (or  $p_{jj}$ ) is the home price of sweet potatoes sold in country  $i$  (or  $j$ ) and produced in country  $i$  (or  $j$ ), and  $p_{ij}$  which is the imported price of sweet potatoes sold in country  $i$  and produced in country  $j$ . Observable trade data include  $q_{ij}$ ,  $q_{ii}$  (or  $q_{jj}$ ) and  $p_{ii}$  (or  $p_{jj}$ ). However, the price of imported sweet potatoes from country  $j$  and consumed in country  $i$  is not obtainable in the trade data. Therefore,  $p_{ij}$  must be estimated. Given the utility and budget structure above,  $p_{ij}$  can be estimated as follows:

$$(3) \quad p_{ij} = \left( \frac{q_{ij}}{q_{ii}} \right)^{\frac{1}{\sigma-1}} p_{ii}.$$

As equation (3) implies, the difference between home and imported prices in country  $i$  will increase if the difference between market shares of domestic and imported sweet potatoes in country  $i$  increases, while the difference between home and imported prices in country  $i$  will decrease if the difference between market shares of domestic and imported sweet potato in country  $i$  decreases.

Rational sweet potato consumers in country  $i$  display an import demand for sweet potatoes produced in country  $j$  as follows:

$$(4) \quad q_{ij} = \frac{p_{ij}^{\sigma-1} M_i}{\sum_{i=1}^n p_{ij}^{\sigma} \quad i}.$$

When sweet potatoes produced in country  $j$  move to country  $i$ , tariff and non-tariff trade costs are incurred. These trade costs are described as follows:

$$(5) \quad \tau_{ij} = \frac{P_{ij}}{t_{ij} P_{jj}},$$

where  $t_{ij}$  represents the value added tariff imposed by country  $i$  on sweet potatoes sourced from country  $j$  and  $t_{ij} > 1$  if  $i \neq j$  but  $t_{ij} = 1$  if  $i = j$ . The variable,  $\tau_{ij}$ , represents non-tariff trade costs resulting from the movement from country  $j$  to country  $i$  and  $\tau_{ij} > 1$  if  $i \neq j$  but  $\tau_{ij} = 1$  if  $i = j$ . The price,  $p_{jj}$ , is the exporting country's home price. Therefore,  $p_{ij} > p_{jj}$  if  $i \neq j$  but  $p_{ij} = p_{jj}$  if  $i = j$ . While the causality of the following may be reversed, the implications are important. One thing this framework indicates at this point is that if country  $i$  does not import from country  $j$ , non-tariff trade costs will be infinite,  $\tau_{ij} = \infty$ , so that no consumer in country  $i$  will purchase sweet potato imported from country  $j$  due to the unacceptably high price.

Substituting equation (5) into equation (4), we obtain an import demand equation defined by tariffs, non-tariff trade costs, exporter price, and importer expenditure as follows:

$$(6) \quad q_{ij} = \frac{(t_{ij}\tau_{ij}p_{jj})^{\sigma-1}}{\sum_{l=1}^n (t_{il}\tau_{il}p_{ll})^{\sigma}} M_i.$$

Therefore, import demand in country  $i$  for sweet potato produced in country  $j$  will be determined by trade costs, exporter's productivity, and importer's preference.

### ***Supply Conditions***

If the factor market for sweet potato production is opened, the production technology of North American sweet potato producers can be formulated by Dixit and Stiglitz's CES functions as follows:

$$(7) \quad q_j = \alpha_j \left[ \sum_{k=1}^n {}_k x_j^{\theta} \right]^{\frac{1}{\theta}},$$

where  $\alpha_j$  represents total factor productivity in country  $j$ , and  ${}_k x_j$  represents input factors used in country  $j$  that come from country  $k$ , with  $0 < \theta \leq 1$ .

The production costs can be summarized as follows:

$$(8) \quad C_j = \sum_{k=1}^K {}_k r_j {}_k x_j,$$

where  ${}_k r_j$  is factor price in country  $j$  for input factor,  ${}_k x_j$ , produced in country  $k$ . If factor market is immobile, then  $K = 1$ . This framework assumes that factors are immobile between countries.

