# Are WTO Tariff Negotiations Reciprocal? An Analysis of Tariff Liberalization

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**Abstract**

This paper presents new evidence on the alleged imbalance in the Uruguay Round agreement, focusing on the tariff component of the multilateral trade liberalization. I adopt the framework of Bagwell and Staiger (1999) and empirically examine the *principle of reciprocity*. The main finding is that deviations from reciprocity are quite small, and thus the Uruguay Round tariff liberalization is reciprocal. The economic significance of terms of trade losses is typically minor for developing countries, accounting for merely -0.15 percent of GDP. The evidence thus suggests that developing countries did not lose significantly from their tariff cuts, and the Uruguay Round has generated rather fair outcomes as far as tariff liberalization is concerned. (JEL Classification: F13, Key words: the Uruguay Round, reciprocity, terms of trade effect, trade negotiations, trade liberalization)

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# 1 Introduction

Are developing countries disadvantaged in multilateral trade liberalization? Critics of the World Trade Organization (WTO) claim that world trading rules favor advanced nations, and the Uruguay Round, a trade negotiation round concluded in 1994, has generated unbalanced outcomes between rich and poor countries. For example, Luis Fernando Jaramillo, former Permanent Representative of Colombia to the United Nations and Chairman of the Group of 77, argues that it seems unlikely that the Uruguay Round will "translate into a positive balance to developing countries" due to the asymmetry in the concessions. He notes:

> "...the tariff reductions which developing countries could take advantage of, apart from being inferior to the ones initially foreseen, are proportionally less deep than the tariff reductions that will benefit trade among developed countries..."[1]

More recently, Stiglitz (2002) has argued that under the trade-liberalization agenda, "a disproportionate part of the gains has accrued to the advanced industrial countries, and in some cases the less-developed countries have actually been worse off."[2] He argues that the Uruguay Round resulted in unfavorable deals for poor countries so that "[t]he trade negotiations opened their markets to manufactured goods produced by the industrialized countries but did not open up the markets of Europe and the United States to the agricultural goods in which poor countries often have a comparative advantage."

Indeed, the asymmetric pattern of trade liberalization is partly confirmed in existing descriptive studies: Various studies report that the Uruguay Round has largely removed import restrictions on manufacturing products while the level of protection remains rel-

[1] This statement was presented in his speech made in 1994. The full speech can be found at www.mail-archive.com/pen-l@galaxy.csuchico.edu/msg00540.html. See also Khor (2000) who argues that the anticipated benefits for developing countries from the Uruguay Round did not realize because developed countries continue to impose high tariffs on the exports of developing countries.

[2] His argument focuses on the Sub-Saharan Africa.

atively high on some selected products such as footwear, clothing, and agricultural food products, which developing countries typically export.[3]

While the existing descriptive studies provide detailed discussions on the tariff structure after the Uruguay Round, however, they do not answer the question of how trade liberalization has affected developing countries on balance: The tariff structure, namely the *level* of tariffs, does not reflect welfare gains or losses associated with the trade liberalization.

On the other hand, calibration has become a popular method to quantify the welfare impact of the Uruguay Round. Several studies have estimated gains and losses from the trade agreement using computable general equilibrium (CGE) models.[4] These studies have provided an important first step in evaluating the Uruguay Round, but they entail various limitations, which are rarely mentioned in policy discussions. For example, CGE results are typically generated from enormously aggregated data: Existing calibration studies typically incorporate 10-20 sectors, but there are about 5,000 tariff categories at the level where tariffs are bound in actual trade negotiations. This high degree of aggregation makes it unclear how much of the policy change is reflected in the welfare estimates from the CGE models. Another type of problem in CGE studies is that parameter values obtained from one data set are applied to a different data set. This raises a question of uncertainty about parameters.[5]

[3]For example, UNCTAD (2000) reports that excessively high tariffs (tariff peaks) still occur in sectors such as clothing and agriculture. Hoekman, Ng, and Olarreaga (2002) further point out that the number of tariff peaks after the Uruguay Round has even increased in some OECD countries due to the tariffication of non-tariff barriers in agriculture. See also IMF and World Bank (2002) and Panagariya (1999a).

[4]For example, Nguyen, Perroni, and Wigle (1993) report that gains from the Uruguay Round are 36 billion dollars (0.8 percent of GDP) for the United States, 27 billion dollars (2 percent of GDP) for Japan, 61 billion dollars (1.8 percent of GDP) for EU, and 16 billion dollars (0.6 percent of GDP) for a group of developing countries. Harrison, Rutherford, and Tarr (1997), using more updated information on the trade agreement, find that gains from the Uruguay Round are 13 billion dollars (0.3 percent of GDP) for the United States, 17 billion dollars (0.5 percent of GDP) for Japan, 39 billion dollars (0.7 percent of GDP) for EU, while some low income regions, particularly the Sub-Saharan Africa, incur a net loss of 300 million dollars.

[5]See Francois (2000) and Whalley (2000) for other issues with the existing CGE studies.

It is striking, given the massive interest in multilateral trade liberalization, that our understanding of the impact of the Uruguay Round is largely drawn from calibration and descriptive studies. Indeed, there are very few econometric studies that systematically analyze the impact of the Uruguay Round on developing countries. This paper represents an empirical analysis that examines how the Uruguay Round has impacted WTO members. In particular, we focus on the *tariff* liberalization and present new evidence on the alleged imbalance in the outcomes of the Uruguay Round.[6] To this end, we will adopt a framework proposed by Bagwell and Staiger (1999) (B-S, thereafter) as a theoretical basis and investigate whether the *principle of reciprocity*, which forms a foundation of General Agreement on Tariffs and Trade (GATT) and its successor the WTO, holds in data.

Reciprocity is a pillar of GATT and the WTO. It broadly refers to the idea that when countries cut tariffs on their imports, the other countries also make similar concessions on their imports. It has been observed that countries seek concessions in a reciprocal manner so that resulting changes in imports caused by tariff cuts will be balanced against corresponding changes in exports. Formally, B-S define reciprocity as a condition that a multilateral tariff reduction generates a change in the total imports that equals a change in the total exports evaluated at the initial world prices for each country.

Defining the terms of trade of a country as the relative price of imports and exports, B-S show that reciprocity is a terms of trade condition that tells how a multilateral tariff liberalization affects the terms of trade: If countries agree to cut tariffs while maintaining reciprocity, this trade liberalization does not affect the terms of trade of participating countries. In other words, reciprocity keeps the terms of trade fixed while countries cut tariffs on their imports. On the other hand, if a multilateral trade liberalization does not satisfy

[6]Our focus on tariffs by no means suggests that non-tariff issues such as intellectual property rights and agriculture subsidies are not important. Indeed, non-tariff issues are equally important in order to assess the overall impacts of the Uruguay Round. However, focusing on tariffs makes the analysis more tractable but nevertheless allows us to ask interesting questions. Given that tariff liberalization is significant part of the Uruguay Round agreement, an evaluation of the tariff liberalization will provide useful insight into the overall impacts of the trade agreement.

reciprocity, tariff reductions will alter the terms of trade.

We will exploit this relationship between reciprocity and the terms of trade movements in order to evaluate welfare consequences of multilateral tariff liberalization. To this end, we will use a theoretical structure that there are two channels through which tariffs can affect welfare: The fist channel is local price movements, which affect the efficiency of domestic production and consumption (efficiency effect). More generally, local price movements can also affect political factors in case the government is politically motivated. The second channel is terms of trade movements, which generate terms of trade gains and losses and alter the distribution of income between countries (terms of trade effect).

When there is no trade agreement, countries choose tariffs unilaterally, and unilateral trade policy leads to a Nash equilibrium. An important characteristic of a Nash equilibrium is that tariffs are set higher than efficient levels and this inefficient outcome arises due to the terms of trade effect. A simple intuition of this result is to think of the terms of trade effect as an "externality": When the home government imposes a tariff, it will hurt foreign producers who are forced to sell their products at a lower world price. The home government, however, does not internalize this cost passed onto foreign producers and thus faces less than the full cost of import protection. As a result, the government oversupplies protection, setting tariffs higher than efficient levels.

In this environment, a tariff reduction can potentially cause two opposite effects: First, a tariff cut will enhance efficiency, which tends to increase welfare (efficiency effect). Second, a tariff reduction can cause a terms of trade deterioration, which tends to reduce welfare (terms of trade effect). If the terms of trade effect dominates, a country will lose from the trade liberalization. Indeed, in a Nash equilibrium, a country will lose from a *unilateral* tariff liberalization because it will generate terms of trade losses that surpass efficiency gains. For this reason, even though there is potential room for Pareto improvement, no one has incentive to cut tariffs unilaterally in a Nash equilibrium. In other words, the terms of trade effect prevents countries from liberalizing trade in the unilateral policy setting.

The purpose of trade agreements in the B-S framework is then to correct for the externality associated with the terms of trade effect, and this is where the principle of reciprocity comes in: If countries agree to cut tariffs while maintaining reciprocity, reciprocity keeps the terms of trade held fixed and thus eliminates the terms of trade effect, which would otherwise arise from tariff changes. At the same time, countries can enjoy gains from efficiency improvements associated with tariff reductions. In short, reciprocity secures gains from trade liberalization through the efficiency channel while neutralizing the terms of trade effect. In this way, reciprocity facilitates trade liberalization and helps countries to achieve more efficient outcomes.[7]

We use the theoretical implications of reciprocity in order to infer welfare consequences of the tariff liberalization in the Uruguay Round. For example, if we find that reciprocity holds in the Uruguay Round, we will conclude that every country gained from the tariff liberalization, as the theory suggests that reciprocity eliminates the terms of trade effect and generates gains through the efficiency channel.

On the other hand, if reciprocity does not hold, the trade agreement generated terms of trade gains and losses, altering the distribution of income among countries. In this case, the *magnitude* of terms of trade becomes quite important in order to infer welfare effects of the trade liberalization. If the magnitude of terms of trade losses is very small, i.e., if the deviation from reciprocity is rather minimal, a country is likely to have gained from the trade liberalization. However, as terms of trade losses become larger, it becomes more likely that a country loses because the terms of trade losses may be so large to surpass efficiency gains.[8]

This basic logic naturally extends to a many-good, many-country case. Thus adopting the B-S framework, we will empirically examine reciprocity in the multi-good, multi-country

[7]For an alternative view on multilateral trade liberalization, see Ethier (2002).

[8]It is important to note that reciprocity does not directly tell us about the *overall* gains and losses from trade liberalization. In other words, our approach cannot quantify gains from local price movements. However, given that the terms of trade effect is the only potential source of losses from tariff liberalization, terms of trade movements provide important information about losses from tariff cuts in the Uruguay Round.

world. We will employ a very disaggregated data set on tariffs and bilateral imports that covers about 5,000 products and consists of 2 million observations. This data set allows us to exploit the information on tariff changes at the very level where tariffs are bound in actual trade negotiations. Using this dataset, we will model how the movements of tariffs after the Uruguay Round have affected international prices in order to construct a *reciprocity statistic*, namely, a metric of reciprocity that measures terms of trade gains and losses for each country.

The reciprocity statistic is a transformation of a country's terms of trade. If the reciprocity statistic is zero, reciprocity is satisfied, and there is no implied terms of trade movement. If the reciprocity statistic is positive (negative), there is an implied terms of trade improvement (deterioration) as a result of a trade agreement. In other words, the sign of reciprocity statistic tells the direction of terms of trade movements. On the other hand, the value of reciprocity statistic corresponds to terms of trade gains and losses due to trade liberalization. Thus the reciprocity statistic also measures the *magnitude* of gains and losses from terms of trade movements.

In order to obtain the estimate of the reciprocity statistic, we will first estimate necessary parameters from our data. We use the gravity equation to model bilateral imports and estimate import demand elasticities. Using our estimates of import elasticities, we will construct the reciprocity statistic for each country.

This paper focuses on the *economic* significance rather than the statistical significance of reciprocity because even if reciprocity does not hold statistically, a small deviation from reciprocity may not be economically important. In other words, we are ultimately interested in the *magnitude* of terms of trade movements. In order to evaluated the magnitude, we will express terms of trade gains and losses as a percentage of GDP: If the terms of trade effect is small in GDP percentage terms, we conclude that the deviation from reciprocity is economically insignificant, and tariff liberalization after the Uruguay Round is reciprocal.

A test of reciprocity is an interesting exercise in itself as well since reciprocity is a key assumption underlying the B-S framework. While there are casual observations on reciprocity

in GATT practice, it has not been formally investigated whether reciprocity holds in the manner specified by B-S. There exist a few empirical attempts to test "reciprocity," but their definitions of reciprocity are fundamentally different from the B-S definition.[9] This paper represents the first empirical test of reciprocity in GATT and the WTO.

The main finding is that the magnitude of terms of trade movements is rather limited, and thus tariff liberalization after the Uruguay Round is roughly reciprocal. We find that many countries, including both developed and developing countries, experienced terms of trade losses. In particular, we find that middle and low income countries incurred terms of trade losses that amounts to 1.8 billion dollars in total. However, the economic significance of these losses is typically small at the individual country level: The simple average of terms of trade gains or losses as a share of GDP is -0.24 percent for high income countries, -0.15 percent for developing countries, and -0.18 percent for all countries. Thus the evidence suggests that terms of trade losses were rather small and developing countries did not lose significantly from the multilateral tariff liberalization.

Moreover, we do not find any systematic pattern in the tariff liberalization such as developed countries tend to benefit from terms of trade improvements. Rather, the Uruguay Round appears to have generated neutral outcomes as far as tariff liberalization is concerned.

The rest of the paper is organized as follows. Section 2 provides a theoretical basis of reciprocity. Section 3 develops an empirical approach to obtain a measure of reciprocity. Section 4 overviews the Uruguay Round tariff liberalization, and Section 5 reports the empirical results. Section 6 concludes.

## 2 The Theoretical Foundation of Reciprocity

Bagwell and Staiger (1999) (B-S) propose a theoretical framework to interpret and evaluate the key principles that form the foundation of GATT and its successor the WTO. This section adopts the B-S framework and provides a theoretical basis of reciprocity and its implications for terms of trade movements. For simplicity, we will explain the theory in

[9] See Freund (2003), and Finger, Reincke, and Castro (1999), for example.

terms of the two-sector, two-country model, but the main results continue to hold in a more general setting. We will discuss the generalization of the model later in the section.

### 2.1 Theory

Suppose there are two countries, $c$ and $c'$, and there are two goods, $x$ and $y$, which are produced under perfect competition. Suppose that good $x$ is the natural import of country $c$, and good $y$ is the natural import of country $c'$. Let $\theta^c$ ($\theta^{c'}$) be the ad valorem tariff of country $c$ ($c'$), and denote $\tau^c \equiv 1 + \theta^c$ and $\tau^{c'} \equiv 1 + \theta^{c'}$. Define $p^c \equiv p_x^c/p_y^c$ ($p^{c'} \equiv p_x^{c'}/p_y^{c'}$) to be the local relative price facing producers and consumers in country $c$ ($c'$). Defining $p^w \equiv p_x^{c'}/p_y^c$ to be the (untaxed) world relative price, the local relative price can be expressed as a function of the tariff and world price, namely, $p^c = \tau^c p^w \equiv p^c(\tau^c,\ p^w)$ and $p^{c'} = p^w/\tau^{c'} \equiv p^{c'}(\tau^{c'},\ p^w)$. Note that the terms of trade of country $c$ ($c'$) is measured by $1/p^w$ ($p^w$).

The production and consumption are determined in a standard manner, so we will leave the details in the Appendix A.1. The equilibrium world price $\tilde{p}^w(\tau^c, \tau^{c'})$ is determined by the market clearing condition for good $y$. The market clearance of good $x$ is then implied by the trade balance conditions.

In the B-S model, trade policy is modelled as a non-corporative game of tariff selection in which governments choose tariffs to maximize government objectives. B-S assume a government objective that is more general than national income maximization, allowing for a possibility that governments are politically motivated and concerned about the distributional consequences of their tariff choices.[10] A key structure imposed on the government objective in the B-S framework is that holding the local price fixed, the government can achieve higher welfare by improving its terms of trade. See the Appendix A.1 for the exact specification.

We now turn to reciprocity. Reciprocity is a fundamental principle of GATT and the WTO and refers to the idea that when counties offer tariff cuts on their imports in a

[10]However, the B-S framework is also consistent with national income maximizing governments: National income maximization is a special case in their framework.

trade negotiation, the other countries make similar concessions on their imports. B-S define reciprocity as follows:

**Reciprocity.** *Consider a set of tariff changes* $\Delta\tau^c \equiv (\tau^{c1} - \tau^{c0})$ *and* $\Delta\tau^{c'} \equiv (\tau^{c'1} - \tau^{c'0})$. *Tariff changes satisfy the principle of reciprocity if they generate a change in imports that is equal to a change in exports:*

$$\begin{aligned} \mathbf{r}^{cc'} \equiv \tilde{p}^{w0}[M_x^c(p^c(\tau^{c1}, \tilde{p}^{w1}), \tilde{p}^{w1}) - M_x^c(p^c(\tau^{c0}, \tilde{p}^{w0}), \tilde{p}^{w0})] \\ -[M_y^{c'}(p^{c'}(\tau^{c'1}, \tilde{p}^{w1}), \tilde{p}^{w1}) - M_y^{c'}(p^{c'}(\tau^{c'0}, \tilde{p}^{w0}), \tilde{p}^{w0})] = 0 \end{aligned} \tag{1}$$

*where* $M_x^c(p^c(\tau^{c1}, \tilde{p}^{w1}), \tilde{p}^{w1})$ *denotes the actual imports of good* $x$ *of country* $c$ *at the new prices and tariff,* $M_x^c(p^c(\tau^{c0}, \tilde{p}^{w0}), \tilde{p}^{w0})$ *is the actual imports of country* $c$ *at the old prices and tariff,* $M_y^{c'}(p^{c'}(\tau^{c'1}, \tilde{p}^{w1}), \tilde{p}^{w1})$ *denotes the actual imports of good* $y$ *of country* $c'$ *at the new prices and tariff,* $M_y^{c'}(p^{c'}(\tau^{c'0}, \tilde{p}^{w0}), \tilde{p}^{w0})$ *is the actual imports of country* $c'$ *at the old prices and tariff, and changes in imports are evaluated at the initial world price.*

Reciprocity thus requires that changes in imports due to trade liberalization should balance across countries at the initial world price. Given this definition, it is straightforward to show that using the trade balance conditions (15) and the market clearing condition (16) from the Appendix A.1, (1) can be rewritten as

$$\mathbf{r}^{cc'} = -[\tilde{p}^{w1} - \tilde{p}^{w0}]M_x^c(p^c(\tau^{c1}, \tilde{p}^{w1}), \tilde{p}^{w1}) = 0 \tag{2}$$

This implies that $\tilde{p}^{w1} = \tilde{p}^{w0}$. In other words, mutual tariff changes that satisfy the principle of reciprocity keep the world price unchanged.[11] This property of reciprocity plays a crucial role in trade agreements.

In order to understand the role of reciprocity in trade agreements, we need to keep track of two different channels through which tariffs can affect welfare: (i) local price movements;

[11] Note that reciprocity can be also defined in terms of country $c'$, i.e., $\mathbf{r}^{c'c} = 0$. However, this is redundant in the two-country setting since $\mathbf{r}^{cc'} = -\mathbf{r}^{c'c}$.

and (ii) world price (i.e., terms of trade) movements.[12]

A tariff will create a wedge between the local and world prices and introduce a distortion in domestic production and consumption. Thus local price movements have direct impacts on efficiency. Moreover, local price movements can also affect domestic political factors if the government is politically motivated. On the other hand, world price movements affect the distribution of income between countries: Holding the local price fixed, a tariff imposed on the imports of a country will improve its terms of trade, and this terms of trade improvement will increase its welfare. However, a terms of trade improvement for one country implies a terms of trade deterioration for the other country. Thus a country can benefit from a terms of trade gain only at the cost of the other country.

Bearing these two channels in mind, we first consider a case in which there is no trade agreement. This will clarify the purpose of trade agreements in the B-S framework, which will in turn help us to understand the role of reciprocity in trade agreements.

When there is no trade agreement, countries choose tariffs unilaterally, and the unilateral tariff setting leads to a Nash equilibrium. Nash tariffs are set higher than efficient levels because each government selects its tariff to realize a terms of trade gain. A simple intuition behind this result is that the terms of trade effect works as an "externality" through which part of the cost of protection is passed onto the other country: When a home government imposes a tariff, it will hurt foreign producers who are forced to sell their products at a lower world price. The home government does not take account of this effect, and thus it faces less than the full costs of protection. As a result, governments oversupply protection relative to efficient levels.

Starting from a Nash equilibrium, a country will gain efficiency from a tariff reduction, which tends to increase welfare. However, a country can potentially lose from a tariff reduction because it may cause a terms of trade deterioration that dominates the efficiency gain. Indeed, a *unilateral* tariff reduction must cause a country to lose if its initial tariff is

[12]This does not depend on the generality of government objectives: Tariffs affect welfare through the same two channels even for national income maximizing governments. See also (20) and (21) in the Appendix A.2

set to a Nash level, and the only source of losses from a tariff reduction is a terms of trade deterioration. In other words, because of the terms of trade effect, no one has incentive to cut tariffs unilaterally in a Nash equilibrium despite potential room for Pareto improvements through efficiency gains.[13]

The purpose of trade agreements in the B-S model is then to solve this "terms-of-trade driven Prisoners' Dilemma" problem and to achieve a Pareto improvement. To achieve this, the externality arising from terms of trade movements needs to be corrected. This is where trade agreements and reciprocity come in: Starting from a Nash equilibrium, suppose that countries agree to cut tariffs on their imports while maintaining reciprocity. Then, everyone will gain from this trade agreement since reciprocity guarantees that the terms of trade is held fixed throughout tariff changes. In this way, trade agreements allow countries to benefit from efficiency improvements without suffering from terms of trade losses. See the Appendix for more formal discussions.[14]

## 2.2 Reciprocity and terms of trade movements

While B-S focus on the case in which reciprocity is satisfied, their framework naturally extends to a case in which reciprocity does not hold. This subsection discusses a relationship between reciprocity and terms of trade movements. It is straightforward to show that a failure of reciprocity implies a world price movement: Suppose $\mathbf{r}^{cc'} > 0$, for example. From the trade balance conditions (15) and the market clearing condition (16), it immediately follows that

$$\mathbf{r}^{cc'} = -(\tilde{p}^{w1} - \tilde{p}^{w0})M_x^{c1} > 0 \tag{3}$$

[13] See the Appendix A.2 and Bagwell and Staiger (1999).

