Does Tariff Liberalization Kick the Good Apples Out?
Theory and Evidence

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Abstract

This paper examines the liberalization of a common tariff when imported varieties vary in quality and cost. Varieties of higher quality and/or lower cost (a) are imported at lower absolute demand elasticities and (b) earn higher revenues. By virtue of larger demand elasticities, low revenue varieties benefit the most from tariff liberalization. Further, if varieties are substitutable, low revenue varieties may benefit at the expense of high revenue varieties. These predictions are confirmed using a case study of US Uruguay Round tariff cuts, where within narrowly defined products, low revenue exporters experienced large gains, and high revenue exporters experienced negligible gains. Further, I find evidence suggesting that product quality played a role in governing the effects of tariffs on trade flows.

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1 Introduction

If one point has been made abundantly clear by the theory of international trade, it is that trade is often driven by heterogeneity. This heterogeneity can result from classical Ricardian differences in relative autarky prices, to the modern treatment of heterogeneity at the firm level. Regardless of the source, heterogeneity almost always reflects in prices and/or market shares. And, as many authors have documented (Schott 2004, in particular), trade data exhibits substantial variation in unit values and trade volumes within precise product categories.\(^1\)

However, despite the massive amount of heterogeneity in varieties across trading partners within narrowly defined products, the rules of the GATT/WTO, on a basic level, seem designed for a more homogenous environment. With regard to tariffs, this point is particularly salient, as outside of special safeguards, retaliatory measures, and all-or-nothing regional agreements, members have very little latitude regarding tariffs applied to different varieties of the same product. One particular guiding principle, “non-discrimination”, imposes that all GATT/WTO members receive equal treatment, usually via a common, or “most favored nation” (MFN), tariff. This applies within any product, across all export sources without preferential status, and (obviously) does not discriminate by quality or other characteristics. Further, this equal treatment rule extends to the process of liberalization, and allows for no consideration of which exporters stand to gain more or less from lower tariffs.

Overall, there is a clear friction between the precise intent of WTO rules regarding tariffs, and the natural differentiation which occurs in trade flows. Critically, even though the WTO prefers (and arguably promotes) the multilateral process over other preferential or regional schemes, it remains unclear how the effects of MFN liberalization accrue within products that exhibit significant within-product differentiation. In what way should MFN tariff reductions influence bilateral trade flows? Are certain countries more likely to gain from MFN liberalization based on the fundamental characteristics of the products they sell? Overall, how are the benefits of additional import market access distributed across competing and differentiated exporters?

This paper answers these questions. Using a simple theoretical model based on Melitz and Ottaviano (2008), I show that the liberalization of a common ad-valorem tariff need not increase bilateral imports of all varieties. In particular, if varieties are differentiated by quality and/or

\(^1\) As an example, consider the import of “Men’s or Boys’ Shirts, of Cotton” (HS6 code 620520) by New Zealand in 1999. Overall, New Zealand imported varieties within this product category from 50 different countries. While the average pre-tariff free-on-board unit value was $20 exporter-specific unit values varied substantially. On one end of the spectrum, Belgium exported varieties at an average of $75 per unit. On the other end, Indonesia exported at an average of $3.60 per unit. Clearly, imports from Belgium and imports from Indonesia are in fact very different. Yet, the WTO mandates that these products are treated equally in setting tariffs, and when liberalizing tariffs.
production cost, I show that liberalization of a common tariff may increase imports of low revenue varieties at the expense of high revenue varieties. In analyzing the effects of US Uruguay Round tariff cuts, I find robust support for the model. Specifically, I find that the benefits of import tariff liberalization are large and statistically significant for low revenue varieties and smaller and statistically insignificant for high revenue varieties. Further, I find that this relationship breaks down when characterizing varieties by their relative price within products, which as detailed below, suggests that quality plays a role in governing the effects of tariffs on trade flows.

The key to the model is the degree to which demand elasticities vary across varieties. Specifically, varieties will be sold at a lower (absolute) demand elasticity if they are of higher quality and/or produced at a lower cost. In both cases, varieties earn larger revenues. Since demand is fairly inelastic for these varieties, changes to tariffs have a fairly small direct effect on the value of bilateral imports. This is in stark contrast with varieties of low quality and/or produced at a high cost. In these cases, revenues are fairly small, and equilibrium demand elasticities are relatively large. Thus, for these varieties, changes to tariffs have a relatively large effect on the value of bilateral imports.

In equilibrium, the effects of changes to a common tariff are aggregated across all varieties, and competition is generally tougher when tariffs fall. That is, when tariffs fall, so does the residual demand for each variety, all else equal. It is the resolution of the tension between this aggregate effect and the effects related to demand elasticities which determine the varieties that benefit from tariff liberalization and to what extent. In particular, I show that the aggregate effect may in fact be larger than the direct effect for some varieties. As detailed above, these are the varieties that earn relatively large revenues before tariffs are cut. Thus, as a novel result, I show that tariff liberalization may in fact decrease imports of varieties that earn large revenues before the tariff cut. In contrast, I show that varieties earning low revenues always benefit from tariff liberalization by virtue of the high demand elasticity at which these varieties are sold. Overall, I show that the traditional negative effects of tariffs are amplified for low revenue varieties, and smaller and/or of opposite sign for high revenue varieties.

Empirically, the model is evaluated using a case study of tariff reductions by the United States resulting from Uruguay Round GATT negotiations. Despite being a result of bargaining within the GATT, this case study is sensible on a number of levels. For one, data are available at the HS10 level, which provides a useful amount of detail within narrowly defined products. Second, reductions to MFN tariffs were relatively quick, most of which occurring over the period 1995-1999. Third, the evidence suggests that import growth rates before the Uruguay Round agreements

\(^2\)For example, “Grand Pianos” is an HS8 product, and HS10 provides detail such as “Containing a case measuring less than 152.40 cm in length”.

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were drafted were independent from whether or not an HS8 product received a tariff cut after the Uruguay Round was completed. Finally, the US HS8 tariff data provides information on whether non-tariff barriers were present. As these policy instruments are outside the scope of the model, such information is crucial, and not available in other datasets such as TRAINS.

Using a number of different specifications, I find evidence which is broadly supportive of the model. Regressing bilateral import growth rates on tariffs and an interaction with pre-Uruguay Round import values, I find that within-products, bilateral import elasticities (with respect to tariffs) were large, significant, and negative for the export sources with the smallest pre-Uruguay Round import values. In contrast, estimated elasticities are small and, with few exceptions, insignificantly different from zero for export sources with the largest pre-Uruguay Round import values. Further, I find that this result is sharpened when focusing on products with below-median levels of exporter concentration, and in products with a relatively large number of varieties. These results are also fairly robust to a large set of supplemental regressions which control for an exporter-specific response to US tariffs and potential outlier exporters.

Finally, to address a possible role for quality rather than only cost-heterogeneity, I expand on the main theoretical result by showing that if quality plays a role, variety-specific revenue is the only measure that captures the characteristics relevant for assessing the effects of tariffs. That is, without precise assumptions over the relationship between quality and costs, there will not exist a monotone relationship between other measures (prices and quantities) and demand elasticity when quality is present. Empirically, this is confirmed in the data, where I show that ordering varieties by their relative price within products rather than revenues results in a sizeable drop in power in predicting the effects of tariff cuts. Further, I find that low price varieties benefited the most from tariff cuts, suggesting that many low price varieties are also low quality varieties. Hence, the data suggests that quality is playing a role in governing the effects of tariffs on bilateral trade flows.

**Related literature**

This paper adds to a number of different areas related to trade, firm heterogeneity, and trade policy. Most notably, it is related to the burgeoning literature on the role quality and cost heterogeneity play in trade flows. The results are reminiscent of Hummels and Skiba (2004), who evaluate the effect of trade costs and tariffs on the average price of US exports. The allowance for both quality and cost dimensions is similar to Baldwin and Harrigan (2011), and Johnson (2009). However, unlike both papers, I do not assume a specific relationship between quality and costs, rather showing that variety-specific revenue captures the characteristics necessary to evaluate a variety-specific effect.
of tariffs. Indeed, the use of revenues as measure that captures characteristics of both costs and quality is similar to recent work by Hallak and Sivadasan (2009).

The rather robust response of low revenue varieties is similar to Kehoe and Ruhl (2009). Indeed, motivated in-part by the results in Kehoe and Ruhl (2009), Arkolakis (2009) presents a framework based on endogenous marketing costs that generates a larger response to trade liberalization by low revenue varieties. While similar to the results in my paper, the results are driven by a completely different mechanism. Further, there is one crucial qualitative difference in equilibrium predictions, where the Arkolakis framework guarantees that all firms gain from liberalization, which is not the case in my paper. Indeed, in the forthcoming empirical work, the top-20% of exporters (within HS8 products) rarely increase trade after tariff liberalization occurs.

There is a relatively recent literature examining the design of the WTO within the context of heterogeneous countries and products. Saggi (2004) compares optimal tariffs set on an MFN basis with those set via unconstrained discrimination in a n-country oligopoly model with heterogeneous suppliers. Generally, Saggi’s model suggests that MFN tariff-setting benefits low cost suppliers since the optimal tariffs applied to their exports would be lower. The model does not examine the removal of tariffs on an MFN basis, and the corresponding effects on trade, which is the focus of my work.

On broader level, my paper is related to the work of Rose (2004) and Subramanian and Wei (2007), who estimate the effects of GATT/WTO membership on bilateral trade flows using a standard gravity model. Critically, my model suggests that this particular class of empirical studies is misspecified by failing to allow for differential effects of GATT/WTO membership as a function of pre-GATT/WTO market penetration within products. In this way, the results detailed below may also motivate modifications of the standard Anderson and Van Wincoop (2003) gravity model.

In terms of the US case study employed in this paper, a number of papers are relevant. Romalis (2006) shows that MFN liberalization by the United States increased both the degree of openness and the growth rates of developing countries. Ludema and Mayda (2009) examine the relationship between exporter concentration and observed tariff concessions by the US. In particular, they show that the US offered larger tariff concessions in products with a more concentrated group of export sources. Finally, very recent work by Feenstra and Weinstein (2010) adapts the methods from

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3 Via a CES demand assumption, all firms in the Arkolakis (2009) framework receive the same percentage demand shock resulting from tariffs. Thus, all firms gain from a reduction in a common iceberg transport cost, but differ in their supply response based on the marginal cost of reaching a larger fraction of consumers.

4 In later work, Saggi and Sara (2007) uses a two country model to examine the National Treatment clause when products may differ in quality. A similar result is reached as in Saggi (2004), where a national treatment clause tends to help those exporters selling the most competitive goods (highest quality goods).
Feenstra (1994) to estimate the gains for trade using a non-CES (translog) demand system. Their estimates imply pricing/mark-up behavior which is consistent with Melitz and Ottaviano (2008) - the model at the heart of my paper.

The rest of the paper is organized as follows. Section two presents a simple theoretical model, with an extension provided in the appendix. Section three details the dataset, and tests the predictions from section two. In section four, I briefly conclude.

