NAFTA'S AND CUSFTA'S IMPACT ON INTERNATIONAL TRADE

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Abstract—This paper identifies NAFTA's effects on trade volumes and prices using detailed trade and tariff data. It identifies demand elasticities from the additional wedges driven between consumption patterns in NAFTA versus non-NAFTA countries caused by tariff reductions. Supply elasticities are identified using tariffs as instruments for observed quantities. Analysis of worldwide trade data for 5,000 commodities shows that NAFTA had a substantial impact on international trade volumes, but a modest effect on prices and welfare. NAFTA increased North American output and prices in many highly protected sectors by driving out imports from nonmember countries.

I. Introduction

The growing trend toward preferential trade liberalization and the potentially harmful effects of preferential trade agreements on international trade make analysis of these agreements important. This paper empirically analyzes the effects of the second largest of these agreements, the North American Free Trade Agreement (NAFTA), on trade volumes, prices, and welfare of both member countries and nonmembers. It uses detailed trade data to identify key supply and demand parameters in a simple static model that is then used to analyze NAFTA. The paper finds that both supply and demand are very sensitive to price changes. NAFTA therefore has substantial effects on trade volumes, but price and welfare effects are found to be modest.

On January 1, 1994, the North American Free Trade Agreement between the United States, Canada, and Mexico entered into force and incorporated the prior Canada-U.S. Free Trade Agreement (CUSFTA). For convenience I will often refer to both agreements simply as "NAFTA." NAFTA is by far the largest free-trade pact outside of the European Union and is the first reciprocal free-trade pact between a substantial developing country and developed economies (Hufbauer & Schott, 1993). Since the advent of NAFTA one of the more striking occurrences has been the rapid increase in Mexican trade. Mexico has become the United States' second-largest trading partner, accounting for 11.5% of U.S. merchandise imports in 2001 and 13.9% of U.S. exports, up from 6.9% and 9.0% respectively in 1993. Only Canada is a partner for more U.S. trade. Mexico now accounts for a larger share of U.S. trade than Korea, Thailand, Singapore, Malaysia, Hong Kong, and Taiwan combined.

Despite NAFTA's size, empirical studies often have great difficulty in identifying an effect of NAFTA. The reason for the mixed results in studies of relatively aggregated trade data is very simple. These studies have great difficulty distinguishing NAFTA's impact from the impact of two other events that occurred at a similar time. The first of these events is Mexico's unilateral trade liberalization that began in 1986. In general equilibrium, import liberalization also promotes exports. Mexico's imports and exports therefore began growing prior to NAFTA. This effect is evident in figure 1. The second event is the peso devaluation of 1994–1995 that also coincided with rapid growth in Mexico's exports.

By contrast, this paper finds that NAFTA has had a substantial impact on trade, though only a modest effect on welfare. It does so by identifying key supply and demand elasticities in detailed trade data, and then using those parameters to estimate the impact of NAFTA on trade volumes and prices. It develops a difference-in-differences-based estimation technique to identify demand elasticities that focuses on where each of the NAFTA partners sources its imports of almost 5,000 six-digit Harmonized System (HS-6) products and compares this to the source of European Union (E.U.) imports of the same products. The technique enables identification of NAFTA's effects on trade volumes even when countries' production costs shift. Inverse supply elasticities are identified by regressing observed import prices (excluding duties) on observed trade quantities, using tariffs as instruments for observed quantities.

NAFTA's impact on trade at the product level can be simply demonstrated with a few figures. Figure 2A shows that Mexico's share of U.S. imports has increased most rapidly in products for which it has been given the greatest increase in tariff preference, defined as the difference between the U.S. tariff on a product sourced from Mexico and the United States' most-favored nation (MFN) tariff rate for the same product.[1] For the 389 products where the U.S. tariff preference for Mexican goods has increased by at least 10 percentage points, the simple average of Mexico's share of U.S. imports has risen by 224% since 1993. For the 2,663 products where Mexico's tariff preference has not increased, its share has risen by a more modest 23%. The timing and cross-product pattern of Mexico's trade increase are themselves highly suggestive that trade was very responsive to NAFTA's tariff preferences, and figure 2B further supports the case. Figure 2B shows Mexico's share of E.U. imports from 1989 to 2000. Without the benefit of a free-trade

Received for publication January 6, 2005. Revision accepted for publication July 11, 2006.

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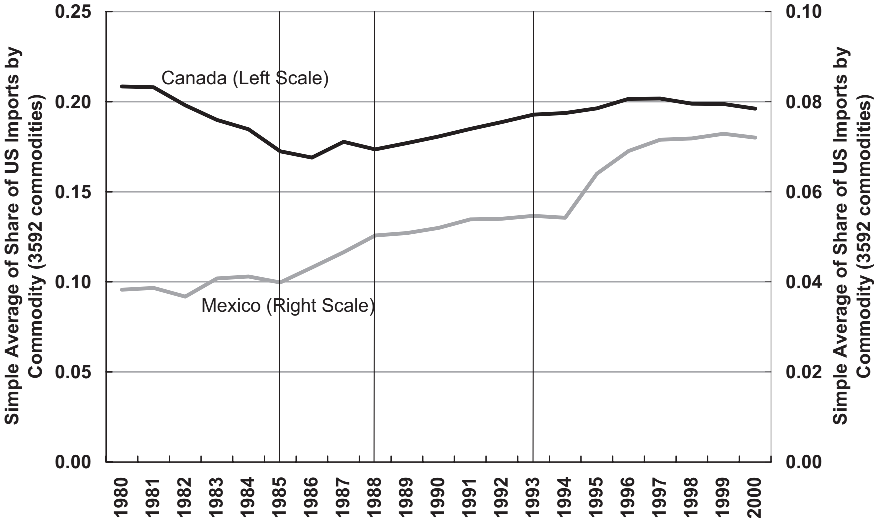
I would particularly like to thank my advisors, Daron Acemoglu, Rudi Dornbusch, and Jaume Ventura. Thanks for generous support are due to the IMF and Reserve Bank of Australia. Thanks are also due to Mark Aguiar, Mary Amiti, Robert Feenstra, Alwyn Young, and participants at seminars and lunches at Chicago GSB, Dartmouth, EIIT Conference, ETSG Conference, Federal Reserve Bank of New York, Harvard, IADB, IMF, MIT, NAEFA Conference, Penn State, Stanford, University of Illinois (Urbana), University of Michigan, University of Pennsylvania, University of Sydney, and USITC. Any errors are my own.

[1] The MFN tariff is the tariff applicable to imports from countries that have normal trade relations with the United States.

The Review of Economics and Statistics, August 2007, 89(3): 416–435

FIGURE 1.—MEXICO'S AND CANADA'S SHARE OF U.S. IMPORTS, 1980–2000



agreement until late 2000, the evolution of Mexico's trade with the E.U. has been very different. Its share of E.U. imports of products with high NAFTA preferences declined by 77%, while its share of E.U. imports of products where NAFTA did not increase preferences rose by 64%. This growing wedge between U.S. and E.U. import patterns will identify demand elasticities and, when combined with estimated supply elasticities, NAFTA's impact on trade volumes and prices.

Canada's share of U.S. imports has also increased since CUSFTA came into effect in 1989, and figures 3A to 3C also suggest that CUSFTA was partly responsible. For products where there was no increased preference for goods of Canadian origin, Canadian goods now account for a 2% smaller share of U.S. imports than they did in 1988. But where the preference increased by at least 10 percentage points, Canada's share of U.S. imports increased by 99%. The timing and cross-product pattern again suggest that CUSFTA is at work. Figure 3C shows Canada's share of U.S. imports from 1980 to 2000. For most of the 1980s, Canada's share of U.S. imports declined in all tariff classes, but just before CUSFTA, Canada's share began to rebound for products where large tariff preferences were negotiated. Figure 3B provides a comparison with Canada's trade with the European Union, which does not have a preferential trade agreement with Canada. For the products with no CUSFTA preferences, Canada's share of E.U. imports has declined by 6%. For products with high CUSFTA preferences, Canada's share of E.U. imports has declined by 40%. Figures 2A to 3C together suggest that NAFTA/CUSFTA have had a substantial impact on trade, and even though U.S. tariffs are typically low, trade appears to be quite sensitive to even small trade preferences.

Much empirical work has been devoted toward evaluating trade and welfare effects of preferential trade areas (Baldwin & Venables, 1995). One major group of studies of preferential trade agreements are ex ante simulations using applied general equilibrium (AGE) models that produce price and welfare predictions in addition to trade volume predictions. Examples of AGE modeling of NAFTA are Kehoe and Kehoe (1995), Brown, Deardorff, and Stern (1995), Cox (1995), Sobarzo (1995), and studies surveyed in Baldwin and Venables (1995). All models predicted welfare gains for NAFTA members. The other major group are ex post studies examining changes in the direction of aggregate trade between countries or regions following the introduction of the PTA. Examples of ex post studies that use aggregate trade data for NAFTA are Gould (1998) and Garces-Diaz (2001). Gould finds that NAFTA has increased U.S.-Mexico trade, but has had no effect on U.S.-Canada or Mexico-Canada trade. Garces-Diaz finds that Mexico's export boom is not attributable to NAFTA.

The most similar papers to this are Clausing (2001) and Trefler (2004). Clausing used detailed U.S. trade data to find evidence that the Canada-U.S. FTA raised U.S. imports from Canada (trade creation) but did not reduce imports from other trading partners (trade diversion). Trefler finds both trade creation and trade diversion, and performs a simple welfare calculation following Pravin Krishna (2003) to find positive welfare effects for the representative Canadian agent. Trefler also finds that Canadian industries that experienced the largest tariff cuts under NAFTA experienced substantial labor productivity gains, but a decline in both output and employment. This paper examines the impact of both the Canada-U.S. FTA and NAFTA on all NAFTA members. The more detailed data used in this paper reveals much more substantial trade diversion than Trefler, so much so that there appear to be essentially no welfare gains for any NAFTA member. The welfare calculations in this paper are also performed by applying the demand and supply elasticities estimated in this paper to the detailed trade data in a simple general equilibrium model.

FIGURE 2A.—MEXICO'S SHARE OF U.S. IMPORTS, 1989–2000

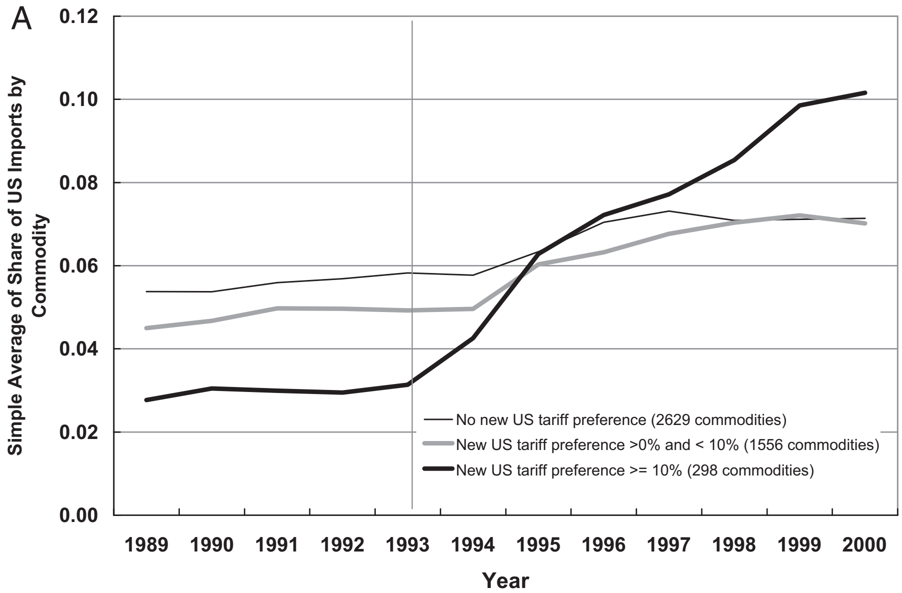
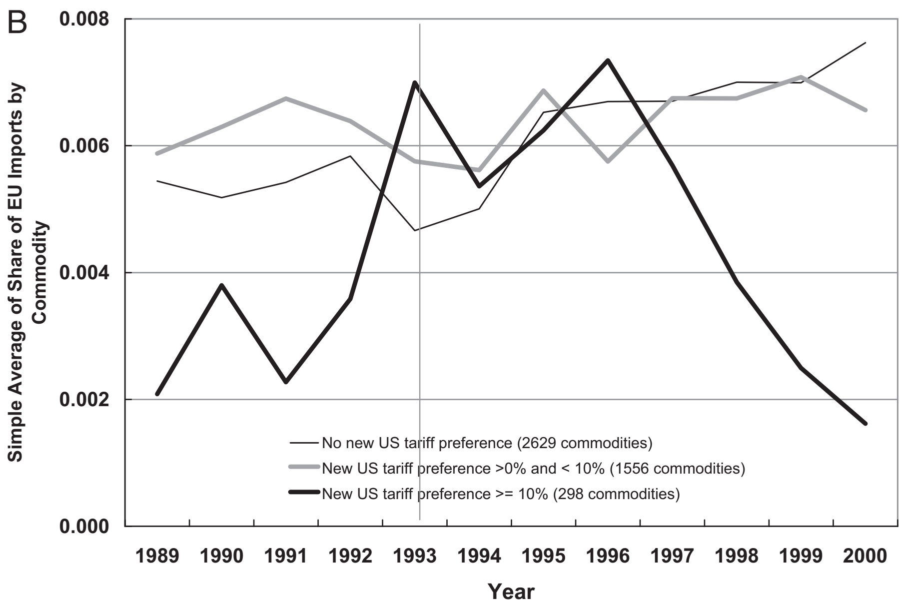