[14] An important contribution of Bagwell and Staiger (1999) is thus that they have provided an *economic* account for reciprocity: Reciprocity has long been understood as reflecting political reality rather than economic reasoning. See Krugman (1991) and Hoekman and Kostecki (1995) for such political views on reciprocity.

where $M_x^{c1} = M_x^c(p^c(\tau^{c1}, \tilde{p}^{w1}), \tilde{p}^{w1})$. This implies that $\tilde{p}^{w1} < \tilde{p}^{w0}$, namely a terms of trade improvement for country $c$. Thus if a mutual tariff change fails to satisfy the principle of reciprocity, it will shift the world price, thus generating a terms of trade gain to one country and a loss to the other. In this example, country $c$ receives a terms of trade gain while country $c'$ incurs a terms of trade loss.[15]

The intuition of this result is quite straightforward: When reciprocity holds ($\mathbf{r}^{cc'} = 0$), the upward pressure on the world price generated by a tariff reduction of country $c$ is balanced against the downward pressure on the world price generated by a tariff reduction of country $c'$ so that they completely offset each other. As a result, a mutual tariff reduction does not affect the world price. However, when reciprocity fails ($\mathbf{r}^{cc'} > 0$), this balance on the world price is disturbed. Then the world price effect of one country's tariff cut will dominate that of the other country's. In the above example, the corresponding movement in the terms of trade suggests that the downward pressure on the world price generated by the tariff cut of country $c'$ dominates, thus causing the world price to decline. In other words, country $c'$ is lowering its tariff "too far" so that its terms of trade worsens.[16]

A similar argument applies to the case in which reciprocity fails to hold so that $\mathbf{r}^{cc'} < 0$: This implies $\tilde{p}^{w1} > \tilde{p}^{w0}$, namely, a terms of trade loss for country $c$ and a terms of trade gain for country $c'$. In summary, the sing of $\mathbf{r}^{cc'}$ suggests the direction of terms of trade movements after a mutual tariff liberalization.

Now we argue that $\mathbf{r}^{cc'}$ has an additional implication about the *magnitude* of terms of trade movements. To see this, we go back to the transformed expression of reciprocity (3): It says that $\mathbf{r}^{cc'}$ is a change in the terms of trade multiplied by the new import volume. In other words, $\mathbf{r}^{cc'}$ corresponds to the value of terms of trade gains or losses evaluated at the

[15]Note that reciprocity is a sufficient condition for both countries to gain from a mutual tariff reduction. Thus terms of trade losses do not necessarily imply that a country loses from cutting tariffs.

[16]Another way to look at this result is to directly interpret the condition $\mathbf{r}^{cc'} > 0$: Recalling the definition of $\mathbf{r}^{cc'}$, $\mathbf{r}^{cc'} > 0$ implies that a mutual tariff reduction causes the imports of country $c$ to expand more than its exports evaluated at the initial world price. Under the balanced trade assumption, a country can expand its imports more than its exports only by improving its terms of trade. Thus if $\mathbf{r}^{cc'} > 0$, it must be the case that $\tilde{p}^{w1} < \tilde{p}^{w0}$.

new import volume.

The above discussion establishes the following proposition:

**Proposition 1.** *A mutual tariff reduction that does not satisfy reciprocity alters the world price, and a world price movement generates a term of trade gain or loss. The sign of* $\mathbf{r}^{cc'}$ *then measures the direction of terms of trade movement, and the value of* $\mathbf{r}^{cc'}$ *measures the magnitude of the terms of trade gain or loss. The relationship between* $\mathbf{r}^{cc'}$ *and terms of trade movements is summarized as follows:*

***Case 1.*** $\mathbf{r}^{cc'} = 0 \Rightarrow \tilde{p}^{w0} = \tilde{p}^{w1}$*, i.e., the terms of trade does not change, and thus there is no terms of trade gain or loss for either country.*

***Case 2.*** $\mathbf{r}^{cc'} > 0 \Rightarrow \tilde{p}^{w0} > \tilde{p}^{w1}$*, i.e., the terms of trade for country* $c$ *(*$c'$*) improves (worsens). The value of the terms of trade gain (loss) for country* $c$ *(*$c'$*) is measured by* $\mathbf{r}^{cc'}$ *(*$-\mathbf{r}^{cc'}$*).*

***Case 3.*** $\mathbf{r}^{cc'} < 0 \Rightarrow \tilde{p}^{w0} < \tilde{p}^{w1}$*, i.e., the terms of trade for country* $c$ *(*$c'$*) worsens (improves). The value of the terms of trade loss (gain) for country* $c$ *(*$c'$*) is measured by* $\mathbf{r}^{cc'}$ *(*$-\mathbf{r}^{cc'}$*).*

We will exploit these properties of reciprocity in order to infer the welfare impacts of the Uruguay Round tariff liberalization. As we argued earlier, if reciprocity holds, both countries gain from a mutual tariff reduction starting from a Nash equilibrium. If reciprocity does not hold, however, this does not necessarily suggest that somebody will lose from a trade liberalization. Indeed, it is possible that both countries gain from a tariff reduction even if reciprocity does not hold.[17] In this case, the magnitude of terms of trade loss becomes an important factor to infer the overall gains from trade liberalization: If the terms of trade loss a country incurs after a tariff reduction is very small, it is more likely that the country will gain from the trade liberalization as long as the efficiency gain is large enough to offset the terms of trade loss.

[17]Note that reciprocity is only a sufficient condition for both countries to gain from a mutual tariff reduction.

The next subsection extends the main results from this subsection to a more general setting.

### 2.3 Many-good, many-country model

The B-S framework can be naturally extended to a more general case, and the main results from the two-by-two model get through in the multi-sector, multi-country model: Starting from a Nash equilibrium, countries will gain from multilateral trade liberalization if they cut tariffs while maintaining reciprocity. This subsection summarizes the generalization of the B-S model. More details can be found in the Appendix A.3.

One of the new features in the many-country model is the possibility of discriminatory tariffs: For a given commodity, a country may apply different tariff rates to different exporters. Differential tariff rates can complicate the analysis, but reciprocity can be well defined even in the discriminatory tariff environment.

Another new feature is that there are many world prices in the multi-good world, and thus we will need an aggregate measure of the terms of trade. We define the *overall terms of trade* to be the average of world prices weighted by trade volumes. The overall terms of trade plays a similar role to that of the terms of trade in the two-by-two model. More specifically, denoting the home country as $c$ and indexing foreign countries by $c'$, the overall terms of trade is denoted as $T^c$ for country $c$ and $T^{c'}$ for country $c'$ respectively. (See (25) and (23) in the Appendix.) A decrease in $T^c$ means a terms of trade gain for country $c$, and an increase in $T^{c'}$ means a terms of trade gain for country $c'$. See the Appendix for more details.

Reciprocity in the multi-sector, multi-country setting is now defined as follows:

**Generalized Reciprocity.** *Consider a set of changes in all trade taxes* $\{\Delta\tau^c\} \equiv \{\tau^{cc'1} - \tau^{cc'0}\}$ *and* $\{\Delta\tau^{c'}\} \equiv \{\tau^{c'1} - \tau^{c'0}\}$. *Changes in trade taxes satisfy the principle of reciprocity if they generate a change in the aggregate import that is equal to a change in the aggregate export*

*evaluated at the initial world prices:*

$$\mathbf{R}^c \equiv \sum_{c'} \sum_{i=1}^{I} \tilde{p}_i^{wc'0}[M_i^{cc'1} - M_i^{cc'0}] - \sum_{c'} \sum_{j=0}^{J} \tilde{p}_j^{w0}[E_j^{cc'1} - E_j^{cc'0}] = 0 \ for country \ c \qquad (4)$$

$$\mathbf{R}^{c'} \equiv \sum_{j=0}^{J} \tilde{p}_j^{w0}[M_j^{c'1} - M_j^{c'0}] - \sum_{i=1}^{I} \tilde{p}_i^{wc'0}[E_i^{c'1} - E_i^{c'0}] = 0 \ for country \ c' \qquad (5)$$

*where $M_i^{cc'}$ is the imports of good $i$ from country $c'$ to $c$, and $E_j^{cc'}$ is the exports of good $j$ from country $c$ to $c'$.*[18]

In the definition of $\mathbf{R}^{c'}$, the summation is over only commodities while $\mathbf{R}^c$ has summations over both goods and trade partners. This is because of the simplifying assumption that foreign countries do not trade with each other and trade only with the home country $c$. Note that $\mathbf{R}^c = -\sum_{c'} \mathbf{R}^{c'}$.

It can be shown that if generalized reciprocity holds, the *overall* terms of trade is held constant. Similarly, if generalized reciprocity does not hold, then the overall terms of trade is altered.

As in the two-good, two-country model, the relationship between $\mathbf{R}^c$ and (overall) terms of trade movements is summarized as follows:

**Proposition 2.** *A multilateral trade tax reduction that does not satisfy reciprocity alters the overall terms of trade, and a terms of trade movement generates a terms of trade gain or loss. The sign of $\mathbf{R}^c$ then measures the direction of the terms of trade movement, and the value of $\mathbf{R}^c$ measures the magnitude of the terms of trade gain or loss. The relationship between $\mathbf{R}^c$ and terms of trade movements is summarized as follows:*

***Case 1.*** *$\mathbf{R}^c = 0 \ \Rightarrow \ \tilde{T}^{c0} = \tilde{T}^{c1}$, i.e., the terms of trade does not change, and there is no terms of trade gain or loss for country $c$.*

[18] This is a generalization of Bagwell and Staiger (1999) to many-country and many-good with possibly discriminatory tariffs. See the footnote 16 in Bagwell and Staiger (1999) for a discussion on a many-good case.

***Case 2.*** $\mathbf{R}^c > 0 \Rightarrow \tilde{T}^{c0} > \tilde{T}^{c1}$*, i.e., the terms of trade for country c improves. The terms of trade gain for country c is measured by* $\mathbf{R}^c$*.*

***Case 3.*** $\mathbf{R}^c < 0 \Rightarrow \tilde{T}^{c0} < \tilde{T}^{c1}$*, i.e., the terms of trade for country c worsens. The terms of trade loss for country c is measured by* $\mathbf{R}^c$*.*

A similar relationship holds for foreign countries $c'$. Given this theoretical linkage between $\mathbf{R}^c$ and the terms of trade effect, our next task is to obtain an estimate of $\mathbf{R}^c$ for each country. We now turn to the empirical strategy to investigate reciprocity.

# 3 Empirical Framework

This section explains the empirical strategy to obtain an estimate of $\mathbf{R}^c$. We first derive an expression for reciprocity that is more convenient for an empirical application. We will show that $\mathbf{R}^c$ can be expressed in terms of percentage changes in world prices and changes in trade volumes caused by tariff shifts. The second step is to model bilateral imports in order to estimate the impact of tariff changes on import volume. We will adopt the gravity model and estimate import demand elasticities to quantify the volume effect of tariff changes. The third step is to model world price movements caused by tariff changes. We will show that world price movements can be backed out using the estimates of import elasticities. Lastly, we will put together all estimates to construct an estimate of $\mathbf{R}^c$ for each country. We begin by rewriting the expression for reciprocity.

## 3.1 Reciprocity

Using trade balance conditions, $\mathbf{R}^c$ can be rewritten as follows:

$$\mathbf{R}^c = -\sum_{c'}\sum_{i}[\tilde{p}_i^{wc'1} - \tilde{p}_i^{wc'0}]M_i^{cc'1} + \sum_{c'}\sum_{j}[\tilde{p}_j^{w1} - \tilde{p}_j^{w0}]E_j^{cc'1} \tag{6}$$

The above expression says that $\mathbf{R}^c$ is a weighted sum of changes in world prices.

We abstract from export taxes for the rest of the paper since they play a very limited role in practice. In the empirical application, we assume that the exporter specific world price

can be decomposed into the common price term and the exporter specific term, namely, $\tilde{p}_i^{wc'} = \tilde{p}_i^w + \xi_{ic'}$ where $\tilde{p}_i^w$ is the common world price and $\xi_{ic'}$ captures the exporter specific factor that accounts for the deviation from the common world price. Assuming that $\xi_{ic'}$ is time-invariant, (6) can be further rewritten as follows:

$$\begin{aligned}\mathbf{R}^c = &-\sum_{c'}\sum_i \frac{\Delta\tilde{p}_i^w}{\tilde{p}_i^{w0}}\left(\tilde{p}_i^{w0}[M_i^{cc'1} - M_i^{cc'0}] + \tilde{p}_i^{w0}M_i^{cc'0}\right) \\ &+\sum_{c'}\sum_j \frac{\Delta\tilde{p}_j^w}{\tilde{p}_j^{w0}}\left(\tilde{p}_j^{w0}[M_j^{c'c1} - M_j^{c'c0}] + \tilde{p}_j^{w0}M_j^{c'c0}\right)\end{aligned} \tag{7}$$

where $\Delta\tilde{p}_i^w = \tilde{p}_i^{w1} - \tilde{p}_i^{w0}$, $\Delta\tilde{p}_j^w = \tilde{p}_j^{w1} - \tilde{p}_j^{w0}$, and the exports of country $c$ are expressed in terms of the imports of country $c'$. The above expression shows that $\mathbf{R}^c$ consists of three terms: (i) $\tilde{p}_i^{w0}M_i^{c'c0}$, the value of imports at time 0; (ii) $\tilde{p}_i^{w0}[M_i^{cc'1} - M_i^{cc'0}]$, a change in imports due to tariff changes evaluated at the initial world prices; and (iii) $\frac{\Delta\tilde{p}_i^w}{\tilde{p}_i^{w0}}$, a percentage change in the equilibrium world price caused by tariff changes. We will need to obtain estimates of the latter two terms in order to construct an estimate of $\mathbf{R}^c$.

Ideally, we will write down a general equilibrium model with many goods and many countries and estimate the effects of tariff changes on imports. However, given the available data, it is beyond the scope of this paper. What we do instead is to estimate import elasticities that allow us to estimate how much import will change holding world prices fixed when tariffs are shifted. In practice, however, equilibrium world prices will change when there are terms of trade effects. Thus we will need to make some adjustments in our estimates to take account of world price movements. We will discuss more details on the estimation procedure below as well as possible biases in our estimates of reciprocity.

We assume that the impact of tariff change on $M_i^{cc'}$ is dominated by own tariff changes, i.e., changes in the tariff on good $i$ of country $c$. As we saw earlier, $M_i^{cc'}$ is a function of tariffs of all countries, and thus we wish to incorporate cross-country and cross-sectoral effects of tariff changes on import volumes. However, the gravity model which we will use below allows us to take account of only the effects of own tariff changes. For this reason, we will focus on the own effects assuming that cross-country and cross-sectoral effects are very small.

We will model the impact of tariff changes on import volume by defining an import demand elasticity as follows:

$$\alpha_i \equiv \frac{dm_i}{d\tau_i}\frac{\tau_{i0}}{m_{i0}} \tag{8}$$

where $m_i$ is the import value of good $i$, $\tau_i$ is one plus an ad valorem tariff imposed on good $i$, and the subscript 0 indicates the initial time point, i.e., *before* trade liberalization. We denote a tariff change from $\tau_{i0}$ to $\tau_{i1}$ as $\Delta\tau_{i1} = \tau_{i1} - \tau_{i0}$ where the subscript 1 indicates a time *after* trade liberalization. Note that $\alpha_i$ is evaluated at the initial world price. (Thus $dm_i$ is a change in import volume valued at the initial world price.) Using this definition of import elasticity, we express a change in imports resulting from a tariff change by $\Delta\tau_{i1}$ evaluated at the initial world price as follows:

$$\Delta m_i = \alpha_i \frac{\Delta\tau_{i1}}{\tau_{i0}} m_{i0} \tag{9}$$

Assuming a common elasticity across countries and indicating trading partners explicitly, we use $\Delta m_i^{cc'}$ as an estimate of $\tilde{p}_i^{w0}[M_i^{cc'1} - M_i^{cc'0}]$. There are two issues involved with using $\Delta m_i^{cc'}$ to estimate $\tilde{p}_i^{w0}[M_i^{cc'1} - M_i^{cc'0}]$, however. First, note that $\Delta m_i^{cc'}$ measures a change in imports due to the tariff change holding the world price fixed. On the other hand, $\tilde{p}_i^{w0}[M_i^{cc'1} - M_i^{cc'0}]$ is a change in the equilibrium trade volume evaluated at the initial equilibrium world price where $M_i^{cc'1}$ is the new import volume under the new equilibrium world price. Since $\Delta m_i^{cc'}$ is obtained holding the world price fixed, it tends to overestimate $\tilde{p}_i^{w0}[M_i^{cc'1} - M_i^{cc'0}]$ if a tariff cut alters the world price: If there is no terms of trade effect, $\Delta m_i^{cc'}$ indeed corresponds to a change in imports due to the tariff change evaluated at the initial world price. However, if there are terms of trade effects, the actual increase in import volume will be smaller than the one measured by (9) to the extent that the tariff reduction pushes up the equilibrium world price. In this case, $\Delta m_i^{cc'}$ tends to overstate $\tilde{p}_i^{w0}[M_i^{cc'1} - M_i^{cc'0}]$.[19]

[19]Note that this is true only holding other countries' tariffs fixed. More generally, the bias is unclear. However, in a special case where other countries also cut tariffs on good $i$, $\Delta m_i^{cc'}$ can be seen as an upper

Second, $\Delta m_i$ does not take account of general equilibrium effects of tariff changes: When a country cuts a tariff on a certain good, the imports of the good will increase, but through the trade balance condition, the exports of some other goods will also increase. To see this, consider the following simple case: Suppose that there are only two countries, $c$ and $c'$. Suppose that country $c$ does not cut its tariffs, but country $c'$ cuts its tariffs. Our estimates of changes in imports of country $c$ are all zero, i.e., $\Delta m_i^{cc'} = 0$ indicating that $\tilde{p}_i^{w0}[M_i^{cc'1} - M_i^{cc'0}] = 0$ for all $i$ in (7). However, $\tilde{p}_i^{w0}[M_i^{cc'1} - M_i^{cc'0}]$ in (7) is not necessarily zero in practice since tariff changes of country $c'$ will also increase its exports, i.e., the imports of country $c$, through the trade balance condition. Thus it should be the case that $\tilde{p}_i^{w0}[M_i^{cc'1} - M_i^{cc'0}] > 0$ for some $i$. In this case, the first term in (7) tends to be understated. However, the opposite holds in the reversed case: If country $c$ cuts its tariffs but country $c'$ does not, the second term in (7) tends to be understated. On net, the bias due to the general equilibrium effects is unclear.

It requires detailed information on the input-output linkages for all goods and for all countries to predict how a tariff cut on one good will affect the exports of other goods. In practice, however, such information is not readily available. Thus the direction of the bias in our estimate of $\mathbf{R}^c$ is not determined in general. We will therefore assume that these general equilibrium effects cancel out each other on average.

Using the above expression (9), we rewrite (7) as follows:

$$\begin{aligned} \mathbf{R}^c = &- \textstyle\sum_{c'} \sum_i \frac{\Delta \tilde{p}_i^w}{\tilde{p}_i^{w0}} \left( \alpha_i \frac{\Delta \tau_{i1}^{cc'}}{\tau_{i0}^{cc'}} m_{i0}^{cc'} + m_{i0}^{cc'} \right) \\ &+ \textstyle\sum_{c'} \sum_j \frac{\Delta \tilde{p}_j^w}{\tilde{p}_j^{w0}} \left( \alpha_j \frac{\Delta \tau_{j1}^{c'c}}{\tau_{j0}^{c'c}} m_{j0}^{c'c} + m_{j0}^{c'c} \right) \end{aligned} \tag{10}$$

where $m_{i0}^{cc'} = \tilde{p}_i^{w0} M_i^{cc'0}$ and $m_{j0}^{c'c} = \tilde{p}_j^{w0} M_j^{c'c0}$. Since $\alpha_i$ is unknown, we will need to estimate $\alpha_i$. We will explain the estimation procedure in the next subsection.

We now turn to the world price term. We will need to obtain estimates of percent-

bound of changes in imports under the assumption that cross-country and cross-sectoral effects are small. As we will see shortly, sectoral tariffs are down on average (Table 1). Thus we treat $\Delta m_i^{cc'}$ as an upper bound of changes in imports caused by tariff shifts.

age changes in equilibrium world prices caused by tariff changes. It is important to take account of the fact that not only one country but also other countries are cutting tariffs and affecting world prices. We will take the following two-step approach to back out world price movements due to tariff changes: First, we will estimate the excess demand for good $i$ of country $c$ caused by its own tariff change by $\Delta m_i^{cc'} = \alpha_i \frac{\Delta \tau_{i1}^{cc'}}{\tau_{i0}^{cc'}} m_{i0}^{cc'}$. Since $\Delta m_i^{cc'}$ is evaluated at the initial world price, it exactly corresponds to the excess demand for good $i$ at the initial world price assuming that the export supply curve is not horizontal and has a positive slope. Summing $\Delta m_i^{cc'}$ over all countries for each good, we obtain the total excess import demand for good $i$ at the initial world price, namely, $\Delta m_i^A \equiv \sum_c \sum_{c'} \alpha_i \frac{\Delta \tau_{i1}^{cc'}}{\tau_{i0}^{cc'}} m_{i0}^{cc'}$.