Given production costs, the profit of the sweet potato producer in country  $j$  is summarized as follows:

$$(9) \quad \pi_j = \sum_{i=1}^n p_{ij} s_i q_j - \sum_{k=1}^K {}_k r_j {}_k x_j,$$

where  $q_j$  is total quantity of sweet potatoes produced in country  $j$  and  $s_i$  represents the share of  $q_j$  sold in country  $i$ .

Using Hotelling's Lemma, profit maximizing sweet potato producers in country  $j$  lead to a supply equation defined by total factor productivity, production costs, and prices of input factors as follows:

$$(10) \quad q_j = \frac{\alpha_j C_j}{\left[ \sum_{k=1}^K {}_k r_j^{\frac{\theta}{\theta-1}} \right]^{\frac{\theta-1}{\theta}}}.$$

Then, sweet potato supply to country  $i$  from country  $j$  is defined as follows:

$$(11) \quad s_i q_j = \frac{s_i \alpha_j C_j}{\left[ \sum_{k=1}^K {}_k r_j^{\frac{\theta}{\theta-1}} \right]^{\frac{\theta-1}{\theta}}}.$$

### ***Equilibrium Home and Imported Prices***



In equilibrium, country  $i$ 's demand for sweet potatoes produced in country  $j$  is equal to country  $j$ 's sweet potato supply to country  $i$ . Thus, the home price of exporting country  $j$  can be derived by setting equation (6) equal to equation (11) as follows:

$$(12) \quad p_{ij} = \frac{\left[ s_i \alpha_j C_j \sum_{l=1}^L (t_{il} \tau_{il} P_{ll})^\sigma \right]^{\frac{1}{\sigma-1}}}{t_{ij} \tau_{ij} \left( \sum_{k=1}^K r_j^{\frac{\theta}{\theta-1}} \right)^{\left( \frac{\theta-1}{\theta} \right) \left( \frac{1}{\sigma-1} \right)} M_i^{\frac{1}{\sigma-1}}}.$$

Substituting equation (12) into equation (5), we obtain the import price of country  $i$  defined in terms of market share, productivity, production costs, tariffs, non-tariff trade costs, exporter price, factor prices, and expenditures as follows:

$$(13) \quad p_{ij} = \frac{\left[ s_i \alpha_j C_j \sum_{l=1}^L (t_{il} \tau_{il} P_{ll})^\sigma \right]^{\frac{1}{\sigma-1}}}{\left( \sum_{k=1}^K r_j^{\frac{\theta}{\theta-1}} \right)^{\left( \frac{\theta-1}{\theta} \right) \left( \frac{1}{\sigma-1} \right)} M_i^{\frac{1}{\sigma-1}}}.$$

Given the elasticity of substitution, equations (4) and (13) are used to identify the effects of NAFTA on home and imported prices and the trade creation and diversion effects in the three North American countries. Furthermore, this study develops two counterfactual scenarios in order to identify the role of trade costs in the market integration of the three North American countries.

### **The North American Sweet Potato Market**

In the North American sweet potato market, the United States is a net exporter and Canada and Mexico are net importers. In 1989, U.S. exports to Canada and Mexico were 0.6 million pounds and 0.1 million pounds, respectively. In 2011, U.S. exports increased to 129 million pounds for Canada and 3 million pounds for Mexico, representing a 210 fold increase for Canada and a 26 fold increase for Mexico. In 1991, the U.S. home price was \$0.13 per pound. By 2011, the U.S.

home price had increased to \$0.19 per pound. In the pre-NAFTA period, U.S. imports of sweet potatoes were 20 million pounds in 1989, while the United States did not import sweet potatoes from Canada and Mexico during that time. In 2011, U.S. imports remained relatively constant at 23 million pounds. However, a shift had occurred as U.S. imports from Canada were 1 million pounds, although the United States still did not import from Mexico. Major exporting countries to the United States were China, the Dominican Republic, and Peru. In 1991, U.S. sweet potato production was 1,119 million pounds; by 2011, U.S. sweet potato production had increased to 2,696 million pounds, representing a 2.4 fold increase during the last twenty-one years. The data imply that the U.S. sweet potato market has been growing under NAFTA.