FIGURE 2B.—MEXICO'S SHARE OF E.U. IMPORTS, 1989–2000



Related papers include Fukao, Okubo, and Stern (2003), who found that NAFTA tariff preferences had a significant effect on U.S. imports in fifteen out of seventy industries studied. Krueger (1999, 2000) finds no evidence that NAFTA has had any impact on intra-North American trade at the three- and four-digit SIC levels. Chang and Winters's (2002) study of MERCOSUR found that due to the tariff preference, competition from Argentina, Uruguay, and Paraguay has led to significant and substantial reductions in American, Chilean, German, Korean, and Japanese export prices to Brazil. Yeats (1997) finds that the fastest growth in intra-MERCOSUR trade was in products in which members did not display a comparative advantage. Kehoe and Ruhl (2002) find that growth in the extensive margin following trade liberalizations is an important source of new trade, especially for the previously thin Canada-Mexico trade relationship. Debaere and Mostashari (2006) find a more limited impact of trade policy on the extensive margin. Head and Ries (1999) study the industry rationalization effects of tariff reductions and find that on balance, NAFTA has had little net effect on the scale of Canadian firms.

This paper is organized as follows. Section II introduces a simple model of preferential trade liberalization that is used to derive the estimating equations and underpin the welfare analysis. Section III describes the data. Section IV presents and discusses the empirical results. Section V concludes.

FIGURE 3A.—CANADA'S SHARE OF U.S. IMPORTS, 1988–2000

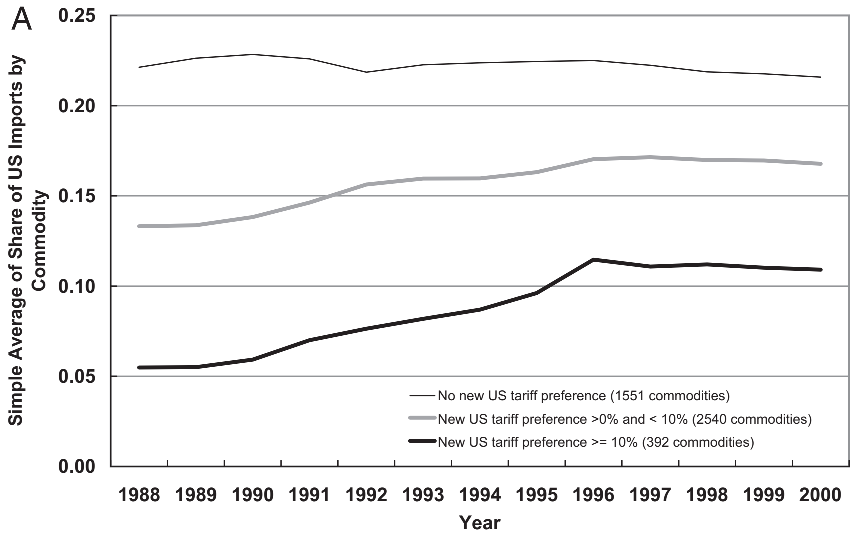


FIGURE 3B.—CANADA'S SHARE OF E.U. IMPORTS, 1988–2000

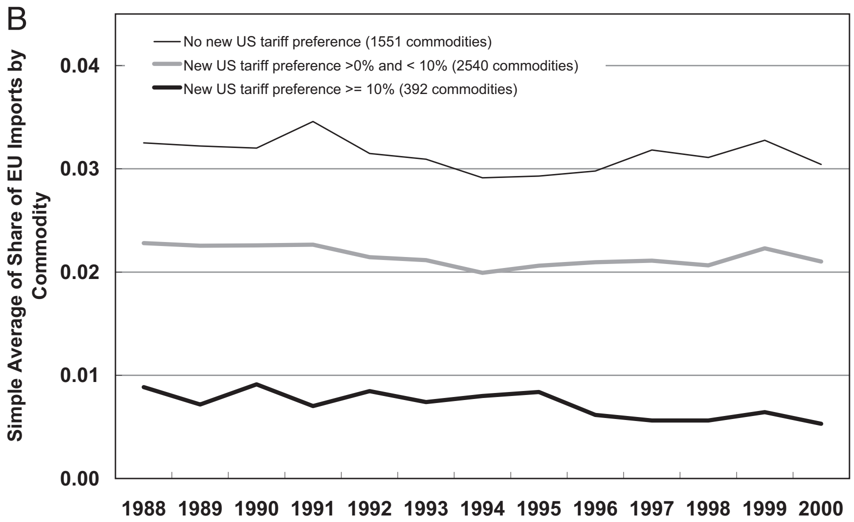
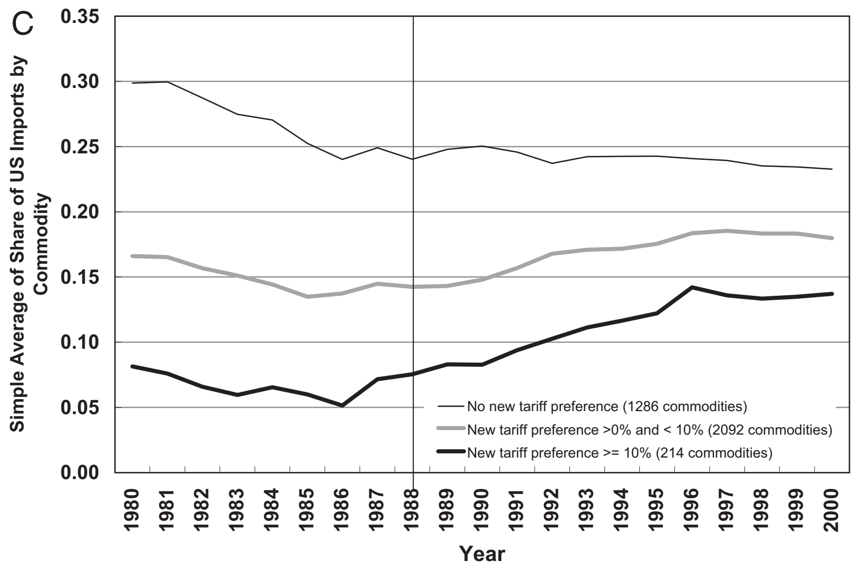


FIGURE 3C.—CANADA'S SHARE OF U.S. IMPORTS, 1980–2000



II. Theoretical Framework and Empirical Strategy

This paper seeks to exploit the product and time variation in the tariff preference that is afforded to goods originating in NAFTA partners to identify NAFTA's and CUSFTA's effect on trade and welfare. The paper identifies demand elasticities by studying where NAFTA members and the European Union source their imports of different products. It seeks to explain changes in North American import sources using the preference afforded to products of North American origin. The idea is that where North American output is afforded no new preference (where the MFN tariff rate is zero, for instance), NAFTA's only impact should come through a general equilibrium effect on output prices, or through reductions in "border effects" due to NAFTA provisions that go beyond tariff liberalization. For products where NAFTA causes a new preference to open up for North American goods, the preference should have an additional effect causing North American consumers to substitute toward newly preferred goods and away from other sources of supply. Supply elasticities are identified using tariffs as instruments that, for a given supply price, shift the demand curve. This strategy can be derived from a simple model. The model and the estimated parameters are then used to evaluate NAFTA's effects on trade volumes, prices, and welfare.

A. Model Description

Firms produce products under perfectly competitive conditions. Trade is driven by preference for variety and by products being differentiated by country of origin. Countries may impose *ad valorem* tariffs on imports. Countries may then enter into preferential trading agreements whereby each country in the agreement lowers tariffs on imports from partner countries but need not adjust the tariff on imports from other countries. This causes consumers to substitute toward the output of preferred countries and away from all other sources of supply, including domestic production. Factor supplies are not explicitly modeled. The model assumptions are set out in detail below.

(1) Products and industries are indexed by i, countries are indexed by j, and time by t.[2]

(2) In each country j, every industry i produces a product i using an industry-specific factor under conditions of perfect competition with marginal cost $c(q^S)_{ijt}$ (henceforth often denoted as c_{ijt}), where q^S is industry production. Note that marginal cost depends on the quantity produced and may vary across producing country and time. I assume a constant inverse supply elasticity:

$$\ln c(q^S)_{ijt} = \eta \ln q^S_{ijt} + \ln \hat{P}_{jt} + D_{jt} + D_{ij} + \varepsilon_{ijt}, \quad (1)$$

where η is the inverse supply elasticity, $\hat{P}_{jt}$ is the aggregate price index in country j, D_{jt} is a country-by-year fixed effect, D_{ij} is a country-by-product fixed effect, and ε_{ijt} is a random supply shock.[3]

(3) In every period, consumers in each country are assumed to maximize Cobb-Douglas preferences over their consumption of the output of each industry, Q_{ijt}, with the fraction of income spent on industry i being b_{ij} (equations [2] and [3]). Expenditure shares for each industry are therefore constant for all prices and incomes.

$$U_{jt} = \sum_i b_{ij} \ln Q_{ijt} \quad (2)$$

$$\sum_i b_{ij} = 1. \quad (3)$$

(4) The output of each industry is not a homogeneous good. Although firms in the same country produce identical goods, production is differentiated by country of origin. Q_{ijt} can be interpreted as a subutility function that depends on the quantity of each variety of i consumed. I choose the CES function with elasticity of substitution $\sigma_i > 1$. Let $q^D_{ijj't}$ denote the quantity of product i consumed in country j that was produced in country j'. Q_{ijt} is defined by equation (4):

$$Q_{ijt} = \left(\sum_{j'} q^{D\,(\sigma_i - 1)/\sigma_i}_{ijj't} \right)^{\sigma_i/(\sigma_i - 1)}. \quad (4)$$

(5) There may be transport costs for international trade. Transport costs are introduced in the convenient "iceberg" form; $g_{ijj't}$ units must be shipped from country j' for 1 unit to arrive in country j; $g_{ijjt} = 1$, $\forall_j$.

(6) Tariffs: $\tau_{ijj't} - 1$ is the *ad valorem* tariff imposed on product i imported by country j from country j'; $\tau_{ijjt} = 1$, $\forall_j$. Tariffs are rebated as a lump sum to consumers.

B. Equilibrium

In equilibrium, consumers maximize utility, firms maximize profits, and trade is balanced. Because of the assumption of perfect competition, prices (exclusive of tariffs and

[2] In the empirical analysis "country" will often mean collection of countries such as the European Union or a "rest of the world" group of countries.