Second, we will calculate world price changes to restore a new equilibrium using the total excess import demand. We will obtain a percentage change in the world equilibrium price to fully offset the excess import demand $\Delta m_i^A$ as follows:

$$\frac{\Delta \hat{p}_i^w}{\hat{p}_i^{w0}} = -\frac{1}{\alpha_i} \frac{\Delta m_i^A}{m_{i0}^A} \tag{11}$$

where $m_i^{A0} \equiv \sum_c \sum_{c'} m_i^{cc'0}$, i.e., the total world imports of good $i$ at time 0. Note that world price movements are identified along the import demand curve in (11). More generally, how a price will adjust in response to excess demand depends on both demand and supply elasticities. Indeed, (11) tends to overestimate world price movements.[20] This suggests that our reciprocity measure has an additional bias to overstate deviations from reciprocity because $\mathbf{R}^c$ is constructed as a weighted sum of (overestimated) world price movements.[21] This bias in the world price term tends to make it more difficult to find reciprocity since our estimates of $\mathbf{R}^c$ are biased away from zero. Thus if we find that reciprocity holds despite of this potential bias, the result will strengthen the case for reciprocity. For now, we use (11) to back out world price movements, but we will conduct robustness checks to take account of supply elasticities later.

[20] In a more general setting, percentage price changes can be expressed as $\frac{\Delta \hat{p}_i^w}{\hat{p}_i^{w0}} = -\frac{\Delta m_i^A}{(\alpha_i - \beta_i) m_{i0}^A}$, where $\beta_i$ is the export supply elasticity. Since $\beta_i$ is positive, (11) tends to exaggerate price changes.

[21] Note that the estimates of trade volumes used as weights are also possibly overestimated.

Under the assumption of common elasticity across countries, (11) can be further rewritten as:

$$\frac{\Delta \hat{p}_i^w}{\hat{p}_i^{w0}} = -\frac{1}{m_{i0}^A} \sum_c \sum_{c'} \frac{\Delta \tau_{i1}^{cc'}}{\tau_{i0}^{cc'}} m_{i0}^{cc'} \tag{12}$$

In other words, percentage changes in equilibrium world prices caused by tariff changes can be obtained based on the information on imports and tariffs as long as price changes are specified as in (11).

Using the price changes calculated as above, we define *reciprocity statistic* for country $c$ as follows:

**Reciprocity statistic.** *The estimate of* $\mathbf{R^c}$*, or reciprocity statistic, is defined as*

$$\begin{aligned} \widehat{\mathbf{R}}^c \equiv & -\textstyle\sum_{c'} \sum_i \frac{\Delta \hat{p}_i^w}{\hat{p}_i^{w0}} \left( \hat{\alpha}_i \frac{\Delta \tau_{i1}^{cc'}}{\tau_{i0}^{cc'}} m_{i0}^{cc'} + m_{i0}^{cc'} \right) \\ & + \textstyle\sum_{c'} \sum_j \frac{\Delta \hat{p}_j^w}{\hat{p}_j^{w0}} \left( \hat{\alpha}_j \frac{\Delta \tau_{j1}^{c'c}}{\tau_{j0}^{c'c}} m_{j0}^{c'c} + m_{j0}^{c'c} \right) \end{aligned} \tag{13}$$

*where* $m_{i0}^{cc'}$ *(*$m_{i0}^{c'c}$*) is the initial value of imports of good* $i$ *from country* $c'(c)$ *to country* $c$ *(*$c'$*),* $\tau_i^{cc'}$ *(*$\tau_i^{c'c}$*) is tariffs imposed by country* $c$ *(*$c'$*) on good* $i$ *from country* $c'$ *(*$c$*),* $\hat{\alpha}_i$ *is the estimate of import elasticity* $\alpha_i$*, and* $\Delta \hat{p}_i^w / \hat{p}_i^{w0}$ *is the estimates of percentage changes in world prices defined as in (11).*

It is straightforward to obtain the value of $\widehat{\mathbf{R}}^c$ once the estimates of import elasticities $\hat{\alpha}_i$ are obtained. We now turn to the estimation of import elasticities.

### 3.2 Bilateral imports

We model bilateral imports as a gravity equation along the lines of Anderson (1979), Deardorff (1998), and Anderson and van Wincoop (2003). The Appendix A.4 provides more details on the gravity model and its derivation.

We will estimate the following model for good $l$ at the 6-digit level within a 2-digit level classification $i$:

$$\ln m_{ilt}^{cc'} = \alpha_{i1} \ln d^{cc'} + \alpha_{i2} \ln \tau_{ilt}^{cc'} + \delta_{ic} + \delta_{ic'} + \delta_{it} + \delta_{il} + \delta_{ict} + \delta_{ic't} + \epsilon_{ilt}^{cc'} \tag{14}$$

where the subscript $t$ denotes for time, $m_{ilt}^{cc'}$ is the value of the imports from country $c$ to $c'$, $d^{cc'}$ is the distance between country $c$ and $c'$, $\tau_{ilt}^{cc'}$ is one plus the ad valorem tariff imposed by country $c$ on country $c'$, $\delta_{it}$ is time effects, $\delta_{ic}$ is importer fixed effects, $\delta_{ic'}$ is exporter fixed effects, $\delta_{il}$ is industry fixed effects at the 6-digit level, $\delta_{ict}$ is importer-time interaction terms, $\delta_{ic't}$ is exporter-time interaction terms, and $\epsilon_{ilt}^{cc'}$ is the error term. In short, the equation (14) says that the bilateral imports of good $l$ in the 2-digit category $i$ from country $c'$ to $c$ are explained by distance between the two countries, country $c$'s tariff on good $l$, and various fixed effects. This specification assumes fixed effects at the 2-digit level.

The parameter of interest is $\alpha_{i2}$, which measures the import elasticity. A key in this specification is that the time fixed effects control for world price movements at the 2-digit level so as to assure that the import elasticity is evaluated at the initial world price. The effects of tariffs on imports are identified from changes and differences in tariffs across countries and goods at the 6-digit level.

### 3.3 Data

We use two-year panel data on bilateral imports and tariffs. The data are taken from the Trade Analysis and Information System (TRAINS) database compiled by the UNCTAD. The TRAINS data contain most favored nation (MFN) tariff rates and preferential tariff rates. The TRAINS data set allows us to exploit the information on changes in tariffs at the Harmonized System (HS) 6-digit level. This is the greatest advantage of the TRAINS data set because HS 6-digit is exactly the level at which tariffs are bound in actual GATT trade negotiations.[22] At the 6-digit level, the date set covers about 5,000 sectors and consists of

[22]When there are more tariff lines within a 6-digit tariff line, 6-digit level tariffs are obtained as simple averages of finer categories. The number of subcategories within a 6-digit line varies across commodities. The data on bilateral imports are also at the 6-digit level.

2 million observations in total.

While the country coverage of the TRAINS data is fairly extensive, the year coverage substantially differs from country to country. The choice of sample countries and years is thus largely constrained by data availability. In selecting sample years, we take account of the following conditions: First, it is important to select years that have an enough interval between each other to allow for tariffs to adjust sufficiently. Second, we need to include years before and after the Uruguay Round to examine the impacts of the multilateral tariff liberalization. Given these requirements, we choose years 1993 and 1999 as the base sample since their country coverage is the most extensive. When tariffs or imports are missing in these two years, we use the data closest to the base years. Since tariffs do not change much every year, it is reasonable to assume that the nearby-year tariffs capture the tariff structure of the base years.[23]

The sample includes 55 countries for which the data on bilateral imports and tariffs are available for both of the base years (or nearby years). Among the 55 countries, the 15 members of European Union (EU) are merged into one since EU is a customs union. This merging reduces the sample size to 41. The sample includes both developed and developing countries as well as GATT signatories (34 countries plus EU members) and non-signatories (6 countries).[24] Table A.1 in the appendix lists sample countries and sample years.

There were 128 countries that had signed GATT by 1994, so our sample covers only one fourth of all GATT signatories. However, the total imports of the sample GATT signatories account for over 90 percent of the total imports of all WTO members. Thus our sample covers substantial part of trade involved with WTO members.

In the empirical application, we assume fixed effects at the 2-digit level. We also assume

[23]Between 1993 and 1999, there was a revision of the HS coding, so 1993 data cannot be readily compared with 1999 data: The 1993 data are coded by the HS 1986/92, while the 1999 data are mostly coded by the HS 1996. The TRAINS data set provides concordances between different nomenclatures. Using the information, the HS 1996 are converted into the HS 1986/92 so that the data in the two years are comparable.

[24]Technically speaking, GATT is a treaty, not an organization. Thus countries that signed GATT are called "contracting parties." We will use the words "GATT signatories" and "WTO members" interchangeably when we refer to our sample countries that signed GATT thereafter.

that import elasticities are the same across 6-digit sectors within a 2-digit sector. We will thus group 6-digit commodities according to the 2-digit code and run regressions for each 2-digit category. There are ninety six categories in total at the 2-digit level. We will also include commodity fixed effects in each regression to control for heterogeneity at the 6-digit level.

One issue with handling very disaggregated bilateral trade data is what to do with the zeros. One can treat bilateral imports data as censored data and use the Tobit model to take account of zero imports. Unfortunately, fixed effects cannot be used in a Tobit procedure because estimates obtained from simple fixed effects Tobit are not consistent.[25] On the other hand, random effects Tobit model requires the normality assumption on random effect terms, but we do not know whether these terms are normally distributed. Moreover, while the Tobit model statistically accounts for zero imports, the gravity model does not explain zero bilateral imports. Thus, instead of statistically taking care of the zeros, we use only nonzero observations in the estimation.[26]

# 4 Trade Liberalization: An Overview

Before going into the estimation, it is instructive to overview some summary statistics of the raw data and let the data trace out the trend of trade liberalization. This section overviews the tariff structure before and after the Uruguay Round.

[25]There exist consistent estimators of fixed effects Tobit for certain cases, however. See Honore (1992), for example.

[26]Pooled Tobit and fixed effects Tobit (despite its defects) were estimated for comparison purposes. The estimates obtained from Tobit models were unreasonably large—In particular, the estimates on the distance term were way too large compared to the existing estimates. The degree of censoring was also very high. In all sectors, the majority of the observations was zero. For example, one sector had about 150,000 observations on bilateral imports, and only 4,000 of them were nonzero observations. In this case, 97 percent of the observations were censored.

### 4.1 Sectoral tariffs

Many existing studies have examined the levels of tariffs after the Uruguay Round, but it is the changes in tariffs that matter for terms of trade movements. This subsection focuses on sectoral tariffs and summarizes how tariffs have been changed since the conclusion of the Uruguay Round.

Figure 1 and Figure 2 plot import weighted tariffs at the HS 6-digit level after the Uruguay Round against those before the Uruguay Round for agriculture and manufacturing, respectively.[27] Import weighted tariffs are not a perfect measure of import protection, but they do offer some insight into the general trend in sectoral tariffs. A 45 degree line is drawn in both figures: If there is no change in the average tariff before and after the Uruguay Round, the data points lie on the 45 degree line. If the average tariff is lower after the Uruguay Round, the data points lie below the 45 degree line. If the average tariff is higher after the Uruguay Round, the data points lie above the 45 degree line. We will expect the data points to lie below the 45 degree line if tariff liberalization has actually taken place since the Uruguay Round.

The general pattern of trade liberalization in agriculture seems to differ slightly from that in manufacturing. In Figure 1, there are many data points that lie below the 45 degree line, but there are also a number of points that lie far above the 45 degree line. These data points indicate that average tariffs on some agricultural products actually increased after the Uruguay Round. These tariff hikes are likely to reflect the tariffication of non-tariff barriers on the products that were previously protected by quotas. Turning to Figure 2, the majority of data points lie below the 45 degree line, which indicates that tariff cuts took place in most manufacturing sectors after the Uruguay Round.

A comparison between Figure 1 and Figure 2 suggests that tariffs are falling both in agriculture and manufacturing although the trend seems a little less pronounced in agriculture because of greater variance in tariff rates.

[27]Import weighted tariffs are calculated using only the sample WTO members. Including non-WTO members does not change the picture much, but slightly increases the average tariffs.

We now turn to individual sectors. Table 1 reports import weighted tariffs at the HS 2-digit level. This table provides product descriptions, the levels of tariffs before and after the Uruguay Round, and changes in tariffs for 96 sectors. HS 1-24 are classified as agriculture, and HS 25-97 are classified as manufacturing. HS 50-63 are sectors related to textile and clothing.

In agricultural sectors (HS 1-24), tariff cuts are relatively small, if any. Average tariffs increased in some sectors such as HS 04 (Dairy products etc.), HS 10 (Cereals), and HS 15 (Animal or vegetable fat and oil etc.).

On the other hand, average tariffs in most manufacturing sectors are lower after the Uruguay Round. Some sectors had relatively large tariff cuts: Those sectors include HS 31 (Fertilizers), HS 60 (Knitted or crocheted fabrics), and HS 93 (Arms and ammunition etc.). However, tariffs on HS 62 (clothing) and HS 64 (footwear), which are important export sectors for many developing countries, declined very little or not at all. Nevertheless, there seems a declining trend in tariffs in the manufacturing sectors including textiles and clothing.

In summary, the data show the declining trend of sectoral tariffs. The degree of tariff liberalization varies across commodities, but tariffs are lowered in most sectors. The trend in agriculture seems somewhat more mixed, but there are tariff reductions taking place in some agricultural sectors as well.

### 4.2 Country-level tariff structure

We now turn to the tariff structures of individual countries. Table 2 reports the import weighted tariff for each country. As mentioned before, import weighted tariffs do not necessarily capture the degree of import protection, but they do offer some information about tariff policies. Countries are ordered by GDP per capita in Table 2.[28] WTO members are roughly grouped into three groups: (i) high income countries; (ii) middle income countries; and (iii) low income countries. The cut-off incomes are arbitrary because this classification is only for expositional purposes. Non-signatories are also ordered according to GDP per

[28]The ordering is based on real GDP per capita from the Penn World Table 6.1.

capita.

The column (1) of Table 2 reports the average tariffs weighted by imports before and after the Uruguay Round, and changes in average tariffs calculated using all commodities. The broad picture is that the *WTO members typically cut their tariffs, while non-members typically did not*. This pattern is particularly true if we drop China from non-members. This finding is important in light of welfare implications of tariff changes: Assuming that the initial tariff levels are set to a Nash level, this declining trend in the average tariffs suggests that WTO members have benefitted from the Uruguay Round through local price movements to the extent that distortions are eliminated by these tariff reductions.

Dividing products into subcategories does not change this pattern. The columns (2) and (3) report average tariffs for agriculture and manufacturing, respectively. These two columns show that tariffs are down for all sectors, including agriculture. However, tariff cuts are typically larger in manufacturing than in agriculture. As for levels, tariffs remain higher in agriculture than in manufacturing.

Large tariff cuts in overall average tariffs mainly come from developing countries. The column (1) of Table 2 shows that overall average tariffs declined by more than 20 percentage points in Sri Lanka and Thailand. Kenya and India also have relatively large reductions in their average tariffs. However, columns (2) and (3) reveal that these large changes are mostly due to tariff cuts on manufacturing products. It is worth noting, though, that there were rather sizable tariff reductions even in agriculture among some developing countries: Average tariffs on agricultural products declined by more than 10 percentage point in Uganda, Kenya, and Trinidad and Tobago.

In summary, there is a downward trend in average import tariffs among WTO members both in agriculture and manufacturing. These changes in average tariffs, however, do not necessarily indicate the direction of terms of trade movements. In the environment in which other countries are also cutting tariffs, how tariff liberalization affects the terms of trade overall depends also on the composition of trade partners as well as traded products. The following empirical section will examine how these tariff cuts as a whole have affected the

terms of trade of WTO members.

# 5 Estimation

Our empirical strategy involves two steps: First, we will estimate the gravity equation to obtain estimates of import elasticities for 96 groups at the 2-digit level. The parameter of interest is the coefficient on the tariff variable. Second, we will construct reciprocity statistic as defined in (13) for each country using the estimates of elasticities and the data on imports and tariffs. We begin by reporting the estimation results of the gravity model.

## 5.1 The gravity model

The basic estimation equation is derived as (14) earlier. In the actual estimation, we also include product fixed effects at the 6-digit level in each regression to control for unobserved heterogeneity.

Table 3 summarizes the estimation results. The full results can be found in Table A.2 in the appendix. It is well known that distance is an important explanatory variable in the gravity model estimated with aggregate trade data.[29] Table 3 confirms this regularity in the sectoral gravity model estimated with highly disaggregated trade data. 99 percent of the estimates are significant at the 5 percent level, and all estimates have a negative sign as expected. A 1 percent increase in distance typically reduces bilateral imports by around 0.6 percent, but there is some variation in this estimate across sectors. In Table A.2, sectors such as HS 09 (Coffee, tea, maté, and spices), HS 13 (Lac; gums, resins, etc.), and HS 14 (Vegetable plaiting materials) seem least affected by distance, while sectors such as HS 34 (Soap, organic surface-active agents etc.), and HS 49 (Printed books, newspapers, etc.) seem most affected.

Turning to the tariff variable, 78 percent of the coefficients on the tariff variable are significant at the 5 percent level, and 93 percent of the estimates have a correct sign. Typically a 1 percent decline in tariff causes imports to increase by round 2 percent, but

[29] See, for example Harrigan (2003).

there is a fair amount of variation in the size of the parameter on tariff across sectors: In Table A.2, tariffs seem to have the largest impact on sectors like HS 89 (Ships, boat, etc.), HS 79 (Zinc and articles thereof), and HS 44 (Wood and articles of wood). In these sectors, a 1 percent decline in tariff causes trade to increase by 5 to 7 percent. On the other hand, tariffs seem to have the least impact on sectors like HS 22 (Beverages, spirits, and vinegar), HS 54 (Man-made filaments) and HS 87 (Vehicles other than railway etc.). There are some sectors for which the tariff variable is not significant. One may suspect this is due to non-tariff barriers (NTBs). We will investigate this possibility later in the section.

Overall, the fits are reasonable, and the estimation results look fairly good. This is a good news since the estimate of the tariff coefficient $\hat{\alpha}_i$ is the key parameter in order to construct reciprocity statistic $\widehat{\mathbf{R}}^c$. Using the estimates obtained here, we will calculate the reciprocity statistic for each country.

### 5.2 A test of reciprocity

Table 4 reports reciprocity statistic for each country. $\widehat{\mathbf{R}}^c$ is calculated using the estimates of import elasticities from Table 3 and percentage price changes calculated from (11). All estimates from Table 3 are used for the computation regardless of their statistical significance. Countries are ordered by per capita income as before.

In Table 4, the reciprocity statistic is highly significant at the 1 percent level based on the standard errors (not reported) that are calculated from the standard errors of estimated elasticities under the assumption that the error terms from different estimation equations are independent. In other words, $\widehat{\mathbf{R}}^c$ is statistically different from zero.

The sign of reciprocity statistic tells the direction of terms of trade movements, and Table 4 shows that many countries have a negative sign. However, there seems no systematic pattern in the distribution of negative signs. For example, Japan and EU have a positive reciprocity statistic, but the United States has a negative one, and so do other developed countries. Recalling that a positive (negative) sign implies a terms of trade improvement (deterioration), Table 4 shows that the terms of trade shifted against many countries, in-

cluding the United States. On the other hand, the terms of trade shifted in favor of Japan, EU, and some of the developing countries.

Turning to the value of reciprocity statistic, Table 4 shows that Japan and EU have received terms of trade gains amounting to 5 billion dollars and 1 billion dollars, respectively. On the other hand, many developing countries experienced terms of trade losses ranging from 2 million dollars to 481 million dollars. The United States incurred the largest terms of trade loss, which amounts to 1.8 billion dollars.

While reciprocity statistics are statistically significant and suggest terms of trade movements, the question we ultimately care about is how economically significant are these terms of trade movements: Even if $\widehat{\mathbf{R}}^c$ is significant, the magnitude of implied deviation from reciprocity may be too small to be economically important. In order to evaluate the economic significance of reciprocity, we measure the size of terms of trade gains and losses as a percentage share of GDP.

The last column of Table 4 reports the value of reciprocity statistic as a percentage of 1993 GDP. It shows that terms of trade gains or losses are rather small relative to the economic size of each country: The simple average of the size of terms of trade gains and losses for all GATT members is merely -0.18 percent of GDP. If we focus on high income countries, the simple average becomes slightly higher, -0.24 percent of GDP. This is largely due to Hong Kong and Singapore which have somewhat higher GDP percentage figures, -0.9 percent and -1.2 percent, respectively. However, terms of trade gains or losses are generally very small for other high income countries. For example, the United States incurred the largest terms of trade loss, but the economic significance of the loss is virtually nil relative to the size of the economy. The same observation applies to Japan and EU that have a positive reciprocity statistic: The magnitude of their terms of trade gains is almost zero relative to their economic sizes.

As for developing countries, namely, middle and low income countries in our categorization, the simple average of terms of trade gains or losses is even smaller: -0.15 percent of GDP.

Note that our estimates of reciprocity statistic tend to exaggerate deviations from reciprocity due to the lack of supply response as we argued in the methodology section. To verify this point, we report the results of robustness checks that take account for supply elasticities in Table A.3. The first column of the table duplicates the original result taken from Table 4. The original estimates of reciprocity are obtained under the assumption that the export supply elasticity is zero. We weaken this assumption and recalculate the reciprocity statistic for four different cases in which the supply elasticity is assumed to be uniformly one, two, three, and four for all sectors, respectively.[30] This is rather a crude exercise, but it gives some idea about the possible bias in our estimates. Indeed, estimated reciprocity statistics become smaller on average as we allow for positive supply elasticities: The simple average of terms of trade losses as share of GDP does decline in Table A.3.

The results so far are particularly interesting in light of Table 2, which reports the weighted average tariffs of sample economies. We saw earlier that there were large average tariff cuts in some countries, such as Thailand and India. These countries are likely to gain from efficiency improvements in domestic production and consumption. It is important to note that a large tariff cut tends to cause a large terms of trade loss if it is implemented unilaterally. Thus the Uruguay Round seems to have helped some of the developing countries to undertake large tariff cuts while minimizing terms of trade losses.