2 Theory

Consumers

The key to the model is the way in which consumers value product variety and quality. Similar to Melitz and Ottaviano (2008), I assume that consumer preferences are quasi-linear, non-homothetic, and exhibit love-of-variety within a differentiated sector. However, I depart from Melitz and Ottaviano by assuming that within the differentiated sector consumers earn utility based on “quality-adjusted consumption” of each variety. Preferences of this type can be defined as follows:

\[
U = x_0 + \theta \int_{i \in \Omega} \lambda_i q_i di - \frac{1}{2} \eta \left( \int_{i \in \Omega} \lambda_i q_i di \right)^2 - \frac{1}{2} \gamma \int_{i \in \Omega} (\lambda_i q_i)^2 di
\]

Here, \( \Omega \) is the measure of available varieties, \( q_i \) is the consumption of variety \( i \), and \( \lambda_i \) is its associated quality. Thus, quality-adjusted consumption of variety \( i \) is defined as \( \lambda_i q_i \). The precise role of quality will be discussed shortly. Further, \( x_0 \) is the numeraire good, where \( \theta \ (> 0) \) and \( \eta \ (> 0) \) determine the substitution pattern between the differentiated industry and the numeraire. Finally, \( \gamma \ (> 0) \) represents the degree to which consumers value product variety.

The budget constraint faced by consumers is written as,

\[
x_0 + \int_{i \in \Omega} p_i^c q_i di \leq I
\]
where \( I \) is income of the representative consumer, and \( p_i \) is the price of variety \( i \). Solving the maximization problem of the representative consumer yields the following inverse demand function for each variety,

\[
p_i^c = \lambda_i (A - \gamma \lambda_i q_i)
\]
where,

\[
A = \theta - \eta \int_{i \in \Omega} \lambda_i q_i di
\]
Here, $p^c_i$ is the price at which consumers purchase varieties. Also, note that the demand intercept, $A$, embodies the competitiveness of the differentiated market. All else equal, the market is more competitive if the quality-adjusted consumption of all varieties, $\int_{i \in \Omega} \lambda_i q_i di$, is larger.

Before moving to the firm’s problem, it is instructive to examine the effects of variety-specific quality, $\lambda_i$, on the demand for each variety. First, note that by differentiating (2), the willingness to pay for a variety is increasing in quality if:

$$\frac{\partial p^c_i}{\partial \lambda_i} = A - 2\gamma \lambda_i q > 0$$

This will be satisfied in equilibrium, as $A - 2\gamma \lambda_i q > 0$ when marginal revenue is positive. Second, note the equation for demand elasticity as a function of variety specific quality and price:

$$\epsilon_{D,i} = \frac{\partial q_i}{q_i} \frac{p^c_i}{\partial p^c_i} = -\frac{p^c_i}{A\lambda_i - p^c_i}$$

Two results are apparent in the equation for $\epsilon_{D,i}$. First, conditional on quality, varieties sold at lower prices will be sold at lower absolute demand elasticities. Further, conditional on price, higher quality varieties (higher $\lambda_i$) will be sold at lower absolute demand elasticities. Given that consumers will tend to spend higher shares of their income on varieties with a lower quality-adjusted price, in equilibrium, there will be a negative relationship between the absolute elasticity of demand and variety-specific revenues. The relationship between revenues and elasticities is crucial for the main theoretical results of the paper, and the link to the empirics.

Firms

For this particular model, each supplier will produce one variety, and thus suppliers are also indexed by $i$. Further, supplier $i$ will produce variety $i$ at a constant marginal cost, $c_i$. I will not assume a specific relationship between the marginal cost of production $c_i$ and the quality of each variety, $\lambda_i$ (different from Baldwin and Harrigan, 2011, and Johnson, 2009). It will soon be clear that the relationship between marginal costs and quality has no bearing on the results outside of their relationship to the observed distribution of revenues within products.

For simplicity, I assume away the extensive margin of trade, focusing instead on a fixed measure $N$ of imported foreign varieties. An extended version of the model with an active extensive margin is presented and discussed in the appendix. I also assume that there exists no domestic sector.\(^5\) To

\(^5\)The results of the model go through with a domestic sector. The only difference is that a domestic sector tempers the effect of tariffs on the aggregate measure, $A$. However, without reliable data that reports the size of the domestic
sell a variety in the import market, the supplier must pay an ad-valorem tariff \( \tau \) for each unit sold. Hence, the relationship between the consumer price detailed above and the price that producers receive is \( p^c_i = (1 + \tau)p^s_i \). This yields the following inverse demand function that foreign suppliers use to optimally set production for the import market.

\[
p^*_i = \frac{\lambda_i}{t} (A - \gamma \lambda_i q_i)
\]

Here, \( t = (1 + \tau) \). Suppliers choose quantities to maximize profits:

\[
\pi (\lambda, c_i) = \max_{q_i} \left\{ \frac{\lambda_i}{t} (A - \gamma \lambda_i q_i) \cdot q_i - c_i q_i \right\}
\]

Optimal production of a given variety \( i \), \( q(\lambda_i, c_i) \), is written as,

\[
q(\lambda_i, c_i) = \frac{A - \frac{c_i}{\lambda_i} t}{2\gamma \lambda_i}, \tag{3}
\]

where the price received for this variety is,

\[
p(\lambda_i, c_i) = \frac{\lambda_i}{t} \left( \frac{A + \frac{c_i}{\lambda_i} t}{2} \right), \tag{4}
\]

and finally, the pre-tariff value of imports of variety \( i \) is written as:

\[
v \left( \frac{c_i}{\lambda_i} \right) = \left( \frac{A^2 - \left( \frac{c_i}{\lambda_i} \right)^2 t^2}{4\gamma t} \right). \tag{5}
\]

As trade data reports the value of trade, and not the profits of each supplier, equation (5) is the object of interest. The value of trade will be affected by tariffs through two channels. The first is directly via the negative effect of tariffs on variety-specific revenue. This can be seen by the negative impact of tariffs on the numerator of (5), and the positive impact of tariffs on the denominator of (5). However, there are also indirect effects of tariffs through the competitiveness term, \( A \):

\[
A = \theta - \eta Q = \theta - \eta Nq
\]

sector at the HS8 level, I cannot test this aspect of the model. Hence, I choose to develop the model without a domestic sector.
Here, $\bar{q}$ is the average quantity of imported varieties. Defining $\bar{c}_\lambda$ as average quality-adjusted costs of imported varieties, and solving for $A$, we have,

$$A = \left( \frac{2\gamma}{2\gamma + \eta N} \right) \theta + \left( \frac{\eta N}{2\gamma + \eta N} \right) \bar{c}_\lambda t$$

(6)

In (6), higher tariffs increase $A$. Intuitively, higher tariffs decrease quality-adjusted production for the import market, thus making the market less competitive. This yields a higher residual demand for each variety, $A$. A useful way to characterize this result will be the elasticity of $A$ with respect to $t$:

$$\epsilon_A \equiv \frac{\partial A}{\partial t} \cdot \frac{t}{A} \equiv \frac{\eta(\bar{c}_\lambda t)}{2\gamma \theta + \eta(\bar{c}_\lambda) t} \in (0, 1)$$

(7)

While $A$ is clearly increasing in $t$, on a percentage basis, $A$ increases slower than $t$. Further, $\epsilon_A$ is increasing in $N$ and $\eta$. Respectively, these imply that in more competitive markets, in which there is a larger degree of substitution between the differentiated sector and the numeraire, the response of $A$ is stronger relative to a change in $t$.

**Trade Liberalization**

As stated in the introduction, the goal of this paper is to evaluate how the effects of trade liberalization are distributed across export suppliers that may not sell varieties of the same quality, or varieties produced at the same marginal cost. By taking logs and then fully differentiating (5) with respect to all endogenous variables and $t$, I can write the following:

$$\frac{\partial v_i}{v_i} = \frac{2A \partial A - 2t \left( \frac{c_i}{\bar{c}_i} \right)^2 \partial t}{A^2 - \left( \frac{c_i}{\bar{c}_i} \right)^2 t^2} - \frac{\partial t}{t}$$

To simplify this expression, I will exploit the monotone link between $\left( \frac{c_i}{\bar{c}_i} \right)^2$ and $v \left( \frac{c_i}{\bar{c}_i} \right)$. Solving for $\left( \frac{c_i}{\bar{c}_i} \right)^2$ in (5) and substituting into the above equation yields a simple relationship between the marginal effect of tariffs and the value of imports prior to the change in tariffs.

$$\partial v_i = \frac{A^2 (\epsilon_A - 1)}{2\gamma t} \frac{\partial t}{t} + v_i \frac{\partial t}{t}$$

(8)
Defined as a total elasticity of import value with respect to tariffs, I can write:

\[ \epsilon_{v,i} \equiv \frac{\partial v_i}{\partial t} = \frac{A^2(\epsilon_A - 1)}{2\gamma tv_i} + 1 \]  

In (8), the marginal effect of tariffs is a function of two terms. The first is a negative effect which is common across all suppliers. The second is specific to the value of imports prior to the change in tariffs, where the negative effect of tariffs is mitigated for higher value imports. This result is summarized in the first proposition of the paper.

**Proposition 1** The elasticity of trade value with respect to tariffs for variety \( i \) is increasing in revenues earned by variety \( i \).

**Proof.** Immediate from (8)

The result in Proposition 1 simply establishes that there is a disparate effect of tariffs across imports within products, where specifically, these effects are governed by the elasticity at which each variety is imported. In this case, high-quality and/or low-cost varieties are consumed at a lower absolute elasticity of demand, and hence, experience a smaller effect from a percentage supply shock (in this case a tariff cut).

There exist other papers, Arkolakis (2009) in particular, that yield a similar result to Proposition 1 but are not due to differences in demand elasticity. I will discuss this and other papers later in the manuscript. However, in order to set-up a comparison of the existing literature with the demand-side effects which are the focus of this paper, I will first go deeper into the quality-cost framework, and in particular, the way in which tariffs induce shifts in demand for each variety.

Crucially, when noting that the tariff changes in this model are pervasive across all imported varieties (MFN tariff cuts), competition is more fierce after the tariff cut. This is embodied in the residual demand level, \( A \), which falls as tariffs fall. In equilibrium, the fall in \( A \) may be larger or smaller than the direct effects summarized in Proposition 1. I now examine when, and for which varieties, changes to \( A \) are large enough to outweigh these direct effects. Precisely, lower tariffs increase imports of variety \( i \) only if the value of imports prior to lower tariffs is sufficiently small. That is, given \( \frac{\partial t}{t} < 0, \frac{\partial v_i}{\partial t} > 0 \) only if:

\[ v_i < \frac{A^2 (1 - \epsilon_A)}{2\gamma t} \]
In contrast, when \( v_i \) is sufficiently high, it is possible that lower tariffs decrease trade. To see this, using (5), the highest possible value of trade is written as:

\[
v^{\text{max}} = v(0) = \frac{A^2}{4\gamma t} \]

Substituting \( v^{\text{max}} \) into \( \partial v_i \), we have:

\[
\partial v_i^{\text{max}} = \frac{A^2 (2\epsilon_A - 1) \partial t}{4\gamma t} \]

Thus, \( \frac{\partial v_i^{\text{max}}}{\partial t} > 0 \) if \( \epsilon_A > \frac{1}{2} \). In other words, the percentage change in residual demand \( A \) must be sufficiently large. Using (7), as a function of model parameters, this occurs if:

\[
\frac{\epsilon}{\lambda} < \frac{2\gamma \theta}{\eta N} \tag{10}
\]

This condition is summarized in the following proposition:

**Proposition 2** If \( \frac{\gamma \theta}{\eta N} \) is relatively small, then tariff liberalization increases imports only if pre-tariff-cut revenues are sufficiently small.