[3] The aggregate price index plays no role in the estimation due to the presence of the country-time fixed effects. It will, however, play a role when calculating the general equilibrium effects of NAFTA below. It is a homogeneity restriction—no extra supply is induced when a product's price rises in line with the general price level.

transport costs) are equal to marginal cost, c_{ijt}. Consider the consumers in country 1, which will be a NAFTA country and for now we will call the United States. Tariffs and transport costs raise the price paid by U.S. consumers for goods imported from country j to $c_{ijt}g_{i1jt}\tau_{i1jt}$. Let T_{i1t} denote tariff revenue collected in the United States on imports of product i, and let Y_{1t} denote U.S. income. U.S. income is equal to the sum of firm revenues plus tariff revenue.[4]

$$T_{i1t} = \sum_j (\tau_{i1jt} - 1) q^D_{i1jt} c_{ijt}, \tag{5}$$

$$Y_{1t} = \sum_i c_{i1t} q^S_{i1t} + \sum_i T_{i1t}. \tag{6}$$

U.S. consumers maximize utility subject to expenditure being equal to income in every period:

$$\forall_i, \sum_j q^D_{i1jt} c_{ijt} g_{i1jt} \tau_{i1jt} = b_{i1} Y_{1t}. \tag{7}$$

Differentiating the Lagrangian for the consumers' constrained optimization problem with respect to consumption levels of each product, we find that tariffs on imported goods cause domestic consumers to substitute away from higher-taxed varieties. The amount of substitution depends on the level of the tariff and on the elasticity of substitution between varieties:

$$\forall_i, \forall_j, \forall_t, \frac{q^D_{i1jt}}{q^D_{i1j't}} = \left(\frac{\tau_{i1j't}}{\tau_{i1jt}}\right)^{\sigma_i} \left(\frac{c_{ij't}}{c_{ijt}}\right)^{\sigma_i} \left(\frac{g_{i1j't}}{g_{i1jt}}\right)^{\sigma_i}. \tag{8}$$

Equilibrium conditions for all other countries are symmetric, which will be exploited by the empirical work to control for the effect of unobserved movements in marginal cost that may be correlated with tariff movements. Finally, all product markets have to clear, taking into account output that melts in transit:

$$\forall_i, \forall_j, \forall_t, q^S_{ijt} = \sum_{j'} q^D_{ij'jt} g_{ij'jt}. \tag{9}$$

C. *Empirical Strategy*

(i) Demand elasticity. I use equation (8) to derive estimating equations for demand elasticities. Equivalent equations exist for every other country, specifically, let country 2 be the aggregate of the twelve countries that were always members of the European Union for the sample period 1989–1999:

$$\forall_i, \forall_j, \forall_t, \frac{q^D_{i2jt}}{q^D_{i2j't}} = \left(\frac{\tau_{i2j't}}{\tau_{i2jt}}\right)^{\sigma_i} \left(\frac{c_{ij't}}{c_{ijt}}\right)^{\sigma_i} \left(\frac{g_{i2j't}}{g_{i2jt}}\right)^{\sigma_i}. \tag{10}$$

Using equations (8) and (10) we can eliminate the marginal-cost terms:

$$\ln \frac{q^D_{i1jt}}{q^D_{i1j't}} - \ln \frac{q^D_{i2jt}}{q^D_{i2j't}} = \sigma_i \left[\ln \frac{\tau_{i1j't}}{\tau_{i1jt}} - \ln \frac{\tau_{i2j't}}{\tau_{i2jt}}\right] + \sigma_i \left[\ln \frac{g_{i1j't}}{g_{i1jt}} - \ln \frac{g_{i2j't}}{g_{i2jt}}\right]. \tag{11}$$

Elimination of the unobserved marginal-cost terms is important because relative costs will shift following a trade liberalization. Equation (11) can be transformed into an equation for Cost including Insurance and Freight (CIF) import values, to match how E.U. trade data are collected:

$$\ln \frac{c_{ijt} \cdot g_{i1jt} \cdot q^D_{i1jt}}{c_{ij't} \cdot g_{i1j't} \cdot q^D_{i1j't}} - \ln \frac{c_{ijt} \cdot g_{i2jt} \cdot q^D_{i2jt}}{c_{ij't} \cdot g_{i2j't} \cdot q^D_{i2j't}} = \sigma_i \left[\ln \frac{\tau_{i1j't}}{\tau_{i1jt}} - \ln \frac{\tau_{i2j't}}{\tau_{i2jt}}\right] + (\sigma_i - 1)\left[\ln \frac{g_{i1j't}}{g_{i1jt}} - \ln \frac{g_{i2j't}}{g_{i2jt}}\right]. \tag{12}$$

So long as I examine only countries j and j' for which the European Union does not change its relative tariffs, ln $(\tau_{i2j't}/\tau_{i2jt})$ is simply a product fixed effect. Since I do not have detailed transport cost data for E.U. trade, to identify σ_i I assume that relative transport costs of shipping products to the United States and the European Union, ln $(g_{i1j't}/g_{i1jt})$ − ln $(g_{i2j't}/g_{i2jt})$, is the sum of a product fixed effect, a year fixed effect, and an error term that is orthogonal to U.S. tariffs.[5] This produces the basic estimating equation (13) based on CIF import values, where D_i and D_t are full sets of product and year dummies respectively, while $\varepsilon_{ijj't}$ is a random disturbance term:

$$\ln \frac{c_{ijt} \cdot g_{i1jt} \cdot q^D_{i1jt}}{c_{ij't} \cdot g_{i1j't} \cdot q^D_{i1j't}} - \ln \frac{c_{ijt} \cdot g_{i2jt} \cdot q^D_{i2jt}}{c_{ij't} \cdot g_{i2j't} \cdot q^D_{i2j't}} = D_i + D_t + \sigma_i \ln \frac{\tau_{i1j't}}{\tau_{i1jt}} + \varepsilon_{ijj't}. \tag{13}$$

Now consider country j to be Canada or Mexico and country j' to be any other country. NAFTA's and CUSFTA's increase in the U.S. tariff preferences for Canadian and Mexican goods, ln $(\tau_{i1j't}/\tau_{i1jt})$, will increase the share of those goods in U.S. consumption relative to their share of E.U. consumption. A fraction of the increased share of U.S. consumption comes from reduced output of domestic suppliers ("trade creation"), and the rest comes from reduced

[4] Revenue from firm sales will all accrue to factors of production (inputs), which are assumed to be domestically owned. Underlying factor markets are not modeled.

[5] The assumption may not be completely innocuous. The most significant recent feature of international trade costs has been the relative decline in air-freight costs. This is likely to disproportionately benefit some commodities and some trade routes. See Hummels (1999) for a detailed examination of international trade costs.

imports from countries outside NAFTA ("trade diversion"). The size of the increased share in an arbitrary industry i depends positively on the size of the increased U.S. tariff preference, and positively on the elasticity of substitution σ between varieties of i.

The European Union was chosen as "country 2" for two main reasons. Firstly, its detailed trade data have long been available electronically. Secondly, the European Union is a relatively large trading partner for the United States, Canada, and Mexico, which maximizes the number of products that can be used to estimate demand elasticities and increases the precision of the estimates. The cost of choosing the European Union as country 2 is that the European Union is excluded from the list of control countries j'. This means that the paper does not directly use some of the substitution between the output of NAFTA countries and E.U. output to identify demand elasticities. For transparency purposes I also report estimates obtained using all trade involving NAFTA countries or E.U. countries, including trade between E.U. members, but note that relative E.U. tariffs ln $(\tau_{i2j't}/\tau_{i2jt})$ are no longer a product fixed effect. Not using the E.U. data at all produced very similar elasticity estimates.

(ii) Supply elasticity. In equation (1) the marginal cost of producing a product in country j was allowed to increase with the quantity produced in that country. NAFTA countries may face an elasticity of supply that is less than infinite, so that demand shifts caused by preferential trade liberalization affect equilibrium prices. These price changes are an important ingredient of welfare analysis, and it is necessary to estimate how prices respond to preferential trade liberalization. The mean supply elasticity can be estimated in a manner that utilizes the very detailed price and quantity data for U.S. imports. Take equation (1) and note that the total supply of product i from country j can be written as U.S. imports of i from j, divided by the share of j's exports of product i that are sent to the United States, divided by the share of j's output of i that gets exported:

$$q^S_{ijt} = q^S_{i1jt} \div \frac{q^S_{i1jt}}{\sum_{j' \neq j} q^S_{ij'jt}} \div \frac{\sum_{j' \neq j} q^S_{ij'jt}}{q^S_{ijt}}. \tag{14}$$

Supply prices and the three elements on the right of equation (14) are available at different levels of aggregation. Tariff-line level data (15,000 products) exists for supply prices c_{ijt} and quantities q^S_{i1jt} supplied to the United States. The share of country j's exports of i that are sent to the United States is available at the HS six-digit level (5,000 products) from the World Bank's World Integrated Trade Solution (WITS) database. The share of country j's output of i that gets exported is mostly available at the three-digit ISIC level in the World Bank's Trade and Production database for manufacturing sectors. This is supplemented using World Bank World Development Indicators data for energy sectors and Food and Agriculture Organization (FAO) data on production and exports for agricultural sectors. Where industry data is unavailable, the share of a country's output that gets exported is simply estimated as the proportion of each reporting country's GDP that gets exported using World Development Indicators data. Supply is therefore measured with error, but the instrumental variables estimation should also take care of measurement error and not just the traditional simultaneity bias so long as the instruments (tariffs) are orthogonal to the measurement error. The parameter η can be identified using tariffs as an instrument since, for a given supply price c_{ijt}, tariffs shift demand. This can be seen from the demand equation. From the model's CES demand assumption, U.S. demand for product i supplied by country j is given by

$$\ln q^D_{i1jt} = -\sigma_i \ln c_{ijt} - \sigma_i \ln \tau_{i1jt} - \sigma_i \ln g_{i1jt} + (\sigma_i - 1) \ln \hat{P}_{i1t} + \ln b_{i1} Y_{1t}, \tag{15}$$

where $\hat{P}_{i1t}$ is the ideal price index for product i in the United States:

$$\hat{P}_{i1t} = \left[\sum_j (c_{ijt} \cdot g_{i1jt} \cdot \tau_{i1jt})^{1-\sigma_i} \right]^{1/(1-\sigma_i)}. \tag{16}$$

Any change in tariffs imposed by the United States on imports of product i from any source will shift demand for product i from all sources, because the tariff changes shift either τ_{i1jt}, the price index $\hat{P}_{i1t}$, or both. These movements in the demand curve identify the supply curve.

III. Data Description

A. *International Trade Data*

International trade data for almost all of the world is now collected according to the Harmonized System (HS), a schedule that is standard across countries at the six-digit level, or approximately 5,000 products. Most of this data are available from the World Bank's WITS database. For some key countries I use more complete national sources of data. The U.S. International Trade Commission (USITC) maintains a database at the ten-digit level (15,000 products) of U.S. imports classified by product, country of origin, import program, month, and port of arrival. Eurostat and Statistics Canada maintain similar databases for the E.U. and Canada.

For the purposes of figures 1 to 3C, it is useful to keep a balanced panel of products. Changes in HS product classifications lead to some attrition, but I am able to track U.S. and E.U. trade in 4,655 six-digit products annually from 1989 to 2000. Because Canada entered into CUSFTA with the United States in 1989, it is useful to collect data for earlier years. Prior to 1989, U.S. trade data were collected

FIGURE 4A.—U.S. IMPORT TARIFFS IN 2000

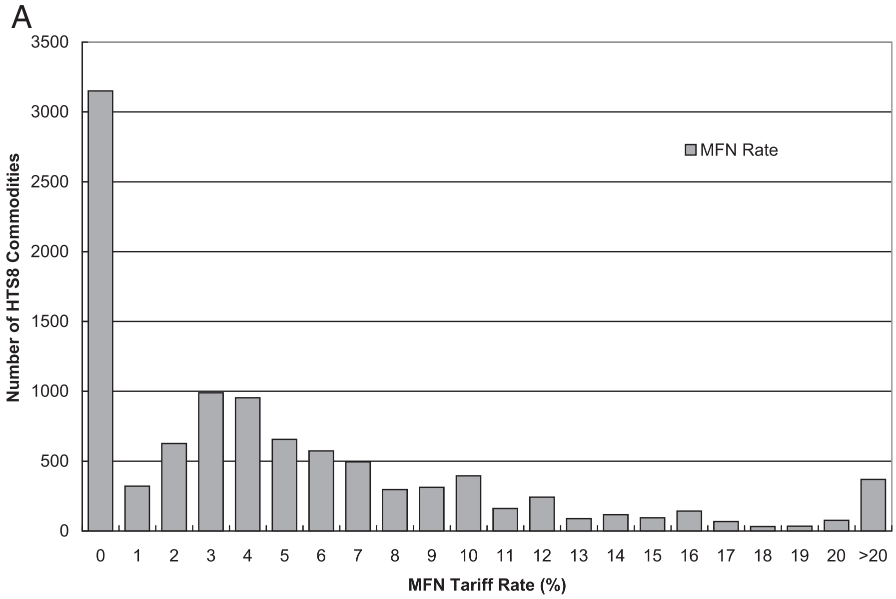
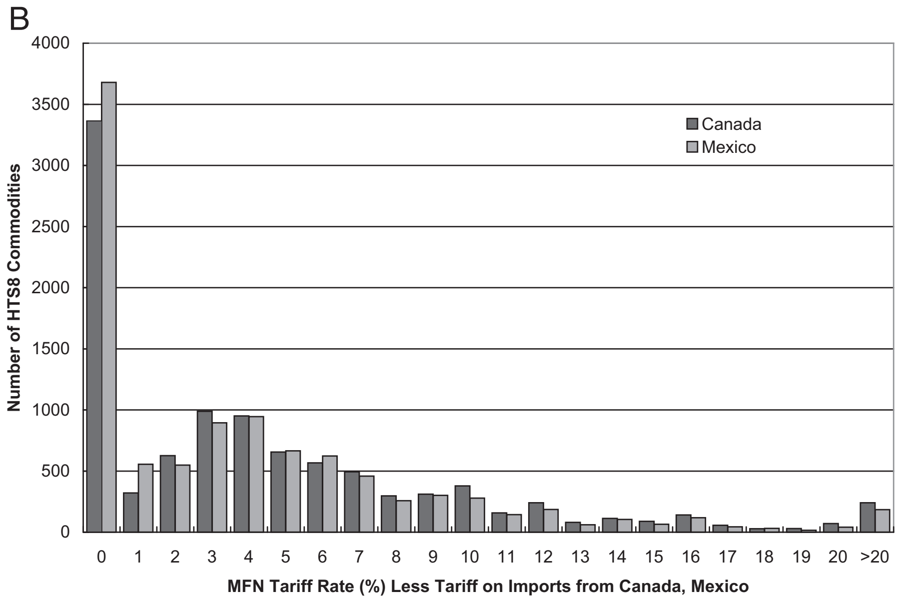