Given the small magnitude of deviation from reciprocity, we conclude that tariff liberalization in the Uruguay Round is roughly reciprocal. Moreover, we find no systematic pattern in the distribution of terms of trade losses and gains. Our results thus do not suggest any bias in the way tariffs are liberalized such as rich countries gaining at the cost of developing countries. Importantly, in light of our earlier observation on the declining trend in average tariffs after the Uruguay Round, the multilateral tariff liberalization appears to have helped many countries to undertake tariff cuts while maintaining terms of trade deteriorations minimal. Thus developing countries did not lose significantly from their tariff

[30] These numbers for the supply elasticity are taken from Goldstein and Khan (1985) who report that estimates of the elasticity vary from one to four at the aggregate level.

cuts.

### 5.3 The volume effects

We now turn to the volume effects of tariff liberalization. We have found that reciprocity roughly holds in data, but one may suspect that our results may be due to relatively small movements in import volumes. To see this is not necessarily the case, we report the impact of tariff changes on import volume in Table 6. In general, these figures capture how much "excess" import demand was generated due to own tariff changes at the individual country level. If tariff changes do not affect world prices, i.e., if terms of trade effects are very small, these figures correspond to percentage changes in import volume due to own tariff changes. In practice, tariff movements can affect world prices, so import volume changes reported in Table 6 do not necessarily coincide with actual changes in imports. Nevertheless, Table 6 offers some sense about the movements in import volume associated with tariff movements.[31]

Table 6 shows that the direct impact of tariff liberalization for the WTO members is an increase in the import volume by 3.5 percent at the aggregate level. At the individual country level, tariff liberalization also appear to have had substantial direct effects in some countries. For example, the direct impact of tariff changes of Thailand, Sri Lanka, and India is an increase in their import demand by 29 percent, 35 percent, and 24 percent, respectively. As we saw earlier, these countries conducted large tariff cuts, and Table 6 suggests that their tariff cuts indeed had a large impact on their imports.

These results suggest that substantial forces were at work to shift world prices after the tariff liberalization. We thus conclude that our results are not driven by the lack of movements in imports.

[31]Note also that these percentage changes measure only the direct impact of tariff changes of a country on its own imports, and thus cross-country and cross-sectoral effects are not taken into account.

# 6 Robustness checks

## 6.1 Non-GATT signatories

The principle of reciprocity applies to only WTO members, so there is no obvious reason to expect reciprocity to hold once non-members are included. It is thus interesting to see how non-member countries will affect our results since the interpretation of reciprocity statistic remains valid even if non-members are included in the calculation.

Table 5 reports reciprocity statistics using all sample countries. Including all non-member countries seems to somewhat undermine reciprocity among WTO members. In particular, the reciprocity statistic of Hong Kong becomes larger. This is mainly due to China since China is the most important trade partner for Hong Kong. The simple average of terms of trade gains or losses also slightly increases: -0.34 percent for high income countries, -0.18 percent for developing countries, and -0.23 percent for all countries. Recall, however, that our estimates tend to overstate deviations from reciprocity: Once again, Table A.4 suggests that our estimates are somewhat exaggerated and reciprocity statistics becomes smaller in size once we take account of supply response.

While including non-members slightly undermines reciprocity among WTO members, terms of trade gains and losses remain rather small in GDP percentage terms. Thus we conclude that terms of trade gains and losses for WTO members are still minimal even after taking account of non-member countries.

## 6.2 Non-tariff barriers

So far, only ad valorem tariffs have been considered in the analysis. However, there are various non-tariff barriers (NTBs) in practice. This subsection takes account of NTBs and checks the robustness of our estimates when NTBs are present.

The TRAINS data contains some information on NTBs, but the country coverage and the year coverage of NTB data are smaller than those of tariff data. Two-year NTB data are available for 30 countries out of our 41 samples. Including NTB variables thus reduces the

number of observations in our data set. We will run regressions both with and without the new NTB variables to check the robustness of estimates to the choice of sample countries.

NTBs are categorized into the following five groups: (i)Threat NTB; (ii)Price NTB; (iii)Quantity NTB; (iv)Quality NTB; and (v)Advanced Payment. Threat NTBs include anti-dumping investigations.[32] Price NTBs include additional taxes and fees such as excise duties and customs service fees. Quantity NTBs include quotas and prohibition. Quality NTBs include authorization and licence.

The import coverage ratio, namely, the share of imports subject to NTBs, is calculated for each NTB category. It is well known that NTBs are hard to quantify, and import coverage ratios are not necessarily a perfect measure of NTBs.[33] With this caveat in mind, Table 7 reports the import coverage ratios of major NTB categories for each country. The first column lists the coverage ratio calculated using all NTBs. The second and the third column list the quantity NTB coverage ratio and the quality NTB coverage ratio, respectively.[34]

The import coverage ratio for quantity NTB decreased in some WTO members, notably in the United States and Japan. However, the overall trend is rather mixed. In particular, quality NTB import coverage ratios increased in many countries after the Uruguay Round. Overall, NTB liberalization seems less systematic than tariff liberalization.

In the empirical application, import coverage ratios are calculated at the individual sector level, and all the five NTB variables are included in the estimation equation at one time. Another way to incorporate NTBs into the regression is to include a dummy variable that is one if a NTB is in place and zero otherwise. Including dummy variables, however, do not change the results much, so we do not report these results here. Merging the five NTB categories into one do not cause major changes, either. Thus the rest of the section focuses only on the estimation results with five NTB variables measured by import coverage

[32]However, anti-dumping duties are categorized as a price NTB.

[33]For example, if a commodity is prohibited, its import is zero by definition and enters as zero in the coverage ratio calculation. In this case, the import coverage ratio cannot even capture the existence of this quantity NTB.

[34]Other forms of NTBs appear less frequently, so we report coverage ratios only for quantity NTB and quality NTB.

ratios. Estimation results are summarized in Table A.5. The first set of results are from the same specification as before, i.e., NTB variables are not included, but the estimation is now conducted using a smaller set of countries that have NTB data. The second set of results are from the specification with NTB variables, namely, NTB1, NTB2, NTB3, NTB4, and NTB5, each corresponding to one of the five categories listed above.[35] All regressions include the same set of fixed effects as before.

In the specification (1), the coefficient of the distance variable is negative and highly significant in almost all sectors. The estimates are also pretty similar to those from the full sample results. The results for the tariff variable are also very similar to the base results. Thus we conclude that the estimates are robust to the choice of sample countries.

Turning to the specification (2), the results show that NTB variables have very little impact on the estimates and the statistical significance of tariff variable and distance.[36] Table A.5 thus shows that the NTB variables do not alter our main estimation results. Using these estimates, we now calculate reciprocity statistic for each country.

Table 8 and 9 report the results on reciprocity statistic for GATT signatories and all sample countries, respectively. The results are very similar to the ones in Table 4 and 5. This is because the estimates of import elasticities used to produce these two sets of tables are also pretty similar to each other. Since the results on reciprocity in Table 8 and 9 are almost the same as the ones in Table 4 and 5, we do not repeat the discussion.

# 7 Conclusions

This paper has presented new evidence on the alleged imbalance in the tariff concessions made in the Uruguay Round. We have empirically examined the principle of reciprocity that offers direct implications for the magnitude of terms of trade movements.

[35] NTB variables are included as a fraction, without taking logs.

[36] However, NTB variables are not significant in many sectors or even have a wrong sign (not reported in Table A.5). Using dummies or merging the five NTB variables yields similar results. Given the limitation of import coverage ratios in correctly quantifying the effects of NTB, these results are not so surprising.

We found significant direct effects of the tariff liberalization on import demand: It increased the import demand of the world by 3.5 percent, that of high income countries by 3.0 percent, and that of developing countries by 8.8 percent.

On the other hand, terms of trade movements due to tariff reductions were rather insignificant: Overall, deviations from reciprocity were very small, so the tariff liberalization in the Uruguay Round was roughly reciprocal. We found terms of trade losses for many countries, including both developed and developing countries, but the economic significance of such losses were minimal, typically accounting for -0.18 percent of GDP for all sample countries, -0.24 percent of GDP for high income countries, and -0.15 percent of GDP for developing countries. Moreover, we did not find any evidence that rich countries tend to benefit from terms of trade improvements. The evidence thus suggests that developing countries did not lose significantly from the Uruguay Round tariff liberalization.

Our results by no means suggest that agricultural subsidies in developed countries have no impact on developing countries, nor they address potential losses for developing countries from tighter protection of intellectual property rights.[37] However, the evidence we present does undermine the claim that the world trading system under the WTO is biased against poor countries. As far as tariff liberalization is concerned, the Uruguay Round seems to have generated rather neutral outcomes.

This paper focused on multilateral tariff liberalization, but many other issues still remain. More work needs to be done on other potential sources of losses to fully understand and assess the overall outcomes of the Uruguay Round.

# A Appendix

This appendix provides more details on the setup of the B-S model.

[37] See Panagariya (1999b) for the controversy over the TRIPS (Trade-Related Aspects of Intellectual Property Rights) agreement. See also McCalman (2001) who estimates gains and losses associated with TRIPS focusing on patent harmonization.

## A.1 The economic environment

Using the definitions of prices given in Section 2, production and consumption are determined as follows:

Goods $x$ and $y$ are produced under perfect competition, and production in each country is determined by the point at which the marginal rate of transformation between $x$ and $y$ are equal to the relative local price. Denote production functions as $Q_i^c = Q_i^c(p^c)$ and $Q_i^{c'} = Q_i^{c'}(p^{c'})$ for $i \in \{x, y\}$.

Consumption is a function of the relative local price and tariff revenue $R^c$ ($R^{c'}$), which is distributed lump sum to consumers in country $c$ ($c'$). Thus the demand for good $i$ in each country is expressed as $D_i^c = D_i^c(p^c, R^c)$ and $D_i^{c'} = D_i^{c'}(p^{c'}, R^{c'})$. Tariff revenue is defined implicitly by $R^c = [D_x^c(p^c, R^c) - Q_x^c(p^c)][p^c - p^w]$ or $R^c = R^c(p^c, p^w)$ for country $c$, and $R^{c'} = [D_y^{c'}(p^{c'}, R^{c'}) - Q_y^{c'}(p^{c'})][1/p^{c'} - 1/p^w]$ or $R^{c'} = R^{c'}(p^{c'}, p^w)$ for country $c'$. Assuming that goods are normal, tariff revenue is increasing in the terms of trade. Then consumption in each country can be written as a function of the local relative price and world price: $C_i^c(p^c, p^w) \equiv D_i^c(p^c, R^c(p^c, p^w))$ and $C_i^{c'}(p^{c'}\, p^w) \equiv D_i^{c'}(p^{c'}, R^{c'}(p^{c'}, p^w))$ for $i \in \{x, y\}$.

The imports of country $c$ are defined as $M_x^c(p^c, p^w) \equiv C_x^c(p^c, p^w) - Q_x^c(p^c)$, and the exports are defined as $E_y^c(p^c, p^w) \equiv Q_y^c(p^c) - C_y^c(p^c, p^w)$. $M_y^{c'}$ and $E_x^{c'}$ are similarly defined for country $c'$. The budget constrains imply trade balance conditions:

$$\begin{aligned} p^w M_x^c(p^c(\tau^c, p^w),\, p^w) &= E_y^c(p^c(\tau^c, p^w), p^w); \\ M_y^{c'}(p^c(\tau^{c'}, p^w), p^w) &= p^w E_x^{c'}(p^{c'}(\tau^{c'}, p^w), p^w) \end{aligned} \tag{15}$$

The equilibrium world price $\tilde{p}^w(\tau^c, \tau^{c'})$ is determined by the market clearing condition for good $y$:

$$E_y^c(p^c(\tau^c, \tilde{p}^w),\, \tilde{p}^w) = M_y^{c'}(p^{c'}(\tau^{c'}, \tilde{p}^w), \tilde{p}^w) \tag{16}$$

while the market clearance for good $x$ is implied by (15) and (16). In addition, the following regularity conditions are imposed throughout: $dp^c/d\tau^c > 0 > dp^{c'}/d\tau^{c'}$ and $\partial\tilde{p}^w/\tau^c < 0 < \partial\tilde{p}^w/\partial\tau^{c'}$.

Government preferences are represented as a general function of the local relative price

and the world price: $W^c(p^c(\tau^c, p^w))$ and $W^{c'}(p^{c'}(\tau^{c'}, p^w))$. The key structure imposed on $W^c$ and $W^{c'}$ is that fixing the local relative price, each government can achieve higher welfare by improving its terms of trade:

$$\frac{\partial W^c(p^c, \tilde{p}^w)}{\partial \tilde{p}^w} < 0 \ and \ \frac{\partial W^{c'}(p^{c'}, \tilde{p}^w)}{\partial \tilde{p}^w} > 0 \tag{17}$$

This representation of government objectives is fairly general. It entails the traditional case in which the government maximizes the national income. It is also consistent with the cases in which the government takes account of distributional concerns as in political economy models. See Bagwell and Staiger (2000) and Bagwell and Stainger (2002), for example, for more discussions on the generality of this representation of government preferences.

### A.2 Welfare implications of tariff policies

Given the economic environment described above, the trade policy of the governments can be modelled as a non-corporative game of tariff selection: Each government unilaterally chooses its tariff so as to maximize the objective function while taking the tariff level of the other country as given. In particular, the reaction functions are implicitly defined by

$$Country\ c: \ W^c_{p^c}[dp^c/d\tau^c] + W^c_{\tilde{p}^w}[\partial \tilde{p}^w/\partial \tau^c] = 0 \tag{18}$$

$$Country\ c': \ W^{c'}_{p^{c'}}[dp^{c'}/d\tau^{c'}] + W^{c'}_{\tilde{p}^w}[\partial \tilde{p}^w/\partial \tau^{c'}] = 0 \tag{19}$$

where the subscripts on $W^c$ and $W^{c'}$ denote partial derivatives. Now denoting $\lambda^c \equiv [\partial \tilde{p}^w/\partial \tau^c]/[dp/d\tau^c] < 0$ and $\lambda^{c'} \equiv [\partial \tilde{p}^w/\partial \tau^{c'}]/[dp^{c'}/d\tau^{c'}] < 0$, (18) and (19) can be rewritten as

$$Country\ c: \ W^c_{p^c} + \lambda^c W^c_{\tilde{p}^w} = 0 \tag{20}$$

$$Country\ c': \ W^{c'}_{p^{c'}} + \lambda^{c'} W^{c'}_{\tilde{p}^w} = 0 \tag{21}$$

(20) and (21) show that each country's best-response tariff is determined by balancing the two price effects, namely, local price effects and world price effects. In other words, the impacts of tariff changes on welfare can be decomposed into two factors, one induced by local price movements ($W^c_{p^c}$) and one induced by world price movements ($W^c_{\tilde{p}^w}$).

Nash tariffs are defined to be a tariff pair that simultaneously satisfy reaction functions (20) and (21). It can be shown that Nash tariffs are inefficient.[38] The intuition of this result is straightforward. In unilateral tariff setting, the actual costs of protection are higher than the government perceives since the government fails to take account of the fact that its tariff choice negatively affects the terms of trade of its trading partner. As a result, both governments oversupply protection, and Nash tariffs are set higher than efficient levels.

We now show that both countries will be better off if they agree to cut tariffs while maintaining reciprocity. Reciprocity keeps the terms of trade fixed, thus neutralizing the welfare effect from terms of trade movements. On the other hand, a tariff cut will change the local price. To see that this local price movement will increase welfare, note that (20) implies that $W^c_{p^c} < 0$. This suggests that the local price of country $c$ is too high in a Nash equilibrium. A tariff cut will cause the local price to fall, so it will generate a welfare gain. Thus the impact of a tariff cut on country $c$'s welfare is strictly positive, i.e., $-W^c_{p^c}(dp^c/d\tau^c)d\tau^c > 0$. Similarly, since (21) implies that $W^{c'}_{p^{c'}} > 0$, a tariff cut will bring about a welfare gain to country $c'$ through a change in the local price so that $-W^{c'}_{p^{c'}}(dp^{c'}/d\tau^{c'})d\tau^{c'} > 0$. It thus follows that starting from a Nash equilibrium, trade liberalization with reciprocity will generate welfare gains to both countries through the local price channel.

If reciprocity does not hold, the overall welfare effect depends also on world price movements. For example, suppose that a trade liberalization causes the terms of trade to improve for country $c$ and deteriorate against country $c'$. In this case, country $c$ benefits from this trade liberalization on balance since it gains from the local price movement as well as from the terms of trade improvement. On the other hand, the overall impact on country $c'$ depends on the relative size of the gain from the local price movement and the loss from the terms of trade deterioration.

[38] See Bagwell and Staiger (1999).

## A.3 Generalization

We will generalize the two-by-two model along the lines of Bagwell and Staiger (1999, 2002, and forthcoming), and derive a theoretical expression for reciprocity in the multi-sector, multi-country model.

Suppose there are $N+1$ countries. The home country is called $c$, and foreign countries are indexed by $c'$ where $c' = 1, 2, ..., N$. Country $c$ imports goods indexed by $x$ where $x = 1, 2, ..., I$. Country $c$ exports goods indexed by z where $z = 0, 1, 2, ..., J$. Thus there are I+J+1 good in total in this economy. Foreign countries $c'$ export goods $x$ to country $c$ and import goods $z$ from country $c$. For simplicity, suppose there is no trade among foreign countries $c'$.

Local relative prices in country $c$ are defined as follows: $p_i^c \equiv p_x^c / p_{z_0}^c$ for import goods with $i = 1, 2, ..., I$, and $p_j^c \equiv p_z^c / p_{z_0}^c$ for export goods with $j = 1, 2, ..., J$ where $p_{z_0}^c = p_z^c$ for $z = 0$. Similarly, local relative prices in foreign countries $c'$ are defined as $p_i^{c'} \equiv p_x^{c'} / p_{z_0}^{c'}$ for import goods, and $p_j^{c'} \equiv p_z^{c'} / p_{z_0}^{c'}$ for export goods where $p_{z_0}^{c'} = p_z^{c'}$ for $z = 0$.

We allow country $c$ to apply differential tariff rates to different trade parters. The world (untaxed) relative prices of goods $x$ are then defined as $p_i^{wc'} \equiv p_x^{c'} / p_{z_0}^c$ for $i = 1, 2, ..., I$, which vary by exporters $c'$. For simplicity, we assume that country $c$ does not differentiate export destinations, so the world prices of goods $z$ are defined as $p_j^w \equiv p_j^c / p_{z_0}^c$ for $j = 0, 1, 2, ..., J$.

Denote the ad valorem trade taxes of country $c$ imposed on country $c'$ as $\theta_i^{cc'}$ and $\theta_j^{cc'}$, with $\theta_j^{cc'} > 0$ ($\theta_j^{cc'} < 0$) indicating an export subsidy (tax). Defining $\tau_i^{cc'} \equiv 1 + \theta_i^{cc'}$ and $\tau_j^{cc'} \equiv 1 + \theta_j^{cc'}$, the local prices of country $c$ can be expressed in terms of world prices and tariffs: $p_i^c = \tau_i^{cc'} p_i^{wc'} \equiv p_i^c(\tau_i^{cc'}, p_i^{wc'})$ and $p_j^c = \tau_j^{cc'} p_j^w \equiv p_j^c(\tau_j^{cc'}, p_j^w)$. Under the assumption of no differentiation of export destinations, $p_j^c = \tau_j^{cc'} p_j^w = \tau_j^{cc''} p_j^w$, so $\tau_j^{cc'} = \tau_j^{cc''}$. To simplify the notation, we rewrite $\tau_j^{cc'}$ as $\tau_j^c$. Similarly for foreign countries $c'$, denote the ad valorem trade taxes of $c'$ as $\theta_i^{c'}$ and $\theta_j^{c'}$ with $\theta_i^{c'} > 0$ ($\theta_i^{c'} < 0$) indicating an export subsidy (tax). Defining $\tau_i^{c'} \equiv 1 + \theta_i^{c'}$ and $\tau_j^{c'} \equiv 1 + \theta_j^{c'}$, the local prices of $c'$ are written as $p_i^{c'} = \tau_i^{c'} p_i^{wc'} \equiv p_i^{c'}(\tau_i^{c'}, p_i^{wc'})$ and $p_j^{c'} = \tau_j^{c'} p_j^w \equiv p_j^{c'}(\tau_j^{c'}, p_j^w)$. Since $p_i^c = \tau_i^{cc'} p_i^{wc'} = \tau_i^{cc''} p_i^{wc''}$ for $c' \neq c''$, it follows that

$$p_i^{wc'} = [\tau_i^{cc''}/\tau_i^{cc'}]p_i^{wc''},\ for\ c' \neq c'' \tag{22}$$

As before, production is determined as a function of local prices, and consumption is determined as a function of local prices and tariff revenue. Note that $p_i^{wc'}$ and $p_j^w$ are the *good-specific* terms of trade: $1/p_i^{wc'}$ ($p_i^{wc'}$) measures is the terms of trade of good $i$ for country $c$ ($c'$), and $p_j^w$ ($1/p_j^w$) measures the terms of trade of good $j$ for country $c$ ($c'$). [39]

We now define the *overall* terms of trade: We first define trade shares as $w_i^c \equiv \frac{M_i^c}{\sum_{i=1}^I M_i^c + \sum_{j=0}^J E_j^c}$ and $w_j^c \equiv \frac{E_j^c}{\sum_{i=1}^I M_i^c + \sum_{j=0}^J E_j^c}$ for country $c$, and $w_i^{c'} \equiv \frac{E_i^{c'}}{\sum_{i=1}^I E_i^{c'} + \sum_{j=0}^J M_j^{c'}}$ and $w_j^{c'} \equiv \frac{M_j^{c'}}{\sum_{i=1}^I E_i^{c'} + \sum_{j=0}^J M_j^{c'}}$, where $M_i^c$ is the total imports of good $i$ of country $c$, $E_j^c$ is the total exports of good $j$ of country $c$, $M_j^{c'}$ is the imports of country $c'$, and $E_i^{c'}$ is the exports of country $c'$. Using these definitions, the overall terms of trade for foreign countries $c'$ are defined as the trade weighted average of world prices:

$$T^{c'} \equiv \sum_{i=1}^{I} w_i^{c'} p_i^{wc'} - \sum_{j=1}^{J} w_j^{c'} p_j^w \tag{23}$$

An increase in $T^{c'}$ means a terms of trade gain for country $c'$.