As detailed in Proposition 2, within this adjusted Melitz-Ottaviano framework, it is possible for the value imports of a given variety to fall when tariffs are cut. This is more likely to occur when love of variety \( \gamma \) is small, \( \eta \) is large or \( N \) is large. Hence, in the forthcoming empirical work, along with the differential effect of tariffs described above, I will focus on the absolute tariff-response of high revenue varieties in order to examine whether variety-specific demand elasticities are empirically relevant in the way the models suggests. Further, as \( N \) can be approximated in the empirical framework, I will evaluate how these effects change when looking at products with relatively large values of \( N \).

**The Role of Quality**

A second way to distinguish this particular theory from alternate frameworks is to focus on the role of quality, and in particular, the role quality plays in determining revenues, prices, and demand elasticities.

When demand is of constant elasticity and consumers make decisions on quality-adjusted quantity (utility defined over \( \lambda_i q_i \)), within a CES demand system, quality and cost have no effect on equilibrium demand elasticities. In contrast, within the quadratic preferences described above,
quality and cost have a very clear effect. Precisely, equilibrium absolute demand elasticities are written as:

\[ \epsilon_{D,i} = \frac{A + \frac{c_i}{\lambda_i}}{A - \frac{c_i}{\lambda_i}} \]  

(11)

In (11), equilibrium demand elasticities are increasing in costs and decreasing in quality, which implies a monotone relationship between quality-adjusted costs and absolute demand elasticity. In deriving the elasticity of trade value with respect to tariffs, this relationship is crucial, since there is also a monotone, in this case negative, relationship between \( v_i \) and \( \frac{c_i}{\lambda_i} \). Hence, initial trade value captures exactly the variety-specific characteristic (demand elasticity) required for the main propositions in the paper.

In contrast, when quality plays a role, variety-specific quantity and price do not necessarily capture the necessary characteristics related to demand elasticities. To see this, first focus on variety-specific price, \( p(\lambda_i, c_i) = \frac{A}{t} \left( \frac{A + c_i t}{2} \right) \). Here, \( p(\lambda_i, c_i) \) is increasing in both variety-specific quality and cost. However, since absolute demand elasticities are falling in quality and rising in cost, this implies that unless there is a specific relationship between quality and cost, there does not exist a monotone relationship between prices and demand elasticities. Hence, prices do not necessarily capture the variety-specific characteristics relevant to evaluate the effects of tariffs on bilateral trade flows.

Next, consider variety-specific quantity, \( q(\lambda_i, c_i) = \frac{A - c_i t}{2\gamma\lambda_i} \). Clearly, \( q(\lambda_i, c_i) \) is decreasing in \( c_i \). The question is whether \( q(\lambda_i, c_i) \) is increasing in \( \lambda_i \). To see when this is the case, I can write the elasticity of quantity with respect to \( \lambda_i \) as follows:

\[ \epsilon_{D,\lambda_i} = \frac{c_i t - 1}{A - \frac{c_i}{\lambda_i} t} \]  

(12)

In (12), quantity is increasing in quality only if \( \frac{c_i t}{\lambda_i} > 1 \). Hence, if this condition is satisfied for all \( i \), then like revenues, quantity will have a monotone relationship with demand elasticities. If not, then quantity does not have a monotone relationship with demand elasticities, and cannot be used to evaluate any disparate effect of tariffs across varieties.

The discussion regarding demand elasticities is summarized in the following proposition.

**Proposition 3** Without a quality dimension, variety-specific revenues, quantities, and prices all have a monotone relationship with demand elasticities. With a quality dimension, only variety-specific revenues are guaranteed to have a monotone relationship with demand elasticities.

The upshot of this discussion and the result in Proposition 3 is that when evaluating the effects
of tariffs, if quality plays a role at all, the only unconditional proxy for quality-adjusted cost is revenue. Hence, as suggested by equation (8), when testing the model, I will construct measures of within-product market penetration based on revenues, where the main predictions are that (1) tariff liberalization disproportionately benefits the lowest-revenue varieties and (2) it is not necessary that high revenue varieties gain at all from tariff liberalization. Further, to evaluate a potential role for quality, I will also construct within-product rankings of quantities and prices. If the latter two measures deliver results that are qualitatively similar to revenue-based rankings, then I will conclude that support for the model is primarily driven by cost-heterogeneity, or a trivial link between cost heterogeneity in quality heterogeneity. In contrast, if using rankings based on quantity, and especially price, yield different results when compared with those based on revenues, then I will conclude that quality is likely playing a role in demand elasticities, and hence, the effects of tariffs on trade flows.

Discussion

The results detailed above are not the first to look at the relationship between product characteristics and bilateral trade flows. For example, recent work by Baldwin and Harrigan (2011) and Johnson (2009) have allowed for a precise impact of quality, via prices, on trade flows. Further, Hummels and Skiba (2004) examine how trade costs and tariffs affect the price-composition of exports. However, to my knowledge, the above framework is the first to demonstrate that the impact of import liberalization may in fact be negative for some measure of imported varieties.

This main theoretical result is closely related to the discussion of tariffs in Hummels and Skiba (2004). Along with per-unit trade costs, Hummels and Skiba allow for an ad-valorem component, such as tariffs. Theoretically, they show that higher tariffs reduce the relative demand for high quality (price) goods, thus lowering the average FOB price of exports. The opposite occurs with transportation costs. Relative to Hummels and Skiba (2004), my model extends the literature in a unique way, where I allow for elasticity differences that are arbitrarily correlated with prices. To be more specific, consider an example in which all imported varieties are produced at the same marginal cost, but yet differ in quality. In this case, higher quality varieties earn higher revenues, and are sold at lower equilibrium demand elasticities. If raising tariffs, high quality varieties will suffer less than low quality varieties, by virtue of the equilibrium demand elasticity at which each are sold. Thus, higher tariffs increase the relative demand for high quality goods - the opposite of what Hummels and Skiba (2004) predict. The critical difference is that the quality component in my model may shift/skew the demand curve such that higher price goods are sold at lower demand elasticities. In contrast, the model in Hummels and Skiba (2004) is consistent with a restricted
version of my model where quality and costs and correlated in such a way to ensure that demand elasticities are always larger with higher prices. Indeed, in later empirical results, I will present evidence that suggests that some low prices goods are actually subject to relatively high demand elasticities.

As mentioned earlier, Arkolakis (2009) presents a model that delivers a differential response to tariffs similar to Proposition 1, but that derives from features unrelated to demand elasticities. In particular, Arkolakis details a model in which firms reach consumers by investing in marketing, itself subject to a convex cost function. Via a CES demand assumption, all firms in the Arkolakis framework receive the same percentage demand shock resulting from tariffs. Thus, all firms gain from a reduction in a common iceberg transport cost, but differ in their supply response based on the marginal cost of reaching a larger fraction of consumers. Indeed, small/less-productive firms that charge higher prices, who are not as far up the marketing cost curve, experience a larger total elasticity of import value with respect to tariffs. The difference in predictions between Arkolakis (2009) and my work are subtle, though where they exist, they highlight the demand-side issues at the heart of my model. Specifically, Proposition 2 highlights the possibility that high revenue varieties do not increase imports after tariff liberalization. Indeed, in the forthcoming empirical work, I show that the top-20% of exporters (within-products) rarely increase trade after tariff liberalization occurs. Further, Proposition 4 implies that high-price varieties benefit the most from liberalization only if quality has no role in demand elasticities. I will also show that if anything, low-price varieties benefit the most, suggesting a role of quality that affects demand elasticities, and hence, the effects of tariff liberalization on bilateral trade flows.

Finally, before moving to the empirics, a note about welfare. From a trade policy perspective, the results in Proposition 1 seem in direct conflict with the intent of the central tenet of the WTO: the principle of non-discrimination. That is, while non-discrimination requires that countries apply and liberalize tariffs equally across MFN exporters, the benefits of that tariff reduction do indeed discriminate along natural margins. The question then becomes, is non-discrimination a sensible policy? Or should countries be allowed to discriminate along some margin?

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6 As detailed in Jackson (1997), there are three traditional arguments which support the use of MFN. One is that MFN prevents policies which distort bilateral patterns of comparative advantage. Further, some argue that MFN results in more liberalization than under preferential systems. Finally, others argue that allowing for discriminatory tariffs would increase the costs of rule formation, where many tariff lines would be more costly to impose and enforce when compared to a single tariff line applied to all exporters.

7 This debate has a very long history. Indeed, Irwin, Mavroidis, and Sykes (2007) describe how Keynes’, during the framing of the GATT, wished to keep open the option of discriminatory tariffs. While this was mainly argued within the context of Great Britain’s imperial relationships, Keynes seems to express a notion that the post-war trading system ought not to be constrained by MFN.
While I leave an in-depth analysis of welfare within a multi-country political economy model for a follow-up paper, I can comment on how consumers in the importing country view non-discrimination, and what would happen if they were allowed to discriminate. Specifically, I can show that, similar to a Ramsey-type tax rule, the importing country would exacerbate the disadvantage to high revenue suppliers under discrimination.\(^8\) This is similar to the result in Saggi (2004) that was discussed in the introduction. Hence, it seems that non-discrimination, while not necessarily helpful to high revenue varieties, likely is preventing optimal discrimination that would make their situation worse. Crucially, as this argument is based on different elasticities within products, it begs the question whether there is evidence of variable elasticities in the data. To examine this possibility, I now move to the empirical section of the paper.

### 3 Tariffs and bilateral trade: The US and the Uruguay Round

In this section, I use detailed import and tariff data for the United States, over the period 1989 to 2004, to estimate the degree to which the effects of MFN tariffs differ within products. To do this, I use HS10 bilateral import data from the UC Davis Center for International Data, as described in Feenstra, Romalis, and Schott (2001). HS8 tariff data is obtained from the US International Trade Commission and from Romalis (2004).\(^9\) I restrict attention to continuing HS10 products over the entire sample, which abstracts from new and/or dying HS10 codes.\(^10\) More information regarding the construction of the sample will be provided shortly.

The level of refinement in the import data will be the HS10-Exporter level. I will henceforth refer to HS10-Exporter pairs as “varieties”. Since MFN tariffs in the US are set at the HS8 level, I will refer to HS8 classifications as “products”. “Industries” will be defined either at the HS2 or HS4 levels of aggregation.

The theory described in section two focused on the effects of a reduction in a common ad valorem tariff that is pervasive across varieties. As such, I will restrict the sample to focus on the effects of

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\(^8\)I can prove this result in two separate ways, both of which are available upon request. First, starting from free trade, I examine whether an importing country with no domestic sector can change tariffs in a discriminatory manner such that zero revenue is earned but consumer surplus increases. In this case, the optimal policy is to increase the tariff on high revenue varieties and subsidize imports of low revenue varieties. In the second example, also starting from free trade but allowing for revenues to change, I evaluate the direction of an optimal policy on a single variety. Precisely, I show that there exists a threshold of quality-adjusted costs above which import subsidies are optimal, and below which import tariffs are optimal.

\(^9\)The Romalis data is also obtained from the UC Davis Center for International Data.

