Tariffs, Competition, and the Long of Firm Heterogeneity Models

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Abstract

I derive a novel solution for the long run, competitive effects of tariffs that is general for many countries, robust to rich cross-country heterogeneity, and a function of only aggregate trade data and country-by-industry Pareto shape parameters. Using this solution, I estimate a structural trade growth equation that is a function of shape parameters, trade flows and tariff cuts. The shape estimates indicate that larger and more developed exporters have, on average, bigger surviving firms, and when evaluated on a common import market, exporters with a better shape earn larger trade revenues. Using the shape estimates, I return to the model to back-out measures of relative competition across countries, where within-industries, less developed countries with a relatively poor shape of firms tend to have less competitive markets. However, I find that countries with less competitive markets experience a greater increase in competition over the sample period, suggesting that firms enter where competition is less fierce. Finally, counterfactuals indicate that tariff cuts over 1994-2000 increased competition in 80% of markets.

Key Words: Firm-heterogeneity, Free Entry, Productivity Estimation, Tariffs, Trade agreements

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1 Introduction

Tariff liberalization is often cited as a way to discipline domestic firms to the benefit of consumers, either by lowering the price of imported goods or making feasible the import of new varieties. However, the ultimate effects of trade liberalization depend on the presence of firms, and their entry and exit choices. For example, classical wisdom suggests that lower tariffs within an import-competing sector will reduce the domestic relative price of that good as long as preliminaries of the model preclude the presence of a Metzler paradox (Metzler (1949)). In new trade models, while classical wisdom is valid in the short-run, firms may adjust entry choices in the long-run. Initially discussed in Venables (1985), a common prediction in nearly all new trade models is one in which unilateral tariff liberalization *decreases* competition in the liberalizing market due to a particularly strong exit of firms. Indeed, the disciplining effect of tariff cuts may go too far, and ultimately hurt consumers in the long-run.[1]

How general are these long-run results? As much of the received literature is based on quasi-symmetric models with relatively few trading partners, the implications of a large tariff shock for the world economy are not yet clear. This is especially the case if variation in country-level characteristics, such as productivity distributions, lead certain countries to be less responsive to shocks and the actions of other firms.[2] Beyond the theoretical results, how do we characterize the effects of entry empirically? If we are to evaluate the effects of entry on the welfare of consumers, we need an empirically feasible model that accounts for the long-run decisions of firms across countries and industries.

In this paper, I examine the long-run effects of tariffs within common firm-heterogeneity models, but in the presence of rich cross-country heterogeneity. The primary theoretical contribution is showing that while the link between tariffs and free entry depends on how countries vary in their underlying characteristics such as productivity distributions and tastes, there exists a simple structural relationship between tariffs and competition that is a function of only a bilateral trade matrix and a vector of country-by-industry Pareto distribution shape parameters. Embedding this relationship within a standard trade flow equation, I structurally estimate these shape parameters using trade flows and tariff cuts subsequent to the Uruguay Round. Armed with the shape estimates, I use trade data to back-out estimates of within-industry rel-

[1] See Melitz and Ottaviano (2008).

[2] Any adjustment in the labor market (Demidova and Rodriguez-Clare (2011)) or the nature of competition (de Blas and Russ (2012)) can produce additional mechanisms that change the long-run effects of liberalization.

ative competition across countries, and counterfactuals related to tariff shocks. The latter suggest that multilateral liberalization subsequent to the Uruguay Round increased competition in 80% of markets, but unilateral liberalization would almost surely decrease competition in liberalizing markets.

I introduce these issues by employing an extended version of Melitz and Ottaviano (2008), which produces variable demand elasticities similar to those empirically supported in Foster, Haltiwanger, and Syverson (2008).[3] The main innovation in my framework is allowing for variation in the shape of the Pareto distribution that governs productivity draws by country and industry.[4] Indeed, shape heterogeneity in the presence of elasticity variation is important on three levels. First, the setup can match the empirical relationship between larger export flows and larger surviving exporting firms.[5] Second, shape variation yields tariff elasticity differences across exporting countries that match the empirical results presented in Spearot (2013). Finally, shape variation affects average profit margins of surviving firms, the probability of survival itself, and the elasticity of survival to shocks, all of which critical for entry decisions.

However, shape heterogeneity complicates the assessment of free entry conditions in that the elasticity of the extensive margin to shocks now varies by location. As a result, the system of free entry conditions that pins down long-run demand within each market is highly non-linear, and may be satisfied by multiple candidate solutions on the interior.[6] To work around this issue, I exploit a simple link between expected profits and expected trade values. Specifically, when using the Pareto distribution, expected profits and expected trade values are proportional to each other, and this proportion is a simple function of the Pareto shape parameter. Subsequently, a percent shock to a tariff or demand parameter within expected profits is also proportional to trade value to that market. Using this link, I show that despite the highly non-linear system of free entry conditions, the long-run response of demand in each market to trade shocks is a simple function of the matrix of trade flows and a vector of productivity shape parameters. For any

[3] I also discuss how the results relate to CES models similar to Melitz (2003), Helpman, Melitz, and Yeaple (2004), Chaney (2008), Arkolakis, Costinot, and Rodriguez-Clare (2011), and Melitz and Redding (2013). Atkeson and Burstein (2008) also produces variable demand elasticities, but the cournot competition assumption is intractable in my setting.

[4] This is consistent with the class of productivity variation modeled in Demidova (2008), but different from variation in the upper bound of the cost distribution as in Melitz and Ottaviano (2008), Hsieh and Ossa (2011), and Bombardini, Kurz, and Morrow (2012).

[5] Using Columbian transaction level import data for 2003, I reject the assumption that average exporter-size is constant within import categories to Colombia. See section two.

[6] Similar complications would arise in other models with adjustments that are not elasticity neutral - for example, Helpman, Melitz, and Rubinstein (2008). However, in these papers free entry is not modeled. Other multi-region models, such as Combes, Duranton, Gobillon, Puga, and Roux (2012), do not allow for such productivity shape heterogeneity.

non-degenerate matrix of trade flows, the long-run demand response to tariffs is unique.

To evaluate the model empirically, I embed the demand response to tariffs via free entry conditions within a log-differentiated trade flow equation. Doing so yields a structural relationship between the growth rate in bilateral trade, a matrix of trade values, tariff cuts, and a vector of Pareto shape parameters. To structurally estimate these shape parameters, I use sectoral trade flow and tariff cut data that occurred subsequent to the period of Uruguay Round tariff negotiations. To my knowledge these are the first estimates of country-by-industry Pareto shape parameters using a common dataset, and despite using aggregate data, the estimates are within sensible bounds and in the vicinity of parameters estimated using firm-level data (eg. Eaton, Kortum, and Kramarz (2011) and Di Giovanni, Levchenko, and Ranciere (2011)).[7] In terms of the relationship to country and industry observables, I find that larger, more developed markets are associated with a better skew of firms in terms of productivity. However (surprisingly), I do not find a relationship between estimated shape parameters and country-industry measures of capital and input intensity, suggesting that production technology is not driving the variation in shape.

Armed with the shape estimates, I return to the model to back-out measures of relative competition across markets, and the response of competition to tariff shocks. In terms of the former, I show that taking the difference between log exports to a given import market and a benchmark market, and then differencing this with a similar measure for a separate exporter, the only remaining variation is a function of observed tariffs, relative competition between the import market and the benchmark market, and the shape estimates of the two exporters involved in the second layer of differencing. Inputing the shape estimates, trade data, and observed tariff cuts, I employ separate parametric and non-parametric estimators to measure competition within industries relative to the US (the benchmark). The results indicate that countries with a better shape of domestic firms, as well as countries that are more developed, have a more competitive market relative to the US. Further, I find that countries with less competitive markets experience a greater increase in competition over the sample period, suggesting that firms enter where competition is less fierce.