To define the overall terms of trade for country $c$, we first define the bilateral trade shares by $k_i^{c'} \equiv \frac{E_i^{c'c}}{\sum_{c'} E_i^{c'c}}$. Using this definition, the country $c$'s *multilateral* terms of trade for good $i$ is defined as follows:

$$p_i^w \equiv \sum_{c'} k_i^{c'} p_i^{wc'} \tag{24}$$

Given this expression, the *inverse* of the overall terms of trade for country $c$ is defined as follows:

$$T^c = \sum_{i=1}^{I} w_i^c p_i^w - \sum_{j=1}^{J} w_j^c p_j^w \tag{25}$$

[39] Note $p_i^{wc'}$ is trade parter specific as well.

A decrease in $T^c$ means a terms of trade gain for country $c$. $T^c$ and $T^{c'}$ play basically the same role as $p^w$ in the two-sector, two-country model.[40] We thus call them simply the terms of trade thereafter.[41]

Letting $\{p^c\}$ and $\{p^{c'}\}$ denote the set of local prices of country $c$ and $c'$, respectively, trade balance conditions are written as follows:

$$\begin{array}{l} \sum_{c'} \sum_{i=1}^{I} p_i^{wc'} M_i^{cc'}(\{p^c\}, T^c) = \sum_{c'} \sum_{j=0}^{J} p_j^w E_j^c(\{p^c\}, T^c); \\ \sum_{i=1}^{I} p_i^{wc'} E_i^{c'c}(\{p^{c'}\}, T^{c'}) = \sum_{j=0}^{J} p_j^w M_j^{c'c}(\{p^{c'}\}, T^{c'}),\ \forall\ c' \end{array} \tag{26}$$

With $\{\tau^c\}$ and $\{\tau^{c'}\}$ representing the set of trade taxes of country $c$ and $c'$, respectively, we write the equilibrium world prices as $\tilde{p}_i^{wc'}(\{\tau^c\}, \{\tau^{c'}\})$ and $\tilde{p}_j^w(\{\tau^c\}, \{\tau^{c'}\})$. Equilibrium world prices are then determined by (22) and market clearing conditions:

$$\begin{array}{l} \sum_{c'} M_i^{cc'}(\{p^c\}, \tilde{T}^c) = \sum_{c'} E_i^{c'c}(\{p^{c'}\}, \tilde{T}^{c'}),\ \forall\ i; \\ \sum_{c'} E_j^{cc'}(\{p^c\}, \tilde{T}^c) = \sum_{c'} M_j^{c'c}(\{p^{c'}\}, \tilde{T}^{c'}),\ for\ j = 1, ..., J \end{array} \tag{27}$$

The equilibrium in the $j = 0$ market is then implied by the trade balance conditions.

As in the two-good and two-country model, we assume that $d\mathbf{p}^c/d\tau_i^{cc'} > 0 > d\mathbf{p}^c/d\tau_j^{c'}$, $d\mathbf{p}^c/d\tau_j^c > 0 > d\mathbf{p}^{c'}/d\tau_i^{c'}$, $dT^c/d\tau_i^{cc'} < 0 < dT^{c'}/d\tau_j^{c'}$, and $dT^c/d\tau_j^c < 0 < dT^{c'}/d\tau_i^{c'}$ where $\mathbf{p}^c$ ($\mathbf{p}^{c'}$) is the trade weighted average of the local price defined in the same manner as in the overall terms of trade $T^c$ ($T^{c'}$).[42]

The government preferences are represented by $W^c(\{p^c\}, \tilde{T}^c)$ for country $c$ and $W^{c'}(\{p^{c'}\}, \tilde{T}^{c'})$ for country $c'$. The structure imposed on the government objectives is that holding the local prices fixed, an improvement in the overall terms of trade achieves higher welfare:

[40] Recall in the two-good, two-country model, an increase in $p^w$ was a terms of trade gain for country $c'$ while a decrease in $p^w$ was a terms of trade gain for country $c$.

[41] It can be shown that tariff revenue is implicitly defined as follows: $R^c = [D^c(\{p^c\}, R^c) - Q^c(\{p^c\})][\mathbf{p}^c - T^c]$ where $D^c$ is the aggregate demand, $Q^c$ is the aggregated supply, $\{p^c\}$ is the set of local prices, and $\mathbf{p}^c$ is the local price index defined using trade volume as weights in the same manner as in $T^c$. Thus $T^c$ is the right expression for the overall terms trade, and tariff revenue is written as $R^c = R(\{p^c\}, T^c)$. Assuming that all goods are normal, each country's tariff revenue is increasing in the good specific terms of trade, and this in turn suggests that tariff revenue is increasing in the overall terms of trade.

[42] Namely, $\mathbf{p}^c \equiv \sum_i w_i^c p_i^c - \sum_j w_j^c p_j^c$ and $\mathbf{p}^{c'} \equiv \sum_i w_i^{c'} p_i^{c'} - \sum_j w_j^{c'} p_j^{c'}$.

$\partial W^c/\partial \tilde{T}^c < 0$ and $\partial W^{c'}/\partial \tilde{T}^{c'} > 0$. We further assume that governments care about world price movements for their revenue implications alone.

In this environment, a Nash equilibrium is defined as a set of tariffs that satisfy the following best-response conditions:

$$\begin{gathered} Country\ c\ : W^c_{\mathbf{p}^c}[d\mathbf{p}^c/d\tau_i^{cc'}] + W^c_{\tilde{T}^c}[d\tilde{T}^c/d\tau_i^{cc'}] = 0, \forall\, c' \\ W^c_{\mathbf{p}^c}[d\mathbf{p}^c/d\tau_j^c] + W^c_{\tilde{T}^c}[d\tilde{T}^c/d\tau_j^c] = 0 \end{gathered} \tag{28}$$

$$Country\ c'\ : W^{c'}_{\mathbf{p}^{c'}}[d\mathbf{p}^{c'}/d\tau_l^{c'}] + W^{c'}_{\tilde{T}^{c'}}[d\tilde{T}^{c'}/d\tau_l^{c'}] = 0,\ for\, l \in \{i,j\} \tag{29}$$

Since the second terms are positive in (28) and (29), it follows that $W^c_{\mathbf{p}^c} < 0$ and $W^{c'}_{\mathbf{p}^{c'}} > 0$ in a Nash equilibrium. Thus starting from a Nash, a trade tax reduction will induce some welfare gain to both country $c$ and $c'$ through local price movements.

Given the definition of generalized reciprocity from the subsection 2.3, it is straightforward to show that $\mathbf{R}^c = -\sum_{c'} \mathbf{R}^{c'}$. To see the implications of generalized reciprocity for terms of trade movements, we rewrite (4) and (5) using the trade balance conditions as follows:

$$\mathbf{R}^c = -\sum_{c'}\sum_{i=1}^{I}[\tilde{p}_i^{wc'1} - \tilde{p}_i^{wc'0}]M_i^{cc'1} + \sum_{c'}\sum_{j=1}^{J}[\tilde{p}_j^{w1} - \tilde{p}_j^{w0}]E_j^{cc'1} = 0 \tag{30}$$

and

$$\mathbf{R}^{c'} = -\sum_{j=1}^{J}[\tilde{p}_j^{w1} - \tilde{p}_j^{w0}]M_j^{c'1} + \sum_{i=1}^{I}[\tilde{p}_i^{wc'1} - \tilde{p}_i^{wc'0}]E_i^{c'1} = 0 \tag{31}$$

Generalized reciprocity does not necessarily imply constant individual world prices: While these conditions will be surely satisfied if $\tilde{p}_i^{wc'}$ and $\tilde{p}_j^{w}$ do not change, (30) and (31) can be still satisfied even when individual world prices change. However, as long as world price movements satisfy (30) and (31), reciprocity implies that the *overall* terms of trade is held constant. To see this, using (24) and trade shares $w_i^c$ and $w_j^c$ defined earlier, we rewrite (30) as follows:

$$[-\sum_{i=1}^{I} w_i^{c1}\tilde{p}_i^{w1} + \sum_{j=1}^{J} w_j^{c1}\tilde{p}_j^{w1}] - [-\sum_{i=1}^{I} w_i^{c1}\tilde{p}_i^{w0} + \sum_{j=1}^{J} w_j^{c1}\tilde{p}_j^{w0}] = 0$$

and this implies that

$$-\tilde{T}^{c1} - (-\tilde{T}^{c0}) = 0$$

where $\tilde{T}^{c0} \equiv \sum_{i=1}^{I} w_i^{c1} \tilde{p}_i^{w0} - \sum_{j=1}^{J} w_j^{c1} \tilde{p}_j^{w0}$ and $\tilde{T}^{c1} \equiv \sum_{i=1}^{I} w_i^{c1} \tilde{p}_i^{w1} - \sum_{j=1}^{J} w_j^{c1} \tilde{p}_j^{w1}$ with new trade volume being used as weights. Thus when generalized reciprocity holds, the *overall terms of trade* is held fixed.

In the two-by-two model, we saw that tariff revenue is constant when reciprocity is satisfied. This result still holds in more general settings. To see this, we rewrite (30) and (31) by adding and subtracting the new local prices:

$$\sum_{c'} \sum_{i=1}^{I} [p_i^{c1} - \tilde{p}_i^{wc'1}] M_i^{cc'1} - \sum_{c'} \sum_{j=1}^{J} [p_j^{c1} - \tilde{p}_j^{w1}] E_j^{cc'1} = \sum_{c'} \sum_{i=1}^{I} [p_i^{c1} - \tilde{p}_i^{wc'0}] M_i^{cc'1} - \sum_{c'} \sum_{j=1}^{J} [p_j^{c1} - \tilde{p}_j^{w0}] E_j^{cc'1} \tag{32}$$

and

$$\sum_{j=1}^{J} [p_j^{c'1} - \tilde{p}_j^{wc'1}] M_j^{c'1} - \sum_{i=1}^{I} [p_i^{c'1} - \tilde{p}_i^{w1}] E_i^{c'1} = \sum_{j=1}^{J} [p_j^{c'1} - \tilde{p}_j^{wc'0}] M_j^{c'1} - \sum_{i=1}^{I} [p_i^{c'1} - \tilde{p}_i^{w0}] E_i^{c'1} \tag{33}$$

These conditions say that new world prices must generate tariff revenue that is equal to the amount of revenue that would be realized when old world prices are combined with the new local prices. In other words, as long as reciprocity is satisfied, the new set of trade taxes and the old set of trade taxes yield exactly the same amount of tariff revenue under the new local prices. Thus when generalized reciprocity holds, the overall terms of trade is held fixed, and there will be no change in tariff revenue. Since revenue is fixed at the new local prices, there will be no pure transfer among countries.

The case in which reciprocity does not hold can be handled similarly as before: Suppose $\mathbf{R}^c > 0$, and then it is straightforward to show that $\tilde{T}^{c1} < \tilde{T}^{c0}$. In this case, it immediately follows that

$$\begin{aligned} \mathbf{R}^c = &\textstyle\sum_{c'} \sum_{i=1}^{I} [p_i^{c1} - \tilde{p}_i^{wc'1}] M_i^{cc'1} - \sum_{c'} \sum_{j=1}^{J} [p_j^{c1} - \tilde{p}_j^{w1}] E_j^{cc'1} \\ &\textstyle- \sum_{c'} \sum_{i=1}^{I} [p_i^{c1} - \tilde{p}_i^{wc'0}] M_i^{cc'1} + \sum_{c'} \sum_{j=1}^{J} [p_j^{c1} - \tilde{p}_j^{w0}] E_j^{cc'1} > 0 \end{aligned}$$

This inequality suggests that a trade agreement that results in $\mathbf{R}^c > 0$ generates an increase in tariff revenue. This revenue gain is made possible only at the cost of other countries since

$\mathbf{R}^c > 0$ together with $\mathbf{R}^c = -\sum_{c'} \mathbf{R}^{c'}$ implies that at least one of the foreign countries must have $\mathbf{R}^{c'} < 0$. Generalized reciprocity thus has implications for movements in the overall terms of trade, and $\mathbf{R}^c$ measures the direction and magnitude of pure transfers for country $c$ vis-à-vis its trading partners. The discussion so far establishes Proposition 2 in the subsection 2.3.

### A.4 Gravity equation

This subsection derives the gravity equation (14) in subsection 3.2. A first key assumption in the gravity model is that goods are differentiated by location of production. Denoting industries by $i$, consumer preferences take a CES functional form:

$$U_c = \prod_i \left( \sum_{c'} \beta_{ic'}^{1/\sigma_i} q_{icc'}^{(\sigma_i - 1)/\sigma_i} \right)^{\frac{\sigma_i}{\sigma_i - 1}\mu_i}, \ \sigma_i > 1 \tag{34}$$

where $q_{icc'}$ is country $c$'s consumption of good $i$ produced in country $c'$ and $\sigma_i$ is the elasticity of substitution for good $i$. It is assumed that $\sigma_i$ is the same across countries for simplicity. $\beta_{ic'}$ and $\mu_i$ are parameters that are also common across countries. $\mu_i$ is the share of income spent on good $i$ and satisfies $\sum_i \mu_i = 1$.

The next key assumption is that transportation costs are of "iceberg" form: For every $t > 1$ units shipped from an exporting country, only 1 unit arrives at an importing country. In other words, $t-1$ units melt away in transit. Denoting the f.o.b. price of good $i$ exported by country $c'$ as $p_i^{c'}$, the price of good $i$ arriving in country $c$ is expressed as $t^{cc'} p_i^{c'}$. In addition to transport costs, we allow tariffs in trade costs. Suppose that country $c$ imposes tariffs on imports from country $c'$. Denoting one plus the ad valorem tariff imposed by country $c$ as $\tau_i^{cc'}$, the c.i.f. price in country $c$ is now expressed as $p_i^{cc'} \equiv t^{cc'} \tau_i^{cc'} p_i^{c'}$. Note that $p_i^{cc} \equiv t^{cc} \tau_i^{cc} p_i^c = p_i^c$ since $t^{cc} = 1$ and $\tau_i^{cc} = 1$. We define $p_i^{wc'} \equiv p_i^{c'}/p_1^c$ to be the "world" (untaxed) relative price of good $i$. Then $p_i^{wc'}$ measures the good $i$ specific terms of trade for country $c'$. Note that $p_1^{wc} = 1$ by construction.

The consumer maximizes the utility function (34) subject to the following budget constraint: $\sum_i \sum_{c'} p_i^{cc'} q_i^{cc'} = y^c$ where $y^c$ is the national income of country $c$. Solving this

maximization problem, we derive the import demand of country $c$ as follows:

$$q_{icc'} = \beta_{ic'} \frac{(t^{cc'}\tau_i^{cc'}p_i^{c'})^{-\sigma_i}}{\mathbf{P}_{ic}^{1-\sigma_i}} \mu_i y^c \tag{35}$$

where $\mathbf{P}_{ic}$ is the CES price index for good $i$ defined as

$$\mathbf{P}_{ic} = \left( \sum_{c'} \beta_{ic'} (t^{cc'}\tau_i^{cc'}p_i^{c'})^{1-\sigma_i} \right)^{\frac{1}{1-\sigma_i}} \tag{36}$$

Anderson and van Wincoop (2003) refer to this price index as *multilateral trade resistance* since it is increasing in the trade barriers against all trading partners.[43]

Using equation (35), the c.i.f. imports of good $i$ from country $c'$ to country $c$ is written as

$$m_i^{cc'} = \beta_{ic'} \left( \frac{t^{cc'}\tau_i^{cc'}p_i^{c'}}{\mathbf{P}_{ic}} \right)^{1-\sigma_i} \mu_i y^c \tag{37}$$

where $m_i^{cc'} = p_i^{cc'} q_i^{cc'}$. Let $y_i^{c'}$ be the income of country $c'$ from good $i$ production so that $y^{c'} = \sum_i y_i^{c'}$. Then market clearance implies

$$y_i^{c'} = \sum_c \beta_{ic'} \left( \frac{t^{cc'}\tau_i^{cc'}p_i^{c'}}{\mathbf{P}_{ic}} \right)^{1-\sigma_i} \mu_i y^c, \ \forall\, c', \ \forall\, i \tag{38}$$

Now let $y_i^w = \sum_c y_i^c$ be the total world income from good $i$ production, and define $s_i^{c'} \equiv y_i^{c'}/y_i^w$ to be the share of country $c'$ in the world income for good $i$. Further define $\bar{s}_i^c \equiv \mu_i y^c / y_i^w$ to be the relative share of income *spent* on good $i$ in country $c$.[44] From equation (38), it is straightforward to show that

$$s_i^{c'} = \beta_{ic'} \sum_c \bar{s}_i^c \left( \frac{t^{cc'}\tau_i^{cc'}p_i^{c'}}{\mathbf{P}_{ic}} \right)^{1-\sigma_i} \tag{39}$$

[43] To be more precise, the multilateral trade resistance in the Anderson and van Wincoop framework is $\mathbf{P}_c$ (overall price index) rather than $\mathbf{P}_{ic}$ (industry-specific price index). There is only one price index in their model because they abstract from finer classifications of commodities assuming that each country specializes in only one good.

[44] Note that $\bar{s}_i^c$ is different from $s_i^c$ since the latter is the share of income *generated* from good $i$ production while the former is the share of income *spent* on good $i$.

Solving the equation (39) for $\beta_{ic'}$ and substituting it into the equation (37), the c.i.f. imports of good $i$ from country $c'$ to country $c$ are written as follows:

$$m_i^{cc'} = \frac{\bar{y}_i^c y_i^{c'}}{y_i^w} \frac{\left(t^{cc'}\tau_i^{cc'}p_i^{c'}\right)^{1-\sigma_i}(\mathbf{P}_{ic})^{\sigma_i-1}}{\sum_c \bar{s}_i^c \left(\frac{t^{cc'}\tau_i^{cc'}p_i^{c'}}{\mathbf{P}_{ic}}\right)^{1-\sigma_i}} \tag{40}$$

where $\bar{y}_i^c \equiv \mu_i y^c$, i.e., the amount of income spent on good $i$ in country $c$. Equation (40) says that countries with higher income trade more, but the effects of income on bilateral trade is industry-specific: Country $c$ tends to import more from country $c'$ if $\bar{y}_i^c$ is larger and if $y_i^{c'}$ is larger. After controlling for the size of the industry, bilateral trade is decreasing in transport costs ($t^{cc'}$) and tariffs ($\tau_i^{cc'}$).

The multilateral trade resistance term $\mathbf{P}_{ic}$ is understood as substitution effects: If country $c$ faces higher trade costs on average so that $\mathbf{P}_{ic}$ is high, it tends to import more from country $c'$. This is because at a given level of bilateral trade barrier between country $c$ and $c'$, a higher trade barrier between $c$ and other countries makes the goods from country $c'$ relatively cheaper, thus increasing imports from country $c'$.

The expression in the denominator of (40) looks somewhat complex. To facilitate the interpretation of this term, we denote it as $\Psi_{ic'} = \sum_c \bar{s}_i^c (t^{cc'}\tau_i^{cc'}p_i^{c'}/\mathbf{P}_{ic})^{1-\sigma_i}$. Bilateral imports are increasing in $\Psi_{ic'}$, which is the weighted average of the *relative* trade costs associated with good $i$ facing country $c'$. At a given level of bilateral trade barrier, if country $c'$ faces higher relative trade costs so that $\Psi_{ic'}$ is larger, aggregate demand for its products becomes lower. This in turn implies that the f.o.b. prices of country $c'$ goods are relatively lower. As a result, country $c$ imports more from country $c'$.[45]

Recalling that $p_i^{wc'} = p_i^{c'}/p_1^c$ and normalizing $p_1^c = 1$, equation (40) is now rewritten as

$$m_i^{cc'} = \frac{\bar{y}_i^c y_i^{c'}}{y_i^w} \frac{(t^{cc'}\tau_i^{cc'}p_i^{wc'})^{1-\sigma_i}}{\mathbf{P}_{ic}^{1-\sigma_i}\Psi_{ic'}} \tag{41}$$

To derive an estimation equation from this gravity equation, we will need to add a few

[45] See also Harrigan (2001). He explains the "relative distance effect," which plays a very similar role as $\Psi_{ic'}$.

more assumptions. First, we assume that transport costs are increasing in distance:

$$t^{cc'} = (d^{cc'})^{\rho_i}$$

where $d^{cc'}$ is the distance between country $c$ and country $c'$, and $\rho_i$ is an industry specific parameter with $\rho_i > 0$.

Second, we assume that the world price $p_i^{wc'}$ consists of two factors:

$$p_i^{wc'} = \lambda_{ic'} p_i^w$$

where $p_i^w$ is the average world price which is common to all countries, and $\lambda_{ic'}$ is a country specific factor that accounts for the deviation of the world price from the average world price. Under these assumptions, we take the logarithm of equation (41) to yield the following equation:

$$\begin{aligned} \ln m_i^{cc'} &= \ln \bar{y}_i^c + \ln y_i^{c'} - \ln y_i^w + \rho_i(1-\sigma_i)\ln d^{cc'} + (1-\sigma_i)\ln \tau_i^{cc'} \\ &+(1-\sigma_i)\ln \lambda_{ic'} + (1-\sigma_i)\ln p_i^w + (\sigma_i - 1)\ln \mathbf{P}_{ic} - \ln \Psi_{ic'} \end{aligned} \tag{42}$$

Adding a time subscript $t$, equation (42) is now written as

$$\begin{aligned} \ln m_{it}^{cc'} &= \ln \bar{y}_{it}^c + \ln y_{it}^{c'} - \ln y_{it}^w + \rho_i(1-\sigma_i)\ln d^{cc'} + (1-\sigma_i)\ln \tau_{it}^{cc'} \\ &+(1-\sigma_i)\ln \lambda_{ic'} + (1-\sigma_i)\ln p_{it}^w + (\sigma_i - 1)\ln \mathbf{P}_{ict} - \ln \Psi_{ic't} \end{aligned} \tag{43}$$

Distance is time-invariant, so $d^{cc'}$ does not have the time subscript. $\lambda_{ic'}$ is also assumed to be time-invariant.

We will use dummy variables to control for most of the explanatory variables other than distance and tariffs in (43). First, we include importer and exporter fixed effects to control for unobserved importer and exporter heterogeneity as well as relative distance effects that account for a time-invariant component of trade costs. The exporter fixed effects also control for $\lambda_{ic'}$.