In 1988, Canadian imports of sweet potatoes were 19 million pounds. Among their suppliers, Canadian sweet potato imports from the United States were 15 million pounds, indicating that 80% of Canadian sweet potato imports came from the United States. Canadian sweet potato imports from Mexico was negligible, with only 11 thousand pounds in 1989. In 2011, Canadian imports of sweet potato increased to 134 million pounds, an 8 fold increase since 1988. During that time, Canadian sweet potato imports from the United States increased to 126 million pounds, a 9 fold increase. The U.S. share of the Canadian sweet potato market increased from 80% in 1988 to 95% in 2011. During the 1986 to 1988 time period, the Canadian home price of sweet potatoes ranged from \$0.31 per pound to \$0.41 per pound. From 1989 to 2011, the Canadian home price of sweet potatoes ranged from \$0.41 per pound to \$0.57 per pound.<sup>1</sup> In 1988, Canadian sweet potatoes exports were 0.6 million pounds, most of which were exported to the United States. In 2011, Canadian exports of sweet potatoes were 16 million pounds, a 26 fold increase in the last twenty-three years. Among these, Canadian sweet potatoes exports to the United States were 1 million pounds, representing 6.8% of total Canadian sweet potato exports.

Major importers of Canadian sweet potatoes were Australia, New Zealand, China, Saint Pierre and Miquelon, and the United Kingdom.

Mexican imports of sweet potatoes in 1989 were 73 thousand pounds, all of which were imported from the United States. In 2011, Mexican imports of sweet potatoes increased to 5 million pounds, an incredible 68 fold increase since 1989. In 1991, the Mexican home price of sweet potatoes was \$0.11 per pound; by 2011, that price had increased to \$0.13 per pound. In 1992, Mexican exports of sweet potatoes were a mere 51 thousand pounds, all of which were exported to the United States. In 2011, Mexican exports of sweet potatoes had increased 73 fold, to 3.7 million pounds. Between 1992 and 2011, Mexican sweet potato production increased from 103 million pounds to 116 million pounds, an increase of only 10 percent during that twenty year timeframe.

## **Data and Parameter Estimation**

### ***Data***

This study uses data obtained from secondary sources but also data estimated through the framework developed in this study. This analysis obtains data for domestic sweet potato production ( $q_j$  or  $q_i$ ), and imports ( $q_{ij}$ ) from the Food and Agriculture Organization of the United Nations [FAO] (2015). Given the start of NAFTA in 1994, this study uses 1986 to 2011 as the timeframe for this research as it includes pre- and post-NAFTA years. The U.S. home price ( $p_{ii}$  or  $p_{jj}$ ) data are obtained from U.S. Department of Agriculture, Economic Research Service (2015). Mexican home price data are obtained from the FAO (2015-a). This study uses sweet potato prices estimated by Agriculture and Agri-Food Canada as the home price of Canadian sweet potatoes (Agriculture and Agri-Food Canada, 2015). Labor is used as an index for input factors in sweet potato production. Hourly wages of the three NAFTA member

countries are obtained from the U.S. Department of Labor, Bureau of Labor Statistics (2015). This study also obtains sweet potato yield data from FAO (2015-b) which is used as an index for total factor productivity ( $\alpha_j$ ). U.S. sweet potato import tariff data are obtained from U.S. International Trade Commission (2015). Import tariff data for Canada and Mexico are obtained from Duty Calculator (2015).

This study also uses data estimated through our analytical framework. This study estimates the quantity of input factors used in production using equation (7) at  $\theta = 0.75$ . Import price data are obtained using equations (3) and (13), where this study fixes  $\theta = 0.75$  and  $\sigma = -3$ . Non-tariff trade costs ( $\tau_{ij}$ ) are estimated using equations (5) and (13). Sweet potato production costs are then calculated using equation (8). Market share data ( $s_i$ ), defined in equation (11), are calculated by  $q_{ij} / q_j$  where  $q_j = \sum_i q_{ij}$ . Total expenditure on sweet potatoes in country  $i$  ( $M_i$ ) is calculated by  $\sum_i p_{ij} q_{ij}$ .