To close the paper, I use the estimates to evaluate two counterfactual predictions related to tariffs and competition. First, focusing on multilateral liberalization, I calculate the role of changing competitiveness

[7] Okubo and Tomiura (2013) do provide regional estimates of productivity distributions in Japan using firm-level data, and find that productivity is more left-skewed in agglomerated regions. Newer work is moving toward using the log-normal distribution to better match the the moments of the data. See Head, Mayer, and Thoenig (2013).

during the course of Uruguay Round tariff cuts. I find that the Uruguay Round increased competition across 80% of country-industry pairs, with this effect most likely in developed markets such as the US, UK, and Germany.[8] Finally, I use the structural model and estimates to evaluate the extent to which unilateral liberalization increases competition, where I find the striking result that in nearly every country-industry pair, unilateral tariff cuts decrease long-run competition. In the few instances that it does not, this occurs in very small and under-developed countries.

Overall, this paper adds a new tool in the evaluation of tariffs and other trade shocks. The structural estimation is related to Eaton and Kortum (2002), Dekle, Eaton, and Kortum (2008) Eaton, Kortum, and Kramarz (2011), Caron, Fally, and Markusen (2012), Edmond, Midrigan, and Xu (2012), and Breinlich and Cuñat (2013), though it is most like Dekle, Eaton, and Kortum (2008) in that changes to aggregate terms are a simple function of observable data. However, the simple relationship I uncover works through the proportionality of average profits and average revenues, which is distinct from Dekle, Eaton, and Kortum (2008), and may vary country-by-industry with the shape of the Pareto distribution. Hsieh and Ossa (2011) also allow for country-by-industry heterogeneity, though focus on the support of the distribution rather than the shape.

The paper is also related to Arkolakis, Costinot, and Rodriguez-Clare (2011), Arkolakis, Costinot, Donaldson, and Rodríguez-Clare (2012), Costinot and Rodríguez-Clare (2012), and Burstein and Cravino (2012), which prove and/or quantify the welfare gains from trade for a wide class of models. My approach is distinct in that it focuses on only entry as the conduit for aggregate effects, and outlines an empirical approach that is robust to heterogeneity in productivity distributions and other exporter and importer shocks not related to tariffs. However, my paper (heavily) exploits proportionality in average profits and average revenues at the bilateral level, which is similar to the aggregate restrictions in Arkolakis, Costinot, and Rodriguez-Clare (2011). Indeed, combining all approaches may yield future gains in terms of unpacking the components of firm-heterogeneity models and their impact on economic aggregates. Finally, my paper provides two ways to view selection and the response of selection to shocks, complementing the theoretical treatment in Mrázová and Neary (2013).

[8] This is consistent with the empirical work in Feenstra and Weinstein (2010), which estimates that mark-ups in the US have fallen over this period.

2 General Setup and Motivation

In terms of the general setup, I will utilize the framework in Melitz and Ottaviano (2008) as the base model. However, I will adjust this particular firm-heterogeneity model to account for differences in productivity distributions across supplying countries, in tastes across consuming countries, and for differences in the level of "internal" mark-up within each market. Further, I will discuss how other models (eg. constant elasticity demand) relate to the structural relationships presented in the manuscript.

Consumers

Consumer preferences in each country are specified according to the following form

$$U_l = x^c_{0,l} + \theta_l \int_{i\in\Omega_l} q^c_{i,l} di - \frac{1}{2}\eta \left(\int_{i\in\Omega_l} q^c_{i,l} di \right)^2 - \frac{1}{2}\gamma \int_{i\in\Omega_l} \left(q^c_{i,l} \right)^2 di, \qquad (1)$$

where Ω_l represents the measure of varieties available in country l, $q^c_{i,l}$ is the consumption of variety i by the representative consumer in l, and the parameters θ_l (> 0) and η (> 0) determine the substitution pattern between the differentiated industry and the outside good, $x^c_{0,l}$. Note that I allow θ_l to differ across countries, which implies that countries may differ fundamentally in their valuation for the differentiated good relative to the numeraire. Finally, γ (> 0) represents the degree to which varieties are substitutable. If γ were zero, all firms would price at the same level, since products would be homogeneous in the eyes of the consumer.

The budget constraint faced by consumers in country l is written as:

$$x^c_{0,l} + \int_{i\in\Omega_j} p^c_{i,l} q^c_{i,l} di \leq I_l \qquad (2)$$

where $p^c_{i,l}$ is the delivered consumer price of variety i to l. Note that implicit in this budget constraint is the assumption that the numeraire is freely traded. As in the existing literature, I will assume that income I_l is such that consumers have positive consumption in both the outside good and differentiated industries.

Hence, the inverse demand function for a given variety i in country l is derived as:

$$p_{i,l}^c \quad = \quad \underbrace{\theta_l - \eta Q_l^c}_{A_l} - \underbrace{\frac{\gamma}{L_l}}_{b_l} q_{i,l} = A_l - b_l q_{i,l} \tag{3}$$

In (3), $q_{i,l}$ is total quantity sold of i to all consumers in l, Q_l^c is the total quantity sold by all firms to the representative consumer in l, and A_l contains all aggregate terms within the demand curve for each variety in l. The focus of the paper will be how competition changes with tariffs as reflected in A_l. Finally, b_l will measure the slope of the aggregate demand curve for each variety in l, which is γ scaled inversely by the number of consumers in l.

Firms

The characterization of firms in each country j is relatively simple. Firms enter under uncertainty, paying a fixed entry cost F_j. Upon entry, firms from country j draw a marginal cost c from a country-specific Pareto distribution with the following pdf:

$$g(c) = k_j \frac{c^{k_j - 1}}{(c_j^m)^{k_j}} \quad , \quad c \in [0, c_j^m] \tag{4}$$

In (4), there are two-layers of productivity heterogeneity across countries. First, slightly more standard in the literature is variation in the upper-bound of the distribution c_j^m, which we henceforth assume to be non-binding for any country selling to any market.[9] The second-layer, which is non-standard (other than a similar class of heterogeneity in Demidova (2008) and Demidova and Rodriguez-Clare (2011)), is variation in the Pareto parameter, k_j. Variation in this parameter across countries will be crucial for the results, and we will discuss the empirical implications of this parameter shortly.

Each firm from a given country j may sell one variety to each market, paying an ad-valorem tariff τ_{jl} on the value of each unit sold from j to l. Note that we allow this tariff to be negative, in that case implying an import subsidy, and that $\tau_{jl} = 0$ when $j = l$. In addition to the tariff, all firms selling to market l will be subject to an ad-valorem sales tax $\tilde{s}_l$. Though we refer to it as a sales tax for exposition, I will later

[9] For example, see Melitz and Ottaviano (2008), Hsieh and Ossa (2011) and Bombardini, Kurz, and Morrow (2012).

discuss how other domestic characteristics have a similar effect on demand.[10] The relationship between the consumer price for variety i detailed in (3) and the price that the foreign producer of i receives is $p^c_{i,jl} = (1+\tau_{jl})(1+\tilde{s}_l)p^s_{i,jl}$. This yields the following inverse demand function that supplier i from country j uses to optimally set production for market l.

$$p^s_{i,jl} = \frac{1}{t_{jl}s_l}\left(A_l - b_l q_{i,jl}\right)$$

where, $t_{jl} = (1+\tau_{jl})$ and $s_l = (1+\tilde{s}_l)$.