FIGURE 4B.—U.S. TARIFF PREFERENCES FOR CANADIAN AND MEXICAN GOODS IN 2000



according to a different product schedule, the TSUSA. Concordances are available for this data, but revisions to the TSUSA also lead to attrition. I am able to track 4,483 products continuously from 1988 to 2000, and 3,592 from 1980 to 2000.

B. Tariff Data

Tariff data are also collected from both the World Bank's WITS database and from national sources. Tariff data are based on either tariff schedules or detailed data on import duties collected. U.S. tariff schedules for the years 1997 to the current year are available from the USITC. I extracted U.S. tariff data for 1989 to 1996 from USITC files.[6] U.S. tariffs are almost invariably set at the HS eight-digit level (10,000 products). While most tariffs are *ad valorem,* there are still several hundred specific tariffs applied. The USITC calculates the *ad valorem* equivalent of any specific tariffs. The distribution of U.S. MFN tariffs in 2000 is illustrated in figure 4A. The simple average of tariff rates is low at 5.2%, but importantly there is a large amount of dispersion, with the standard deviation of MFN tariff rates being 12%. Under

[6] These data were made available by Feenstra, Romalis, and Schott (2002).

TABLE 1.—PROPORTION OF HTS EIGHT-DIGIT TARIFF VARIATION CAPTURED BY BROADER CLASSIFICATIONS

Classification	MFN Tariff	Canada Preference	Mexico Preference
HS-2 (97 categories)	0.387	0.389	0.370
HS-4 (1,258 categories)	0.557	0.573	0.522
HS-6 (5,115 categories)	0.684	0.705	0.651

Note: Table 1 reports the percentages of the variance in U.S. MFN and preferential tariffs at the HTS eight-digit level (10,082 products) for the year 1999 that are captured by broader product classifications. Each tariff measure is regressed on full sets of dummy variables for the broader classifications. The *R*-squared from each regression is reported in table 1. The 25 products with MFN tariffs above 50% are excluded from the calculations.

NAFTA, all but a couple hundred of these tariffs have been eliminated for Canada and are in the process of being eliminated for Mexico, creating a large variation in the preference given to goods of Canadian or Mexican origin (figure 4B). Table 1 shows that much of this variation occurs within fine product classifications. Table 1 reports the percentage of the variance of U.S. MFN tariff rates and tariff preferences for Canada and Mexico at the tariff-line level that can be explained by full sets of dummy variables for broader industry classifications. Much of the tariff variation remains unexplained by these variables, therefore existing industry-level studies of NAFTA ignore most of the tariff variation.

Preferential treatment for some goods existed prior to CUSFTA/NAFTA. In 1965, Canada and the United States negotiated the Auto Pact, allowing duty-free trade in many automotive goods. The Auto Pact was incorporated into CUSFTA. Mexico was a beneficiary of the Generalized System of Preferences (GSP), under which the United States (and other developed countries) gave developing countries preferential access to their markets.[7] The United States gave duty-free access to the output of developing countries for several thousand HS eight-digit products, although goods where developing countries may have gained most from preferential access were often excluded (notably many agricultural items and textiles, clothing, and footwear), and the preference could be removed under "competitive needs limitations" to the GSP. Details of the Auto Pact and GSP program are included in the tariff schedules. Although the United States engaged in some fine-tuning of the GSP program, there are only two changes that affected a significant amount of U.S. trade during the sample period. The first was the expulsion ("graduation") of Hong Kong, Korea, Singapore, and Taiwan from the scheme at the end of 1988. This can be accommodated by dropping either pre-1989 data or these four countries from the analysis—I drop the pre-1989 data.[8] The second change was that upon entry into NAFTA, Mexico was no longer entitled to claim GSP benefits for trade with the United States.

Tariffs are aggregated from the HS eight-digit level to the six-digit level in two different ways: by taking simple averages; or by taking trade-weighted averages. There are several limitations to using tariff schedules to calculate tariffs. One limitation is the effect of the maquiladoras on Mexican exports to the United States. Under "production-sharing" provisions, duty does not have to be paid on the U.S.-sourced content of many exports to the United States, while the full value of those transactions is recorded in U.S. trade data. The tariff schedule will therefore often overstate the NAFTA preferences. A second limitation of the tariff schedule is that preferential tariff arrangements are often circumscribed by restrictive rules of origin that need to be satisfied to qualify for the tariff preference. To partly address these limitations I also calculate tariffs using data on actual import duty paid. The drawback of this approach is that tariff rates can only be observed when there is trade. Where there is no trade, I revert to the tariff schedule for that item. This alternative set of eight-digit "applied" tariffs are also aggregated to the six-digit level using simple averages and trade-weighted averages. This gives a total of four measures of tariffs at the HS six-digit level.

Quantitative restrictions on imports of many textile, clothing, and footwear products under the Multi-Fiber Agreement (MFA) and of many agricultural products provide a further complication. Many of these restrictions are binding, although a large number are not (Evans & Harrigan, 2003). They are extremely difficult to account for, since many restrictions encompass many HS products and most apply bilaterally. The existence of binding quotas will tend to bias downward the estimated substitution elasticities. Eliminating products subject to quotas did not, however, lead to higher substitution elasticity estimates.

The preferences given to Canadian and Mexican production are systematically related to some of the characteristics of the products. This is evident from figures 2A to 3C showing a systematic negative relationship between the preference and Canada's and, to a lesser extent, Mexico's share of U.S. imports. Canadian and, to a lesser extent, Mexican tariffs are strongly correlated with U.S. tariffs. Given that the most protected sectors are agriculture and simple manufactures like textiles, apparel, and footwear, the highest preferences are mostly in these sectors, subject to the existence of quantitative restrictions. The NAFTA preferences are biased toward products in which developed countries have a comparative disadvantage. This effect can also be seen in price data in tables 2A to 2C. The relative price of Canadian and U.S. goods is usually substantially higher in products where there are large tariff preferences under NAFTA. This suggests that NAFTA may have caused an expansion of North American production of products for which North America is a relatively high-cost producer.

[7] See Office of the United States Trade Representative (1999) for details of the U.S. GSP scheme.

[8] There is a detailed concordance between the 1988 and 1989 U.S. data detailing the change in trade and tariff schedules. I considered that keeping a broader set of comparison countries was more important than keeping an extra year of data. The substitution elasticity estimates are not very sensitive to this choice.

TABLE 2A.—TARIFF PREFERENCES AND RELATIVE PRICES OF U.S. IMPORTS FROM CANADA AND MEXICO

Year 1999 Tariff Preference (%)	Median Log Relative Price of U.S. Imports from Canada				Median Log Relative Price of U.S. Imports from Mexico			
	1989	1993	1999	*N*	1989	1993	1999	*N*
0	0.082	0.088	0.168	1,457	−0.094	0.014	−0.059	663
(0, 10]	0.154	0.175	0.201	2,496	−0.121	−0.033	0.007	1,327
>10	0.423	0.533	0.602	521	−0.127	0.005	−0.057	234

Note: For each HTS ten-digit product the FOB unit price of U.S. imports from Canada, Mexico, and the aggregate of all other countries has been calculated for the years 1989, 1993, and 1999. The log price of imports from Canada and Mexico relative to imports from all other countries is then calculated. The median log relative price is then tabulated for three arbitrary ranges of tariff preference given by the U.S. to imports from Canada and Mexico. Products are only included if they are imported in all three years. The number of products for each calculation is reported.

TABLE 2B.—TARIFF PREFERENCES AND RELATIVE PRICES OF CANADIAN IMPORTS FROM THE UNITED STATES AND MEXICO

Year 1999 Tariff Preference (%)	Median Log Relative Price of Canadian Imports from the U.S.				Median Log Relative Price of Canadian Imports from Mexico			
	1989	1993	1999	*N*	1989	1993	1999	*N*
0	−0.065	−0.036	−0.001	1,257	−0.048	−0.011	0.016	76
(0, 10]	0.018	0.012	0.039	1,228	−0.182	0.203	0.126	136
>10	0.338	0.391	0.383	706	−0.245	0.269	0.207	36

Note: For each HTS ten-digit product the FOB unit price of Canadian imports from the U.S., Mexico, and the aggregate of all other countries has been calculated for the years 1989, 1993, and 1999. The log price of imports from the U.S. and Mexico relative to imports from all other countries is then calculated. The median log relative price is then tabulated for three arbitrary ranges of tariff preference given by Canada to imports from the U.S. and Mexico. Products are only included if they are imported in all three years. The number of products for each calculation is reported.

TABLE 2C.—TARIFF PREFERENCES AND RELATIVE PRICES OF MEXICAN IMPORTS FROM THE UNITED STATES AND CANADA

Year 1999 Tariff Preference (%)	Median Log Relative Price of Mexican Imports from the U.S.				Median Log Relative Price of Mexican Imports from Canada			
	1989	1993	1999	*N*	1989	1993	1999	*N*
(0, 10]	—	−0.226	−0.263	1,547	—	0.002	0.105	640
(10, 20]	—	−0.257	−0.441	2,081	—	0.098	0.037	813
>20	—	−0.076	0.000	709	—	0.426	0.464	232

Note: For each HS six-digit product the FOB unit price of Mexican imports from the U.S., Canada, and the aggregate of all other countries has been calculated for the years 1993 and 1999 (1989 data being unavailable). The log price of imports from the U.S. and Canada relative to imports from all other countries is then calculated. The median log relative price is then tabulated for three arbitrary ranges of tariff preference given by Mexico to imports from the U.S. and Canada. These tariff ranges differ from tables 2A and 2B because there are almost no observations where the preference is zero. Products are only included if they are imported in both years. The number of products for each calculation is reported.

Data on Canadian import duties charged are collected for all years and products by Statistics Canada. The *ad valorem* component of tariff schedules is also available for most years for many countries, including Canada and Mexico, from the World Bank's WITS database. Canadian tariff data are aggregated to the six-digit level in the same way as U.S. tariff data. Mexican trade data are available only at the six-digit level in the WITS database, so Mexican tariffs were aggregated to the six-digit level by taking simple averages. I can therefore estimate demand elasticities using the trade of each of the NAFTA partners.

IV. Results

A. Demand Elasticity

The mean elasticity of substitution is estimated using equation (13) and setting $\sigma_i = \sigma$ for all products. There is insufficient tariff variation to obtain meaningful substitution elasticity estimates for detailed industries. To recapitulate, $c_{ijt} \cdot g_{i1jt} \cdot q^D_{i1jt}$ is the CIF value of U.S. imports of product i from country j at time t; $c_{ijt} \cdot g_{i2jt} \cdot q^D_{i2jt}$ is the CIF value of E.U. imports of product i from country j at time t; $\tau_{i1jt} - 1$ is the U.S. *ad valorem* tariff on imports of product i from country j at time t; D_i and D_t are full sets of product and year dummies respectively; and $\varepsilon_{ijj't}$ is a random disturbance term. The parameter σ is of interest because it is one of the key determinants of the effect of trade impediments on the volume of trade and because it is a critical ingredient of welfare analysis of trade liberalization.