Second, we include time fixed effects to capture the effects of $y_{it}^w$ and $p_{it}^w$. It is crucial to control for world price movements to obtain the right estimates of import elasticities. Time

effects will remove the impact of world price movements and thus assure that elasticities are evaluated at initial world prices.

Third, we will use importer-time interaction terms to control for $\bar{y}_{it}^{c}$ and $\mathbf{P}_{ict}$, and exporter-time interaction terms to control for $y_{it}^{c'}$, and $\Psi_{ic't}$.

Denoting $\alpha_{i1} = \rho_i(1-\sigma_i)$ and $\alpha_{i2} = 1-\sigma_i$, equation (43) is now written as

$$\ln m_{it}^{cc'} = \alpha_{i1} \ln d^{cc'} + \alpha_{i2} \ln \tau_{it}^{cc'} + \delta_{ic} + \delta_{ic'} + \delta_{it} + \delta_{ict} + \delta_{ic't} + \epsilon_{it}^{cc'} \tag{44}$$

In the empirical application, import elasticities are assumed to be common across 6-digit sectors within a 2-digit sector. Thus the actual estimation equation is expressed as follows:

$$\ln m_{ilt}^{cc'} = \alpha_{i1} \ln d^{cc'} + \alpha_{i2} \ln \tau_{ilt}^{cc'} + \delta_{ic} + \delta_{ic'} + \delta_{it} + \delta_{il} + \delta_{ict} + \delta_{ic't} + \epsilon_{ilt}^{cc'}$$

where $i$ is a subscript for a 2-digit good, $l$ is for the a 6-digit good, and $\delta_{ij}$ is industry fixed effects at the 6-digit level. This is the gravity equation (14) in subsection 3.2.

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**Table 1: Import weighted average tariff rates by industry**

| HS | Product description | Before | After | Change |
|---|---|---|---|---|
| 01 | Live animals. | 1 | 1 | 0 |
| 02 | Meat and edible meat offal. | 16 | 16 | 0 |
| 03 | Fish and crustaceans, molluscs and other aquatic invertebrates. | 5 | 5 | 0 |
| 04 | Dairy produce; birds' eggs; natural honey; edible products of animal origin, | 14 | 21 | 8 |
| 05 | Products of animal origin, not elsewhere specified or included. | 2 | 2 | -1 |
| 06 | Live trees and other plants; bulbs, roots and the like; cut flowers and ornam | 4 | 6 | 2 |
| 07 | Edible vegetables and certain roots and tubers. | 7 | 6 | -1 |
| 08 | Edible fruit and nuts; peel of citrus fruit or melons. | 6 | 7 | 0 |
| 09 | Coffee, tea, maté and spices. | 2 | 1 | -1 |
| 10 | Cereals. | 8 | 13 | 5 |
| 11 | Products of the milling industry; malt; starches; inulin; wheat gluten. | 10 | 10 | 1 |
| 12 | Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit; indus | 2 | 3 | 0 |
| 13 | Lac; gums, resins and other vegetable saps and extracts. | 5 | 4 | -1 |
| 14 | Vegetable plaiting materials; vegetable products not elsewhere specified or | 2 | 2 | 0 |
| 15 | Animal or vegetable fats and oils and their cleavage products; prepared edit | 7 | 10 | 3 |
| 16 | Preparations of meat, of fish or of crustaceans, molluscs or other aquatic inv | 10 | 10 | 0 |
| 17 | Sugars and sugar confectionery. | 7 | 6 | 0 |
| 18 | Cocoa and cocoa preparations. | 6 | 7 | 2 |
| 19 | Preparations of cereals, flour, starch or milk; pastrycooks' products. | 10 | 7 | -3 |
| 20 | Preparations of vegetables, fruit, nuts or other parts of plants. | 14 | 12 | -2 |
| 21 | Miscellaneous edible preparations. | 11 | 11 | -1 |
| 22 | Beverages, spirits and vinegar. | 11 | 10 | -1 |
| 23 | Residues and waste from the food industries; prepared animal fodder. | 3 | 3 | 1 |
| 24 | Tobacco and manufactured tobacco substitutes. | 28 | 24 | -3 |
| 25 | Salt; sulphur; earths and stone; plastering materials, lime and cement. | 2 | 1 | -1 |
| 26 | Ores, slag and ash. | 1 | 0 | 0 |
| 27 | Mineral fuels, mineral oils and products of their distillation; bituminous sub | 2 | 2 | 0 |
| 28 | Inorganic chemicals; organic or inorganic compounds of precious metals, o | 6 | 3 | -3 |
| 29 | Organic chemicals. | 7 | 4 | -3 |
| 30 | Pharmaceutical products. | 4 | 1 | -3 |
| 31 | Fertilisers. | 11 | 4 | -7 |
| 32 | Tanning or dyeing extracts; tannins and their derivatives; dyes, pigments an | 7 | 5 | -2 |
| 33 | Essential oils and resinoids; perfumery, cosmetic or toilet preparations. | 6 | 4 | -3 |
| 34 | Soap, organic surface-active agents, washing preparations, lubricating prep | 7 | 4 | -3 |
| 35 | Albuminoidal substances; modified starches; glues; enzymes. | 6 | 6 | -1 |
| 36 | Explosives; pyrotechnic products; matches; pyrophoric alloys; certain comb | 5 | 4 | -1 |
| 37 | Photographic or cinematographic goods. | 6 | 4 | -2 |
| 38 | Miscellaneous chemical products. | 6 | 4 | -2 |
| 39 | Plastics and articles thereof. | 6 | 5 | -1 |
| 40 | Rubber and articles thereof. | 5 | 4 | -2 |
| 41 | Raw hides and skins (other than furskins) and leather. | 4 | 2 | -1 |
| 42 | Articles of leather; saddlery and harness; travel goods, handbags and simila | 5 | 6 | 1 |
| 43 | Furskins and artificial fur; manufactures thereof. | 4 | 2 | -2 |
| 44 | Wood and articles of wood; wood charcoal. | 4 | 1 | -2 |
| 45 | Cork and articles of cork. | 4 | 2 | -2 |
| 46 | Manufactures of straw, of esparto or of other plaiting materials; basketware | 3 | 3 | 0 |
| 47 | Pulp of wood or of other fibrous cellulosic material; recovered (waste and s | 2 | 1 | -1 |
| 48 | Paper and paperboard; articles of paper pulp, of paper or of paperboard. | 4 | 3 | -1 |
| 49 | Printed books, newspapers, pictures and other products of the printing indus | 1 | 1 | -1 |

Note: Average tariff rates are calculated using imports as weights.

**Table 1: Import weighted average tariff rates by industry, cont.**

| HS | Product description | Before | After | Change |
|---|---|---|---|---|
| 50 | Silk. | 5 | 7 | 1 |
| 51 | Wool, fine or coarse animal hair; horsehair yarn and woven fabric. | 5 | 4 | -1 |
| 52 | Cotton. | 7 | 5 | -2 |
| 53 | Other vegetable textile fibres; paper yarn and woven fabrics of paper yarn. | 5 | 4 | -2 |
| 54 | Man-made filaments. | 8 | 7 | -1 |
| 55 | Man-made staple fibres. | 10 | 7 | -3 |
| 56 | Wadding, felt and nonwovens; special yarns; twine, cordage, ropes and cabl | 8 | 5 | -3 |
| 57 | Carpets and other textile floor coverings. | 5 | 5 | 1 |
| 58 | Special woven fabrics; tufted textile fabrics; lace; tapestries; trimmings; em | 10 | 7 | -3 |
| 59 | Impregnated, coated, covered or laminated textile fabrics; textile articles of | 9 | 6 | -3 |
| 60 | Knitted or crocheted fabrics. | 11 | 7 | -5 |
| 61 | Articles of apparel and clothing accessories, knitted or crocheted. | 9 | 9 | 1 |
| 62 | Articles of apparel and clothing accessories, not knitted or crocheted. | 9 | 8 | -1 |
| 63 | Other made up textile articles; sets; worn clothing and worn textile articles; | 7 | 7 | 0 |
| 64 | Footwear, gaiters and the like; parts of such articles. | 10 | 10 | 0 |
| 65 | Headgear and parts thereof. | 5 | 4 | -1 |
| 66 | Umbrellas, sun umbrellas, walking-sticks, seat-sticks, whips, riding-crops a | 3 | 3 | 1 |
| 67 | Prepared feathers and down and articles made of feathers or of down; artific | 4 | 4 | 1 |
| 68 | Articles of stone, plaster, cement, asbestos, mica or similar materials. | 4 | 2 | -2 |
| 69 | Ceramic products. | 8 | 6 | -2 |
| 70 | Glass and glassware. | 7 | 4 | -3 |
| 71 | Natural or cultured pearls, precious or semi-precious stones, precious metal | 1 | 3 | 1 |
| 72 | Iron and steel. | 5 | 4 | -2 |
| 73 | Articles of iron or steel. | 7 | 4 | -3 |
| 74 | Copper and articles thereof. | 4 | 2 | -2 |
| 75 | Nickel and articles thereof. | 2 | 1 | 0 |
| 76 | Aluminium and articles thereof. | 4 | 3 | 0 |
| 78 | Lead and articles thereof. | 5 | 3 | -1 |
| 79 | Zinc and articles thereof. | 4 | 2 | -2 |
| 80 | Tin and articles thereof. | 2 | 1 | -1 |
| 81 | Other base metals; cermets; articles thereof. | 4 | 3 | -1 |
| 82 | Tools, implements, cutlery, spoons and forks, of base metal; parts thereof o | 6 | 4 | -2 |
| 83 | Miscellaneous articles of base metal. | 6 | 3 | -3 |
| 84 | Nuclear reactors, boilers, machinery and mechanical appliances; parts there | 5 | 2 | -3 |
| 85 | Electrical machinery and equipment and parts thereof; sound recorders and | 5 | 2 | -3 |
| 86 | Railway or tramway locomotives, rolling-stock and parts thereof; railway o | 4 | 2 | -2 |
| 87 | Vehicles other than railway or tramway rolling-stock, and parts and accesso | 8 | 4 | -4 |
| 88 | Aircraft, spacecraft, and parts thereof. | 2 | 1 | -2 |
| 89 | Ships, boats and floating structures. | 3 | 2 | -1 |
| 90 | Optical, photographic, cinematographic, measuring, checking, precision, m | 5 | 2 | -3 |
| 91 | Clocks and watches and parts thereof. | 4 | 2 | -2 |
| 92 | Musical instruments; parts and accessories of such articles. | 5 | 3 | -2 |
| 93 | Arms and ammunition; parts and accessories thereof. | 9 | 3 | -6 |
| 94 | Furniture; bedding, mattresses, mattress supports, cushions and similar stuf | 4 | 2 | -2 |
| 95 | Toys, games and sports requisites; parts and accessories thereof. | 4 | 2 | -2 |
| 96 | Miscellaneous manufactured articles. | 7 | 4 | -3 |
| 97 | Works of art, collectors' pieces and antiques. | 0 | 0 | 0 |

Note: Average tariff rates are calculated using imports as weights.
HS 1-24 are agriculture, and HS 25-97 are manufacturing, HS 50-63 are textile and clothing.

**Table 2: Import weighted average tariff rates by country**

| | (1) All products | | | (2) Agriculture | | | (3) Manufacturing | | |
|---|---|---|---|---|---|---|---|---|---|
| | Before | After | Change | Before | After | Change | Before | After | Change |
| *GATT signatories* | | | | | | | | | |
| United States | 3 | 2 | -1 | 1 | 2 | 1 | 3 | 2 | -1 |
| Norway | 1 | 1 | 0 | 1 | 6 | 5 | 1 | 1 | 0 |
| Canada | 4 | 1 | -3 | 2 | 9 | 7 | 4 | 1 | -3 |
| Switzerland | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Australia | 8 | 4 | -4 | 3 | 1 | -1 | 8 | 4 | -4 |
| Singapore | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Hong Kong | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Japan | 5 | 3 | -2 | 14 | 11 | -3 | 3 | 1 | -2 |
| European Union | 3 | 3 | 0 | 6 | 5 | -1 | 3 | 2 | 0 |
| New Zealand | 8 | 3 | -5 | 6 | 1 | -5 | 8 | 3 | -5 |
| Korea | 9 | 6 | -3 | 15 | 13 | -2 | 8 | 5 | -3 |
| Argentina | 13 | 11 | -1 | 6 | 9 | 3 | 13 | 11 | -1 |
| Trinidad and Tobago | 15 | 6 | -9 | 27 | 16 | -11 | 12 | 5 | -8 |
| Hungary | 9 | 5 | -5 | 19 | 25 | 7 | 9 | 4 | -5 |
| Uruguay | 6 | 5 | -1 | 7 | 6 | -1 | 6 | 4 | -1 |
| Chile | 11 | 10 | -1 | 11 | 10 | -1 | 11 | 10 | -1 |
| Malaysia | 8 | 6 | -3 | 4 | 12 | 9 | 9 | 6 | -3 |
| Poland | 9 | 2 | -7 | 10 | 12 | 2 | 9 | 1 | -7 |
| Mexico | 12 | 7 | -5 | 9 | 20 | 11 | 13 | 6 | -7 |
| South Africa | 13 | 4 | -9 | 5 | 4 | -1 | 14 | 4 | -10 |
| Brazil | 13 | 12 | -1 | 10 | 6 | -4 | 14 | 13 | -1 |
| Tunisia | 27 | 26 | -1 | 22 | 23 | 1 | 27 | 26 | -1 |
| Thailand | 31 | 10 | -21 | 28 | 30 | 2 | 31 | 9 | -22 |
| Turkey | 7 | 2 | -5 | 20 | 18 | -2 | 7 | 1 | -5 |
| Venezuela | 14 | 13 | -1 | 14 | 17 | 2 | 14 | 12 | -2 |
| Colombia | 10 | 11 | 1 | 12 | 15 | 3 | 9 | 10 | 1 |
| Paraguay | 11 | 6 | -5 | 9 | 10 | 2 | 12 | 5 | -7 |
| Peru | 16 | 13 | -4 | 16 | 15 | -1 | 16 | 12 | -4 |
| Romania | 12 | 8 | -3 | 27 | 27 | 0 | 9 | 7 | -3 |
| Indonesia | 12 | 6 | -7 | 11 | 4 | -7 | 13 | 6 | -6 |
| Sri Lanka | 35 | 7 | -28 | 26 | 18 | -8 | 37 | 5 | -32 |
| Bolivia | 9 | 9 | 0 | 10 | 10 | 0 | 9 | 9 | 0 |
| India | 31 | 21 | -10 | 29 | 27 | -2 | 31 | 21 | -11 |
| Kenya | 21 | 10 | -11 | 16 | 6 | -10 | 22 | 10 | -12 |
| Uganda | 14 | 6 | -8 | 20 | 8 | -12 | 13 | 6 | -7 |
| Average | 11 | 7 | -5 | 12 | 11 | -1 | 11 | 6 | -5 |
| *Non-signatories* | | | | | | | | | |
| Taiwan | 6 | 7 | 0 | 15 | 20 | 5 | 6 | 6 | 0 |
| Saudi Arabia | 11 | 11 | 0 | 7 | 10 | 3 | 11 | 11 | 0 |
| Algeria | 16 | 17 | 1 | 10 | 14 | 4 | 18 | 18 | 0 |
| Ecuador | 9 | 11 | 3 | 8 | 14 | 6 | 9 | 11 | 2 |
| China | 31 | 15 | -17 | 27 | 45 | 18 | 31 | 13 | -18 |
| Nepal | 16 | 13 | -3 | 8 | 11 | 4 | 17 | 13 | -3 |
| Average | 15 | 12 | -2 | 13 | 19 | 7 | 15 | 12 | -3 |

Note: Average tariff rates are calculated using imports as a weight. The unit is percentage. Commodities under HS 01-24 and under HS 25-97 are classified as agriculture and manufacturing respectively.

**Table 3: Summary of regression results**

| | Tariff | Distance |
|---|---|---|
| Mean | -2.17 | -0.57 |
| Median | -2.10 | -0.56 |
| Maximum | 2.66 | -0.04 |
| Minimum | -7.24 | -1.06 |
| Variance | 2.73 | 0.04 |
| Significant at 5 % level | 78% | 99% |
| Significant at 10 % level | 80% | 99% |
| Correct sign | 93% | 100% |

Note: This table reports summary statistics of the estimated coefficients on tariff and distance variables in the gravity model. The last three rows report percentages of estimates that qualify for the descriptions in the first column.
For example, 78 percent of the estimates of the coefficient on the tariff variable are significant at the 5 percent level.

**Table 4 : Estimates of reciprocity, GATT signatories**

| Country | Estimate of $\mathbf{R}^c$ US $ Million | Terms of trade gains and losses as % of 1993 GDP |
|---|---|---|
| *GATT signatories* | | |
| United States | -1,841 | 0.0 |
| Norway | -136 | -0.1 |
| Canada | -316 | -0.1 |
| Switzerland | 125 | 0.1 |
| Australia | -542 | -0.2 |
| Singapore | -672 | -1.2 |
| Hong Kong | -1,036 | -0.9 |
| Japan | 5,168 | 0.1 |
| EU | 1,283 | 0.0 |
| New Zealand | -158 | -0.4 |
| Korea | -64 | 0.0 |
| Argentina | -281 | -0.1 |
| Trinidad and Tobago | -2 | 0.0 |
| Hungary | -84 | -0.2 |
| Uruguay | -34 | -0.2 |
| Chile | -79 | -0.2 |
| Malaysia | 128 | 0.2 |
| Poland | -75 | -0.1 |
| Mexico | 225 | 0.1 |
| South Africa | -120 | -0.1 |
| Brazil | -28 | 0.0 |
| Tunisia | -57 | -0.4 |
| Thailand | -481 | -0.4 |
| Turkey | -363 | -0.2 |
| Venezuela | -94 | -0.2 |
| Colombia | -46 | -0.1 |
| Paraguay | -19 | -0.3 |
| Peru | -37 | -0.1 |
| Romania | 5 | 0.0 |
| Indonesia | -192 | -0.1 |
| Sri Lanka | -52 | -0.5 |
| Bolivia | -11 | -0.2 |
| India | -98 | 0.0 |
| Kenya | -10 | -0.2 |
| Uganda | -8 | -0.3 |
| *Non-signatories* | - | - |
| Taiwan | - | - |
| Saudi Arabia | - | - |
| Algeria | - | - |
| Ecuador | - | - |
| China | - | - |
| Nepal | - | - |

Note: $\mathbf{R}^c$ is the reciprocity statistic defined in the text.

$\mathbf{R}^c$ is calculated using the estimates of import elasticities from the regressions without NTB variables.

**Table 5 : Estimates of reciprocity, All countries**

| Country | Estimate of $\mathbf{R}^c$ US $ Million | Terms of trade gains and losses as % of 1993 GDP |
|---|---|---|
| *GATT signatories* | | |
| United States | -2,359 | 0.0 |
| Norway | -157 | -0.1 |
| Canada | -482 | -0.1 |
| Switzerland | 210 | 0.1 |
| Australia | -619 | -0.2 |
| Singapore | -815 | -1.4 |
| Hong Kong | -2,200 | -1.9 |
| Japan | 6,612 | 0.2 |
| EU | 1,551 | 0.0 |
| New Zealand | -147 | -0.3 |
| Korea | 283 | 0.1 |
| Argentina | -357 | -0.2 |
| Trinidad and Tobago | -2 | -0.1 |
| Hungary | -101 | -0.3 |
| Uruguay | -36 | -0.3 |
| Chile | -92 | -0.2 |
| Malaysia | 104 | 0.2 |
| Poland | -81 | -0.1 |
| Mexico | 262 | 0.1 |
| South Africa | -125 | -0.1 |
| Brazil | 35 | 0.0 |
| Tunisia | -80 | -0.5 |
| Thailand | -630 | -0.5 |
| Turkey | -404 | -0.2 |
| Venezuela | -111 | -0.2 |
| Colombia | -37 | -0.1 |
| Paraguay | -20 | -0.3 |
| Peru | -25 | -0.1 |
| Romania | 13 | 0.1 |
| Indonesia | -196 | -0.1 |
| Sri Lanka | -102 | -1.0 |
| Bolivia | -11 | -0.2 |
| India | -101 | 0.0 |
| Kenya | -4 | -0.1 |
| Uganda | -8 | -0.2 |
| *Non-signatories* | | |
| Taiwan | 734 | 0.3 |
| Saudi Arabia | 34 | 0.0 |
| Algeria | 12 | 0.0 |
| Ecuador | -14 | -0.1 |
| China | -524 | -0.1 |
| Nepal | -11 | -0.3 |

Note: $\mathbf{R}^c$ is the reciprocity statistic defined in the text.

$\mathbf{R}^c$ is calculated using the estimates of import elasticities from the regressions without NTB variables.

**Table 6 : Percentage changes in imports due to own tariff changes**

| Country | GATT (% change) | All sample (% change) |
|---|---|---|
| Aggregate | 3.5 | 3.6 |
| *GATT signatories* | | |
| United States | 2.2 | 2.3 |
| Norway | 0.4 | 0.4 |
| Canada | 3.7 | 3.8 |
| Switzerland | 0.0 | 0.0 |
| Australia | 7.3 | 6.7 |
| Singapore | 0.0 | 0.0 |
| Hong Kong | 0.0 | 0.0 |
| Japan | 2.8 | 2.4 |
| EU | 1.1 | 0.6 |
| New Zealand | 10.0 | 9.8 |
| Korea | 5.8 | 5.4 |
| Argentina | 1.3 | 1.0 |
| Trinidad and Tobago | 4.3 | 4.3 |
| Hungary | 9.4 | 9.3 |
| Uruguay | 1.8 | 1.8 |
| Chile | 1.8 | 1.8 |
| Malaysia | 6.8 | 6.7 |
| Poland | 12.7 | 12.5 |
| Mexico | 7.7 | 7.3 |
| South Africa | 7.1 | 7.1 |
| Brazil | 1.3 | 1.2 |
| Tunisia | 1.9 | 1.9 |
| Thailand | 29.0 | 28.6 |
| Turkey | 9.0 | 8.3 |
| Venezuela | -1.1 | -1.1 |
| Colombia | -0.5 | -0.5 |
| Paraguay | 7.8 | 7.5 |
| Peru | 6.6 | 6.6 |
| Romania | 11.8 | 10.3 |
| Indonesia | 8.6 | 8.6 |
| Sri Lanka | 35.7 | 39.2 |
| Bolivia | 0.9 | 0.9 |
| India | 24.6 | 23.5 |
| Kenya | 13.6 | 14.1 |
| Uganda | 10.0 | 10.0 |
| *Non-signatories* | | |
| Taiwan | - | -2.9 |
| Saudi Arabia | - | -0.2 |
| Algeria | - | 0.1 |
| Ecuador | - | -7.6 |
| China | - | 20.0 |
| Nepal | - | 3.9 |

Note: This table reports percentage changes in the import demand of each country caused by own tariff changes.