Firms choose quantities to maximize profits, where the maximization problem for firm i from j exporting to l is written as:

$$\pi_{i,jl}\left(c_i\right) = \max_{q_{i,jl}}\left\{\frac{1}{t_{jl}s_l}\left(A_l - b_l q_{i,jl}\right)\cdot q_{i,jl} - c_i q_{i,jl}\right\}.$$

Suppressing i's for the remainder of the paper, the optimal quantity in selling to l from j is written as,

$$q_{jl}(c) = \frac{A_l - c t_{jl} s_l}{2b_l},$$

producer revenues are written as

$$v_{jl}(c) = \frac{A_l^2 - (c t_{jl} s_l)^2}{4 b_l t_{jl} s_l},$$

and profits are written as

$$\pi_{jl}(c) = \frac{(A_l - c t_{jl} s_l)^2}{4 b_l t_{jl} s_l}.$$

Pareto Shape and Average Firm-size

To motivate the more nuanced differences in productivity distributions that I exploit throughout the paper, I now solve for the average (surviving) firm-level export value from country j to import market l. Precisely,

[10] And though it may seem superfluous for a majority of the theory, $\tilde{s}_l$ will be crucial in terms of deriving an empirical specification that is robust to unobserved market-specific shocks.

I integrate the firm-level revenues over $[0, \frac{A_l}{t_{jl}s_l}]$, subject to the truncated productivity distribution, $\frac{g_j(c)}{G_j(\frac{A_l}{t_{jl}s_l})}$:

$$\overline{v}_{jl} = \int_0^{\frac{A_l}{t_{jl}s_l}} \frac{A_l^2 - (ct_{jl}s_l)^2}{4b_l t_{jl} s_l} \frac{g_j(c)}{G_j(\frac{A_l}{t_{jl}s_l})} dc = \frac{A_l^2}{2b_l s_l t_{jl}(k_j+2)} \tag{5}$$

In (5), the average surviving firm-level export value *does not* depend on the upper bound of the Pareto parameter. This is due to average export value being a truncated average (conditional on export status). Thus, when imposing the Pareto distribution, and after controlling for tariffs, average exporter size within an industry does not vary across exporters unless the Pareto parameter k_j differs across j. Further, given the monotone relationship between revenues and elasticities, average elasticities do not vary when k_j is homogenous since average firm-level revenues do not vary.[11]

In Figure 1, I present evidence using transaction-level import data from Colombia that is not consistent with the assumption of constant k_j across exporters. Specifically, I show that within HS6 products, there is a strong and positive relationship between total export value to Colombia by Exporter-HS6 group (V_{jl}), and the average revenues earned by the successful exporting firms ($\overline{v}_{jl}$) within the same Exporter-HS6 group. While this relationship is intuitive, with no variation in k_j, there should be no such relationship in the data. Further, in Spearot (2013), I provide evidence the rejects the assumption of constant tariff elasticities when evaluating MFN tariff cuts and imports to the US. On both levels, allowing for k_j's to differ by country and industry is important to capture the composition of exporting firms across countries, and the response of these firms to shocks.

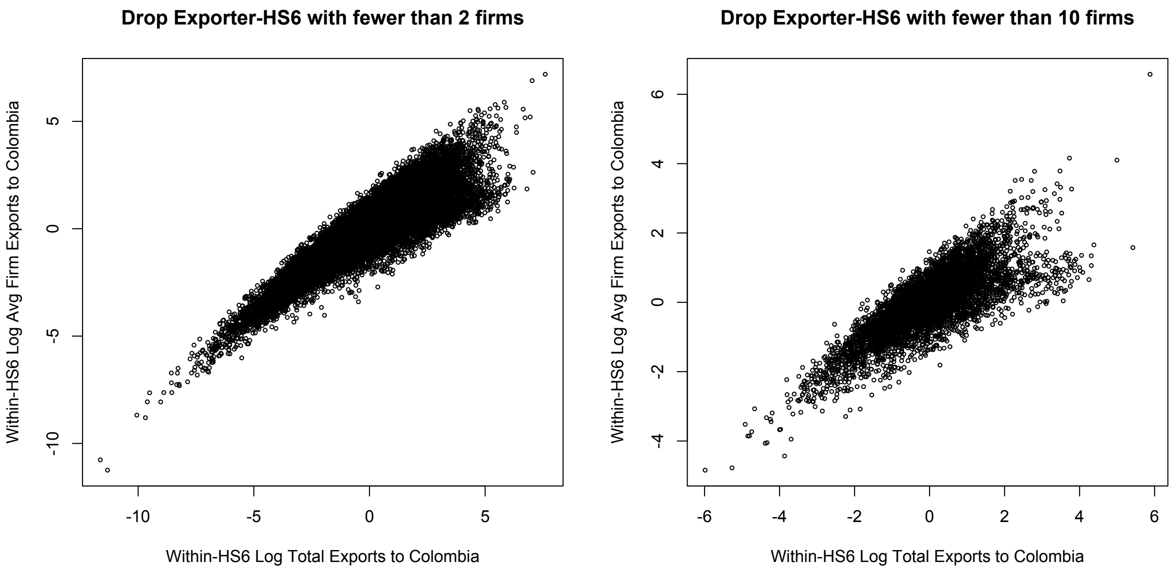
Pareto Shape and Trade Flows

Another implication of variation in the Pareto shape parameter is present when estimating a trade flow equation. To see this, total trade value from exporter j to market l is written as follows:

$$V_{jl} = N_j G\left(\frac{A_l}{t_{jl}s_l}\right)\overline{v}_{jl} = \frac{N_j A_l^{k_j+2}}{2b_l s_l^{k_j+1} t_{jl}^{k_j+1}(k_j+2)(c_j^m)^{k_j}} \tag{6}$$

[11] See Spearot (2013).

Figure 1: Total Exports and Average Firm-level Exports to Colombia - Within HS6



Notes: This figure plots the log of average firm-level exports to Colombia by Exporter-HS6 group against the log of total exports to Colombia by Exporter-HS6 group. All data de-meaned by HS6 product. Left-panel requires two or more firms to construct Exporter-HS6 average, and right-panel requires 10 or more firms. All data from 2003.

Taking logs and fully differentiating with respect to endogenous variables and tariffs, we get:

$$\frac{dV_{jl}}{V_{jl}} = \frac{dN_j}{N_j} + (k_j+2)\frac{dA_l}{A_l} - (k_j+1)\frac{dt_{jl}}{t_{jl}} \tag{7}$$

The typical approach in the literature is to use importer and exporter fixed effects when estimating a trade flow equation in levels or changes. However, when there is variation in the Pareto parameter, the effects of aggregate changes to the import market, $\frac{dA_l}{A_l}$, are not absorbed by the importer fixed effect. Hence, unless one can provide a solution for $\frac{dA_l}{A_l}$ as a function of observable trade data, it will be in the error term, and crucially, a function of the observable trade shock. Further, as the trade shocks and Pareto parameters will have a structural effect on $\frac{dA_l}{A_l}$, an interaction of exporter and importer dummy variables (with cross-equation restrictions) to proxy for $(k_j+2)\frac{dA_l}{A_l}$ will be missing key structural relationships between trading partners. Hence, the remainder of the paper is focused on evaluating $\frac{dA_l}{A_l}$ within a general set of trading relationships, and providing a way to estimate $\frac{dA_l}{A_l}$ using observable trade and tariff data.