### ***Parameter Estimation***

In order to conduct counterfactual analysis, this study estimates benchmark values of parameters in equation (13). The parameter values are estimated using the methods mentioned above and are presented in Table 1. For the purpose of this analysis, the parameter values are estimated for pre- and post-NAFTA periods.

### **[Table 1 Approximately Here]**

Market share parameters,  $s_i$ , show that the sweet potato markets of the three NAFTA member countries are dominated by their own products; this trend continues after the implementation of NAFTA, except for the U.S. sweet potato market. For example, the home share of sweet potatoes in the Mexican market increased from 98.3% pre-NAFTA to 99.6% post-

NAFTA, the home share of sweet potatoes in the Canadian market increased from 65% pre-NAFTA to 87.1% post-NAFTA; and the home share of sweet potatoes in the U.S. market decreased from 98.4% pre-NAFTA to 95.7% post-NAFTA. U.S. sweet potato exports to Canada and Mexico increased after NAFTA; U.S. sweet potato exports to Canada increased from 1.5% pre-NAFTA to 2.6% post-NAFTA while U.S. sweet potato exports to Mexico increased from 0.1% pre-NAFTA to 0.2% post-NAFTA. However, Canadian and Mexican sweet potato exports to the United States decreased after NAFTA; Canadian sweet potato exports to the U.S. decreased from 34.7% pre-NAFTA to 1.6% post-NAFTA and Mexican sweet potato exports to the U.S. decreased from 1.7% pre-NAFTA to 0.4% post-NAFTA.

Table 1 shows the tariff rate,  $t_{ij}$ . This study considers the elimination of the tariff between NAFTA member countries in post-NAFTA years, while maintaining tariffs between NAFTA member countries and non-member countries in post-NAFTA years. As Table 1 shows, non-tariff trade costs,  $\tau_{ij}$ , are much greater than that of tariffs. As indicated previously, non-tariff trade costs are estimated by using our framework which reflects quantity based trade costs. This study uses equations (3) and (5) to estimate non-tariff trade costs. In equation (3), prices of imported sweet potato are derived by dividing imported volumes by domestic volume, which is then multiplied by the domestic price. The import prices is then used in equation (5) to estimate non-tariff trade costs. This estimation method creates high non-tariff trade costs when imported volume is small relative to domestic volume and low non-tariff trade costs when imported volume is similar to the domestic volume. Since the relative size of imported sweet potatoes is small relative to domestic volume in each market, this study confirms that non-tariff trade costs did not significantly decrease from the pre-NAFTA to the post-NAFTA period.

Our study uses yield as an index for total productivity,  $\alpha_j$ . When  $\alpha_j$  is 1 for the United States in the pre-NAFTA period,  $\alpha_j$  is 0.767 for Canada, 1.130 for Mexico, and 0.966 for the rest of the world (ROW). However, after NAFTA is implemented,  $\alpha_j$  is 1.253 for the United States, 0.925 for Canada, and 1.312 for Mexico, and 1.164 for the rest of the world (ROW). When the U.S. wage rate,  $r_j$ , is 1 in the pre-NAFTA period, the wage rate is 1.109 for Canada, 0.107 for Mexico, and 0.739 for ROW. These wage rates increase to 1.493 for the United States, 1.310 for Canada, 0.168 for Mexico, and 0.990 for ROW in the post-NAFTA period.

### **Empirical Results**

Using benchmark parameter values, this study estimates home and imported prices, non-tariff trade costs, and trade creation and diversion generated by NAFTA. Table 2 shows home and imported prices between pre-NAFTA and post-NAFTA time periods. Home prices of sweet potatoes in the three NAFTA member countries increase from pre-NAFTA to post-NAFTA time periods. The U.S. home price of sweet potatoes increases from \$0.13 per pound pre-NAFTA to \$0.18 per pound, reflecting 37% increase during that period of time. The Canadian home price of sweet potatoes increases from \$0.36 per pound pre-NAFTA to \$0.48 per pound following implementation of NAFTA, indicating a 33% increase during that time period. The Mexican home price of sweet potatoes increases from \$0.098 per pound pre-NAFTA to \$0.102 per pound in post-NAFTA, reflecting a 3.6% increase.