**Table 7: NTB import coverage ratios: Percentage of imports**

| | (1) All NTB | | | (2) Quantity NTB | | | (3) Quality NTB | | |
|---|---|---|---|---|---|---|---|---|---|
| | Before | After | Change | Before | After | Change | Before | After | Change |
| *GATT signatories* | | | | | | | | | |
| United States | 20 | 34 | 14 | 10 | 1 | -10 | 0 | 31 | 30 |
| Norway | 6 | 5 | -2 | 1 | 1 | 1 | 4 | 2 | -2 |
| Canada | 20 | 18 | -1 | 1 | 4 | 3 | 18 | 15 | -3 |
| Switzerland | 2 | 4 | 2 | 1 | 0 | -1 | 1 | 4 | 3 |
| Australia | 9 | 27 | 18 | 0 | 0 | 0 | 6 | 26 | 21 |
| Singapore | 14 | 32 | 19 | 1 | 22 | 21 | 13 | 14 | 1 |
| Hong Kong | - | - | - | - | - | - | - | - | - |
| Japan | 33 | 32 | -1 | 8 | 6 | -2 | 31 | 29 | -2 |
| European Union | 13 | 10 | -3 | 2 | 3 | 0 | 5 | 6 | 1 |
| New Zealand | 1 | 38 | 38 | 0 | 0 | 0 | 0 | 38 | 38 |
| Korea | 2 | 2 | 0 | 1 | 2 | 2 | 2 | 0 | -2 |
| Argentina | 11 | 54 | 43 | 7 | 30 | 23 | 3 | 45 | 42 |
| Trinidad and Tobago | - | - | - | - | - | - | - | - | - |
| Hungary | 34 | 9 | -25 | 32 | 1 | -31 | 20 | 8 | -12 |
| Uruguay | 37 | 41 | 3 | 21 | 7 | -14 | 17 | 40 | 23 |
| Chile | 35 | 31 | -4 | 0 | 7 | 6 | 21 | 26 | 5 |
| Malaysia | 16 | 12 | -3 | 1 | 1 | 0 | 16 | 12 | -3 |
| Poland | 0 | 10 | 10 | 0 | 0 | 0 | 0 | 10 | 10 |
| Mexico | 21 | 49 | 28 | 6 | 0 | -6 | 20 | 49 | 30 |
| South Africa | 0 | 13 | 13 | 0 | 0 | 0 | 0 | 13 | 13 |
| Brazil | 31 | 42 | 11 | 0 | 23 | 23 | 31 | 41 | 10 |
| Tunisia | 12 | 57 | 45 | 3 | 2 | -1 | 12 | 55 | 43 |
| Thailand | - | - | - | - | - | - | - | - | - |
| Turkey | 7 | 7 | -1 | 0 | 0 | 0 | 7 | 6 | -1 |
| Venezuela | 10 | 26 | 16 | 2 | 7 | 5 | 9 | 17 | 8 |
| Colombia | - | - | - | - | - | - | - | - | - |
| Paraguay | 2 | 34 | 32 | 2 | 11 | 9 | 0 | 34 | 34 |
| Peru | 4 | 37 | 34 | 0 | 4 | 4 | 4 | 34 | 31 |
| Romania | - | - | - | - | - | - | - | - | - |
| Indonesia | 9 | 23 | 14 | 6 | 9 | 3 | 3 | 14 | 11 |
| Sri Lanka | - | - | - | - | - | - | - | - | - |
| Bolivia | - | - | - | - | - | - | - | - | - |
| India | 57 | 47 | -10 | 34 | 0 | -33 | 53 | 47 | -6 |
| Kenya | - | - | - | - | - | - | - | - | - |
| Uganda | - | - | - | - | - | - | - | - | - |
| Average | 16 | 27 | 11 | 5 | 5 | 0 | 11 | 24 | 12 |
| *Non-signatories* | | | | | | | | | |
| Taiwan | 46 | 18 | -27 | 23 | 6 | -17 | 36 | 17 | -19 |
| Saudi Arabia | 8 | 10 | 2 | 0 | 1 | 1 | 8 | 9 | 1 |
| Algeria | 6 | 18 | 12 | 3 | 0 | -3 | 4 | 18 | 14 |
| Ecuador | - | - | - | - | - | - | - | - | - |
| China | 47 | 38 | -8 | 0 | 16 | 16 | 47 | 30 | -17 |
| Nepal | 15 | 0 | -15 | 0 | 0 | 0 | 15 | 0 | -15 |
| Average | 24 | 17 | -7 | 5 | 4 | -1 | 22 | 15 | -7 |

Note: This table reports NTB import coverage ratios. (1) All NTB reports coverage ratios calculated using all NTBs. (2) Quantity NTB reports coverage ratios calculated using quantity NTBs. (3) Quality NTB reports coverage ratios calculated using quality NTBs.

**Table 8 : Estimates of reciprocity with NTB variables, GATT signatories**

| Country | Estimate of $\mathbf{R}^c$ US $ Million | Terms of trade gains and losses as % of 1993 GDP |
|---|---|---|
| *GATT signatories* | | |
| United States | -1,832 | 0.0 |
| Norway | -137 | -0.1 |
| Canada | -317 | -0.1 |
| Switzerland | 123 | 0.1 |
| Australia | -545 | -0.2 |
| Singapore | -669 | -1.2 |
| Hong Kong | -1,035 | -0.9 |
| Japan | 5,178 | 0.1 |
| EU | 1,295 | 0.0 |
| New Zealand | -158 | -0.4 |
| Korea | -66 | 0.0 |
| Argentina | -281 | -0.1 |
| Trinidad and Tobago | -2 | 0.0 |
| Hungary | -84 | -0.2 |
| Uruguay | -34 | -0.2 |
| Chile | -79 | -0.2 |
| Malaysia | 126 | 0.2 |
| Poland | -77 | -0.1 |
| Mexico | 221 | 0.1 |
| South Africa | -121 | -0.1 |
| Brazil | -28 | 0.0 |
| Tunisia | -57 | -0.4 |
| Thailand | -488 | -0.4 |
| Turkey | -366 | -0.2 |
| Venezuela | -93 | -0.2 |
| Colombia | -46 | -0.1 |
| Paraguay | -19 | -0.3 |
| Peru | -37 | -0.1 |
| Romania | 4 | 0.0 |
| Indonesia | -194 | -0.1 |
| Sri Lanka | -53 | -0.5 |
| Bolivia | -11 | -0.2 |
| India | -99 | 0.0 |
| Kenya | -11 | -0.2 |
| Uganda | -8 | -0.3 |
| *Non-signatories* | - | - |
| Taiwan | - | - |
| Saudi Arabia | - | - |
| Algeria | - | - |
| Ecuador | - | - |
| China | - | - |
| Nepal | - | - |

Note: $\mathbf{R}^c$ is the reciprocity statistic defined in the text.

$\mathbf{R}^c$ is calculated using the estimates of import elasticities from the regressions with NTB variables.

**Table 9 : Estimates of reciprocity with NTB variables, All countries**

| Country | Estimate of $\mathbf{R}^c$ US $ Million | Terms of trade gains and losses as % of 1993 GDP |
|---|---|---|
| *GATT signatories* | | |
| United States | -2,345 | 0.0 |
| Norway | -158 | -0.1 |
| Canada | -481 | -0.1 |
| Switzerland | 209 | 0.1 |
| Australia | -622 | -0.2 |
| Singapore | -812 | -1.4 |
| Hong Kong | -2,189 | -1.9 |
| Japan | 6,630 | 0.2 |
| EU | 1,566 | 0.0 |
| New Zealand | -147 | -0.3 |
| Korea | 284 | 0.1 |
| Argentina | -357 | -0.2 |
| Trinidad and Tobago | -2 | -0.1 |
| Hungary | -102 | -0.3 |
| Uruguay | -36 | -0.3 |
| Chile | -92 | -0.2 |
| Malaysia | 102 | 0.2 |
| Poland | -82 | -0.1 |
| Mexico | 258 | 0.1 |
| South Africa | -125 | -0.1 |
| Brazil | 36 | 0.0 |
| Tunisia | -80 | -0.5 |
| Thailand | -638 | -0.5 |
| Turkey | -407 | -0.2 |
| Venezuela | -111 | -0.2 |
| Colombia | -38 | -0.1 |
| Paraguay | -20 | -0.3 |
| Peru | -25 | -0.1 |
| Romania | 13 | 0.0 |
| Indonesia | -199 | -0.1 |
| Sri Lanka | -107 | -1.0 |
| Bolivia | -11 | -0.2 |
| India | -104 | 0.0 |
| Kenya | -5 | -0.1 |
| Uganda | -8 | -0.2 |
| *Non-signatories* | | |
| Taiwan | 746 | 0.3 |
| Saudi Arabia | 34 | 0.0 |
| Algeria | 12 | 0.0 |
| Ecuador | -14 | -0.1 |
| China | -563 | -0.1 |
| Nepal | -11 | -0.3 |

Note: $\mathbf{R}^c$ is the reciprocity statistic defined in the text.

$\mathbf{R}^c$ is calculated using the estimates of import elasticities from the regressions with NTB variables.

**Table A.1: Sample countries and years**

| Country | Tariff years | | Trade years | | NTB years | | GATT | WTO |
|---|---|---|---|---|---|---|---|---|
| Algeria | 1993 | 1998 | 1993 | 1999 | 1992 | 1999 | NA | NA |
| Argentina | 1993 | 1999 | 1993 | 1999 | 1993 | 1999 | 1967 | 1995 |
| Australia | 1993 | 1999 | 1993 | 1999 | 1993 | 1999 | 1948 | 1995 |
| Bolivia | 1993 | 1999 | 1993 | 1999 | NA | NA | 1990 | 1995 |
| Brazil | 1993 | 1999 | 1993 | 1999 | 1993 | 1999 | 1948 | 1995 |
| Canada | 1993 | 1999 | 1993 | 1999 | 1993 | 1999 | 1948 | 1995 |
| Chile | 1991 | 1999 | 1993 | 1999 | 1991 | 1999 | 1949 | 1995 |
| China | 1993 | 1998 | 1993 | 1999 | 1993 | 1997 | NA | 2001 |
| Colombia | 1992 | 1999 | 1992 | 1999 | NA | NA | 1981 | 1995 |
| Ecuador | 1993 | 1999 | 1993 | 1999 | NA | NA | NA | 1996 |
| European Union | 1993 | 1999 | 1993 | 1999 | 1993 | 1999 | - | 1995 |
| Hong Kong | 1994 | 1999 | 1994 | 1999 | NA | NA | 1986 | 1995 |
| Hungary | 1993 | 1997 | 1993 | 1999 | 1993 | 1999 | 1973 | 1995 |
| India | 1992 | 1999 | 1992 | 1999 | 1992 | 1997 | 1948 | 1995 |
| Indonesia | 1993 | 1999 | 1993 | 1999 | 1994 | 1999 | 1950 | 1995 |
| Japan | 1993 | 1999 | 1993 | 1999 | 1993 | 1996 | 1955 | 1995 |
| Kenya | 1994 | 2000 | 1992 | 2000 | NA | NA | 1964 | 1995 |
| Korea | 1992 | 1999 | 1992 | 1999 | 1992 | 1996 | 1967 | 1995 |
| Malaysia | 1993 | 1997 | 1993 | 1997 | 1994 | 1996 | 1957 | 1995 |
| Mexico | 1991 | 1999 | 1992 | 1999 | 1991 | 1999 | 1986 | 1995 |
| Nepal | 1993 | 2000 | 1993 | 1999 | 1993 | 1998 | NA | NA |
| New Zealand | 1993 | 1999 | 1993 | 1999 | 1993 | 1999 | 1948 | 1995 |
| Norway | 1993 | 2000 | 1993 | 1999 | 1993 | 1996 | 1948 | 1995 |
| Paraguay | 1991 | 1999 | 1993 | 1999 | 1993 | 1999 | 1994 | 1995 |
| Peru | 1993 | 1999 | 1994 | 1999 | 1993 | 1999 | 1951 | 1995 |
| Poland | 1991 | 2000 | 1992 | 1999 | 1991 | 1999 | 1967 | 1995 |
| Romania | 1991 | 1999 | 1991 | 1999 | NA | NA | 1971 | 1995 |
| Saudi Arabia | 1994 | 1999 | 1994 | 1999 | 1994 | 1999 | NA | NA |
| Singapore | 1994 | 2001 | 1994 | 1999 | NA | NA | 1973 | 1995 |
| South Africa | 1993 | 1999 | 1993 | 2001 | 1994 | 1999 | 1948 | 1995 |
| Sri Lanka | 1993 | 2000 | 1993 | 1999 | NA | NA | 1948 | 1995 |
| Switzerland | 1993 | 1999 | 1993 | 1999 | 1993 | 1996 | 1966 | 1995 |
| Taiwan | 1992 | 1999 | 1992 | 1999 | 1992 | 1999 | NA | 2002 |
| Thailand | 1991 | 2000 | 1993 | 1999 | NA | NA | 1982 | 1995 |
| The United States | 1993 | 1999 | 1993 | 1999 | 1993 | 1999 | 1948 | 1995 |
| Trinidad and Tobago | 1992 | 1999 | 1992 | 1999 | NA | NA | 1962 | 1995 |
| Tunisia | 1992 | 1998 | 1992 | 1998 | 1992 | 1999 | 1990 | 1995 |
| Turkey | 1993 | 1997 | 1993 | 1999 | 1994 | 1997 | 1951 | 1995 |
| Uganda | 1994 | 2000 | 1994 | 1999 | NA | NA | 1962 | 1995 |
| Uruguay | 1992 | 1999 | 1994 | 1999 | 1995 | 1999 | 1953 | 1995 |
| Venezuela | 1992 | 1999 | 1992 | 1999 | 1992 | 1999 | 1990 | 1995 |

**Table A.2 : Fixed effects estimation**

| HS 2-gidit (Chapters) | ln(tariff) | robust s.e. | ln(distance) | robust s.e. | Adj.R2 | Obs. |
|---|---|---|---|---|---|---|
| 01 Live animals. | -0.96 | (0.57)* | -0.73 | (0.06)*** | 0.42 | 2732 |
| 02 Meat and edible meat offal. | -0.70 | (0.45) | -0.46 | (0.05)*** | 0.40 | 5441 |
| 03 Fish and crustaceans, molluscs a | -2.50 | (0.37)*** | -0.45 | (0.02)*** | 0.40 | 19431 |
| 04 Dairy produce; birds' eggs; natur | -1.04 | (0.30)*** | -0.38 | (0.05)*** | 0.44 | 5826 |
| 05 Products of animal origin, not el | -0.24 | (0.66) | -0.28 | (0.04)*** | 0.41 | 4557 |
| 06 Live trees and other plants; bulb | -2.09 | (0.46)*** | -0.60 | (0.04)*** | 0.50 | 3978 |
| 07 Edible vegetables and certain roo | -2.28 | (0.38)*** | -0.57 | (0.03)*** | 0.42 | 12587 |
| 08 Edible fruit and nuts; peel of citr | -0.77 | (0.35)** | -0.40 | (0.03)*** | 0.43 | 12940 |
| 09 Coffee, tea, maté and spices. | -2.16 | (0.37)*** | -0.26 | (0.03)*** | 0.47 | 10664 |
| 10 Cereals. | -0.61 | (0.88) | -0.42 | (0.07)*** | 0.40 | 2947 |
| 11 Products of the milling industry; | -1.08 | (0.55)** | -0.50 | (0.05)*** | 0.42 | 4490 |
| 12 Oil seeds and oleaginous fruits; r | 0.06 | (0.54) | -0.46 | (0.03)*** | 0.35 | 9923 |
| 13 Lac; gums, resins and other vege | -1.19 | (0.71)* | -0.28 | (0.04)*** | 0.41 | 3836 |
| 14 Vegetable plaiting materials; veg | -2.61 | (1.28)** | -0.26 | (0.07)*** | 0.40 | 1915 |
| 15 Animal or vegetable fats and oils | -1.79 | (0.43)*** | -0.22 | (0.03)*** | 0.34 | 10802 |
| 16 Preparations of meat, of fish or c | -2.94 | (0.49)*** | -0.46 | (0.03)*** | 0.47 | 6832 |
| 17 Sugars and sugar confectionery. | -4.14 | (0.54)*** | -0.82 | (0.05)*** | 0.40 | 4639 |
| 18 Cocoa and cocoa preparations. | -0.21 | (0.49) | -0.74 | (0.05)*** | 0.45 | 4072 |
| 19 Preparations of cereals, flour, sta | -4.26 | (0.49)*** | -1.01 | (0.04)*** | 0.51 | 6386 |
| 20 Preparations of vegetables, fruit, | -1.68 | (0.32)*** | -0.44 | (0.02)*** | 0.48 | 15129 |
| 21 Miscellaneous edible preparation | -1.97 | (0.34)*** | -0.86 | (0.03)*** | 0.48 | 7571 |
| 22 Beverages, spirits and vinegar. | -0.57 | (0.18)*** | -0.77 | (0.04)*** | 0.49 | 6320 |
| 23 Residues and waste from the foo | -4.14 | (0.86)*** | -0.47 | (0.05)*** | 0.34 | 4651 |
| 24 Tobacco and manufactured tobac | -1.18 | (0.39)*** | -0.42 | (0.07*** | 0.42 | 2620 |
| 25 Salt; sulphur; earths and stone; p | -2.82 | (0.47)*** | -0.44 | (0.02)*** | 0.35 | 16684 |
| 26 Ores, slag and ash. | -3.75 | (1.22)*** | -0.04 | (0.05) | 0.43 | 4908 |
| 27 Mineral fuels, mineral oils and p | 0.02 | (0.73) | -0.68 | (0.04)** | 0.49 | 9247 |
| 28 Inorganic chemicals; organic or i | -3.02 | (0.34)*** | -0.43 | (0.01)*** | 0.39 | 43595 |
| 29 Organic chemicals. | -2.91 | (0.25)*** | -0.35 | (0.01)*** | 0.39 | 81059 |
| 30 Pharmaceutical products. | -1.05 | (0.35)*** | -0.69 | (0.02)*** | 0.48 | 14141 |
| 31 Fertilisers. | 1.63 | (1.49) | -0.35 | (0.05)*** | 0.40 | 5734 |
| 32 Tanning or dyeing extracts; tann | -2.33 | (0.31)*** | -0.71 | (0.01)*** | 0.47 | 22878 |
| 33 Essential oils and resinoids; perf | -1.52 | (0.32)*** | -0.77 | (0.02)*** | 0.54 | 16695 |
| 34 Soap, organic surface-active age | -4.86 | (0.38)*** | -0.95 | (0.02)*** | 0.53 | 12086 |
| 35 Albuminoidal substances; modif | 0.32 | (0.41) | -0.72 | (0.03)*** | 0.50 | 5990 |
| 36 Explosives; pyrotechnic product | -2.74 | (1.11)** | -0.44 | (0.06)*** | 0.38 | 2135 |
| 37 Photographic or cinematographic | -1.90 | (0.45)*** | -0.69 | (0.03)*** | 0.54 | 10976 |
| 38 Miscellaneous chemical product | -4.88 | (0.40)*** | -0.77 | (0.02)*** | 0.44 | 22332 |
| 39 Plastics and articles thereof. | -3.49 | (0.16)*** | -0.91 | (0.01)*** | 0.48 | 68387 |
| 40 Rubber and articles thereof. | -2.85 | (0.23)*** | -0.60 | (0.01)*** | 0.45 | 34252 |
| 41 Raw hides and skins (other than | -1.53 | (0.39)*** | -0.35 | (0.03)*** | 0.31 | 11775 |
| 42 Articles of leather; saddlery and | -2.39 | (0.31)*** | -0.59 | (0.02)*** | 0.62 | 14756 |
| 43 Furskins and artificial fur; manu | -0.55 | (0.85) | -0.47 | (0.06)*** | 0.46 | 2847 |
| 44 Wood and articles of wood; woo | -4.96 | (0.29)*** | -0.66 | (0.01)*** | 0.42 | 26296 |
| 45 Cork and articles of cork. | -5.67 | (1.53)*** | -0.50 | (0.10*** | 0.57 | 1361 |
| 46 Manufactures of straw, of espart | -0.42 | (1.79) | -0.60 | (0.07)*** | 0.56 | 2232 |
| 47 Pulp of wood or of other fibrous | 2.66 | (1.08)** | -0.53 | (0.06)*** | 0.42 | 3948 |
| 48 Paper and paperboard; articles of | -4.67 | (0.23)*** | -0.91 | (0.01)*** | 0.48 | 43273 |
| 49 Printed books, newspapers, pictu | -1.77 | (0.32)*** | -1.06 | (0.02)*** | 0.63 | 13201 |
| 50 Silk. | -4.31 | (1.04)*** | -0.37 | (0.07)*** | 0.47 | 2229 |