Long Free Entry

With the basics of the model and the motivation for varying Pareto shape parameters in-hand, I now turn to the long-run equilibrium conditions. The first involves long run free-entry, in which firms enter until the expected profits are equal to a fixed cost of entry, F_j. By imposing the Pareto assumption in (4), the expected profits of selling from j to l are written as:

$$\overline{\pi}_{jl} = \frac{A_l^{k_j+2}}{2b_l(k_j+2)(k_j+1)(c_j^m)^{k_j} t_{jl}^{k_j+1} s_l^{k_j+1}}.$$

Aggregating over all available markets, the free entry condition for country j is written as:

$$\sum_l \frac{A_l^{k_j+2}}{2b_l(k_j+2)(k_j+1)(c_j^m)^{k_j} t_{jl}^{k_j+1} s_l^{k_j+1}} = F_j. \tag{8}$$

In (8), the key issue is that if k_j's are identical across countries and equal to k, then the long-run equilibrium consists of a system of equations which are linear in A_l^{k+2} for all l. However, when k_j's vary, the system of free entry conditions will exhibit a different degree of non-linearity for each country. Indeed, this can lead to multiple solutions to the system of free entry conditions such that $A_l > 0$ for all l.[12]

Though only used in the Appendix for extended intuition within a two-country model, the final component of the equilibrium is the number of firms that enter each country, which given the solution(s) to the system of free entry conditions, are pinned down using the definition of A_l. To back-out the number of entering firms, note that $\overline{q}_{jl}^c$, the expected quantity sold to the representative consumer in l by a given entrant in j, is written as:

$$\overline{q}_{jl}^c = \frac{A_l^{k_j+1}}{\gamma(k_j+1)(c_j^m)^{k_j} t_{jl}^{k_j} s_l^{k_j}}$$

Using $A_l = \theta_l - \eta \sum_j N_j \overline{q}_{jl}^c$, where N_j is the number of firms that have entered j, N_j's are linked to A_l via

$$A_l \quad = \quad \theta_l - \eta \sum_j N_j \frac{A_l^{k_j+1}}{\gamma(k_j+1)(c_j^m)^{k_j} t_{jl}^{k_j} s_l^{k_j}}. \tag{9}$$

[12] An earlier working paper details these issues using a two-country model in which two solutions are possible, and numerically solves a three-country model in which 6 candidate solutions exist on the interior.

In equilibrium, this linear system of equations in N_j (given A_l's) will determine when a candidate solution to free entry conditions in (8) is consistent with $N_j > 0$ for all j.

2.1 Tariffs and Free Entry conditions.

I now examine how the system of free entry conditions in (8) responds to an arbitrary group of tariff shocks. Specifically, I will focus on how the A's respond to tariffs, within an industry and subject to an arbitrary number of trading partners. Indeed, the A's are an important measure (in some cases a sufficient statistic) to evaluate welfare within firm heterogeneity models (Melitz and Ottaviano, 2008; Melitz and Redding, 2013). Hence, I will begin by providing a general solution to how the A's change with tariffs, and also provide a simple formula that maps a matrix of trade flows within an industry to a unique set of changes to A's after a trade shock. In doing so, I highlight a new and simple structural implication of firm-heterogeneity models in the long run.[13]

To begin, recall from above the free entry condition for each country j:

$$\sum_l \frac{A_l^{k_j+2}}{2b_l(k_j+2)(k_j+1)(c_j^m)^{k_j} t_{jl}^{k_j+1} s_l^{k_j+1}} = F_j.$$

Again, these conditions pin down the A_l's, and hence, the level of competition in each industry (or alternatively the highest cost domestic firm that can operate after accounting for the internal tax). Fully differentiating the free entry condition for j with respect to all A_l's and t_{jl}'s, we get:

$$\sum_l \frac{A_l^{k_j+2}}{2b_l(k_j+1)(c_j^m)^{k_j} t_{jl}^{k_j+1} s_l^{k_j+1}} \frac{dA_l}{A_l} = \sum_l \frac{A_l^{k_j+2}}{2b_l(k_j+2)(c_j^m)^{k_j} t_{jl}^{k_j+1} s_l^{k_j+1}} \frac{dt_{jl}}{t_{jl}}$$

Multiplying both sides by $N_j \frac{(k_j+1)}{(k_j+2)}$, and imposing trade value from (6), (10) can be written as:

$$\sum_{l=1..M} V_{jl} \frac{dA_l}{A_l} = \frac{(k_j+1)}{(k_j+2)} \sum_l V_{jl} \frac{dt_{jl}}{t_{jl}}. \tag{10}$$

Note that the direct impact of t_{jl} is a function of the value of trade, V_{jl}, and a function of the Pareto shape parameter, $\frac{(k_j+1)}{(k_j+2)}$. The former governs the size of shocks relative to other markets that j serves.

[13] For those readers interested in extended intuition from a two-country framework, see Appendix C.

In terms of the latter, the shape correction $\frac{(k_j+1)}{(k_j+2)}$ governs the average elasticity of producers in j on any market, and hence, the responsiveness of producers from j to demand shocks within each market.[14] This differential impact will be crucial for the theoretical results discussed below.

Stacking all differentiated free entry conditions in matrix form, and solving for $\frac{dA_l}{A_l}$'s, we have:

$$\begin{pmatrix} \frac{dA_1}{A_1} \\ \vdots \\ \frac{dA_l}{A_l} \\ \vdots \\ \frac{dA_m}{A_m} \end{pmatrix} = \begin{pmatrix} V_{11} & \dots & V_{1l} & \dots & V_{1m} \\ \vdots & \ddots & \vdots & & \vdots \\ V_{l1} & \dots & V_{ll} & \dots & V_{1l} \\ \vdots & & \vdots & \ddots & \vdots \\ V_{m1} & \dots & V_{lm} & \dots & V_{mm} \end{pmatrix}^{-1} \cdot \begin{pmatrix} \frac{k_1+1}{k_1+2} \sum_{r=1..m} V_{1r} \frac{dt_{1r}}{t_{1r}} \\ \vdots \\ \frac{k_l+1}{k_l+2} \sum_{r=1..m} V_{lr} \frac{dt_{lr}}{t_{lr}} \\ \vdots \\ \frac{k_m+1}{k_m+2} \sum_{r=1..m} V_{mr} \frac{dt_{mr}}{t_{mr}} \end{pmatrix} \tag{11}$$

The power of this transformation is that the movement of the demand curve in each country subsequent to an arbitrary group of trade shocks is a simple structural function of (in theory) observable trade and productivity data. With regard the former, one needs domestic sales by domestic firms along with trade data to fill the square matrix of trade flows. There are additional terms related to the shape of the productivity distribution, but these can be estimated using firm-level data, and later, I detail a strategy to estimate these shape parameters structurally using aggregate data. Using both trade data and the structural estimates, I can then predict in which countries and industries a trade shock increases competition.