In the three NAFTA member countries, the increase in imported prices from pre-NAFTA to post-NAFTA is greater than the increase in home prices except for the imported price of U.S. sweet potatoes in the Mexican sweet potato market. The imported prices of U.S. sweet potatoes in the Canadian sweet potato market increase from \$0.14 per pound pre-NAFTA to \$0.31 per pound post-NAFTA, reflecting a 119% increase. Imported prices of Canadian sweet potatoes in

the U.S. sweet potato market increase from \$1.11 per pound pre-NAFTA to \$1.86 per pound post-NAFTA, a 67% increase. Imported prices of Mexican sweet potatoes in the U.S. sweet potato market increase from \$0.68 per pound pre-NAFTA to \$1.40 per pound post-NAFTA, a 107% increase. Increasing import prices relative to home prices in the three NAFTA member countries are due to high non-tariff trade costs. As shown in Table 1, non-tariff trade costs are much higher than tariffs imposed by importing countries; these high non-tariff trade costs are not reduced under NAFTA. For example, non-tariff trade costs of U.S. sweet potato exports to the Canadian sweet potato market increase from 1.077 pre-NAFTA to 1.751 post-NAFTA (see Table 1).

**[Table 2 Approximately Here]**

Table 3 shows the effect of NAFTA on trade creation and diversion. Canadian sweet potato imports from NAFTA member countries increase from 17 million pounds pre-NAFTA to 43 million pound post-NAFTA, indicating a 149% trade creation effect. Mexican sweet potato imports from other NAFTA countries increase from 0.9 million pound pre-NAFTA to 3.0 million pound post-NAFTA, indicating a 215% trade creation effect. However, U.S. sweet potato imports decrease from 1.7 million pounds pre-NAFTA to 0.5 million pound post-NAFTA. Total sweet potato trade volume among NAFTA countries increases from 20 million pounds pre-NAFTA to 46 million pound post-NAFTA, for an overall 133% trade creation effect.

Conversely, Mexican sweet potato imports from non-NAFTA countries decrease from 161 thousand pounds pre-NAFTA to 62 thousand pound post-NAFTA, reflecting a 160% trade diversion effect. U.S. sweet potato imports from non-NAFTA countries decrease from 18 million pound pre-NAFTA to 17 million pound post-NAFTA, a 5% trade diversion effect. In contrast, Canadian sweet potato imports from non-NAFTA countries increase from 4 million pound pre-NAFTA to 6 million pound post-NAFTA. This indicates that total sweet potato imports of

NAFTA countries from non-NAFTA countries increased from 22 million pound pre-NAFTA to 23 million pound post-NAFTA, reflecting no NAFTA trade diversion effect. As a result, this study indicates that, in the case of sweet potatoes, the trade creation effects of NAFTA overwhelms any trade diversion effects.

**[Table 3 Approximately Here]**

According to the results of this study, non-tariff trade costs are high post-NAFTA, even though NAFTA eliminates tariff and other trade regulations. In order to determine the effect of non-tariff trade costs on trade creation and diversion, this study develops two counterfactual scenarios. In counterfactual scenario one, this study eliminates non-tariff trade costs among NAFTA countries in order to determine the change in the trade volume of the three NAFTA member countries (market integration scenario). In counterfactual scenario two, this study increases non-tariff trade costs among NAFTA countries in order to determine the change in the trade volume of the three NAFTA countries (market segregation scenario).

According to Table 4, the market integration scenario significantly increases the sweet potato imports of NAFTA countries from their NAFTA-partner countries while sharply decreases sweet potato imports of NAFTA countries from non-NAFTA countries. For example, U.S. sweet potato imports from their NAFTA-partner countries increased by 2,350 million pound, reflecting a 138,995% trade creation effect, while U.S. sweet potato imports from non-NAFTA countries decreased by 15 million pound, reflecting a 526% trade diversion effect. Canadian sweet potato imports from their NAFTA-partner countries increased by 107 million pound, reflecting a 622% trade creation effect, while Canadian sweet potato imports from non-NAFTA countries decreased by 4 million pounds, reflecting a 2,082% trade diversion effect. Mexican sweet potato imports from their NAFTA-partner countries increased by 10 million pound, reflecting a 1,119% trade creation effect, while Mexican sweet potato imports from non-