I use HS six-digit trade and tariff data from 1989 to 1999. Later years are omitted because the Mexico-E.U. free-trade agreement commenced in 2000. Country j is alternatively Canada or Mexico, and country j' is the aggregate of all countries that did not substantially change their preferential trade relations with either the United States or the European Union between 1989 and 1999. A list of these countries is provided in appendix table A1. A discussion of this aggregation appears in Romalis (2005). Four different measures of tariffs are used, depending on whether the tariff schedule or actual duty paid are used to calculate tariffs at the eight-digit level, and whether tariffs were aggregated to the six-digit level using simple averages or trade weights.

Results are reported in tables 3A and 3B. Table 3A reports results based on changes in the destination of Canadian exports, while Table 3B reports results based on the

TABLE 3A.—SUBSTITUTION ELASTICITY ESTIMATES BASED ON U.S. AND E.U. IMPORTS FROM CANADA AND CONTROL COUNTRIES, 1989–1999

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
σ	6.52 (0.80)	6.68 (0.90)	9.38 (0.88)	8.73 (1.06)	6.25 (0.77)	6.30 (0.85)	8.49 (0.84)	7.72 (0.97)
Commodity Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control Countries	Table A1	Table A1	Table A1	Table A1	All	All	All	All
Tariff Measure	Schedule; import weighted	Schedule; simple average	Applied; import weighted	Applied; simple average	Schedule; import weighted	Schedule; simple average	Applied; import weighted	Applied; simple average
N	35,537	35,533	35,536	35,532	36,089	36,085	36,088	36,084
Commodities	4,631	4,631	4,631	4,631	4,694	4,694	4,694	4,694

Note: Dependent variable is ln (U.S. imports from Canada/U.S. imports from control countries) − ln (EU12 imports from Canada/EU12 imports from control countries) by year and HS six-digit commodity. The substitution elasticity estimate comes from regressions of this variable on a measure of the tariff preference that the U.S. gives to goods of Canadian origin. The EU12 includes the 12 countries that were members of the E.U. in 1989. The "Table A1" control countries are listed in appendix table A1. When "All" countries are used as a control, this includes all countries (including intra-E.U. international trade) with the exception of NAFTA countries. Robust standard errors adjusted for clustering on each commodity are in parentheses. There is a small difference between the number of observations in columns for the same set of control countries because a small number of observations with extreme values for the calculated tariff preference (where ln (1 + preference) is greater than 0.5) are discarded.

TABLE 3B.—SUBSTITUTION ELASTICITY ESTIMATES BASED ON U.S. AND E.U. IMPORTS FROM MEXICO AND CONTROL COUNTRIES, 1989–1999

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
σ	9.90 (1.02)	10.15 (1.15)	10.90 (1.19)	9.59 (1.25)	9.88 (1.00)	10.04 (1.08)	10.88 (1.16)	9.61 (1.20)
Commodity Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control Countries	Table A1	Table A1	Table A1	Table A1	All	All	All	All
Tariff Measure	Schedule; import weighted	Schedule; simple average	Applied; import weighted	Applied; simple average	Schedule; import weighted	Schedule; simple average	Applied; import weighted	Applied; simple average
N	19,335	19,335	19,334	19,333	19,414	19,414	19,413	19,412
Commodities	3,415	3,415	3,415	3,415	3,427	3,427	3,427	3,427

Note: Dependent variable is ln (U.S. imports from Mexico/U.S. imports from control countries) − ln (EU12 imports from Mexico/EU12 imports from control countries) by year and HS six-digit commodity. The substitution elasticity estimate comes from regressions of this variable on a measure of the tariff preference that the U.S. gives to goods of Mexican origin. The EU12 includes the 12 countries that were members of the E.U. in 1989. The "Table A1" control countries are listed in appendix table A1. When "All" countries are used as a control, this includes all countries (including intra-E.U. international trade) with the exception of NAFTA countries. Robust standard errors adjusted for clustering on each commodity are in parentheses. There is a small difference between the number of observations in columns for the same set of control countries because a small number of observations with extreme values for the calculated tariff preference (where ln (1 + preference) is greater than 0.5) are discarded.

TABLE 3C.—SUBSTITUTION ELASTICITY ESTIMATES BASED ON CANADIAN AND E.U. IMPORTS FROM THE UNITED STATES AND CONTROL COUNTRIES, 1989–1999

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
σ	5.51 (0.47)	5.07 (0.45)	2.99 (0.44)	2.84 (0.46)	5.31 (0.42)	4.96 (0.41)	3.09 (0.39)	2.95 (0.39)
Commodity Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control Countries	Table A1	Table A1	Table A1	Table A1	All	All	All	All
Tariff Measure	Applied; import weighted	Applied; simple average	Schedule; import weighted	Schedule; simple average	Applied; import weighted	Applied; simple average	Schedule; import weighted	Schedule; simple average
N	44,280	44,277	44,278	44,278	49,038	49,035	49,038	49,038
Commodities	5,150	5,150	5,150	5,150	5,242	5,242	5,242	5,242

Note: Dependent variable is ln (Canadian imports from U.S./Canadian imports from control countries) − ln (EU12 imports from U.S./EU12 imports from control countries) by year and HS six-digit commodity. The substitution elasticity estimate comes from regressions of this variable on a measure of the tariff preference that Canada gives to goods of U.S. origin. The EU12 includes the 12 countries that were members of the E.U. in 1989. The "Table A1" control countries are listed in appendix table A1. When "All" countries are used as a control, this includes all countries (including intra-E.U. international trade) with the exception of NAFTA countries. Robust standard errors adjusted for clustering on each commodity are in parentheses. There is a small difference between the number of observations in columns for the same set of control countries because a small number of observations with extreme values for the calculated tariff preference (where ln (1 + preference) is greater than 0.5) are discarded.

TABLE 3D.—SUBSTITUTION ELASTICITY ESTIMATES BASED ON CANADIAN AND E.U. IMPORTS FROM MEXICO AND CONTROL COUNTRIES, 1989–1999

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
σ	8.06 (1.14)	7.85 (1.16)	6.80 (1.24)	7.32 (1.31)	7.64 (1.10)	7.20 (1.14)	6.63 (1.19)	7.02 (1.28)
Commodity Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control Countries	Table A1	Table A1	Table A1	Table A1	All	All	All	All
Tariff Measure	Applied; import weighted	Applied; simple average	Schedule; import weighted	Schedule; simple average	Applied; import weighted	Applied; simple average	Schedule; import weighted	Schedule; simple average
N	13,137	13,137	13,139	13,139	13,219	13,219	13,220	13,220
Commodities	2,674	2,674	2,674	2,674	2,695	2,695	2,695	2,695

Note: Dependent variable is ln (Canadian imports from Mexico/Canadian imports from control countries) − ln (EU12 imports from Mexico/EU12 imports from control countries) by year and HS six-digit commodity. The substitution elasticity estimate comes from regressions of this variable on a measure of the tariff preference that Canada gives to goods of Mexican origin. The EU12 includes the 12 countries that were members of the E.U. in 1989. The "Table A1" control countries are listed in appendix table A1. When "All" countries are used as a control, this includes all countries (including intra-E.U. international trade) with the exception of NAFTA countries. Robust standard errors adjusted for clustering on each commodity are in parentheses. There is a small difference between the number of observations in columns for the same set of control countries because a small number of observations with extreme values for the calculated tariff preference (where ln (1 + preference) is greater than 0.5) are discarded.

TABLE 3E.—SUBSTITUTION ELASTICITY ESTIMATES BASED ON MEXICAN AND E.U. IMPORTS FROM THE UNITED STATES, CANADA, AND CONTROL COUNTRIES, 1990–1999

	(1)	(2)	(3)	(4)
σ	2.50 (0.48)	1.98 (0.41)	0.77 (0.88)	0.56 (0.82)
Commodity Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Imports from U.S./Canada	U.S.	U.S.	Canada	Canada
Control Countries	Table A1	All	Table A1	All
Tariff Measure	Schedule; simple average	Schedule; simple average	Schedule; simple average	Schedule; simple average
N	38,002	42,457	19,692	20,314
Commodities	4,684	4,844	3,430	3,524

Note: Dependent variable in columns 1 and 2 is ln (Mexican imports from U.S./Mexican imports from control countries) − ln (EU12 imports from U.S./EU12 imports from control countries) by year and HS six-digit commodity. Dependent variable in columns 3 and 4 is ln (Mexican imports from Canada/Mexican imports from control countries) − ln (EU12 imports from Canada/EU12 imports from control countries) by year and HS six-digit commodity. The substitution elasticity estimate comes from regressions of the dependent variable on a measure of the tariff preference that Mexico gives to goods of U.S. or Canadian origin. The EU12 includes the 12 countries that were members of the E.U. in 1989. The "Table A1" control countries are listed in appendix table A1. When "All" countries are used as a control, this includes all countries (including intra-E.U. international trade) with the exception of NAFTA countries. Robust standard errors adjusted for clustering on each commodity are in parentheses. A small number of observations with extreme values for the calculated tariff preference (where ln (1 + preference) is greater than 0.5) are discarded.

destination of Mexican exports.[9] The estimates of the mean elasticity of substitution range between 6.2 and 10.9 and are reasonably precisely estimated. Moving across the columns, the estimates are slightly sensitive to the choice of tariff measure—the estimates using Canadian exports are lower when the tariff schedule is used. The estimates based on Mexican exports tend to be higher than those based on Canadian exports. The estimates are very similar whether the "control" countries j' are limited to those listed in appendix table A1 or include all non-NAFTA countries. The estimates are similar in magnitude to elasticities estimated by Clausing (2001) and Lai and Trefler (2002).

These elasticities of substitution suggest that consumers are very willing to substitute between different sources of a product. One implication of this willingness to substitute is that small costs to international trade, whether due to natural barriers such as transport costs or artificial barriers such as tariffs, will have a large effect on trade volumes. With a substitution elasticity of 6, ignoring for a moment terms-of-trade effects, the median U.S. tariff of 5.5% will reduce consumption of imported varieties relative to domestic varieties by 27%. With a substitution elasticity of 11, this reduction in relative consumption is 45%. But on some products the effect of trade barriers will be much more dramatic; U.S. tariffs range up to 350%.

I also estimate equation (13) using, alternately, Canada and Mexico as "country 1." The trade and tariff data were obtained at the HS six-digit level for Mexico and Canada from the World Bank's World Integrated Trade Solution (WITS) database, and at the tariff-line level for Canada from Statistics Canada. One caveat with these results is that the tariff schedules in the WITS database include only the *ad valorem* component of tariffs, and are not available for all years.[10] This is not a severe limitation in the case of Canada, because Canadian data on duties collected are available for all years at the tariff-line level and these "applied" tariffs can also be used to estimate elasticities. Substitution elasticity estimates obtained using Canada's applied tariffs and reported in tables 3C and 3D ranged from 5.0 to 5.5 when examining the destination of U.S. exports and 7.2 to 8.1 when examining Mexican exports. The estimates obtained using Mexican tariff data and reported in table 3E are much lower, at 2.0 to 2.5 when examining U.S. exports and 0.6 to 0.8 when examining Canadian exports. These low estimates partly result from the greater measurement error in the Mexican tariff data, but may also result from a important force driving Mexican imports being the U.S. tariff reductions on Mexican goods containing suffi-

[9] Only OLS estimates are reported. Earlier drafts of this paper also reported GLS estimates that sought to exploit the serial correlation of the disturbances and Heckman estimates that sought to model the missing observations. These estimates were very similar.

[10] Canadian tariff schedules for 1990–1992 and 1994 had to be estimated from surrounding years' data, as did Mexican tariff schedules for 1990, 1992–1994, and 1996.