\(^10\)See Pierce and Schott (2009) for a discussion and concordance for new and dying product codes.
ad-valorem MFN tariffs on MFN imports. The issue, however, is that not all imports are subject to MFN tariffs, and not all tariffs are ad-valorem. To deal with this, I will adopt the following restrictions on the observations included in my dataset.

R1: HS10-Exporter pairs must always be imported under MFN over the entire sample period.

R2: HS8 products must not list any non-tariff barriers to trade over the entire sample period.

The first condition removes non-MFN trade from the dataset, and in particular, varieties for which preferential access is an (relevant) option. This is particularly important for NAFTA trade, and to test this restriction, I will later drop NAFTA countries from the sample to examine how the results may change. In the second restriction, I remove products for which at some point in the sample, non-tariff barriers, or specific tariffs, are listed in the HS8 tariff files.

Before presenting the precise regression framework (which will further restrict the sample), I first detail the reductions in US import tariffs which resulted from the Uruguay Round. Two particular characteristics of this round of tariffs cuts are presented in Figure 1. In the left panel, I have plotted
mean and median tariffs across HS8 products for each year, 1989-2004. The last year prior to the enactment of the Uruguay Round (1994) is denoted by the vertical line. Notably, there is very little movement in tariffs prior to the enactment of the Uruguay Round. Directly after, tariffs fell steadily, flattening out between 2000 and 2004. Overall, mean and median tariffs fell by roughly 50%. Further, in the right-panel of Figure 1, I plot the empirical distribution of MFN tariffs in 1992 and 2004 (which will be the years over which I evaluate the effects of tariffs). Of note, US MFN reductions in the Uruguay Round doubled the number of MFN tariffs that were zero.

Next, to give a broad picture of the effects of tariff reductions, I will impose two additional restrictions on the sample:

R3: Tariffs must be stable over the period 1989-1994

R4: Tariffs must not rise over the period 1994-2004.

Together, the two restrictions remove 2.2% of HS8 products from the dataset, which removes only 0.29% of the total number of HS10-Exporter pairs. The first restriction focuses the sample to products with a stable “pre-period” during which initial market penetration can be measured. The second restricts products to those where tariffs were cut or stayed constant after the formation of the WTO. Since non-tariff barriers were allowed to be “tariffied” into ad-valorem rates upon their removal, getting rid of the few products with increasing ad-valorem tariffs provides a secondary check that these products are removed from the database.

In Figure 2, I provide some illustrative evidence on the effect of MFN tariff reductions, and a differential effect of tariff reductions by market penetration before the tariff cut. To begin, focus on the left panel of Figure 2, where I have plotted relative trade growth for products that received a tariff cut and products that did not. To calculate relative trade growth, I first calculate the log of the ratio of imports in year $t$ to imports in 1992 for each HS10-Exporter pair. Then, for each year, I de-mean these growth rates across Exporter-HS4 pairs. Thus, in each year, average trade growth relative to 1992 is equal to zero. In the left panel of Figure 2, I have decomposed this “zero” into HS8 products that received a tariff cut, and HS8 products that did not. Further, I have denoted the first draft of the final act of the Uruguay round, which occurred at the end of 1991, and the year in which the final act was signed, 1994, by vertical black lines. Clearly, products that received a tariff cut experienced positive trade growth relative to those products that did not. More notably, trade growth rates for each product group were very close to one another prior to 1994. In the appendix, I present another chart showing that trade growth rates were similar all the way back to 1980. This suggests that after controlling for factors unrelated to tariff cuts (the Exporter-HS4-Year fixed
effects), products which received a tariff cut were not growing differently than those that did not receive a tariff cut.\textsuperscript{11} Given that good instruments for tariffs at the HS8 level do not exist for this analysis (to the author’s knowledge), the fact that trade growth pre-WTO appears to be invariant to future tariffs cuts is particularly helpful.

In the right panel of Figure 1, I have further decomposed these “zeros” by the relative position of each HS10-Exporter observation within their respective HS8 product category. Precisely, I decompose the averages in the left-panel by whether or not, within each HS8 product, an HS10-Exporter was in the top 20\% of positive trade values over the period 1989-1990. Clearly, the group

\textsuperscript{11}This is a statistically robust statement. Regressing the log change in imports of each HS8 product between 1989 and 1992 on a dummy variable identifying a tariff cut and HS4 fixed effects yields an insignificant relationship between pre-Uruguay round trade growth rates and future tariff cuts. Precisely,

\[
\log\left(\frac{v_{i,j,92}}{v_{i,j,89}}\right) = -0.0647 \cdot I\left(\frac{t_{i,04}}{t_{i,94}} < 0\right) + HS4
\]

where \(i\) represents HS10 varieties and \(j\) represents exporters. Standard errors are robust and clustered by Exporter and HS2 industry.
that benefited the most from a tariff cut relative to their no-tariff cut control group were those HS10-Exporter pairs that either did not trade (“zeros”) or were in the bottom 80% of their given product category. In contrast, it is unclear whether varieties in the top 20% of their given HS8 category benefited from tariff cuts relative to similar varieties in the no-tariff cut HS8 control groups. Overall, the evidence in Figure 2 details a differential impact of MFN tariffs which is consistent with the theory developed in section two. I now test the robustness of these features using a broad set of regressions.

**Tariffs and Relative Market Penetration: Baseline regressions**

Given that tariffs only changed once and over a relatively short period, the empirical strategy will be similar to Trefler (2004), using long differences to evaluate the effects of tariffs on bilateral trade. The object of interest will be the growth rate in trade over the period 1992-2004. This growth rate will be labeled \( \log(v_{i,j,04}/v_{i,j,92}) \), where \( v_{i,j,s} \) measures the value of imports in nominal US dollars of HS10 variety \( i \) from exporter \( j \) in year \( s \). Hence, this growth rate requires the following (and final) restriction on the sample used for the majority of the analysis.

\[ R5: \text{HS10-Exporter pairs must report imports in both 1992 and 2004.} \]

The growth rate will be regressed on a number of factors within a number of different specifications, though the common regressor in each will be the log change in MFN tariffs over the period 1994-2004. Precisely, I will measure tariffs as in section two, where \( t_{i,s} = 1 + \tau_{i,s} \). Here, \( \tau_{i,s} \) is the percentage point MFN tariff for HS10 variety \( i \) in year \( s \) (though understanding that tariffs are set at the HS8 level). To calculate a measure of import elasticity, I will measure the change in tariffs using log differences, \( \log(t_{i,04}/t_{i,94}) \), similar to the way in which I measure the change in import value for each HS10-Exporter. Finally, note that I measure the change in tariffs starting in 1994 because tariffs were essentially frozen during WTO negotiations. Via (R3), those few products with tariffs that move in the pre-period are dropped from the dataset.

Restriction (R3) is crucial in measuring pre-tariff-cut market penetration, as doing so requires that policy measures were not moving. Initial market penetration will defined by six sub-groups, five of which based on quintiles of positive imports over the period 1989-1990 (the earliest periods such that HS10 classifications were used). After dropping observations of varieties that did not trade in both 1992 and 2004, within each HS8 product, I first collect all varieties (HS10-Exporter pairs) that did not report trade in both 1989 and 1990, and call this “group zero”. This group is identified by a dummy variable \( D_{i,j}^0 \). Next, HS10-Exporter observations for which imports occurred during 1989-1990 are grouped into quintiles within each HS8 product. These quintiles will be identified in
Table 1: Mean and Median Import Value by within-product quintile

<table>
<thead>
<tr>
<th>Group:</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ($'s):</td>
<td>0</td>
<td>89,143</td>
<td>355,891</td>
<td>1,038,760</td>
<td>3,336,006</td>
<td>21,426,412</td>
</tr>
<tr>
<td>Median ($'s):</td>
<td>0</td>
<td>31,880</td>
<td>144,084</td>
<td>444,908</td>
<td>1,409,428</td>
<td>6,151,874</td>
</tr>
</tbody>
</table>

Notes: This table presents mean and median import values over HS10-Exporter pairs broken down by import penetration group.

order by dummy variables $D_{i,j}^1$, $D_{i,j}^2$, $D_{i,j}^3$, $D_{i,j}^4$, and $D_{i,j}^5$, with the lowest 20% of positive imports within each HS8 product identified by $D_{i,j}^1$, and the highest 20% of positive imports within each HS8 product identified by $D_{i,j}^5$.

Table 1 presents the mean and median import values over 1989-1990 for each of these groups, after dropping HS8 products without five HS10-Exporter observations with positive trade (i.e. dropping HS8 products where quintiles are not defined). The point to be taken from Table 1 is that the top 20% of HS10-Exporter observations are, on average, roughly 7X larger than those in the 60-80th percentile. A similar magnitude difference is evident at the median. Overall, the largest 20% of exporters are, in fact, quite large, which is consistent with similar results presented at the firm level in Bernard, Jensen, Redding, and Schott (2007). Thus, given the theory in section two, I hypothesize that the effects of MFN liberalization on this group are modest relative to groups 0-4. I now seek evidence in support of this hypothesis.

To test for any differences across quintiles, I start by estimating the following equation.

$$
\log(\frac{v_{i,j,04}}{v_{i,j,92}}) = \left( \beta_{US,D0}D_{i,j}^0 + \beta_{US} + \beta_{US,D2}D_{i,j}^2 + \cdots + \beta_{US,D5}D_{i,j}^5 \right) \log(\frac{t_{i,04}}{t_{i,94}}) + \beta_{D0}D_{i,j}^1 + \cdots + \beta_{D5}D_{i,j}^5 + Fixed + \epsilon_{i,j}
$$

(13)

In (13), I allow for a differential impact of tariffs across groups, where in particular, I measure the effects of group membership and a differential effect of tariff cuts relative to group one. In (13), $\beta_{US}$ represents the long-run elasticity of import value with respect to tariffs for the group of HS10-Exporters that reported trade in 1989 and 1990, but were in the bottom 20% of reported import values within their respective HS8 product. Thus, $\beta_{US,Dk}$ represents the difference in elasticity, relative to group one, for group $k$. To be clear, $\beta_{US,D5}$ represents the difference in import elasticity of the largest exporters relative to the smallest exporters.
An alternate way of estimating the model in (13) is by directly estimating elasticities for each group, and not differences relative to a base group. Equation (14) does exactly this:

\[
\log\left(\frac{v_{i,j,04}}{v_{i,j,92}}\right) = \left(\beta_{US,D0}D_{i,j}^0 + \cdots + \beta_{US,D5}D_{i,j}^5\right)\log\left(\frac{t_{i,04}}{t_{i,94}}\right) + \beta_{D1}D_{i,j}^1 + \cdots + \beta_{D5}D_{i,j}^5 + Fixed + \epsilon_{i,j}
\]  

Equation (14)

In both (13) and (14), I will include a robust set of fixed effects at the Exporter-Industry level to control for trends unrelated to changes in MFN tariffs. For example, some exporter-industry pairs may be declining or growing due to development or a long-run adjustment toward different industries. This is particularly important in light of the Kehoe and Ruhl (2009) explanation for extensive margin growth, which is that price-shocks in countries like China are one factor driving the growth of the extensive margin. If price-shocks play a critical role, these Exporter-Industry trends should help control for them. Further, these Exporter-Industry fixed effects may help control for export sources which engage in liberalization of their own in certain industries, and hence, there are additional issues of reallocation that may be absorbed in the fixed effects.