Comparison to Constant-elasticity Demand

As (11) is derived using a fairly specific preference structure, a natural question is to what degree the relationship between competition and tariffs is general for other demand systems, and other assumptions over trade costs. In Appendix A, I derive a similar result for CES demand system of the form,

$$q_{i,l} = \frac{I_l p_i^{-\sigma_l}}{\int_{i \in \Omega_l} p_s^{1-\sigma_l} ds}$$

where σ_l is the elasticity of substitution within the differentiated sector in country l, I_l is income in country l, $\int_{i \in \Omega_l} p_s^{1-\sigma_l} ds$ is a transformation of the CES-type price index for country l, and p_i is the price of each

[14] This is similar to the type of demand shock that is identified in Foster, Haltiwanger, and Syverson (2008).

variety. I allow for arbitrary bilateral ad-valorem tariffs (t_{jl}) and fixed costs (F_{jl}) in serving each market. Further, I make no assumptions over the cost distribution other than that it is well-behaved. Defining $B_l = \frac{I_l}{\int_{i\in\Omega_l} p_s^{1-\sigma} ds} \frac{1}{\sigma}\left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma}$ as the analogous demand level within the CES setup, we can write profits of j selling to l as $\pi_{jl}^{ces} = B_l t_{jl}^{-\sigma_l} c_i^{1-\sigma_l} - F_{jl}$, and firm-level trade value as $v_{jl}^{ces} = \sigma_l B_l t_{jl}^{-\sigma_l} c_i^{1-\sigma_l}$. Given these assumptions, the link between an arbitrary set of trade shocks and demand level changes in each country is written as:

$$\begin{pmatrix} \frac{1}{\sigma_1}\frac{dB_1}{B_1} \\ \vdots \\ \frac{1}{\sigma_r}\frac{dB_r}{B_r} \\ \vdots \\ \frac{1}{\sigma_m}\frac{dB_m}{B_m} \end{pmatrix} = \begin{pmatrix} V_{11} & \dots & V_{1r} & \dots & V_{1m} \\ \vdots & \ddots & \vdots & & \vdots \\ V_{r1} & \dots & V_{rr} & \dots & V_{1r} \\ \vdots & & \vdots & \ddots & \vdots \\ V_{m1} & \dots & V_{rm} & \dots & V_{mm} \end{pmatrix}^{-1} \begin{pmatrix} \sum_{l=1..M}\frac{dt_{1l}}{t_{1l}}V_{1l} \\ \vdots \\ \sum_{l=1..M}\frac{dt_{rl}}{t_{rl}}V_{rl} \\ \vdots \\ \sum_{l=1..M}\frac{dt_{ml}}{t_{ml}}V_{ml} \end{pmatrix}$$

Hence, the effect of tariffs for CES has the same basic form as the quasi-linear quadratic preferences used in this paper, and in some cases is more general since no distributional assumptions have been used. However, since demand elasticities in CES are constant across markets, there are no differential effects of demand shocks on average profits across exporters within markets, and hence, no Pareto or other distributional correction is needed. Indeed, this is what distinguishes the variable-elasticity demand system from others, and the remainder of the paper will be focused on analytical results and empirical implementation of this demand system to evaluate the long-run effects of tariffs.

3 Theory to Empirics

Moving back to the quasi-linear quadratic model, the key to using (11) in an empirical context is the proxy for, or the estimation of, the unobserved Pareto shape parameters. Unfortunately, existing firm-level studies such as Di Giovanni, Levchenko, and Ranciere (2011) and Eaton, Kortum, and Kramarz (2011) do not provide Pareto shape estimates that vary by both industry and country, and thus I must find another way to account for the shape parameters.[15] Below, I outline an approach that treats the shape parameters

[15] Further, their estimates are scaled by the elasticity of substitution, and hence, additional estimates of demand elasticities are required to recover the fundamental productivity parameters.

as the primary object of estimation. Indeed, this is sensible given that the shape parameters are the only free parameters other than trade data and trade shocks in (11).

To begin, defining $\Lambda \equiv V^{-1}$, and Λ_{ls} representing the l^{th} row and s^{th} column of Λ, one can expand the solution for $\frac{dA_l}{A_l}$ from (11) as follows:

$$\frac{dA_l}{A_l} = \sum_{s=1..m} \Lambda_{ls} \frac{k_s+1}{k_s+2} \sum_{r=1..m} V_{sr} \frac{dt_{sr}}{t_{sr}}$$

Substituting $\frac{dA_l}{A_l}$ into the log trade flow equation in (7), we get:

$$\frac{dV_{jl}}{V_{jl}} = (k_j+2)\left(\sum_{s=1..m} \Lambda_{ls} \frac{k_s+1}{k_s+2} \sum_{r=1..m} V_{sr} \frac{dt_{sr}}{t_{sr}}\right) - (k_j+1)\frac{dt_{jl}}{t_{jl}} + \frac{dN_j}{N_j} \qquad (12)$$

In (12) there are M Pareto parameters to estimate. Further, we can also employ M exporter fixed effects to absorb the changes to the number of entering firms, $\frac{dN_j}{N_j}$. However, as long as there are more than $2M$ trading relationships (there is a maximum of MxM), one can estimate these parameters and fixed effects by using variation across trading partners within each exporter.

Other Importer and Exporter Shocks

We have yet to account for other shocks, such as changes in market size L_l, the internal tax s_l, or shifts in the upper-bound of the cost distribution, c_j^m. Further, though not modeled due to the presence of the outside good, there may also be changes in wages in supplying markets or the marginal utility of income in consuming markets. All of these shocks affect trade growth as well as the structural relationship within the free entry conditions, and hence, complicate the estimation of skew parameters required for counterfactual analysis.[16]

To make these issues concrete, suppose that c_j^m and L_l change along with tariffs. Fully differentiating (7) with respect to A_l, t_{jl}, c_j^m, and L_l to get:

$$\frac{dV_{jl}}{V_{jl}} = (k_j+2)\frac{dA_l}{A_l} - (k_j+1)\frac{dt_{jl}}{t_{jl}} + \frac{dN_j}{N_j} + \frac{dL_l}{L_l} - k_j \frac{dc_j^m}{c_j^m}$$

[16] See Simonovska (2010) for an analysis of income effects within trade models, and Cosar and Fajgelbaum (2012) and Atkin and Donaldson (2012) for the effects of internal frictions.

Clearly, in (13), importer and exporter fixed effects would absorb $\frac{dL_l}{L_l}$ and $k_j\frac{dc_j^m}{c_j^m}$ respectively. However, these shocks may also enter into $\frac{dA_l}{A_l}$ through changes to the system of free entry conditions. Fully differentiating the free entry system, and solving for $\frac{dA_l}{A_l}$ as before, we get:

$$\frac{dA_l}{A_l} = \sum_{s=1..m} \Lambda_{ls} \frac{k_s+1}{k_s+2} \left(\sum_{r=1..m} V_{sr} \left(\frac{dt_{sr}}{t_{sr}} - \frac{1}{k_s+1}\frac{dL_r}{L_r} + \frac{k_s}{k_s+1}\frac{dc_s^m}{c_s^m} \right) \right) \tag{13}$$

Hence, the other exporter and importer shocks affect both trade growth, as well as the structural relationship between trade values and free entry conditions.

To consistently estimate shape parameters subject to other unobserved shocks, in the appendix I show that the following estimating equation accounts for *all* possible exporter and importer shocks, including within extended models with wages and no outside good.

$$\begin{aligned} \frac{dV_{jl}}{V_{jl}} \quad = \quad & (k_j+2) \left(\sum_{s=1..m} \Lambda_{ls} \frac{k_s+1}{k_s+2} \left(\sum_{r=1..m} V_{sr} \left(\frac{dt_{sr}}{t_{sr}} - \frac{1}{k_s+1} d_r^m + \frac{1}{k_s+1} d_s^x \right) \right) \right) \\ & - (k_j+1) \frac{dt_{jl}}{t_{jl}} + d_l^m - d_j^x + n_j^x \end{aligned} \tag{14}$$

In (14), given data to construct each $\frac{dV_{jl}}{V_{jl}}$, Λ_{ls}, V_{sr}, and $\frac{dt_{sr}}{t_{sr}}$, we are left to estimate M separate d_j^x's, d_l^m's, n_j^x's and finally, k_j's, where n_j^x and d_j^x are "outer" and "inner" exporter controls, respectively, and d_l^m is a set of importer controls. Of course, some of these exporter and importer controls will be excluded due to co-linearity issues. However, in the appendix I show that n_j^x should be correlated positively with entry growth, but d_j^x should not. Hence, using external data on establishment growth, this will provide for a simple test of external validity that will support the way the specification controls for other shocks. Finally, while (14) will produce consistent estimates of k_j's even when s_l's are changing, when this occurs (13) can only identify changes to $\frac{A_l}{s_l}$ rather than changes to A_l. I will return to this point in section five.