TABLE 4.—INVERSE SUPPLY ELASTICITY ESTIMATES, 1989–1999

	(1) IV	(2) IV	(3) IV	(4) OLS
η	0.45 (0.04)	0.52 (0.05)	0.24 (0.05)	−0.31 (0.00)
Commodity × Country Fixed Effects	Yes	Yes	Yes	Yes
Year × Country Fixed Effects	Yes	Yes	Yes	Yes
Estimation Technique	IV	IV	IV	OLS
Instruments (see notes)	Set 1	Set 2	Set 3	—
N	1,116,619	1,116,619	1,116,619	1,116,619

Note: The dependent variable is the observed FOB unit price of each country's exports in HS ten-digit U.S. import data. This is regressed on an estimate of the total quantity produced of each product by each exporting country. That quantity estimate is produced using the quantity exported to the U.S. at the ten-digit level; the share of each country's exports at the HS six-digit level that are exported to the U.S.; and the share of each industry's output that is exported. Four U.S. tariff measures are used as instruments for the (estimated) quantity: U.S. tariff rates on exports from the exporting country, Canada, Mexico, and all other countries. Instrument "Set 1" includes all these tariffs; "Set 2" only includes the tariff on exports from the exporting country; and "Set 3" includes the tariffs on exports from Canada, Mexico, and all other countries. Standard errors are reported in parentheses.

cient North American content, stimulating Mexican imports of components from the United States and Canada.

B. *Supply Elasticity*

I estimate the mean inverse supply elasticity using equation (1). I obtain both IV and OLS estimates using the most detailed U.S. import price and quantity data available, the ten-digit level. Estimation of equation (1) requires estimates of country j's total output of i—the construction of this data is explained above at equation (14). I use four tariff rates as instruments for the quantity q^S_{ijt} in equation (1). Firstly, I use the U.S. tariff rates on exports from country j, Canada, Mexico, and all other countries. Secondly, I only use the tariff rate on exports from country j. An increase in this tariff will, conditional on the supply price, shift demand downward. Thirdly, I omit the tariff rate on exports from country j but include the other three tariff measures. An increase in these tariff rates will, conditional on the supply price and the tariff on exports from country j, shift demand upward. Tariffs are measured at the ten-digit level using data on duties paid. Where data on duties paid are not available, I use the tariff schedule.[11] I omit all products where there is a specific tariff, because a specific tariff generates a causal link from supply prices to the measured *ad valorem* equivalent tariff.

Column 1 of table 4 contains results where the four tariff rates are used as an instrument for quantity. I estimate the parameter η to be 0.45. This result suggests that supply to the United States is fairly elastic, even for products where the United States consumes most of the output. A shock to demand that causes a 1% increase in worldwide consumption will cause the supply price to increase by 0.45%. Column 2 reports the results when the tariff on exports from country j is the only instrument. The estimate of η is very similar at 0.52. Column 3 reports the results when the tariff on exports from country j has been omitted from the set of instruments. The estimate of η of 0.24 suggests that supply is more elastic. Column 4 reports OLS results purely for inspection—the coefficient has the wrong sign but has no useful interpretation since OLS does not identify the supply curve.

[11] When the tariff schedule is used, the MFN rate is used for the "all other countries" tariff measure.

C. *Welfare and Trade Volume*

With estimates of demand and supply elasticities it is possible to make tentative calculations of NAFTA's and CUSFTA's price and welfare effects without invoking the greatly simplifying "small-country" assumption. I use the simple model in section II of the paper. The model, while extremely parsimonious with parameters, will be applied to rich trade and tariff data. This calculation will be consistent with the structure of the model and the estimated parameters. The strategy is to estimate the first-order welfare effects of CUSFTA and NAFTA on the United States, Canada, Mexico, and the rest of the world (ROW). The important ingredients of that calculation are reported in this section; the details of that calculation and additional data requirements are left to the appendix.

I estimate the effects of each trade agreement on the purchasing power of a country's output, holding output quantities constant. Nominal income is given by equation (6), and the ideal price index corresponding to the utility function in equation (2) is

$$\hat{P}_{jt} = \prod_i \left[\sum_{j'} (c_{ij't} \cdot g_{ijj't} \cdot \tau_{ijj't})^{1-\sigma} \right]^{b_{ij}/(1-\sigma)}. \tag{17}$$

This measure will understate welfare because it will fail to account for a second-order effect from the reoptimization of production following changes in relative prices. The calculations proceed in four steps. Firstly, I estimate how prices and quantities of each product respond to the tariff liberalization, keeping existing aggregate income constant. I then use product prices and industry price indexes to estimate expenditures on each country's goods and the change in aggregate incomes. These new aggregate incomes are then used to recalculate equilibrium product prices. This process is iterated until the estimated changes in prices and incomes are consistent with no change in each country's trade balance. Welfare calculations are then performed.

(i) Equilibrium. From equation (1), ignoring fixed effects and supply shocks, the inverse supply curve is

$$\ln c_{ijt} = \eta \ln \left(\sum_{j'} q^S_{ij'jt} \right) + \ln \hat{P}_{jt}. \tag{18}$$

Totally differentiating equation (18) yields

$$d \ln c_{ijt} = \eta\left(\sum_{j'} s_{ij'jt} d \ln q^S_{ij'jt}\right) + d \ln \hat{P}_{jt}, \tag{19}$$

where $s_{ij'jt} = q^S_{ij'jt}/(\Sigma_{j'} q^S_{ij'jt})$ is simply the proportion of country j's output of product i that is supplied to country j'. Totally differentiating the demand equation (15) yields

$$\begin{aligned} d \ln q^D_{ij'jt} = &-\sigma d \ln c_{ijt} - \sigma d \ln \tau_{ij'jt} - \sigma d \ln g_{ij'jt} \\ &+ (\sigma - 1) d \ln \hat{P}_{ij't} + d \ln Y_{j't}. \end{aligned} \tag{20}$$

In equilibrium, the change in demand due to NAFTA will equal the change in supply. Substituting $d \ln q^D_{ij'jt}$ from equation (20) for $d \ln q^S_{ij'jt}$ in equation (19) and ignoring transport costs (that I assume to be unchanged) yields how equilibrium supply prices c_{ijt} change in response to changed tariffs, industry price indexes $\hat{P}_{ij't}$ (defined in equation [16]), aggregate price indexes $\hat{P}_{jt}$, and aggregate incomes:

$$\begin{aligned} d \ln c_{ijt} = \frac{\eta}{1 + \eta\sigma}\Bigg[&\sum_{j'} - s_{ij'jt} \sigma d \ln \tau_{ij'jt} + \sum_{j'} s_{ij'jt} \\ &\times (\sigma - 1) d \ln \hat{P}_{ij't} + \sum_{j'} s_{ij'jt} d \ln Y_{j't} + \frac{1}{\eta} d \ln \hat{P}_{jt}\Bigg]. \end{aligned} \tag{21}$$

Equation (21) together with equations (16), (17), and (6) defining $\hat{P}_{ij't}$, $\hat{P}_{jt}$, and $Y_{j't}$ form a nonlinear system of equations involving hundreds of thousands of products. I make one modification to the system to make the general equilibrium not too computationally burdensome to solve numerically. I group all non-NAFTA countries into the aggregate ROW. Although I treat the output of each country in the ROW as a separate product, I compute the change in the aggregate income for the ROW and price indexes $\hat{P}_{ij't}$ and $\hat{P}_{j't}$ that are common to every country in the ROW.

The solution is obtained iteratively in four steps. Firstly, the changes in tariffs under CUSFTA/NAFTA are inserted into equation (21) to yield estimates of price changes of individual products $d \ln c_{ijt}$. This only captures the "proximate" effect of the tariff reductions on the price of output produced in NAFTA countries. In the second step these new prices are then used to construct the change in price indexes $d \ln \hat{P}_{ij't}$ and $d \ln \hat{P}_{jt}$ using equations (16) and (17). The change in these price indexes are then used in the third step to reestimate the price changes of individual goods using equation (21). This time the prices of all goods in an industry are affected if there were any tariff changes in that industry. Iterating the second and third steps quickly leads to convergence of the individual goods prices and the price indexes. In the fourth step these new prices and price indexes are used to estimate the change in income $d \ln Y_{j't}$. I use the fact that in an equilibrium with an unchanged trade balance, the change in a country's income equals the change in expenditures on its output (net of taxes and transport costs) plus the change in taxes collected on imported goods.

TABLE 5.—MODEL RESULTS

Change in Welfare due to CUSFTA (% of GDP)

Country	Real Value of Existing Output	Real Tariff Revenue	Welfare
USA	0.01	−0.02	−0.01
Canada	0.26	−0.29	−0.02
Mexico	0.00	0.00	0.00
Rest of World	0.00	—	0.00

See text for an explanation of the decomposition.

Change in Welfare due to NAFTA (% of GDP)

Country	Real Value of Existing Output	Real Tariff Revenue	Welfare
USA	0.03	−0.02	0.01
Canada	0.02	−0.02	0.00
Mexico*	1.09	−1.39	−0.30
Rest of World	0.00	—	0.00

See text for an explanation of the decomposition.

Change in Bilateral Trade Due to CUSFTA (billions 1988 USD \ %)

Partners	USA	Canada	Mexico	ROW
USA		4.05%	0.02%	0.10%
Canada	6.30		−3.01%	−0.88%
Mexico	0.01	−0.06		0.06%
ROW	0.63	−0.58	0.01	

Note: Elements below principal diagonal are in billions of 1988 USD, other elements are percentage changes.

Change in Bilateral Trade Due to NAFTA (billions 1993 USD \ %)

Partners	USA	Canada	Mexico	ROW
USA		−0.31%	23.16%	−0.40%
Canada	−0.61		27.50%	−0.61%
Mexico	18.30	0.94		−9.46%
ROW	−2.96	−0.40	−1.94	

Note: Elements below principal diagonal are in billions of 1993 USD, other elements are percentage changes.

The change in quantities demanded are estimated by substituting the tariff reductions and the changes in goods prices, price indexes, and aggregate incomes into equation (20). Changed expenditures and trade taxes are then a simple function of the tariff reductions and the estimated price and quantity responses. The change in income is then used to reestimate the price changes of individual goods using equation (21). Iterating the second through fourth steps leads to convergence in the estimates of goods prices, price indexes, and national incomes. More details of solving for the change in equilibrium prices are in the appendix.

(ii) Welfare and trade volume. The welfare decomposition for CUSFTA and NAFTA is summarized in table 5. Increases in the real value of output of NAFTA members is offset by the decline in tariff revenue, leaving small welfare changes in this simple static model. These results suggest that something about the agreements is not altogether wholesome—too much tariff revenue is being forgone for too small a reduction in the price index. In part this reflects the evidence that the biggest tariff preferences are being given on products where North American firms are not low-cost producers. In other words, there is too much trade

diversion. On a less negative note, the welfare effects for the aggregate ROW are also small.

To an extent the welfare result is not surprising, because the model omits potential sources of welfare changes from increasing returns to scale, imperfect competition, and productivity changes. Econometric evidence on the extent of welfare gains due to greater exploitation of scale economies is mixed because there is robust evidence that increased foreign competition is associated with smaller firms in import-competing industries in addition to the evidence that foreign liberalization increases the size of exporting firms (Tybout, 2004). Tybout notes that even if exporter expansion were the dominant effect of liberalization, it is unlikely that returns to scale would amount to much because exporting plants already tend to be the largest in the industry and are not likely to have much more potential for scale economy exploitation.

Welfare gains from the expansion in the output of firms where price exceeds marginal cost will also be offset by contractions in the output by other firms where price exceeds marginal cost. Imperfect competition may also give rise to substantial terms-of-trade movements in response to trade policy, but Chang and Winters's (2002) finding of large terms-of-trade gains (losses) for MERCOSUR members (nonmembers) does not appear in the similar data used in this paper for NAFTA. Although the methodology is quite different, if preferential tariff reductions did cause large reductions in export prices of nonmembers, then this should be detected by the regressions of equation (1) that identify the supply elasticity. The impact of preferential tariffs is to reduce demand for imports from firms in nonmember countries. If foreign firms react to this reduction in demand by reducing their markups, then the supply-elasticity regressions will suggest that supply is very inelastic because small quantity changes will be associated with large price changes. The regressions suggest that supply to the United States is actually quite elastic. A possible reconciliation of the results in this paper and Chang and Winters is that competition was more intense in the U.S. market than in the Brazilian market so that there were already low markups and hence little room for markup reduction. Another component of gains in imperfectly competitive models is through changes in the extensive margin. Debaere and Mostashari (2006) show that while preferential tariff reductions influence the extensive margin of countries' exports to the United States, the net effect is moderate.

Evidence on productivity effects surveyed in Tybout (2004) suggests that trade does rationalize production by expanding the output of the most efficient plants, and that foreign competition improves intraplant efficiency. This effect may be muted for NAFTA—this paper will present direct evidence that NAFTA actually helps to expand output in highly protected (hence presumably relatively inefficient) industries. The combination of the evidence surveyed in Tybout (2004) and the evidence in Debaere and Mostashari (2006) and this paper suggest that the net effect of omitted welfare channels may not be substantial.