I will occasionally include two additional controls, \(dVT_{i,t}\) and \(VGrow_{i,t}\). In the first, I measure the log of total trade growth between 1992 and 2004 for products in variety \(i's\) industry (defined either by HS2 or HS4 industries) but not variety \(i's\) HS8 product. This is especially important in light of tariff cuts in other HS8 products that are in the same HS2 or HS4 industry. I hypothesize that the coefficient on this variable will be less than zero, where higher demand outside an HS8 industry will force down demand within that particular HS8 industry.\(^{12}\) The second control, \(VGrow_{i,t}\), measures the log growth in imports for each HS10-Exporter variety over the period 1989-1990. I will only be able to use this control when excluding group zero from the sample. The motivation for adding in this control is to at least partially rule out a mean-reversion story. If there is mean reversion, high import growth in 1989-1990 might suggest low import growth in later periods.

The results from estimating (13) and (14) are presented in Table 3. Within each quadrant in Table 3, I present estimates for a restricted version of the model without tariff interactions in the first two columns. In the second two columns, I add in tariff interactions from (14). Finally, in the last two columns, I present the results for (13), which evaluates differential elasticities.

Table 3 reports strong support for the model developed in section two. To begin, I will discuss the results for the full sample, which are in the top panels of Table 3. First, note columns 1

\(^{12}\) For example, suppose that tariffs fall 3% in a given HS8 product, but that tariffs in their particular HS2 industry fall on average 10%. Thus, while the within-HS8 tariff cuts are the focus of the paper, disproportionally large outside tariff cuts may shift down demand for all varieties in a given HS8 industry.
and 2, which report that the average elasticity of trade value with respect to tariffs is negative and significantly different from zero. Depending on the assumptions over fixed effects, the point estimates of the average elasticity of import value with respect to tariffs ranges from -3 to -6. As foreshadowed in Figure 1, the tariff cuts which were implemented during the Uruguay Round had a significant effect on imports into the US.

In terms of the predictions from section two, focusing on columns 4 and 10 in the top panel of Table 3, it is clear that for varieties in group one, the smallest 20% of active varieties in 1989-90 as measured by revenues, tariffs had a negative, large, and statistically significant effect on the growth rate of imports between 1992 and 2004. As we move down rows from group one toward group five, we see that the interaction with tariffs becomes less negative with each successive group. This culminates with varieties in group five, where tariffs did not have a significant negative impact on import values. Further, in columns 6 and 12, it is clear that when measuring a differential elasticity between groups 1 and 5, the difference is positive and significantly different from zero. Focusing on the last row in the top panel of Table 3, we see $dVT_{i,t}$ has a negative and significant impact on bilateral imports.

Next, in the bottom panels of Table 3, I estimate the model but while dropping varieties for which trade was not reported in 1989 and 1990. Here, we find that the results are robust within this smaller sample. Within this sample, we are also able to estimate the effect of both $dVT_{i,t}$ and $VGrow_{i,j,t}$. The former again has a significant and negative effect on trade. For the latter, high trade growth in the pre-period tends to be associated with low growth in later periods. This suggests that some sort of mean reversion is present in the data, though not enough such that the effects of tariffs by groups are changed in a large way.

One last issue to discuss is the estimates for the group dummy variables that are not interacted with tariffs. Here, we find that higher revenue varieties tend to have lower growth rates. This would be supported by the model if I also included a cost shifter across varieties that was not related to tariffs. For example, this might include a common rate of productivity growth, independent of whether or not a product received a tariff cut.

**Tariffs and Relative Market Penetration: Exporter Interactions**

Next, I estimate a number of specifications which include interactions between US MFN tariffs and exporter characteristics which are more general than variety-specific market penetration. First, I estimate (13) allowing for a differential impact of tariffs as a function of exporter GDP per capita (data taken from the Penn World Tables). The coefficient on this interaction is labeled $\beta_{US,GDP}$. This interaction is sensible on a number of levels. First, less-developed countries may have poor
institutions, and thus may respond slowly to changes in tariffs relative to more developed exporters. In this case, $\beta_{US,GDP}$ would be negative. Or, perhaps developed countries are more likely to employ unionized labor, which may yield a laggard response to price shocks. In this case, $\beta_{US,GDP}$ would be positive. Another explanation for positive $\beta_{US,GDP}$ would be that developed countries are more likely to sell high quality products, and that the effect of high quality products may be picked up to some extent by this coefficient. Indeed, in the top panels of Table 4, though insignificant at conventional levels in all regressions, this is exactly what I find, where there is an imprecise but positive relationship between the effect of tariffs and GDP per capita of the exporting country. However, despite this positive interaction between tariffs and exporter GDP per capita, we still find that there is a positive and statistically significant difference in estimated elasticities between group one and group five, as the theory predicts.

Moving beyond exporter development, I now allow for a full interaction between exporter dummy variables and the log change in US MFN tariffs. Precisely, I estimate the following:

$$\log\left(\frac{v_{i,j,04}}{v_{i,j,92}}\right) = (\beta_{US,D0}D_{i,j}^0 + \beta_{US,D2}D_{i,j}^2 + \cdots + \beta_{US,D5}D_{i,j}^5) \log\left(\frac{t_{i,04}}{t_{i,94}}\right)$$

In (15), $\text{Exp}$ is a vector of exporter dummies, and $\beta_{US,Exp}$ represents a vector of exporter-specific import elasticities for group zero. The motivation for this interaction is as follows. In Appendix A, when including a flexible extensive margin of trade, the relationship between quality-adjusted costs (as defined by the Pareto shape parameter) and import value is negative only if the measure of potential exporters is unresponsive to the Pareto shape parameter, and the pool of potential exporting firms does not vary across exporters. Indeed, the interaction between exporter dummies and US MFN tariff changes may account for both a larger difference in the pool of potential exporters, or some differential effect of tariffs on this pool. Also, if financing issues vary substantially across countries (as in Manova, 2008), then the exporter-tariff interaction is warranted.

The results from estimating (15) are presented in the bottom panel of Table 4. Again, $\beta_{US,D0} - \beta_{US,D5}$ measure the differential effect of MFN tariffs by quintile relative to an exporter-specific tariff elasticity for group one. Relative to group one, higher revenue varieties fared worse with lower tariffs than lower revenue varieties. Indeed, this effect is most pronounced in group five. Overall, despite a huge number of additional interactions with the tariff variable, the results in Table 4 are supportive of the theory from section two.

Next, I return to the specifications in (13) and (14), evaluating the effects of potential outlier
Table 2: Mean and Median Import Value by within-product quintile

<table>
<thead>
<tr>
<th>Group:</th>
<th>0%</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
<th>60%</th>
<th>70%</th>
<th>80%</th>
<th>90%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>HHI:</td>
<td>0.009</td>
<td>0.103</td>
<td>0.156</td>
<td>0.198</td>
<td>0.231</td>
<td>0.266</td>
<td>0.307</td>
<td>0.362</td>
<td>0.441</td>
<td>0.563</td>
<td>0.984</td>
</tr>
<tr>
<td>N</td>
<td>5</td>
<td>9</td>
<td>11</td>
<td>14</td>
<td>17</td>
<td>21</td>
<td>27</td>
<td>37</td>
<td>55</td>
<td>97</td>
<td>429</td>
</tr>
<tr>
<td>N (no D0):</td>
<td>5</td>
<td>6</td>
<td>8</td>
<td>10</td>
<td>13</td>
<td>16</td>
<td>20</td>
<td>26</td>
<td>36</td>
<td>70</td>
<td>345</td>
</tr>
</tbody>
</table>

Notes: This table presents the empirical distribution for a number of HS8 product measures. The first, “HHI”, presents deciles of a share-based Herfindahl Index of Exporter concentration within HS8 products. The last two rows present the number of HS10-Exporter pairs in each HS8 industry, with and without group zero.

exporters on the results presented in Table 3. In particular, I run regressions excluding NAFTA countries, and also regressions excluding China. The motivation for the former is that while it is possible that much trade from NAFTA countries may be accounted as MFN even if preferences are available (since rules-of-origin can be onerous), it seems odd that either country (in particular Canada) would enter the database significantly. Regarding the latter, China is obviously a large and fast-growing export market, which enters the WTO during the sample and also engages in a substantial amount of vertical trade with the US. Thus, I remove both NAFTA countries and China separately to evaluate whether the results are driven by large regional trading partners and/or a massive growing exporter. The results from excluding these countries are presented in Table 5. Overall, high revenue varieties experience a muted effect of liberalization, and low revenue varieties experience an amplified effect. Further, relative to group one, high revenue varieties fared worse with lower tariffs than low revenue varieties, though when China is excluded, this difference is not significant at conventional levels.

Tariffs and Relative Market Penetration: HS8 Characteristics

The key to the model in section two is that quality-cost heterogeneity yields heterogeneous demand elasticities across varieties. To rank elasticities, import values are used, since they have a negative, monotone relationship with absolute demand elasticities. While the results thus far tend to support theory, I will now dig deeper to evaluate other explanations for the results, along with identifying HS8 product “types” that are more likely to support the theory.

First, I will examine how the level of exporter concentration within a given product influences the differential effect of tariffs within the same product. The effects of exporter concentration on bargained tariff cuts have been examined by Ludema and Mayda (2009), where they show that import markets with a higher concentration of export sources are forced to engage in larger tariff concessions. This is confirmed empirically using a US case study over a similar time-period to
that in this paper. The intuition is that since tariff cuts in the GATT/WTO are determined via extensive bargaining, agents in concentrated export sectors are less likely to free-ride off of tariff concessions negotiated by other exporters (since the other exporters are small in comparison). Thus, when exporter concentration is relatively large, free-riding is minimized and bargained tariff cuts in the import market are larger. In the specifications above, the Exporter-Industry fixed effects should control for mean differences exporter concentration. However, if exporter concentration has unmodeled and unobserved effects on the differential response to tariffs, the above estimates may be contaminated.

To examine these issues, within an HS8 product, I first aggregate trade from the HS10-Exporter level to the Exporter level over the period 1989-1990. Then, I construct a Hirschman-Herfindahl index (HHI) for each HS8 product based on the market share of exporters. The distribution of HHI is presented in the first row of Table 2. After identifying the median value of HHI across the entire sample, I group each product into “Low” and “High” measures of HHI. To examine the effects of exporter concentration, I interact dummy variables identifying low and high HHI products with all non-fixed effects in (14). The results are presented in the left panels of Table 6. Here, we find distinct differences in import elasticities for products that likely have very different industry structures, where only those products with below median HHI (low concentration) yield estimates which are consistent with the theory. In particular, for low HHI products, the estimated effect of tariffs is smallest for the top 20% of export sources in all regressions. In contrast, for products with high HHI, there is no systematic difference in elasticities across groups. As high HHI products do not seem to support the model developed in section two, this suggests that high HHI products may have different underlying demand characteristics, or that supply conditions are more favorable for suppliers which are highly successful relative to their peers.

Finally, recall that Proposition 2 details a condition on the relative values of $\gamma$, $\eta$, and $N$ such that the differential effect of tariff liberalization is strong enough to “kick out” high revenue varieties. While $\gamma$ and $\eta$ are hard to back-out of the data, $N$ can be approximated by the relative number of varieties within an HS8 product category. In Table 2, the last rows detail the distribution of the number of HS10-Exporter observations within each HS8 product. Remarkably, there is significant variation in the number of varieties within HS8 products across the sample. The minimum is 5 (by construction since quintiles require at least 5 observations). The maximum is over 400. I also report the number of varieties when restricting the sample to varieties with positive trade in 1989 and 1990.