NAFTA countries decreased by 0.1 million pound, reflecting a 200% trade diversion effect. As a result, total sweet potato trade volume among NAFTA countries increased by 2,468 million pound, reflecting a 12,431% trade creation effect, while total sweet potato imports of NAFTA countries from non-NAFTA countries decreased by 19 million pound, reflecting a 86% trade diversion effect. According to the results of the market integration scenario, the decrease in sweet potato imports of NAFTA countries from non-NAFTA countries is relatively small compared to the increase in sweet potato imports of NAFTA countries from their NAFTA-partner countries. For example, the decreased volume in U.S. sweet potato imports from non-NAFTA countries is 0.64% of the increased volume of U.S. sweet potato imports from NAFTA countries. Decreased volume in Canadian sweet potato imports from non-NAFTA countries is 3.68% of the increased volume of Canadian sweet potato imports from NAFTA countries. Decreased volume in Mexican sweet potato imports from non-NAFTA countries is 1.04% of the increased volume of Mexican sweet potato imports from NAFTA countries. As a result, total decreased volume in the NAFTA countries' imports represents 0.77% of the total increased volume of the three NAFTA countries' imports.

**[Table 4 Approximately Here]**

Table 5 shows that the market segregation scenario decreases the sweet potato imports of NAFTA countries from NAFTA-partner countries, while it increases the sweet potato imports of NAFTA member countries from non-NAFTA countries. For example, Canadian sweet potato imports from their NAFTA-partner countries decrease by 17 million pounds, while Canadian sweet potato imports from non-NAFTA countries increase by 220 million pounds. U.S. and Mexican sweet potato imports from NAFTA-partner countries decrease by 1.7 million pound and 0.9 million pound, respectively. At the same time, U.S. and Mexican sweet potato imports from non-NAFTA countries decrease by 0.7 million pounds and 12 thousand pounds, respectively.

The results of two different counterfactual scenarios does not reject the notion that the reason the trade volume of sweet potatoes in the three NAFTA member countries is relatively small may be due to high non-tariff trade costs.

**[Table 5 Approximately Here]**

### **Conclusion**

This study sought to describe the effect of NAFTA on the North American sweet potato market. To accomplish this, this study uses both observable (trade volume and home prices) and unobservable trade data (import prices and trade costs). In order to obtain unobservable trade data, this study uses the Dixit and Stiglitz's CES utility and production functions by which the market equilibrium price of each NAFTA member country could be derived and allow for the reasonable estimation of unobservable trade data for the three NAFTA countries.

After obtaining both observable and unobservable trade data, this study estimates home and imported prices at bench market parameter values in both pre-NAFTA and post-NAFTA. Unlike previous studies (Lambert and Mockoy, 2009; Pangarita, 2000; and Zahniser, et al., 2015), this study confirms that the degree of integration of the North American sweet potato markets is relatively low, given that the three North American sweet potato markets are dominated by their home product and the difference between home and imported prices in each NAFTA country have increased with NAFTA implementation. This result suggests that there may be high trade costs existing between borders among the three NAFTA countries. Consistent with our expectations, the estimated non-tariff trade costs are much higher than the tariffs imposed by each NAFTA country. Therefore, even though NAFTA eliminated tariffs and other trade barriers between NAFTA-partner countries, market integration will be slow unless non-tariff trade costs are reduced. Non-tariff trade costs come from a very broad range of economic, social, and political forces in each NAFTA member country. Although it was not purpose of this

study to explain from where non-tariff trade costs occur, future research to identify the sources of these non-tariff trade costs and feasible options for their reduction would be beneficial to the integration of these markets.

This study develops two counterfactual scenarios to identify the effect of non-tariff trade costs on trade creation and diversion. The market integration scenario significantly increases sweet potato imports of NAFTA countries from their NAFTA-partner countries, while sharply decreasing sweet potato imports of NAFTA countries from non-NAFTA countries. The market segregation scenario decreases sweet potato imports of NAFTA member countries from their NAFTA-partner countries while increasing sweet potato imports of NAFTA countries from non-NAFTA countries. As a result, these two different counterfactual scenarios suggest that the reason trade volume of sweet potatoes in the three NAFTA member countries is relatively small may result from high non-tariff trade costs.