**Table A.2: Fixed effects estimation, cont.**

| HS 2-gidit (Chapters) | ln(tariff) | robust s.e. | ln(distance) | robust s.e. | Adj.R2 | Obs. |
|---|---|---|---|---|---|---|
| 51 Wool, fine or coarse animal hair; | -1.88 | (0.37)*** | -0.46 | (0.03)*** | 0.39 | 8441 |
| 52 Cotton. | -2.24 | (0.23)*** | -0.54 | (0.01)*** | 0.39 | 36781 |
| 53 Other vegetable textile fibres; pa | 0.55 | (0.61) | -0.27 | (0.04)*** | 0.37 | 4777 |
| 54 Man-made filaments. | -0.80 | (0.23)*** | -0.56 | (0.01)*** | 0.38 | 25326 |
| 55 Man-made staple fibres. | -1.89 | (0.20)*** | -0.51 | (0.01)*** | 0.37 | 32638 |
| 56 Wadding, felt and nonwovens; sp | -2.93 | (0.41)*** | -0.73 | (0.03)*** | 0.44 | 10028 |
| 57 Carpets and other textile floor co | -3.98 | (0.60)*** | -0.43 | (0.03)*** | 0.46 | 7905 |
| 58 Special woven fabrics; tufted tex | -2.13 | (0.33)*** | -0.57 | (0.02)*** | 0.45 | 13199 |
| 59 Impregnated, coated, covered or | -1.08 | (0.32)*** | -0.74 | (0.03)*** | 0.43 | 9370 |
| 60 Knitted or crocheted fabrics. | -3.73 | (0.61)*** | -0.86 | (0.03)*** | 0.47 | 7141 |
| 61 Articles of apparel and clothing a | -1.94 | (0.19)*** | -0.65 | (0.01)*** | 0.59 | 47908 |
| 62 Articles of apparel and clothing a | -1.62 | (0.15)*** | -0.68 | (0.01)*** | 0.59 | 64112 |
| 63 Other made up textile articles; se | -2.11 | (0.30)*** | -0.53 | (0.02)*** | 0.53 | 20946 |
| 64 Footwear, gaiters and the like; pa | -2.32 | (0.29)*** | -0.51 | (0.02)*** | 0.52 | 16814 |
| 65 Headgear and parts thereof. | -1.15 | (0.75) | -0.63 | (0.04)*** | 0.63 | 4605 |
| 66 Umbrellas, sun umbrellas, walkin | -4.27 | (1.19)*** | -0.81 | (0.07)*** | 0.62 | 2213 |
| 67 Prepared feathers and down and | -4.89 | (1.10)*** | -0.48 | (0.06)*** | 0.60 | 2556 |
| 68 Articles of stone, plaster, cement | -2.75 | (0.33)*** | -0.64 | (0.02)*** | 0.45 | 18497 |
| 69 Ceramic products. | -2.99 | (0.33)*** | -0.60 | (0.02)*** | 0.49 | 13889 |
| 70 Glass and glassware. | -2.05 | (0.26)*** | -0.66 | (0.01)*** | 0.48 | 25384 |
| 71 Natural or cultured pearls, precio | -4.10 | (0.30)*** | -0.34 | (0.02)*** | 0.43 | 17143 |
| 72 Iron and steel. | -2.52 | (0.25)*** | -0.57 | (0.01)*** | 0.35 | 44720 |
| 73 Articles of iron or steel. | -2.26 | (0.18)*** | -0.82 | (0.01)*** | 0.47 | 58548 |
| 74 Copper and articles thereof. | -4.29 | (0.38)*** | -0.63 | (0.02)*** | 0.47 | 19479 |
| 75 Nickel and articles thereof. | -0.28 | (1.36) | -0.33 | (0.06)*** | 0.45 | 3426 |
| 76 Aluminium and articles thereof. | -1.86 | (0.35)*** | -0.82 | (0.02)*** | 0.44 | 17867 |
| 78 Lead and articles thereof. | -3.32 | (1.20)*** | -0.81 | (0.08)*** | 0.41 | 2270 |
| 79 Zinc and articles thereof. | -4.73 | (1.40)*** | -0.50 | (0.06)*** | 0.38 | 3044 |
| 80 Tin and articles thereof. | -1.97 | (1.72) | -0.60 | (0.08)*** | 0.48 | 1872 |
| 81 Other base metals; cermets; artic | -0.78 | (0.95) | -0.27 | (0.04)*** | 0.46 | 6375 |
| 82 Tools, implements, cutlery, spoo | -2.70 | (0.23)*** | -0.55 | (0.01)*** | 0.56 | 34937 |
| 83 Miscellaneous articles of base m | -2.67 | (0.30)*** | -0.81 | (0.02)*** | 0.56 | 21889 |
| 84 Nuclear reactors, boilers, machin | -1.88 | (0.09)*** | -0.69 | (0.00)*** | 0.49 | 240240 |
| 85 Electrical machinery and equipm | -2.17 | (0.09)*** | -0.74 | (0.00)*** | 0.53 | 175089 |
| 86 Railway or tramway locomotives | -4.81 | (1.36)*** | -0.77 | (0.06)*** | 0.42 | 3618 |
| 87 Vehicles other than railway or tra | -0.84 | (0.15)*** | -0.73 | (0.01)*** | 0.47 | 37879 |
| 88 Aircraft, spacecraft, and parts the | -1.79 | (1.25) | -0.42 | (0.05)*** | 0.57 | 4207 |
| 89 Ships, boats and floating structur | -7.24 | (0.87)*** | -0.23 | (0.05)*** | 0.39 | 3937 |
| 90 Optical, photographic, cinematog | -1.94 | (0.16)*** | -0.56 | (0.01)*** | 0.54 | 81396 |
| 91 Clocks and watches and parts the | -2.37 | (0.36)*** | -0.45 | (0.02)*** | 0.50 | 15914 |
| 92 Musical instruments; parts and a | -0.19 | (0.69) | -0.34 | (0.03)*** | 0.57 | 7543 |
| 93 Arms and ammunition; parts and | -0.57 | (0.74) | -0.42 | (0.05)*** | 0.47 | 3323 |
| 94 Furniture; bedding, mattresses, n | -3.56 | (0.29)*** | -0.84 | (0.01)*** | 0.58 | 27930 |
| 95 Toys, games and sports requisite | -1.00 | (0.28)*** | -0.56 | (0.01)*** | 0.55 | 24189 |
| 96 Miscellaneous manufactured arti | -2.22 | (0.26)*** | -0.56 | (0.01)*** | 0.54 | 25150 |
| 97 Works of art, collectors' pieces a | 1.20 | (1.57) | -0.52 | (0.05)*** | 0.60 | 3363 |

Note: The dependent variable is the log of import value (in US dollar). Only observations with positive imports are used for the estimation. Robust standard errors are in parentheses.

**Table A.3: Robustness Check, GATT signatories**

| | Original | TOT | (1) | TOT | (2) | TOT | (3) | TOT | (4) | TOT |
|---|---|---|---|---|---|---|---|---|---|---|
| | US $ Million | % of GDP | US $ Million | % of GDP | US $ Million | % of GDP | US $ Million | % of GDP | US $ Million | % of GDP |
| *GATT signatories* | | | | | | | | | | |
| United States | -1,841 | 0.0 | -779 | 0.0 | -472 | 0.0 | -479 | 0.0 | -338 | 0.0 |
| Norway | -136 | -0.1 | -138 | -0.1 | -145 | -0.1 | -115 | -0.1 | -90 | -0.1 |
| Canada | -316 | -0.1 | -120 | 0.0 | -254 | 0.0 | -422 | -0.1 | -200 | 0.0 |
| Switzerland | 125 | 0.1 | 95 | 0.0 | 71 | 0.0 | 70 | 0.0 | 53 | 0.0 |
| Australia | -542 | -0.2 | -370 | -0.1 | -219 | -0.1 | -185 | -0.1 | -159 | -0.1 |
| Singapore | -672 | -1.2 | -493 | -0.9 | -375 | -0.7 | -306 | -0.5 | -258 | -0.4 |
| Hong Kong | -1,036 | -0.9 | -696 | -0.6 | -534 | -0.5 | -434 | -0.4 | -367 | -0.3 |
| Japan | 5,168 | 0.1 | 3,180 | 0.1 | 2,345 | 0.1 | 1,971 | 0.0 | 1,567 | 0.0 |
| EU | 1,283 | 0.0 | 911 | 0.0 | 552 | 0.0 | 689 | 0.0 | 501 | 0.0 |
| New Zealand | -158 | -0.4 | -95 | -0.2 | -46 | -0.1 | -57 | -0.1 | -42 | -0.1 |
| Korea | -64 | 0.0 | -61 | 0.0 | -94 | 0.0 | 21 | 0.0 | -21 | 0.0 |
| Argentina | -281 | -0.1 | -177 | -0.1 | -114 | 0.0 | -98 | 0.0 | -82 | 0.0 |
| Trinidad and Tobago | -2 | 0.0 | 0 | 0.0 | -15 | -0.3 | -7 | -0.1 | -5 | -0.1 |
| Hungary | -84 | -0.2 | -53 | -0.1 | -41 | -0.1 | -31 | -0.1 | -27 | -0.1 |
| Uruguay | -34 | -0.2 | -20 | -0.1 | -11 | -0.1 | -9 | -0.1 | -8 | -0.1 |
| Chile | -79 | -0.2 | -46 | -0.1 | -21 | 0.0 | -60 | -0.1 | -32 | -0.1 |
| Malaysia | 128 | 0.2 | 78 | 0.1 | 74 | 0.1 | 59 | 0.1 | 50 | 0.1 |
| Poland | -75 | -0.1 | -42 | 0.0 | -56 | -0.1 | -34 | 0.0 | -27 | 0.0 |
| Mexico | 225 | 0.1 | 75 | 0.0 | 38 | 0.0 | 60 | 0.0 | 34 | 0.0 |
| South Africa | -120 | -0.1 | -80 | -0.1 | -54 | 0.0 | -55 | 0.0 | -39 | 0.0 |
| Brazil | -28 | 0.0 | -31 | 0.0 | 85 | 0.0 | -24 | 0.0 | 0 | 0.0 |
| Tunisia | -57 | -0.4 | -33 | -0.2 | -51 | -0.3 | -31 | -0.2 | -26 | -0.2 |
| Thailand | -481 | -0.4 | -323 | -0.3 | -180 | -0.1 | -153 | -0.1 | -139 | -0.1 |
| Turkey | -363 | -0.2 | -256 | -0.1 | -168 | -0.1 | -140 | -0.1 | -123 | -0.1 |
| Venezuela | -94 | -0.2 | -106 | -0.2 | -85 | -0.1 | -54 | -0.1 | -51 | -0.1 |
| Colombia | -46 | -0.1 | -54 | -0.1 | -13 | 0.0 | -18 | 0.0 | -18 | 0.0 |
| Paraguay | -19 | -0.3 | -13 | -0.2 | -6 | -0.1 | -6 | -0.1 | -5 | -0.1 |
| Peru | -37 | -0.1 | -32 | -0.1 | -13 | 0.0 | -14 | 0.0 | -13 | 0.0 |
| Romania | 5 | 0.0 | 9 | 0.0 | -20 | -0.1 | -6 | 0.0 | -4 | 0.0 |
| Indonesia | -192 | -0.1 | -171 | -0.1 | -133 | -0.1 | -72 | 0.0 | -73 | 0.0 |
| Sri Lanka | -52 | -0.5 | -39 | -0.4 | -24 | -0.2 | -22 | -0.2 | -19 | -0.2 |
| Bolivia | -11 | -0.2 | -8 | -0.1 | -5 | -0.1 | -4 | -0.1 | -4 | -0.1 |
| India | -98 | 0.0 | -94 | 0.0 | -12 | 0.0 | -26 | 0.0 | -29 | 0.0 |
| Kenya | -10 | -0.2 | -10 | -0.2 | 1 | 0.0 | -3 | -0.1 | -3 | -0.1 |
| Uganda | -8 | -0.3 | -5 | -0.2 | -4 | -0.1 | -3 | -0.1 | -3 | -0.1 |
| Simple average | | -0.18 | | -0.13 | | -0.10 | | -0.08 | | -0.07 |

Note: Column (1), (2), (3), and (4) report the reciprocity statistic under the assumption that export supply elasticities are one, two, three, and four, respectively. See the text for more details.

**Tabl A.4 : Robustness check, All countries**

| | Original | TOT | (1) | TOT | (2) | TOT | (3) | TOT | (4) | TOT |
|---|---|---|---|---|---|---|---|---|---|---|
| | US $ Million | % of GDP | US $ Million | % of GDP | US $ Million | % of GDP | US $ Million | % of GDP | US $ Million | % of GDP |
| *GATT signatories* | | | | | | | | | | |
| United States | -2,359 | 0.0 | -890 | 0.0 | -596 | 0.0 | -567 | 0.0 | -388 | 0.0 |
| Norway | -157 | -0.1 | -143 | -0.1 | -149 | -0.1 | -118 | -0.1 | -92 | -0.1 |
| Canada | -482 | -0.1 | -193 | 0.0 | -289 | -0.1 | -448 | -0.1 | -223 | 0.0 |
| Switzerland | 210 | 0.1 | 154 | 0.1 | 115 | 0.0 | 105 | 0.0 | 82 | 0.0 |
| Australia | -619 | -0.2 | -391 | -0.1 | -237 | -0.1 | -196 | -0.1 | -168 | -0.1 |
| Singapore | -815 | -1.4 | -585 | -1.0 | -447 | -0.8 | -365 | -0.6 | -307 | -0.5 |
| Hong Kong | -2,200 | -1.9 | -1,419 | -1.2 | -1,087 | -0.9 | -883 | -0.8 | -742 | -0.6 |
| Japan | 6,612 | 0.2 | 4,055 | 0.1 | 2,972 | 0.1 | 2,459 | 0.1 | 1,975 | 0.0 |
| EU | 1,551 | 0.0 | 1,147 | 0.0 | 703 | 0.0 | 801 | 0.0 | 607 | 0.0 |
| New Zealand | -147 | -0.3 | -91 | -0.2 | -45 | -0.1 | -59 | -0.1 | -42 | -0.1 |
| Korea | 283 | 0.1 | 140 | 0.0 | 52 | 0.0 | 130 | 0.0 | 70 | 0.0 |
| Argentina | -357 | -0.2 | -209 | -0.1 | -137 | -0.1 | -114 | 0.0 | -95 | 0.0 |
| Trinidad and Tobago | -2 | -0.1 | -2 | 0.0 | -14 | -0.3 | -7 | -0.2 | -5 | -0.1 |
| Hungary | -101 | -0.3 | -65 | -0.2 | -49 | -0.1 | -38 | -0.1 | -32 | -0.1 |
| Uruguay | -36 | -0.3 | -20 | -0.1 | -11 | -0.1 | -9 | -0.1 | -8 | -0.1 |
| Chile | -92 | -0.2 | -52 | -0.1 | -26 | -0.1 | -65 | -0.1 | -35 | -0.1 |
| Malaysia | 104 | 0.2 | 56 | 0.1 | 57 | 0.1 | 45 | 0.1 | 38 | 0.1 |
| Poland | -81 | -0.1 | -48 | -0.1 | -58 | -0.1 | -37 | 0.0 | -30 | 0.0 |
| Mexico | 262 | 0.1 | 86 | 0.0 | 43 | 0.0 | 60 | 0.0 | 34 | 0.0 |
| South Africa | -125 | -0.1 | -84 | -0.1 | -56 | 0.0 | -59 | 0.0 | -42 | 0.0 |
| Brazil | 35 | 0.0 | 18 | 0.0 | 107 | 0.0 | 1 | 0.0 | 20 | 0.0 |
| Tunisia | -80 | -0.5 | -48 | -0.3 | -64 | -0.4 | -41 | -0.3 | -34 | -0.2 |
| Thailand | -630 | -0.5 | -411 | -0.3 | -249 | -0.2 | -208 | -0.2 | -184 | -0.1 |
| Turkey | -404 | -0.2 | -274 | -0.2 | -186 | -0.1 | -153 | -0.1 | -133 | -0.1 |
| Venezuela | -111 | -0.2 | -111 | -0.2 | -88 | -0.1 | -58 | -0.1 | -54 | -0.1 |
| Colombia | -37 | -0.1 | -49 | -0.1 | -14 | 0.0 | -17 | 0.0 | -18 | 0.0 |
| Paraguay | -20 | -0.3 | -13 | -0.2 | -7 | -0.1 | -6 | -0.1 | -5 | -0.1 |
| Peru | -25 | -0.1 | -28 | -0.1 | -12 | 0.0 | -13 | 0.0 | -12 | 0.0 |
| Romania | 13 | 0.1 | 12 | 0.0 | -16 | -0.1 | -3 | 0.0 | -2 | 0.0 |
| Indonesia | -196 | -0.1 | -178 | -0.1 | -143 | -0.1 | -77 | 0.0 | -77 | 0.0 |
| Sri Lanka | -102 | -1.0 | -75 | -0.7 | -51 | -0.5 | -44 | -0.4 | -38 | -0.4 |
| Bolivia | -11 | -0.2 | -8 | -0.1 | -5 | -0.1 | -5 | -0.1 | -4 | -0.1 |
| India | -101 | 0.0 | -91 | 0.0 | -15 | 0.0 | -26 | 0.0 | -29 | 0.0 |
| Kenya | -4 | -0.1 | -8 | -0.2 | 1 | 0.0 | -2 | 0.0 | -2 | 0.0 |
| Uganda | -8 | -0.2 | -5 | -0.2 | -3 | -0.1 | -3 | -0.1 | -3 | -0.1 |
| *Non-signatories* | | | | | | | | | | |
| Taiwan | 734 | 0.3 | 443 | 0.2 | 327 | 0.1 | 305 | 0.1 | 234 | 0.1 |
| Saudi Arabia | 34 | 0.0 | -155 | -0.1 | -135 | -0.1 | -102 | -0.1 | -85 | -0.1 |
| Algeria | 12 | 0.0 | -51 | -0.1 | -41 | -0.1 | -33 | -0.1 | -30 | -0.1 |
| Ecuador | -14 | -0.1 | -16 | -0.1 | -9 | -0.1 | -8 | -0.1 | -7 | 0.0 |
| China | -524 | -0.1 | -388 | -0.1 | -132 | 0.0 | -136 | 0.0 | -130 | 0.0 |
| Nepal | -11 | -0.3 | -8 | -0.2 | -4 | -0.1 | -4 | -0.1 | -3 | -0.1 |
| Simple average | | -0.20 | | -0.15 | | -0.11 | | -0.09 | | -0.08 |

Note: Column (1), (2), (3), and (4) report the reciprocity statistic under the assumption that export supply elasticities are one, two, three, and four, respectively. See the text for more details.

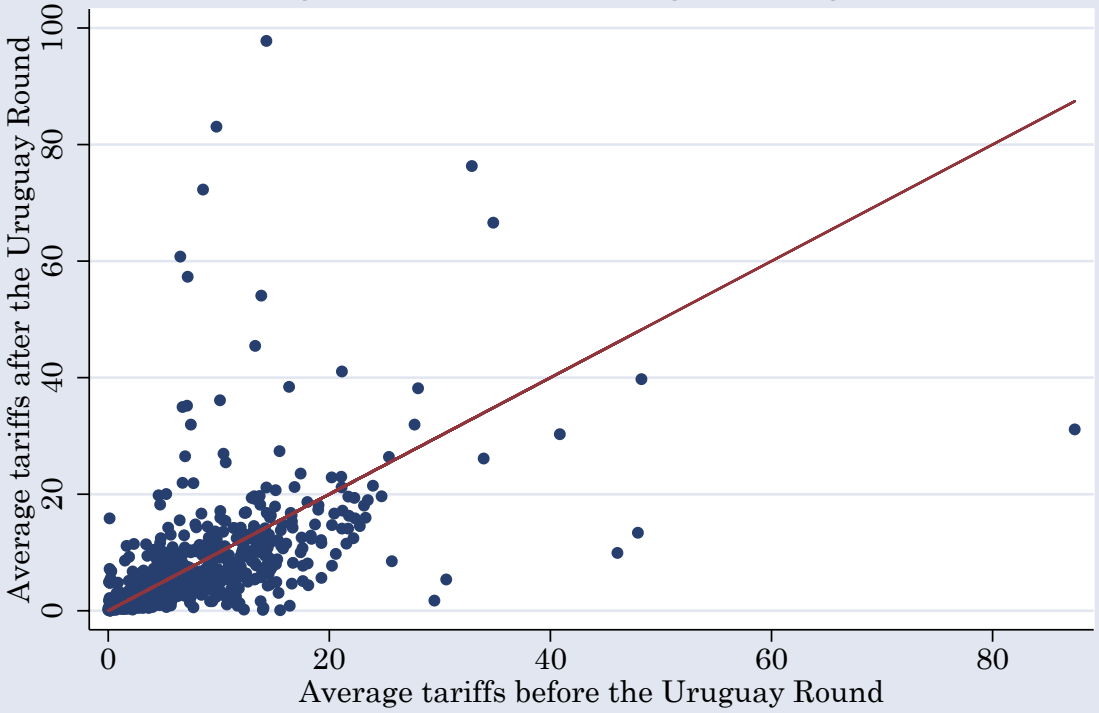
**Table A.5: Summary of regression results with NTB variables**

| | (1) | | (2) | |
|---|---|---|---|---|
| | Without NTB variables | | With NTB variables | |
| | Tariff | Distance | Tariff | Distance |
| Mean | -2.29 | -0.59 | -2.24 | -0.57 |
| Median | -2.36 | -0.59 | -2.31 | -0.59 |
| Maximum | 2.45 | -0.04 | 2.70 | 0.88 |
| Minimum | -8.00 | -1.09 | -8.00 | -1.09 |
| Variance | 3.11 | 0.04 | 3.17 | 0.06 |
| Correct sign | 91% | 100% | 92% | 100% |
| Significant at 5 % | 75% | 99% | 75% | 99% |
| Significant at 10% | 78% | 99% | 79% | 99% |

Note: This table reports summary statistics of the estimated coefficients on tariff and distance variables in the gravity model. The first set of results is from regressions that do not include NTB variables but use a smaller set of sample countries whose NTB data are available.
The second set of results is from regressions that include NTB variables.
The last three rows report percentages of estimates that qualify for the descriptions in the first column.
The full table can be obtained upon request.

## Figure 1

Average tariffs at the HS 6–digit level, agriculture




## Figure 2

Average tariffs at the HS 6–digit level, manufacturing