Similar to HHI, I estimate the model with dummy variables identifying below median and above median values of $N$, and an interaction of these dummy variables with all non-fixed effects in the
model. The estimates, presented in the right panels of Table 6, are supportive of the result in Proposition 2. Here, when an HS8 product has a relatively large number of varieties, there is never a significant effect of tariffs on high revenue varieties, and always a significant effect of tariffs on low revenue varieties. In contrast, for HS8 products with a relatively low value of \( N \), the results are not supportive of the model.

**Tariffs and Relative Market Penetration: Does Quality play a role?**

As a final test of the model, I will address a potential role of variety-specific quality by constructing alternate within-product rankings based on quantity and price, to be evaluated alongside the value bins that have been used in the paper thus far. As discussed in the simple model in section 2, pre-tariff-cut revenues map in a monotonic fashion with quality-adjusted costs, and hence, demand elasticities. In contrast, it is not necessary that quantity or price map to quality-adjusted costs in a monotonic fashion. Hence, it makes sense to define bins by quantity and price, and to see whether the qualitative results are similar to value-based bins. If so, then it is likely that quality does not matter, or that costs and quality are related in a systematic fashion. If not, then it is sufficient to conclude that non-trivial correlations in quality and cost exist, both of which influencing demand elasticities.

To define quantity and price bins, I must restrict the sample to products for which units are consistent during the pre-period. Precisely, I restrict the sample to those HS8 products that use only one quantity over 1989 and 1990. After restricting the sample in this fashion, I define quantity and price bins according to a hypothetical ranking if quality played a minimal role. Precisely, when constructing quantity bins, varieties that did not trade in 1989 or 1990 will be placed in group \( Q_0 \). For varieties that were imported in both 1989 and 1990, groups \( Q_1 \) to \( Q_5 \) are ranked as above according to increasing quintiles of quantity within each HS8 product. For prices, \( P_0 \) will represent varieties that were not traded in 1989 or 1990. For groups \( P_1 \) to \( P_5 \), I assign varieties according to *decreasing* unit-value quintiles within HS8 products. To be clear, the highest 20% of reported prices will be in group \( P_1 \), and the lowest 20% of reported prices will be in group \( P_5 \).

To evaluate a potential role of quality, I run the same regression on the same sample, with the exception that varieties may be placed in different bins depending on the ranking scheme that is used. If quality plays a role, I hypothesize that value-based bins will capture more variation in trade growth than quantity and price bins. Further, if quality plays a role, the response to tariffs when bins are defined by price may be very different than with value bins. The results from these regressions are presented in Table 7. Whether using the full sample, or the restricted sample, the results when using value bins are similar to above, where specifically, low revenue varieties
benefit strongly from liberalization, and high revenue varieties do not benefit on any significant level. This is again suggestive of elasticities that are diminishing in revenues. When using quantity bins, the results are somewhat similar, though the ranking of coefficient estimates is not exactly consistent with those from regressions using value-based bins. Further, the value of adjusted $R^2$, which measures the residual variation explained by the model after accounting for fixed effects, is consistently one percentage point less than when using value bins. Since quality is the only factor that might remove the positive relationship between quantity and revenues, this suggests a role for quality in the model.

This point is even more stark when evaluating the differences in regression results when defining bins according to HS10-Exporter prices. Here, lower price varieties are assigned to higher groups, which adopts a convention that if quality does not play a role, lower price varieties should be imported at lower absolute demand elasticities. When looking at these results, first, we see that the amount of variation captured by the model is less than half of the variation captured when using value bins. Thus, price bins do not seem to capture the necessary characteristics that govern the effects of tariffs. Further, we see that of any group, the lowest price varieties (groups 4 and 5 when defined by price bins), which would have low elasticities with no quality dimension, are the most sensitive to tariffs. This suggests that there is a relevant role of quality in determining demand elasticities, and hence, a role of quality in governing the effects of tariffs.

4 Conclusion

This paper has presented a simple model of import market liberalization and bilateral trade. Theoretically, I show that when quality/cost heterogeneity yields differences in demand elasticities, trade liberalization necessarily increases imports only of varieties that are of high cost or low quality - both of which sold at relatively high demand elasticities and earning relatively low revenues. In evaluating the model using a case study of US tariff reductions resulting from the Uruguay Round, I find robust support for the model.

As for future work, the most promising extension is a policy-equipped framework to evaluate whether, in the presence of quality-cost heterogeneity, the current rules of the WTO are sufficient to guarantee efficiency in trade negotiations. I plan to address this issue in a follow-up paper.
References


A Extensive Margin

An aspect absent from the above model is a treatment of the extensive margin. As bilateral trade values, the object of interest in the empirical analysis, are recorded at the country level and not the variety level, it is crucial to address the extent to which aggregation and entry of new varieties matters for the above results. To examine these issues, I now derive an extended model in which $L$ exporters, indexed by $l$, supply to a common import market. Each exporter $l$ is identical with the exception of the distribution of quality-adjusted marginal costs, and the pool of potential exporting firms, $N_l$. Precisely, I assume that, for exporter $l$, quality-adjusted costs are distributed from 0 to $\tilde{c}_{\text{max}}$ with Pareto shape parameter $k_l$ ($>1$). The upper-bound on costs, $\tilde{c}_{\text{max}}$, is assumed to be non-binding, and thus larger than the demand intercept, $A$. Thus, the distribution of quality-adjusted costs for each country $l$ is written as:

$$G_l \left( \frac{c}{\lambda} \right) = \frac{\left( \frac{c}{\lambda} \right)^{k_l}}{(\tilde{c}_{\text{max}})^{k_l}}$$

Here, higher values of $k_l$ yield a higher quality-adjusted cost, on average.

Focusing on an arbitrary exporter $l$, I now will derive the relationship between quality-adjusted costs and import values. In (3), firms cannot sell unless their post-tariff price is less than or equal to $A$. This will occur if $\left( \frac{c_l}{\lambda} \right) \in [0, \frac{A}{\gamma t}]$. Thus, assuming that quality-adjusted costs are distributed according to $G_l \left( \frac{c}{\lambda} \right)$, the import value from country $l$ is written as:

$$V_l = \frac{N_l}{\tilde{c}_{\text{max}}^{k_l}} \frac{A^{2+k_l}}{2\gamma t^{1+k_l}(k_l+2)}$$

Similarly, total quality-adjusted quantity imported from importer $l$ is written as:

$$Q_l = \frac{N_l}{\tilde{c}_{\text{max}}^{k_l}} \frac{A^{1+k_l}}{2\gamma t^{k_l}(k_l+1)}$$

Next, I will establish that $V_l$ is decreasing in $k_l$ and then derive the effect of tariffs on import value from exporter $l$. Taking logs of $V_l$ and differentiating with respect to $k_l$:

$$\frac{\partial \log(V_l)}{\partial k_l} = \log \left( \frac{A}{\tilde{c}_{\text{max}} t} \right) - \frac{1}{k_l+2} < 0$$
The inequality follows from the assumption that $\tilde{c}_m$ is non-binding.\footnote{\tilde{c}_m > c_m > A implies that $\log \left( \frac{A}{\tilde{c}_m} \right) < 0$} Holding the level of potential exporters, $N_l$, constant, the value of imports from exporter $l$ is decreasing in $k_l$. Thus, unless the number of potential exported varieties does not rise strongly with $k_l$, those exporters with the highest quality-adjusted cost earn the lowest revenues.\footnote{Allowing $N_l$ to change with $k_l$, there is still a negative relationship between $k_l$ and $V_l$ if $\frac{\partial N_l k_l}{\partial k_l N_l} < k_l \left( \frac{1}{k_l + 2} - \log \left( \frac{A}{\tilde{c}_m} \right) \right)$. This seems like a sensible assumption to make, since if firms need capital to enter the foreign market, it is unlikely that more capital would be available in less efficient markets.}

With this relationship in mind, I now show that the results from the basic model described above remain despite including a flexible response at the extensive margin. Precisely, taking logs of $V_l$ and differentiating with respect to $t$, the elasticity of import value with respect to tariffs for country $l$ is written as follows:

\[
\varepsilon_{v,l} = k_l (\varepsilon_A - 1) + \left( 2 \varepsilon_A - 1 \right) \frac{\log \left( A \tilde{c}_m \right)}{\varepsilon_A} \quad (18)
\]

where,

\[
\varepsilon_A = \frac{1}{1 + \frac{\theta}{\eta \sum_{k \in L} Q_l k_l}} \in (0, 1)
\]

Again $\varepsilon_A > 0$, as higher tariffs decrease competitiveness and increase the residual consumer demand for each variety.

In (18), higher values of $k_l$ increase the negative impact of tariffs. Put differently, higher values of $k_l$ yield a larger range of $\varepsilon_A$ such that the impact of trade liberalization is negative. Precisely, rearranging (18), $\varepsilon_{v,l} < 0$ if the following condition is satisfied:

\[
\varepsilon_A < \frac{k_l + 1}{k_l + 2} \quad (19)
\]

As the right-hand side of (19) is increasing in $k_l$, higher values of $k_l$ yield a larger range of $\varepsilon_A$ such that liberalization increasing imports from exporter $l$. In the limit, as $k_l$ approaches infinity, (19) is always satisfied.

In summary, countries with a higher average quality-adjusted cost, who under reasonable conditions earn lower revenues, benefit the most from the liberalization of MFN tariffs.
B Trade Growth Pre-1989

In Figure 2, I provided evidence suggesting that tariffs had a meaningful effect on trade, and that trade growth before tariffs were cut was unrelated to future tariffs cuts. In Figure 3, I extend the illustration of trade growth back to 1980 using TSUSA data from the UC Davis for International Data. The issue with using TSUSA is that there exists no nested concordance with the HS classification system.

To begin, I calculate whether a TSUSA product receives a tariff cut during the Uruguay Round according to the following procedure. Precisely, I adopt the convention that a TSUSA product receives a tariff cut if at least one of the HS8 products that links to it receives a tariff cut. Once I have identified which TSUSA products received a tariff cut, I merge this information with the Exporter-TSUSA bilateral import data over the period 1980-1988.

To measure relative trade growth for observations occurring in 1989 or later, I first calculate the log of the ratio of imports in year $t$ to imports in 1992 for each HS10-Exporter pair. Then, for each year, I de-mean these growth rates across Exporter-SITC4 pairs. SITC4 is used because it has a nested link to both HS8 and TSUSA. Thus, in each year after 1989, average trade growth relative to 1992 is equal to zero. For observations occurring before 1989, I first calculate the log of the ratio of imports in year $t$ to imports in 1988 for each TSUSA-Exporter pair. Then, for each year, I de-mean these growth rates across Exporter-SITC4 pairs. Thus, in each year before 1988, average trade growth relative to 1988 is equal to zero.