I now outline the data to be used in estimation, and present the results from estimation using a case study of tariff cuts subsequent to the Uruguay round.

4 The Long of Manufacturing in the 90's

In this section, I structurally estimate trade flows, and the Pareto parameters that govern them, using sectoral data during the implementation period of Uruguay Round WTO tariff cuts. The primary data I use is sourced from the Trade, Production, and Protection database from the World Bank, as described in Nicita and Olarreaga (2007). The dataset itself consists of two files, both reported at the 3-digit ISIC classification (revision 2). The first is a bilateral trade dataset that includes importer and exporter-reported trade values. The second is a country-level dataset that reports output by industry, along with aggregate exports and imports, and trade protection measures.[17] Tariff data at the ISIC level is obtained from the Worldbank TRAINS dataset, where for each exporter-importer-ISIC group, I use the average applied tariff across corresponding HS6 products. I now describe the construction of the sample, by industry.

The primary requirements for the empirical strategy outlined in the previous section are a matrix of trade values prior to liberalization, tariff growth rates, and the subsequent growth rates in trade. All growth rates are measured in log changes. To define the set of countries active in a given industry i in a given year, I first restrict the sample to those countries that report output in that industry in that year (ie. countries within which firms have entered). Then, subject to this restricted set of countries, compare exporter-reported exports and importer-reported imports for each country pair. I keep bilateral trade data in the sample if both the importer and exporter report that trade occurred. Using this restricted sample, I assign domestic sales from j to j as total output in that industry i in that year minus total exports. For exports from j to l in industry i, I use the exporter reported FOB trade values.

The two years I use to construct growth rates in trade are 1994 and 2000. The motivation for these two years is that Uruguay Round tariff cuts were implemented in large part over this period, and hence, this is a period of large and quasi-exogenous changes to tariffs that provide useful variation for estimating the parameters in (14). All initial conditions are measured in 1994. When trade data is missing for 1994 or 2000, I use averages from 1993 and 1995 for the former, and 1999 and 2001 for the latter. While not ideal, this choice is made on the side of caution so as to include as many trading relationships as possible, independent of whether a country reports trade values in 1994 or 2000. When tariff data is missing for 1994,

[17] Since New Zealand and China do not report the required data within the World Bank dataset, I obtain supplemental information from the CEPII "TradeProd" dataset as described in De Sousa, Mayer, and Zignago (2012).

I take the maximum applied tariff over the period 1990-1994 (Uruguay Round negotiation period). When tariff data is missing in 2000, I use the minimum tariff over the period 2000-2004. The final sample includes 58 countries, which is slightly larger than the sample in Dekle, Eaton, and Kortum (2008). However, not all countries will be available for every industry.

Estimation

To estimate M Pareto shape parameters, $2M$ exporter shocks, and M importer shocks for each industry, I estimate (14) via non-linear least squares (NLS). Given the large number of parameters to estimate, I use a simulated annealing algorithm to ensure that the estimates do not converge at a local minimum (rather than global).[18] Since Pareto shape parameters should be positive for a properly defined PDF, I use constrained NLS to ensure that the estimates are consistent with a properly defined productivity distribution. I will report the degree to which the estimates are at the bounds. Further, I will comment on when the mean and median shape estimates are greater than one, since this corresponds to the case in which highly productive firms are relatively rare compared with unproductive firms. Indeed, this is the working assumption in trade theory. I also bound the exporter and importer shocks to lie between -5 and 5 (log growth) to reduce the size of the parameter space. Finally, since the trade equation outlined in (7) is primarily driven by an interaction of variables that vary (individually) in j and l, I cannot identify all exporter and importer shocks while still being able to recover $\frac{dA_l}{A_l}$. Hence, for one country within each industry, I normalize the d_j^x, d_l^m and n_j^x shocks to zero.

Once all k_j's have been estimated, I associate the estimated k_j's with outside measures, such as development, country size, and production technology by country-industry.[19] Then, I derive a technique to use the shape estimates to measure relative competition across markets. Finally, using the solution in (11), I calculate the contribution of tariff cuts over the period 1994 to changes in A's, and also use the model to generate the predicted effects of unilateral liberalization.

[18]Simulated annealing is essentially a "smart" grid search that randomly chooses points within a pre-defined space and builds up picture of the estimating surface. The algorithm slowly reduces the search space as good candidate solutions arise. The procedure I use is described by the coding authors in Xiang, Gubian, Suomela, and Hoeng (2013).

[19]The Pareto shape estimates are available at the author's website.

4.1 Results

To begin, Table 1 reports the average and median k_j estimates by industry, the share of those estimates that hit the lower bound (zero), and the number of countries used within each industry for estimation. In the last row of the table, which tabulates the average and median shape estimates across all manufacturing industries, we find that the median shape estimate of 1.37 is in the vicinity of estimates of the firm-size distribution for France, as discussed in Eaton, Kortum, and Kramarz (2011) and Di Giovanni, Levchenko, and Ranciere (2011).[20] However, it is notable that approximately 10% of estimates are predicted to be at the lower bound of the constrained NLS procedure (zero).

In terms of goodness of fit, I present two diagnostic measures related to the improvement in the sum of squared residuals (SSR) when allowing for shape heterogeneity. First, I report the simple improvement (reduction) in SSR when allowing for shape variation, which will obviously be positive since we are allowing for a more flexible model with such variation. However, the improvement in SSR is substantial, where in the column labeled "% Improve", the sum of squared error falls by around 22% on average, with some industries exhibiting massive reductions in SSR ("Manufacture of miscellaneous products of petroleum and coal" falls 66%, for example). More rigorously, I run a F-test after every regression, with the unrestricted model being that with shape variation, and the restricted model requiring that shape parameters are homogeneous across countries within an industry. For all industries, I can reject the restricted model with shape-homogeneity, and almost always with a high level of significance. Overall, I find that the shape estimates are sensible on average, but differ in a way meaningful for capturing trade flows.

Next, I present the tabulated results by country in Table 2. Again, there is wide variation across countries in the shape estimates, and these differences are economically meaningful. For example, while Chile has a median shape estimate of 2.97, Canada has a median shape estimate of 1.24. It terms of average exporter size as derived in (5), this difference implies that observed exporters from Canada are 52% larger than observed exporters from Chile when measured on a common market.

This heterogeneity more coherent in Figure 2, where in the left-hand panel there is a noticeable (and statistically significant) downward relationship between GDP per capita and average shape estimates by

[20]For example, in Eaton, Kortum, and Kramarz (2011), the shape estimate for export values is 1.25, and is an estimate of $\frac{k}{\sigma-1}$, where σ is the elasticity of substitution. Adjusting using the median elasticity of substitution estimate of 2.2 from Broda and Weinstein (2006), the implied Pareto parameter of the productivity distribution is 1.04.