Footnote 1.

Since there is no official report on Canadian sweet potatoes, this study uses the average price of sweet potatoes as estimated by Agriculture and Agri-food Canada.

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Table 1. Bench Mark Parameter Values

		Pre-NAFTA				Post-NAFTA			
		US <sub>i</sub>	CANADA <sub>i</sub>	MEXICO <sub>i</sub>	ROW <sub>i</sub>	US <sub>i</sub>	CANADA <sub>i</sub>	MEXICO <sub>i</sub>	ROW <sub>i</sub>
<i>s<sub>ij</sub></i>	US <sub>j</sub>	0.984	0.015	0.001	0.000	0.957	0.026	0.002	0.016
	CANADA <sub>j</sub>	0.347	0.650	0.000	0.002	0.016	0.871	0.000	0.113
	MEXICO <sub>j</sub>	0.017	0.000	0.983	0.000	0.004	0.000	0.996	0.000
	ROW <sub>j</sub>	0.041	0.009	0.000	0.949	0.028	0.010	0.000	0.962
<i>t<sub>ij</sub></i>	US <sub>j</sub>	1.00	1.02	1.10	1.13	1.00	1.00	1.00	1.13
	CANADA <sub>j</sub>	1.05	1.00	1.10	1.13	1.00	1.00	1.00	1.13
	MEXICO <sub>j</sub>	1.05	1.02	1.00	1.13	1.00	1.00	1.00	1.13
	ROW <sub>j</sub>	1.05	1.02	1.10	1.00	1.05	1.02	1.10	1.00
<i>τ<sub>ij</sub></i>	US <sub>j</sub>	1.00	1.08	2.18	8.51	1.00	1.75	1.45	2.77
	CANADA <sub>j</sub>	2.93	1.00	∞	11.23	3.85	1.00	∞	2.33
	MEXICO <sub>j</sub>	6.56	10.58	1.00	22.94	13.69	20.18	1.00	31.17
	ROW <sub>j</sub>	1.77	1.00	2.19	1.00	2.06	1.95	2.38	1.00
<i>α<sub>j</sub></i>		1.000	0.767	1.130	0.966	1.253	0.925	1.312	1.164
<i>r<sub>j</sub></i>		1.000	1.109	0.107	0.739	1.493	1.310	0.168	0.990
<i>σ</i>		-3.00							
<i>θ</i>		0.75							

Table 2. Home and Imported Prices in Pre-NAFTA and Post-NAFTA

<u>Pre-NAFTA: 1989-1993: \$/lb</u>				
	$P_{ius}$	$P_{ica}$	$P_{imx}$	$P_{irow}$
US <sub>i</sub>	0.128	1.110	0.675	0.362
Canada <sub>i</sub>	0.140	0.363	1.060	0.200
Mexico <sub>i</sub>	0.306	N/A	0.098	0.472
ROW <sub>i</sub>	1.227	4.603	2.551	0.196
<u>Post-NAFTA: 1994-2011: \$/lb</u>				
	$P_{ius}$	$P_{ica}$	$P_{imx}$	$P_{irow}$
US <sub>i</sub>	0.175	1.857	1.396	0.546
Canada <sub>i</sub>	0.306	0.483	2.058	0.502
Mexico <sub>i</sub>	0.253	N/A	0.102	0.662
ROW <sub>i</sub>	0.548	1.272	3.593	0.253
<u>Percentage Change between Pre-NAFTA and Post-NAFTA</u>				
	$P_{ius}$	$P_{ica}$	$P_{imx}$	$P_{irow}$
US <sub>i</sub>	37.11	67.29	106.76	50.61
Canada <sub>i</sub>	119.01	33.14	94.19	151.35
Mexico <sub>i</sub>	-17.15	N/A	3.62	40.13
ROW <sub>i</sub>	-55.36	-72.36	40.84	29.06