So why the recent relative popularity of regional agreements? The effects of CUSFTA/NAFTA on the most protected sectors may provide part of the answer. The left panels of figure 5 show the combined estimated effects of NAFTA and CUSFTA on output prices in six-digit sectors where the MFN tariff exceeds 10%. The median highly protected sector in the United States and Canada appears to expand, though only slightly, while the median highly protected Mexican sector contracts slightly. It should be remembered that these calculations will not account for the effects of more stringent rules of origin, which will tend to further shore up the position of highly protected sectors (Krueger, 1999). The reason why many protected sectors benefit is quite simple. The preferential tariff reductions are squeezing out imports from nonmember countries in many of these sectors, which on average drives up the price of North American supply. Since there is a high cross-product correlation in tariff rates in the United States, Canada and, to a lesser extent, Mexico, there could be a large reduction in imports in these sectors.[12] This trade diversion is confirmed econometrically in the next subsection. If highly protected sectors do in fact benefit from NAFTA and CUSFTA, then this may make future multilateral liberalization in these sectors more difficult because the price effects of true free trade in these sectors will now be even larger. This is consistent with evidence on tariffs found in Limao (2006). By contrast, the alternative of unilateral liberalization where the United States, Canada, or Mexico drop all their tariffs looks grim for highly protected industries (figure 5, right panels), though the price declines would be smaller if the rest of the world also eliminated its tariffs.

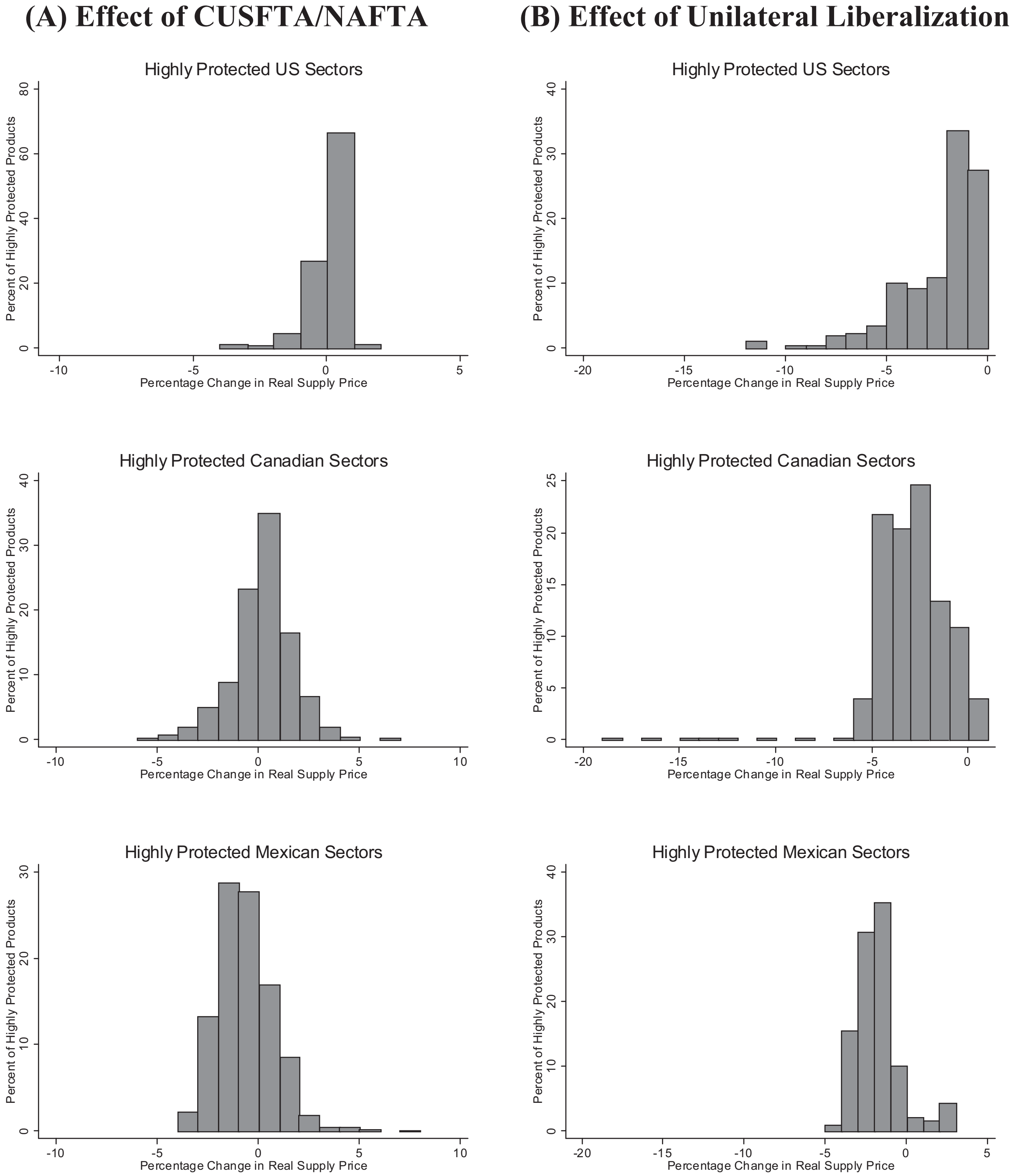
Trade volume effects are more substantial. CUSFTA causes a 4% increase in two-way trade between Canada and the United States. NAFTA causes a 23% increase in two-way trade between Mexico and the United States and a 28% increase between Mexico and Canada. Aggregate trade with the rest of the world is not greatly affected except for a 9% decline in trade between Mexico and the rest of the world. Declines in imports from the rest of the world in some highly protected sectors is partly offset by increased imports elsewhere.

D. *Econometric Confirmation of Trade Diversion*

A concern raised by the welfare analysis was the role of trade diversion in reducing static welfare gains and, by often benefiting highly protected sectors, potentially making multilateral liberalization harder. Trade data enable a direct search for this trade diversion. Consider the value of exports of product i from a non-NAFTA country j' to a NAFTA

[12] The simple correlations of HS six-digit tariffs is 0.5 for the United States and Canada, 0.25 between the United States and Mexico, and 0.35 between Canada and Mexico.

FIGURE 5.—HIGHLY PROTECTED SECTORS



Note: "Unilateral liberalization" means the dropping of all tariffs by the relevant country. "Real supply price" is the output price exclusive of tariffs and transport costs divided by the aggregate price index for that country.

country and to the European Union, grossed up for transport costs. From the CES demand assumption:

$$\ln \frac{c_{ij't} \cdot g_{i1j't} \cdot q^D_{i1j't}}{c_{ij't} \cdot g_{i2j't} \cdot q^D_{i2j't}} = -\sigma \ln \frac{\tau_{i1j't}}{\tau_{i2j't}} - (\sigma - 1) \ln \frac{g_{i1j't}}{g_{i2j't}} + (\sigma - 1) \ln \frac{\hat{P}_{i1t}}{\hat{P}_{i2t}} + \ln \frac{b_{i1} Y_{1t}}{b_{i2} Y_{2t}}, \tag{22}$$

where $\hat{P}_{i1t}$ ($\hat{P}_{i2t}$) is the ideal price index of all sellers of product i in the NAFTA country (E.U.) inclusive of tariffs and transport costs. Trade diversion results from NAFTA because tariff reductions on North American output directly lower North American price indexes $\hat{P}_{i1t}$, thereby depressing exports from other countries to North America. These tariff reductions also indirectly affect North American (and to a much lesser extent E.U.) price in-

TABLE 6.—TRADE DIVERSION INFERRED FROM NORTH AMERICAN AND E.U. IMPORTS FROM CONTROL COUNTRIES (c')

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Trade Diversion	2.84 {0.000}	2.96 {0.000}	3.37 {0.000}	3.87 {0.000}	1.44 {0.004}	1.33 {0.009}	2.23 {0.000}	2.11 {0.000}
Tariff								
$\ln \tau_{US\text{-}Can}$	0.06	0.34	0.49	0.40	−0.71	−0.69	0.24	0.06
	(0.93)	(0.82)	(0.54)	(0.53)	(0.75)	(0.81)	(0.37)	(0.42)
$\ln \tau_{US\text{-}Mex}$	1.27	1.30	1.44	1.38	1.26	1.41	0.90	0.98
	(0.60)	(0.57)	(0.44)	(0.45)	(0.49)	(0.48)	(0.34)	(0.33)
$\ln \tau_{Can\text{-}US}$	2.02	1.91	1.26	1.75	0.19	0.11	0.26	0.44
	(0.52)	(0.54)	(0.45)	(0.47)	(0.35)	(0.37)	(0.34)	(0.30)
$\ln \tau_{Can\text{-}Mex}$	−0.95	−1.00	−0.30	−0.07	0.33	0.08	0.42	0.38
	(0.42)	(0.44)	(0.29)	(0.57)	(0.32)	(0.30)	(0.24)	(0.23)
$\ln \tau_{Mex\text{-}US}$	−1.32	−1.31	−1.10	−1.21	−0.61	−0.61	−0.48	−0.54
	(0.55)	(0.54)	(0.50)	(0.51)	(0.42)	(0.41)	(0.38)	(0.38)
$\ln \tau_{Mex\text{-}Can}$	1.76	1.71	1.57	1.61	0.98	1.03	0.89	0.96
	(0.55)	(0.55)	(0.51)	(0.52)	(0.42)	(0.43)	(0.38)	(0.39)
MFN Tariffs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Commodity Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control Countries	Table A1	Table A1	Table A1	Table A1	All	All	All	All
Tariff Measure	Schedule; import weighted	Schedule; simple average	Applied; import weighted	Applied; simple average	Schedule; import weighted	Schedule; simple average	Applied; import weighted	Applied; simple average
N	42,630	42,454	42,734	42,447	43,756	43,633	43,930	43,626
Commodities	5,312	5,313	5,321	5,313	5,349	5,345	5,354	5,345

Note: Dependent variable is ln (North American imports from control countries) − ln (EU12 imports from control countries) by year and HS six-digit commodity, where North America is the sum of the U.S., Canada, and Mexico. The EU12 includes the 12 countries that were members of the E.U. in 1989. The dependent variable is regressed on measures of the tariffs that North American countries levy on goods from within North America and on the MFN tariffs of the U.S., Canada, Mexico, and the E.U. For example, $\tau_{US\text{-}Can}$ is the tariff that the U.S. levies on goods from Canada plus 1. The first row, "Trade Diversion," reports the sum of the coefficients on tariffs levied by North American countries on imports from their NAFTA partners (the six coefficients reported below)—the p-value for the test that this sum is zero is reported in braces. A significant positive number is evidence of trade diversion resulting from preferential tariffs. The "Table A1" control countries are listed in appendix table A1. When "All" countries are used as a control, this includes all countries (including intra-E.U. international trade) with the exception of NAFTA countries. Robust standard errors adjusted for clustering on each commodity are in parentheses. There is a small difference between the number of observations in columns for the same set of control countries because a small number of observations with extreme values of the calculated tariff (where ln (1 + tariff) exceeds 0.5) are discarded. Data on actual duties collected are not available for Mexico so regressions always include the Mexican tariff schedule. Since Mexican tariffs on U.S. and Canadian goods are very similar, the separate effects of these two tariffs may be difficult to empirically disentangle.

dexes by affecting the pretariff prices that suppliers charge in these markets. A regression of the log-difference between North American and E.U. imports from the control countries on preferential and MFN tariffs should reveal trade diversion. In the absence of a closed-form solution for how prices respond to tariff changes, I estimate the following equation:

$$\begin{aligned}\ln \frac{M_{i1j't}}{M_{i2j't}} &= \beta_1 \ln \tau_{i,US,Can,t} + \beta_2 \ln \tau_{i,US,Mex,t} \\ &+ \beta_3 \ln \tau_{i,Can,US,t} + \beta_4 \ln \tau_{i,Can,Mex,t} \\ &+ \beta_5 \ln \tau_{i,Mex,US,t} + \beta_6 \ln \tau_{i,Mex,Can,t} \\ &+ \beta_7 \ln \tau_{i,US,MFN,t} + \beta_8 \ln \tau_{i,Can,MFN,t} \\ &+ \beta_9 \ln \tau_{i,Mex,MFN,t} + \beta_{10} \ln \tau_{i,EU,MFN,t} \\ &+ D_i + D_t + \varepsilon_{it},\end{aligned} \tag{23}$$

where $M_{i1j't}$ ($M_{i2j't}$) are North American (E.U.) imports of product i from the control countries j' measured on a CIF basis (since E.U. trade data inclusive of actual tariffs paid is unavailable), and the explanatory variables are preferential and MFN tariffs. For example, $\tau_{i,US,Can,t}$ is the U.S. tariff on product i imported from Canada plus 1, and $\tau_{i,US,MFN,t}$ is the U.S. MFN tariff on product i plus 1. I assume that relative transport costs ln ($g_{i1j't}/g_{i2j't}$) and relative expenditures ln ($b_{i1}Y_{1t}/b_{i2}Y_{2t}$) are captured by full sets of product and year fixed effects and a disturbance term that is orthogonal to the tariffs. The sum of the coefficients on the preferential tariffs (β_1 to β_6) gives some idea about how trade from nonmember countries is diverted as a result of NAFTA, as it reveals the decline in exports from the control countries to North America relative to the European Union that results from a 1% reduction in intra–North American tariffs. The results in table 6 provide strong evidence that NAFTA/CUSFTA have been trade diverting. Every 1% reduction in intra–North American tariffs causes a 2.8% to 3.9% decline in exports from j' to North America relative to the European Union when j' includes only the appendix table A1 countries, and a 1.3% to 2.2% decline if j' includes all non-NAFTA countries. Therefore imports into North America tend to decline in highly protected sectors following NAFTA, with the implication that the price and quantity of North American output tends to rise in these sectors.