Table 1: **Pareto Shape Estimates and Estimation Diagnostics - by Manufacturing Industry**

ISIC	Name	# Ctry	Skew Estimates Avg.	Med.	lower	upper	NLS SSR Constant	Hetero	% Imp	F_{stat}
311	**Food manufacturing**	53	1.1	0.62	0.11	0.02	2991.48	2543.81	0.15	5.562***
313	**Beverage industries**	48	1.55	0.71	0.15	0.02	1475.54	1113.56	0.25	5.932***
314	**Tobacco manufactures**	39	2.27	1.28	0.26	0.05	1209.37	770.26	0.36	3.552***
321	**Manufacture of textiles**	48	1.42	1.06	0.08	0.02	2627.04	2110.48	0.2	7.022***
322	**Manufacture of wearing apparel, except footwear**	28	2.68	2.51	0.07	0	680.85	462.56	0.32	7.753***
323	**Manufacture of leather and products of leather, leather substitutes and fur, except footwear and wearing apparel**	25	2.51	2.13	0.16	0.08	850.32	592.93	0.3	5.99***
324	**Manufacture of footwear, except vulcanized or moulded rubber or plastic footwear**	37	2.38	0.85	0.14	0.11	1089.01	767.72	0.3	5.689***
331	**Manufacture of wood and wood and cork products, except furniture**	45	1.91	0.63	0.11	0.04	1907.23	1492.77	0.22	6.454***
332	**Manufacture of furniture and fixtures, except primarily of metal**	44	1.52	1.2	0.14	0.04	1681.84	1359.31	0.19	5.527***
341	**Manufacture of paper and paper products**	51	2.14	0.94	0.14	0.08	2699.35	2125.81	0.21	6.745***
342	**Printing, publishing and allied industries**	51	1.88	1.15	0.12	0.04	2087.42	1642.1	0.21	6.987***
351	**Manufacture of industrial chemicals**	35	3.26	3.16	0.09	0.03	1190.18	881.5	0.26	7.764***
352	**Manufacture of other chemical products**	44	1.68	1.18	0.07	0.04	1718.15	1365.18	0.21	6.734***
353	**Petroleum refineries**	32	3.57	3.52	0.09	0.03	1345.66	905.74	0.33	4.948***
354	**Manufacture of miscellaneous products of petroleum and coal**	10	5.06	5.28	0.1	0.1	123.31	42.07	0.66	2.124*
355	**Manufacture of rubber products**	36	2.9	2.79	0.06	0	1159.61	911.58	0.21	5.789***
356	**Manufacture of plastic products not elsewhere classified**	49	1.91	1.21	0.08	0.04	2209.11	1761.11	0.2	6.957***
361	**Manufacture of pottery, china and earthenware**	32	1.98	1.18	0.06	0.03	677.74	504.23	0.26	5.291***
362	**Manufacture of glass and glass products**	43	2.48	1.94	0.07	0.02	1703.35	1323.83	0.22	6.227***
369	**Manufacture of other non-metallic mineral products**	47	2.43	1.53	0.13	0.08	1866.6	1439.77	0.23	6.219***
371	**Iron and steel basic industries**	36	2.72	2.23	0.08	0.03	1655.69	1213.91	0.27	7.006***
372	**Non-ferrous metal basic industries**	26	4.16	3.75	0.08	0.04	937.62	681	0.27	6.174***
381	**Manufacture of fabricated metal products, except machinery and equipment**	45	1.44	0.92	0.09	0.02	2194.27	1716.48	0.22	8.035***
382	**Manufacture of machinery except electrical**	30	2.03	1.4	0	0.03	534.59	394.65	0.26	7.435***
383	**Manufacture of electrical machinery apparatus, appliances and supplies**	41	1.52	0.95	0.07	0.02	1872.99	1475.15	0.21	7.597***
384	**Manufacture of transport equipment**	38	2.13	1.48	0.08	0.05	2466.22	2013.42	0.18	5.581***
385	**Manufacture of professional and scientific and measuring and controlling equipment not elsewhere classified, and of photographic and optical goods**	29	3.07	3.01	0.1	0.03	810.74	617.6	0.24	6.751***
390	**Other Manufacturing Industries**	22	1.45	0.74	0.04	0.04	448.36	319.9	0.29	4.673***
	Total	58	2.17	1.37	0.1	0.04	1676.74	1304.08	0.22	

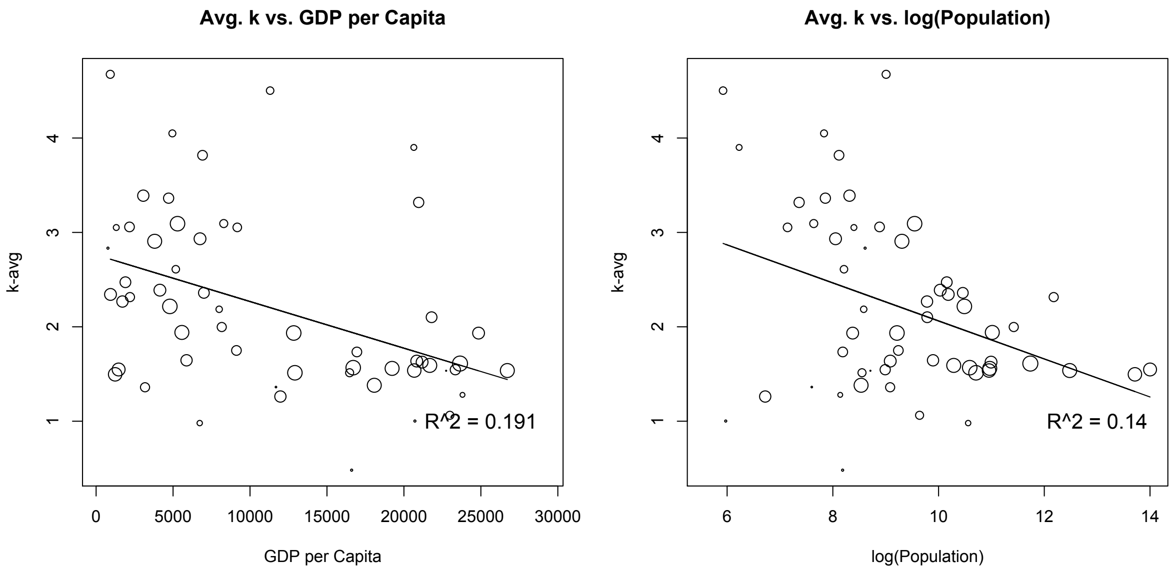
Notes: The column"lower" reports the share of estimates that are at the NLS estimation bound of k=0, and "upper" reports those at the upper bound of k=10. "# Cntry" reports the number of countries in the sample for each industry. "Constant" reports the SSR of a model in which shape is common across countries within industries, and "Hetero" from the model with shape allowed to vary across countries within industries. "Improve" reports the percent improvement when allowing for shape heterogeneity. "F_{stat}" reports the F statistic from treating the heterogeneous shape model as the unrestricted model, and the common shape model as the restricted model. *** p<0.01, ** p<0.05, * p<0.1