Table 3. NAFTA's Trade Creation and Diversion Effects at Bench Mark

	$j_s$ =NAFTA Countries		Trade Creation Effect	
	Pre-NAFTA	Post-NAFTA	$\Delta q_i^{1)}$	$\Delta\%$
US <sub>i</sub>	1691402	524013	-1167390	-69
CANADA <sub>i</sub>	17244626	42893249	25648623	149
MEXICO <sub>i</sub>	920704	2903851	1983147	215
TOTAL	19856733	46321112	26464380	133
	$j$ =ROW		Trade Diversion Effect	
	Pre-NAFTA	Post-NAFTA	$\Delta q_{ij}^{2)}$	$\Delta q_{ij}\%$
US <sub>i</sub>	17929620	17002393	-927226	-5
CANADA <sub>i</sub>	4137039	5930549	1793510	30
MEXICO <sub>i</sub>	161488	62219	-99269	-160
TOTAL	22228147	22995162	767015	3
$(\Delta q_{ij} \div \Delta q_j) \times 100\%$				
US <sub>i</sub>		79.43		
CANADA <sub>i</sub>		6.99		
MEXICO <sub>i</sub>		-5.01		
TOTAL		2.90		

1)  $\Delta q_j \geq 0$  means "trade creation effect"

$\Delta q_j < 0$  means "no trade creation effect"

2)  $\Delta q_{ij} < 0$  means "trade diversion effect"

$\Delta q_{ij} \geq 0$  means "no trade diversion effect"

Table 4. NAFTA's Trade Creation and Diversion Effects at Market Integration Scenario

	$j_s$ =NAFTA Countries		Trade Creation Effect	
	Pre-NAFTA	Post-NAFTA	$\Delta q_i^{1)}$	$\Delta\%$
US <sub>i</sub>	1691402	2352655904	2350964501	138995
CANADA <sub>i</sub>	17244626	124469569	107224943	622
MEXICO <sub>i</sub>	920704	11219841	10299137	1119
TOTAL	19856733	2488345314	2468488581	12431
	$j$ =ROW		Trade Diversion Effect	
	Pre-NAFTA	Post-NAFTA	$\Delta q_{ij}^{2)}$	$\Delta q_{ij}\%$
US <sub>i</sub>	17929620	2865457	-15064163	-526
CANADA <sub>i</sub>	4137039	189600	-3947439	-2082
MEXICO <sub>i</sub>	161488	53883	-107606	-200
TOTAL	22228147	3108940	-19119207	-86
$(\Delta q_{ij} \div \Delta q_j) \times 100$				
US <sub>i</sub>			-0.64	
CANADA <sub>i</sub>			-3.68	
MEXICO <sub>i</sub>			-1.04	
TOTAL			-0.77	

1)  $\Delta q_j \geq 0$  means "trade creation effect"

$\Delta q_j < 0$  means "no trade creation effect"

2)  $\Delta q_{ij} < 0$  means "trade diversion effect"

$\Delta q_{ij} \geq 0$  means "no trade diversion effect"

Table 5. NAFTA's Trade Creation and Diversion Effects at Market Segregation Scenario

	$j_s$ =NAFTA Countries		Trade Creation Effect	
	Pre-NAFTA	Post-NAFTA	$\Delta q_i^{1)}$	$\Delta\%$
US <sub>i</sub>	1691402	14941	-1676461	-99
CANADA <sub>i</sub>	17244626	156073	-17088553	-99
MEXICO <sub>i</sub>	920704	32	-920672	-100
TOTAL	19856733	171047	-19685686	-99.14
	$j$ =ROW		Trade Diversion Effect	
	Pre-NAFTA	Post-NAFTA	$\Delta q_{ij}^{2)}$	$\Delta q_{ij}\%$
US <sub>i</sub>	17929620	17185173	-744446	-4
CANADA <sub>i</sub>	4137039	224506433	220369394	5327
MEXICO <sub>i</sub>	161488	149454	-12035	-7
TOTAL	22228147	241841060	219612913	988
$(\Delta q_{ij} \div \Delta q_j) \times 100$				
US <sub>i</sub>		44.41		
CANADA <sub>i</sub>		-1289.57		
MEXICO <sub>i</sub>		1.31		
TOTAL		-1115.60		

1)  $\Delta q_j \geq 0$  means "trade creation effect"

$\Delta q_j < 0$  means "no trade creation effect"

2)  $\Delta q_{ij} < 0$  means "trade diversion effect"

$\Delta q_{ij} \geq 0$  means "no trade diversion effect"