In Figure 3, I have decomposed this “zero” into HS8 products that received a tariff cut, and HS8 products that did not. Similar to Figure 2, we see that there is no obvious difference in pre-Uruguay Round import growth rates between products that received a tariff cut over 1994-2004 and those that didn’t.
Figure 3: Bilateral Trade Growth - 1980-2004

The figure illustrates the bilateral trade growth from 1980 to 2004, with trade growth represented in terms of 1992 Base for HS and 1988 Base for TSUSA. The graph shows two data sets: TSUSA Data and HS Data. The HS Data line is indicated by a solid black dot, representing HS8 Tariff Cut in 1994-2004, while the TSUSA Data line is represented by an open circle, indicating No HS8 Tariff Cut in 1994-2004. The Final Act signed is marked by an arrow on the graph.
Table 3: Effects of MFN tariffs by within-product quintile

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| TARIFFS |  |  |  |  |  |  |  |  |  |  |  |  |

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| TARIFFS |  |  |  |  |  |  |  |  |  |  |  |  |

| N | 48600 | 48600 | 3242 | 13970 | 36634 | 36634 | 2540 | 11056 |
| Fixed Exporter_HS2 Exporter_HS4 Exporter_HS2 Exporter_HS4 Exporter_HS2 Exporter_HS4 Exporter_HS2 Exporter_HS4 |

| Adj R² | 0.038 | 0.044 | 0.038 | 0.044 | 0.036 | 0.05 | 0.036 | 0.051 | 0.036 | 0.051 | 0.036 | 0.051 |

Notes: The dependent variable is the log ratio of import value in 2004 to import value in 1992 for exporter j in HS10 industry i. The excluded group is 00, which is the dummy variable identifying whether exporter j in HS10 product i was not imported to the US during the years 1989 or 1990. The “Full Sample” includes all observations, including those of variables that were not imported in 1989 or 1990. The “Restricted Sample” excludes these variables. Fixed effects are estimated using a white procedure according to the groups listed in the column “Fixed”. Standard errors are heteroskedasticity robust and clustered by Exporter and Fixed effect industry (Exp_Hs4 fixed effects imply Exporter and HS4 clusters used for standard errors) according to the multi-level procedure in Cameron, Gelbach, and Miller (2006). The labels *, **, and *** identify estimates which are significantly different from zero at the 10%, 5%, and 1% levels, respectively. “Adj R²” reports adjusted R² values for the regression after the data has been demeaned by the fixed effects.
Table 4: Effects of MFN tariffs by within-product quintile: Exporter Characteristics

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<td>0.03</td>
<td>-0.89**</td>
<td>-0.906</td>
</tr>
<tr>
<td>0.09</td>
<td>-1.227**</td>
<td>-1.244**</td>
</tr>
<tr>
<td>0.10</td>
<td>-1.817**</td>
<td>-1.689</td>
</tr>
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</tr>
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<td>1.615</td>
</tr>
<tr>
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<td>1.615</td>
</tr>
<tr>
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</tr>
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</tr>
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<td>1.188</td>
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<td>0.051</td>
<td>0.039</td>
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<tr>
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<td>0.051</td>
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<td>0.064</td>
<td>0.051</td>
</tr>
<tr>
<td>0.04</td>
<td>0.046</td>
<td>0.051</td>
</tr>
<tr>
<td>0.04</td>
<td>0.064</td>
<td>0.051</td>
</tr>
</tbody>
</table>

Exporter-Tariff Interaction

| **θ**                  | **β**       | **β**                                              |
| -0.018                 | -0.029      | -0.022                                             |
| 0.069                  | -0.315**    | -0.33**                                            |
| 0.075                  | -0.597**    | -0.61**                                           |
| 0.078                  | -0.880**    | -0.89**                                          |
| 0.095                  | -1.224**    | -1.237**                                          |
| 0.109                  | 0.143       | 0.166                                             |
| 1.931                  | 1.201       | 2.081                                             |
| 1.609                  | 1.957       | 2.053                                             |
| 1.029                  | 1.082       | 1.818                                             |
| 1.936                  | 1.957       | 2.053                                             |
| 3.26                   | 3.056       | 1.818                                             |
| 3.46**                 | 3.58**      | 1.818                                             |
| 1.715                  | 1.743       | 1.818                                             |
| -3.745**               | -1.195**    | -3.938**                                          |
| 0.04                   | 0.047       | 0.04                                             |
| 0.04                   | 0.054       | 0.04                                             |
| 0.04                   | 0.066       | 0.04                                             |

Notes: The dependent variable is the log ratio of import value in 2004 to import value in 1992 for exporter j in HS10 industry l. The excluded group is D0, which is the dummy variable identifying whether exporter j in HS10 product i was not imported to the US during the years 1989 or 1990. The “Full Sample” includes all observations, including those of varieties that were not imported in 1989 or 1990. The “Restricted Sample” excludes these varieties. Fixed effects are estimated using a within procedure according to the groups listed in the column “Fixed”. Standard errors are heteroskedasticity robust and clustered by Exporter and Fixed effect industry (Exp_Hs4 fixed effects implies Exporter and HS4 clusters used for standard errors) according to the multi-level procedure in Cameron, Gelbach, and Miller (2006). The labels **, *, and *** identify estimates which are significantly different from zero at the 10%, 5%, and 1% levels, respectively. "adj R2" reports adjusted R2 values for the regression after the data has been demeaned by the fixed effects.
### Table 5: Effects of MFN tariffs by within-product quintile: No NAFTA, CHINA

<table>
<thead>
<tr>
<th><strong>Full Sample</strong></th>
<th><strong>No China</strong></th>
<th><strong>No NAFTA</strong></th>
<th><strong>No China, No NAFTA</strong></th>
<th><strong>No China, No NAFTA</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>( \beta_0 )</td>
<td>-0.015</td>
<td>-0.015</td>
<td>-0.006</td>
<td>-0.006</td>
</tr>
<tr>
<td>( \beta_1 )</td>
<td>0.073</td>
<td>0.073</td>
<td>0.085</td>
<td>0.085</td>
</tr>
<tr>
<td>( \beta_2 )</td>
<td>-0.287***</td>
<td>-0.287***</td>
<td>-0.366***</td>
<td>-0.366***</td>
</tr>
<tr>
<td>( \beta_3 )</td>
<td>0.097</td>
<td>0.097</td>
<td>0.088</td>
<td>0.088</td>
</tr>
<tr>
<td>( \beta_4 )</td>
<td>-0.594***</td>
<td>-0.594***</td>
<td>-0.508***</td>
<td>-0.508***</td>
</tr>
<tr>
<td>( \beta_5 )</td>
<td>0.078</td>
<td>0.078</td>
<td>0.085</td>
<td>0.085</td>
</tr>
<tr>
<td>( \beta_6 )</td>
<td>-0.843***</td>
<td>-0.843***</td>
<td>-0.762***</td>
<td>-0.762***</td>
</tr>
<tr>
<td>( \beta_7 )</td>
<td>0.093</td>
<td>0.093</td>
<td>0.095</td>
<td>0.095</td>
</tr>
<tr>
<td>( \beta_8 )</td>
<td>-1.211***</td>
<td>-1.211***</td>
<td>-1.535***</td>
<td>-1.535***</td>
</tr>
<tr>
<td>( \beta_9 )</td>
<td>0.104</td>
<td>0.104</td>
<td>0.122</td>
<td>0.122</td>
</tr>
<tr>
<td>( \beta_{10} )</td>
<td>-3.809</td>
<td>-3.809</td>
<td>-6.799***</td>
<td>-6.799***</td>
</tr>
<tr>
<td>( \beta_{11} )</td>
<td>0.779</td>
<td>0.779</td>
<td>0.121</td>
<td>0.121</td>
</tr>
<tr>
<td>( \beta_{12} )</td>
<td>0.014</td>
<td>0.014</td>
<td>0.012</td>
<td>0.012</td>
</tr>
<tr>
<td>( \beta_{13} )</td>
<td>0.046</td>
<td>0.046</td>
<td>0.053</td>
<td>0.053</td>
</tr>
<tr>
<td>( \beta_{14} )</td>
<td>0.042</td>
<td>0.042</td>
<td>0.049</td>
<td>0.049</td>
</tr>
<tr>
<td>( \beta_{15} )</td>
<td>-0.091</td>
<td>-0.091</td>
<td>-0.244***</td>
<td>-0.244***</td>
</tr>
<tr>
<td>( \beta_{16} )</td>
<td>0.064</td>
<td>0.064</td>
<td>0.073</td>
<td>0.073</td>
</tr>
<tr>
<td>( \beta_{17} )</td>
<td>-0.603***</td>
<td>-0.603***</td>
<td>-0.552***</td>
<td>-0.552***</td>
</tr>
<tr>
<td>( \beta_{18} )</td>
<td>0.050</td>
<td>0.050</td>
<td>0.071</td>
<td>0.071</td>
</tr>
<tr>
<td>( \beta_{19} )</td>
<td>-0.949***</td>
<td>-0.949***</td>
<td>-0.899***</td>
<td>-0.899***</td>
</tr>
<tr>
<td>( \beta_{20} )</td>
<td>0.066</td>
<td>0.066</td>
<td>0.071</td>
<td>0.071</td>
</tr>
<tr>
<td>( \beta_{21} )</td>
<td>-1.224***</td>
<td>-1.224***</td>
<td>-1.197***</td>
<td>-1.197***</td>
</tr>
<tr>
<td>( \beta_{22} )</td>
<td>0.088</td>
<td>0.088</td>
<td>0.106</td>
<td>0.106</td>
</tr>
<tr>
<td>( \beta_{23} )</td>
<td>-3.914</td>
<td>-3.914</td>
<td>-6.604***</td>
<td>-6.604***</td>
</tr>
<tr>
<td>( \beta_{24} )</td>
<td>-3.914</td>
<td>-3.914</td>
<td>-6.604***</td>
<td>-6.604***</td>
</tr>
<tr>
<td>( \beta_{25} )</td>
<td>-3.424</td>
<td>-3.424</td>
<td>-5.122***</td>
<td>-5.122***</td>
</tr>
<tr>
<td>( \beta_{26} )</td>
<td>0.873</td>
<td>0.873</td>
<td>0.918</td>
<td>0.918</td>
</tr>
<tr>
<td>( \beta_{27} )</td>
<td>-4.404***</td>
<td>-4.404***</td>
<td>-5.809**</td>
<td>-5.809**</td>
</tr>
<tr>
<td>( \beta_{28} )</td>
<td>0.078</td>
<td>0.078</td>
<td>0.097</td>
<td>0.097</td>
</tr>
<tr>
<td>( \beta_{29} )</td>
<td>-2.292</td>
<td>-2.292</td>
<td>-4.142***</td>
<td>-4.142***</td>
</tr>
<tr>
<td>( \beta_{30} )</td>
<td>0.163</td>
<td>0.163</td>
<td>0.716</td>
<td>0.716</td>
</tr>
<tr>
<td>( \beta_{31} )</td>
<td>0.061</td>
<td>0.061</td>
<td>0.073</td>
<td>0.073</td>
</tr>
<tr>
<td>( \beta_{32} )</td>
<td>-0.104***</td>
<td>-0.104***</td>
<td>-0.113***</td>
<td>-0.113***</td>
</tr>
<tr>
<td>( \beta_{33} )</td>
<td>0.011</td>
<td>0.011</td>
<td>0.012</td>
<td>0.012</td>
</tr>
<tr>
<td>( \beta_{34} )</td>
<td>-3.792***</td>
<td>-3.792***</td>
<td>-3.183***</td>
<td>-3.183***</td>
</tr>
<tr>
<td>( \beta_{35} )</td>
<td>0.025</td>
<td>0.025</td>
<td>0.064</td>
<td>0.064</td>
</tr>
</tbody>
</table>