The finding of trade diversion is in stark contrast to Clausing (2001), who has reasonably precise estimates suggesting no trade diversion. Clausing regresses growth rates of U.S. imports from the rest of the world on the CUSFTA trade preferences, and finds no correlation. The likely reason for this is that rapid growth of emergingmarket manufacturing exports in the 1980s and 1990s led to substantial growth of U.S. imports of the simple manufactures that these countries excelled at producing. The CUSFTA trade preferences tend to be high on these products. Trade diversion may have been masked by the rapid growth in imports that would have occurred in the absence of CUSFTA. The specification in this paper essentially uses E.U. trade data to eliminate the bias caused by that correlation.

V. Conclusion

This paper uses detailed worldwide trade data to identify the effects of NAFTA and CUSFTA on international trade. It develops a difference-in-differences-based method to identify demand elasticities using the tariff changes by studying where NAFTA members and the European Union source their imports of different products. It identifies supply elasticities using tariffs as instruments for observed quantities. NAFTA and CUSFTA have had a substantial effect on international trade quantities, but less effect on prices and welfare in member and nonmember countries. Intra–North American trade increased most rapidly in products where the greatest trade preferences were conferred, even though Canada and the United States appear to be high-cost producers of many of these products. The share of E.U. imports of the same products coming from North America declined. Welfare calculations using the estimated parameters and the paper's simple static model suggest almost zero welfare impact on member and nonmember countries. Of some concern is the possibility that NAFTA and CUSFTA actually increased North American output and prices in many highly protected sectors by driving out imports from nonmember countries. This development might make future multilateral trade liberalization more difficult because it magnifies the price and output decline these sectors experience following MFN tariff reductions.

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APPENDIX A

Table A1.—Countries with No Substantial Change in Preferential Trade Relations with the European Union and the United States

Afghanistan	Gabon	Norfolk Is
Angola	Gambia	North Korea
Antigua Barbuda	Ghana	Norway
Argentina	Greenland	Oman
Aruba	Grenada Is	Pakistan
Australia	Guatemala	Palau
Bahamas	Guinea	Panama
Bahrain	Guinea-Bissau	Papua New Guinea
Bangladesh	Guyana	Paraguay
Barbados	Haiti	Peru
Belize	Honduras	Philippines
Benin	Hong Kong	Pitcairn Is
Bermuda	India	Qatar
Bhutan	Indonesia	Rwanda
Bolivia	Iran	Samoa
Botswana	Jamaica	Saudi Arabia
Brazil	Japan	Senegal
Brunei	Kenya	Seychelles
Burkina Faso	Kiribati	Sierra Leone
Burundi	Korea	Singapore
Cambodia	Laos	Solomon Is
Cameroon	Lesotho	Somalia
Cape Verde	Liberia	Sri Lanka
Cayman Is	Libya	St Kitts-Nevis
Cen African Rep	Macao	St Lucia Is
Chad	Madagascar	St Vinc & Gren
Chile	Malawi	Sudan
China	Malaysia	Suriname
Christmas Is	Maldive Is	Swaziland
Cocos Is	Mali	Switzerland
Colombia	Marshall Is	Taiwan
Comoros	Mauritania	Tanzania
Congo (DROC)	Mauritius	Thailand
Congo (ROC)	Mongolia	Togo
Cook Is	Montserrat Is	Tonga
Costa Rica	Mozambique	Trin & Tobago
Cote d'Ivoire	Namibia	Tuvalu
Cuba	Nauru	Uganda
Djibouti	Nepal	United Arab Em
Dominica Is	Netherlands Ant	Uruguay
Dominican Rep	New Caledonia	Venezuela
Ecuador	New Zealand	Vietnam
El Salvador	Nicaragua	Yemen
Eq Guinea	Niger	Zambia
Ethiopia	Nigeria	Zimbabwe
Fiji	Niue	

APPENDIX B

1. Solving Industry Equilibrium Prices

The effect of one country's tariff reductions on the supply price of each variety of i, c_{ijt}, and on the price index for all varieties of i was solved iteratively at the HS six-digit level (5,000 products). The solution is aided by the price index for industry i in country j', $\hat{P}_{ij't}$, having a convenient representation in terms of relative consumption shares when it is normalized by the price of any variety of i. Dividing the price index for product i in equation (16) by the price of country j''s output of i yields

$$\frac{\hat{P}_{ij't}}{c_{ij't}} = \left[\sum_{j} \left(\frac{c_{ijt} \cdot g_{ij'jt} \cdot \tau_{ij'jt}}{c_{ij't}} \right)^{1-\sigma} \right]^{1/(1-\sigma)}. \tag{B1}$$

Under the model's assumptions, all of the elements of this normalized price index other than σ are data. The term $(c_{ij't} \cdot g_{ij'jt} \cdot \tau_{ij'jt}/c_{ij't})^{1-\sigma}$ is simply the share of country j''s consumption of i that comes from country c divided by the share that comes from country j'. This is simply a combination of trade and production data. Let time t and t' denote the pre- and postliberalization periods respectively. The new price index (normalized by the old price $c_{ij't}$) is a weighted sum of the new tariffs and the new supply prices induced by those tariffs:[13]

$$\frac{\hat{P}_{ij't'}}{c_{ij't}} = \left[\sum_{j} \left(\frac{c_{ijt} \cdot g_{ij'jt} \cdot \tau_{ij'jt}}{c_{ij't}} \right)^{1-\sigma} \left(\frac{c_{ijt'}\tau_{i1jt'}}{c_{ijt}\tau_{i1jt}} \right)^{1-\sigma} \right]^{1/(1-\sigma)}, \tag{B2}$$

where the weights $(c_{ij't} \cdot g_{ij'jt} \cdot \tau_{ij'jt}/c_{ij't})^{1-\sigma}$ are observable data from the preliberalization period. The first step is to calculate the initial impact of the tariff reductions on output prices in the United States, Canada, and Mexico. Using equation (21) this impact is

$$d \ln c_{ijt} = \frac{\eta}{1+\eta\sigma} \sum_{j'} (-s_{ij'jt}\sigma d \ln \tau_{ij'jt}). \tag{B3}$$

The second step is to use the new tariffs and prices of NAFTA-country output to compute the change in industry price indexes using equation (B2). The changes in the aggregate price indexes $\hat{P}_{j't}$ are estimated from the changes in the industry price indexes using equation (17), where the expenditure weight b_{ij} is estimated consumption of i in each country or country group j divided by that country's GDP. The estimated change in the price indexes can be inserted into equation (B4) to solve for new supply prices of every variety:

$$d \ln c_{ijt} = \frac{\eta}{1+\eta\sigma} \sum_{j'} \Big(-s_{ij'jt}\sigma d \ln \tau_{ij'jt} + s_{ij'jt}(\sigma-1) d \ln \hat{P}_{ij't} + \frac{1}{\eta} d \ln \hat{P}_{jt} \Big). \tag{B4}$$

These prices are in turn used to recalculate all price indexes. The price estimates converge after a few iterations. I then use the fact that in an equilibrium with an unchanged trade balance, the change in a country's income equals the change in expenditures on its output (net of taxes and transport costs) plus the change in taxes collected on imported goods. The change in quantities demanded are estimated by substituting the tariff reductions and the changes in goods prices and price indexes into equation (20). Changed quantities and prices give changed expenditures on each country's output. Changed tariff revenue is calculated using the tariff reductions and the estimated price and quantity responses. The change in aggregate incomes can be inserted into equation (B5) to solve for new supply prices of every variety:

$$d \ln c_{ijt} = \frac{\eta}{1+\eta\sigma} \sum_{j'} \Big[-s_{ij'jt}\sigma d \ln \tau_{ij'jt} + s_{ij'jt}(\sigma-1) d \ln \hat{P}_{ij't} + s_{ij'jt} d \ln Y_{j't} + \frac{1}{\eta} d \ln \hat{P}_{jt} \Big]. \tag{B5}$$

These prices are in turn used to recalculate the price indexes and aggregate incomes. This process is iterated until the estimated changes in prices and aggregate incomes generate no change in the trade balance.

2. Additional Data Description for Model Solution

Data is for the year preceding each trade agreement unless unavailable, in which case the closest year is used. The tariff data used for the United States and Canada are applied tariffs because they are conveniently arranged with the trade data in the Feenstra database of U.S. trade data and the Canadian trade data from Statistics Canada, and because they capture more nuances of trade policy than the tariff schedules alone. Tariff schedules are used for Mexico because applied tariffs are unavailable.

s_{ijjt}: Important data for the model are the shares of each country's output of each product that are consumed domestically. Production data for U.S. manufacturing sectors are from the NBER Productivity database and was merged with U.S. import and export data at the four-digit SIC

[13] Transport costs are assumed to be invariant to the tariffs and the quantities supplied.

level produced by Feenstra (1996, 1997). U.S. consumption of U.S. output by industry is calculated as U.S. shipments less U.S. exports. The estimates of s_{ijjt} for the United States from the SIC data are applied to every six-digit HS code that falls within a four-digit SIC code. Where a six-digit HS code maps into more than one SIC code, I use ten-digit HS import data for the United States to select the SIC code that matches the largest amount of trade at the six-digit level.[14] The equivalent production, import, and export data for U.S. nonmanufacturing sectors and for Canada and Mexico at the two- to four-digit ISIC level (depending on product) came from the OECD's STAN database, and the estimates of s_{ijjt} are mapped into HS six-digit codes using a concordance from ISIC to HS6 from the World Bank's WITS database. s_{ijjt} for other countries is estimated using the World Bank's Trade and Production database for three-digit ISIC manufacturing sectors, the World Development Indicators for energy sectors, and FAO data for agricultural sectors. For products and countries where industry data are unavailable, s_{ijjt} is estimated from World Development Indicators data as the share of each country's GDP that is not exported.

[14] The ten-digit import data for the United States includes a concordance to (import-based) SIC.

$s_{ij'jt}$: the share of each country's output of each product that is consumed by other countries is calculated using trade data and the estimates of s_{ijjt}. $s_{ij'jt}$ is simply the share of each product that is exported multiplied by the share of j's exports that go to country j' at the HS six-digit level:

$$s_{ij'jt} = (1 - s_{ijjt}) \frac{q_{ij'jt}}{\sum_{j' \neq j} q_{ij'jt}}. \tag{B6}$$

Production at the HS six-digit level is estimated as exports at the HS six-digit level from the WITS database divided by the coarser estimates of the share of each product that is exported $(1 - s_{ijjt})$. Consumption at the HS six-digit level is imports minus exports from the WITS database plus estimated production.

b_{ij}: expenditure weights in the utility functions are simply estimated consumption in country j of each HS six-digit product (regardless of source) divided by the GDP of that country reported by the World Bank's World Development Indicators.

σ, η: I set the value of σ at 6, which is close to the median estimate. Higher values of σ lead to a greater trade volume response but have a small effect on welfare estimates. The inverse supply elasticity η is taken as the average IV estimate in table 4 of 0.4.