Notes: The dependent variable is the log ratio of export value in 2004 to import value in 1992 for exporter j in HS10 industry i. The excluded group is D0, which is the dummy variable identifying whether exporter j in HS10 product i was not exported to the US during the years 1989 or 1990. The "Full Sample" includes all observations, including those of varieties that were not imported in 1989 or 1990. The "Restricted Sample" excludes these varieties. Fixed effects are estimated using within procedure according to the groups listed in the column "Fixed". Standard errors are heteroskedasticity robust and clustered by Exporter and Fixed effect industry (Exp_HS4 fixed effects implies Exporter and HS4 clusters used for standard error). According to the multi-level procedure in Cameron, Gelbach, and Miller (2006). The labels ***, **, and * identify estimates which are significantly different from zero at the 10%, 5%, and 1% levels, respectively. Adj R^2 reports adjusted R^2 values for the regression after the data has been demeaned by the fixed effects.
Table 6: Effects of MFN tariffs by within-product quintile: Exporter HHI, and Number of Varieties

<table>
<thead>
<tr>
<th>Cluster ID</th>
<th>Number of Clusters</th>
<th>N</th>
<th>Fixed Exporter_HS2</th>
<th>Fixed Exporter_HS4</th>
<th>Restricted Sample</th>
<th>N</th>
<th>Fixed Exporter_HS2</th>
<th>Fixed Exporter_HS4</th>
<th>Restricted Sample</th>
</tr>
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<tr>
<td></td>
<td></td>
<td>3242</td>
<td>13970</td>
<td>3242</td>
<td>13970</td>
<td>36634</td>
<td>36634</td>
<td>36634</td>
<td>36634</td>
</tr>
<tr>
<td>HS8 Exporter Concentration</td>
<td>Full Sample</td>
<td>Low HHI</td>
<td>High HHI</td>
<td>Low HHI</td>
<td>High HHI</td>
<td>Low HN</td>
<td>High HN</td>
<td>Low HN</td>
<td>High HN</td>
</tr>
<tr>
<td>( \beta_{\text{hs}} )</td>
<td>-0.087</td>
<td>-0.105</td>
<td>[0.083]</td>
<td>[0.105]</td>
<td>[0.039]</td>
<td>[0.093]</td>
<td>0.076</td>
<td>0.037</td>
<td></td>
</tr>
<tr>
<td>( \beta_{\text{ss}} )</td>
<td>-0.018</td>
<td>-0.086</td>
<td>-0.011</td>
<td>-0.051</td>
<td>-0.049</td>
<td>-0.113</td>
<td>0.028</td>
<td>0.029</td>
<td></td>
</tr>
<tr>
<td>( \beta_{\text{as}} )</td>
<td>-0.281***</td>
<td>-0.449***</td>
<td>-0.217***</td>
<td>-0.404***</td>
<td>-0.594***</td>
<td>-0.248***</td>
<td>-0.524***</td>
<td>-0.653***</td>
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<tr>
<td>( \beta_{\text{as}} )</td>
<td>-0.621***</td>
<td>-0.604***</td>
<td>-0.529***</td>
<td>-0.553***</td>
<td>-0.724***</td>
<td>-0.583***</td>
<td>-0.671***</td>
<td>-0.575***</td>
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</tr>
<tr>
<td>( \beta_{\text{as}} )</td>
<td>-0.846***</td>
<td>-1.039***</td>
<td>-0.778***</td>
<td>-0.956***</td>
<td>-1.132***</td>
<td>-0.836***</td>
<td>-1.076***</td>
<td>-0.763***</td>
<td></td>
</tr>
<tr>
<td>( \beta_{\text{as}} )</td>
<td>-1.144***</td>
<td>-1.488***</td>
<td>-1.097***</td>
<td>-1.506***</td>
<td>-1.363***</td>
<td>-1.222***</td>
<td>-1.422***</td>
<td>-1.156***</td>
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</tr>
<tr>
<td>( \beta_{\text{as}} )</td>
<td>-1.468**</td>
<td>-1.603</td>
<td>-0.700**</td>
<td>-1.499**</td>
<td>-2.715</td>
<td>-1.527**</td>
<td>-3.017</td>
<td>-1.876**</td>
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</tr>
<tr>
<td>( \beta_{\text{as}} )</td>
<td>-4.523***</td>
<td>-1.603</td>
<td>-0.808***</td>
<td>-2.498</td>
<td>-3.729</td>
<td>-3.553**</td>
<td>-5.021</td>
<td>-3.097</td>
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</tr>
<tr>
<td>( \beta_{\text{as}} )</td>
<td>-1.187</td>
<td>-3.441</td>
<td>-3.132</td>
<td>-3.421</td>
<td>-5.024</td>
<td>-3.132</td>
<td>-5.546</td>
<td>-2.666</td>
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</tr>
<tr>
<td>( \beta_{\text{as}} )</td>
<td>-2.355</td>
<td>-2.266</td>
<td>-2.22</td>
<td>-2.791</td>
<td>-2.492</td>
<td>-2.968</td>
<td>-2.686</td>
<td>-2.488</td>
<td></td>
</tr>
<tr>
<td>( \beta_{\text{as}} )</td>
<td>0.125</td>
<td>-3.549</td>
<td>-1.006</td>
<td>-5.826**</td>
<td>-2.014</td>
<td>-0.734</td>
<td>-5.903***</td>
<td>-1.199</td>
<td></td>
</tr>
<tr>
<td>( \beta_{\text{as}} )</td>
<td>-3.741***</td>
<td>-3.769***</td>
<td>-1.153***</td>
<td>-1.163***</td>
<td>-3.842***</td>
<td>-3.739***</td>
<td>-1.195***</td>
<td>-1.142***</td>
<td></td>
</tr>
<tr>
<td>( \beta_{\text{as}} )</td>
<td>[0.771]</td>
<td>[0.789]</td>
<td>[0.126]</td>
<td>[0.124]</td>
<td>[0.774]</td>
<td>[0.763]</td>
<td>[0.128]</td>
<td>[0.126]</td>
<td></td>
</tr>
</tbody>
</table>

| HS8 Exporter Concentration | Full Sample | Low HHI | High HHI | Low HHI | High HHI | Low N | High N | Low N | High N | Low N | High N |
| \( \beta_{\text{hs}} \) | -0.006 | -0.08 | [0.111] | [0.119] | [0.134] | [0.178] | -0.112 | -0.283 |
| \( \beta_{\text{ss}} \) | -0.283*** | -0.393*** | -0.216*** | -0.386*** | -0.383*** | -0.295*** | -0.251* | -0.269*** |
| \( \beta_{\text{as}} \) | -0.613*** | -0.578*** | -0.542*** | -0.572*** | -0.523*** | -0.632*** | -0.426*** | -0.589*** |
| \( \beta_{\text{as}} \) | -0.834*** | -0.999*** | -0.793*** | -0.936*** | -0.939*** | -0.872*** | -0.825*** | -0.844*** |
| \( \beta_{\text{as}} \) | -1.136*** | -1.447*** | -1.102*** | -1.483*** | -1.16*** | -1.266*** | -1.148*** | -1.234*** |
| \( \beta_{\text{as}} \) | -5.377*** | -2.914 | -7.428*** | -4.319 | -3.395 | -5.444** | -5.03 | -7.599*** |
| \( \beta_{\text{as}} \) | -3.052 | -5.02 | -3.814 | -7.165** | -6.814*** | -2.568 | -7.269*** | -4.224 |
| \( \beta_{\text{as}} \) | -4.916*** | -1.939 | -5.068*** | -2.794 | -3.526 | -4.162** | -5.006 | -4.101** |
| \( \beta_{\text{as}} \) | -2.187 | -3.615 | -4.33*** | -4.515* | -5.496*** | -1.494 | -6.843*** | -3.455 |
| \( \beta_{\text{as}} \) | -2.376*** | -2.213 | -1.941*** | -2.637* | -2.41 | -1.951** | -2.617*** | -2.143*** |
| \( \beta_{\text{as}} \) | -0.544 | -3.564 | -1.805 | -5.815*** | -2.19 | -1.23 | -6.043*** | -1.787 |
| \( \beta_{\text{as}} \) | -4.274 | -2.331 | -2.878*** | -2.524* | -2.457 | -2.429*** | -2.394*** | -2.747*** |
| \( \beta_{\text{as}} \) | -0.102** | -0.114*** | -0.109*** | -0.13*** | -0.105*** | -0.107*** | -0.127*** | -0.111*** |
| \( \beta_{\text{as}} \) | -3.941*** | -3.911*** | -2.129*** | -2.155*** | -4.088*** | -3.912*** | -1.284*** | -1.196*** |
| \( \beta_{\text{as}} \) | [0.829] | [0.846] | [0.145] | [0.141] | [0.834] | [0.822] | [0.141] | [0.148] |

Notes: The dependent variable is the log ratio of import value in 2004 to import value in 1992 for exporter j in HS10 industry i. The excluded groups are D0, which is the dummy variable identifying whether exporter j in HS10 product i was not imported to the US during the years 1989 or 1990, and the dummy variable identifying above median HHI or N. The "Full Sample" includes all observations, including those of variables that were not imported in 1989 or 1990. The "Restricted Sample" excludes these varieties. Fixed effects are estimated using within procedure according to the groups listed in the column "Fixed". Standard errors are heteroskedasticity robust and clustered by Exporter and Fixed effect industry (Exp_HS4 fixed effects). Exporter and HS4 clusters used for standard errors) according to the multi-level procedure in Cameron, Gelbach, and Miller (2006). The labels *, **, and *** identify estimates which are significantly different from zero at the 10%, 5%, and 1% levels, respectively. "Adj R²" reports adjusted R² values for the regression after the data has been demeaned by the fixed effects.
Table 7: Comparison of Value, Quantity, and Price bins

<table>
<thead>
<tr>
<th>Bin Definition</th>
<th>Full Sample</th>
<th>Restricted Sample: Positive Trade in 1989 and 1990</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Value</td>
<td>Quantity</td>
</tr>
<tr>
<td>Adj R^2</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>N</td>
<td>33411</td>
<td>10829</td>
</tr>
<tr>
<td>Fixed</td>
<td>2795</td>
<td>9985</td>
</tr>
<tr>
<td>Fixed Clusters</td>
<td>2795</td>
<td>9985</td>
</tr>
</tbody>
</table>

The dependent variable is the log ratio of import value in 2004 to import value in 1992 for exporter j in HS10 industry i. The excluded group is 00, which is the dummy variable identifying whether exporter j in HS10 product i was not imported to the US during the years 1989 or 1990. The “Full Sample” includes all observations, including those of varieties that were not imported in 1989 or 1990. The “Restricted Sample” excludes these varieties. Fixed effects are estimated using a within procedure according to the groups listed in the column “Fixed.” Standard errors are heteroskedasticity robust and included by Exporter and Fixed effect industry (Exp. HS4 fixed effects includes Exporter and HS4 clusters used for standard errors) according to the multi-level procedure in Cameron, Gelbach, and Miller (2006). The labels *, **, and *** identify estimates which are significantly different from zero at the 10%, 5%, and 1% levels respectively. "Adj R^2" reports adjusted R^2 values for the regression after the data has been demeaned by the fixed effects.