Table 2: **Average and Median Pareto Shape - by Country**

Country	#ISIC	Avg.	Med.	lower	upper	Country	#ISIC	Avg.	Med.	lower	upper
Argentina	20	2.36	1.74	0.20	0.05	**Lithuania**	14	2.61	1.15	0.21	0.00
Australia	20	2.10	1.72	0.00	0.00	**Latvia**	13	4.05	2.63	0.00	0.15
Austria	19	1.55	1.38	0.05	0.00	**Macedonia**	4	1.00	1.29	0.25	0.00
Benin	4	2.83	2.40	0.25	0.00	**Morocco**	20	2.47	1.77	0.15	0.05
Belgium-Lux.	4	0.78	0.76	0.00	0.00	**Moldova**	11	3.05	2.65	0.27	0.09
Bolivia	18	3.06	2.65	0.22	0.11	**Mexico**	17	2.00	1.72	0.12	0.00
Canada	26	1.59	1.24	0.04	0.00	**Malta**	14	4.50	2.59	0.07	0.29
Chile	27	3.09	2.97	0.15	0.07	**Malaysia**	21	1.65	1.30	0.14	0.00
China	24	1.55	1.16	0.04	0.00	**Netherlands**	15	1.06	1.03	0.00	0.00
Colombia	27	2.22	2.06	0.26	0.00	**Norway**	22	1.93	1.59	0.00	0.04
Costa Rica	18	3.82	3.05	0.11	0.17	**New Zealand**	4	0.48	0.50	0.25	0.00
Cyprus	21	1.26	1.26	0.19	0.00	**Oman**	15	3.09	1.98	0.07	0.07
Germany	24	1.47	1.16	0.00	0.00	**Panama**	19	3.36	2.51	0.21	0.16
Ecuador	26	2.91	1.79	0.08	0.08	**Poland**	10	0.98	0.77	0.00	0.00
Finland	26	1.38	1.27	0.15	0.00	**Portugal**	27	1.93	1.37	0.04	0.00
France	22	1.63	1.20	0.00	0.00	**Qatar**	11	3.90	3.71	0.18	0.00
Great Britain	26	1.56	1.22	0.00	0.00	**Romania**	22	2.39	1.59	0.09	0.00
Hong Kong	2	1.53	1.53	0.00	0.00	**Senegal**	15	4.68	3.04	0.20	0.27
Hungary	18	1.75	1.42	0.00	0.00	**Singapore**	9	1.28	1.08	0.00	0.00
Indonesia	17	2.31	1.28	0.00	0.06	**Slovakia**	12	2.19	1.52	0.17	0.00
India	25	1.50	1.37	0.08	0.00	**Slovenia**	3	1.36	0.47	0.00	0.00
Ireland	18	1.73	1.66	0.11	0.00	**Spain**	27	1.57	1.18	0.00	0.00
Israel	15	1.51	1.23	0.20	0.00	**Sri Lanka**	21	2.27	1.46	0.14	0.00
Italy	25	1.54	1.17	0.00	0.00	**Sweden**	22	1.64	1.31	0.04	0.00
Jordan	21	3.39	2.07	0.19	0.14	**Trinidad and Tob.**	16	3.05	1.18	0.25	0.19
Japan	28	1.61	1.37	0.00	0.00	**Tunisia**	17	1.36	0.71	0.24	0.00
Kenya	22	2.34	1.73	0.14	0.09	**Turkey**	26	1.94	1.45	0.08	0.00
Korea	27	1.51	1.34	0.07	0.00	**Uruguay**	22	2.93	1.67	0.32	0.14
Kuwait	19	3.32	0.99	0.21	0.21	**United States**	26	1.54	1.19	0.00	0.00
						Total	28	2.17	1.37	0.10	0.00

Notes: This table presents mean and median shape estimates by country. "lower" reports the share of estimates that are at the NLS estimation bound of k=0. "upper" reports those estimates that are at the upper bound k=10. "# ISIC" reports the number of ISIC industries for each country.

Figure 2: Estimate Pareto Shape Parameters, Development, and Country Size



Notes: The left-hand figure is average k by country and GDP per capita, and the right-hand figure is average k by country and log of Population. Bubble size is proportional to number of observations per country.

country.[21] In the right-hand panel of Figure 2, we find another negative (and significant) relationship between the log of population and average shape estimates. Hence, the results in Figure 2 suggest that developed and large countries tend to have a better shape of firms. An interesting implication of the results for less-developed countries is that higher shape parameters may yield an additional component of volatility along with institutions or the natural implications of differences in country size as discussed in di Giovanni and Levchenko (2012). Indeed, within industries, countries with higher k estimates will be more responsive to shocks at the intensive and extensive margin, the former being related to higher absolute demand elasticities, and the latter due to the higher elasticity of survival to shocks.

To dig deeper into the associations between country and industry characteristics, I regress the shape estimates for industry i in country j against the log of country j GDP per capita and population, including industry fixed effects.

$$\widehat{k}_{ij} \quad = \quad \alpha_1 \log(GDPPC_j) + \alpha_2 \log(Population_j) + \alpha_i + \varepsilon_{ij}$$

[21] GDP per capita and population data are sourced from the *Penn World Tables*.

The results from estimating (15) are presented in the first two columns of Table 3. Again, the results indicate that there is a negative and statistically significant relationship between Pareto shape parameters and both development and population. However, since we are using industry-fixed effects, we are absorbing all variation related to productivity distributions that may be specific to each industry.

To evaluate the robustness of these relationships, I now add measures of capital and input intensity, which are country-by-industry characteristics that may correlate with population and development, but also influence how cost draws govern profitability. For example, perhaps the cost-variation that is heterogeneous across firms is skewed toward capital (within a Cobb-Douglas aggregator), and hence, variation in cost draws may be amplified or mitigated via capital intensity. In terms of recovering shape parameters and associating them with development, if developed countries are more capital intensive, we may be erroneously associating higher development and lower k when in fact capital intensity is playing a role. Similarly, if larger, more developed countries have a larger cost share in outsourcing, but cost-variation is only applied to the cost share of final assembly, then again it is possible that we are erroneously associating shape estimates with these country-by-industry technology parameters.

To test for these possibilities, I acquire country-industry specific capital-labor and input-output ratios for 1994, and add them to the estimating equation. These ratios are obtained from the Trade, Production, and Protection dataset. To calculate the capital-labor ratio, I use the ratio of gross fixed capital formation to wages. To calculate the input-output ratio, I take the difference between Output and Value-Added of industry i in country j and divide this measure by the output of industry i in country j. Adding these measures to the estimating equation, the results are presented in column (3) of Table 3. Here, we find no appreciable relationship between capital intensity or input intensity and estimated shape parameters. However, despite the much smaller sample (due to the availability of capital and labor data), the relationships of shape estimates to development and country size still remain. Hence, the results do not indicate that the variation in k_{ij} across countries within industries is associated with factor intensities.

Pareto Shape and Trade Flows

In Spearot (2013), I derive how countries are less responsive to trade shocks when their exporting firms are relatively large. To test the model, I use 10-digit data on imports to the US. Absent data on exporter-

Table 3: Pareto Shape Estimates, Country and Industry Characteristics

	$\widehat{k}_{ij}$ (1)	(2)	(3)
$\log(GDPPC_j)$	-0.330***	-0.443***	-0.307***
	(0.076)	(0.076)	(0.087)
$\log(Population_j)$		-0.345***	-0.307***
		(0.044)	(0.053)
$\log(\frac{\text{Gross Fixed Capital}}{\text{Wages}}_j)$			0.125
			(0.109)
$\log(\frac{\text{Output - Value Added}}{\text{Output}}_j)$			-0.060
			(0.417)
Observations	1,036	1,036	697
R^2	0.111	0.168	0.173
Industry Fixed?	Yes	Yes	Yes

Notes: The dependent variable is the estimated Pareto shape parameter for industry i in country j. GDP per Capita and Population data sourced from the *Penn World Tables.* Output, Value Added, Gross Fixed Capital, and Wage data sourced from the Worldbank. Robust Standard Errors. *** p<0.01, ** p<0.05, * p<0.1

product Pareto shape parameters or average exporter size at that level of disaggregation, I discuss some conditions under which total export value from each exporter-product group is positively correlated with average exporting-firm size. In the current exercise, I evaluate whether within the market for industry i in country l, higher Pareto shape parameters of export suppliers correlate negatively with the value of trade. If so, this not only would confirm the strategy used in Spearot (2013), but would also provide a useful proxy for k_{ij}'s and average exporter size, since the domestic output data required to estimate these measures is not widely available across countries at more disaggregate levels than ISIC.

To test for this relationship, I regress the log of exports in industry i from exporter j to importer l in 1994 on the estimated shape parameter for industry i in exporter j, development in exporter j, population of exporter j, and industry-importer (i, l) fixed effects.

$$\log(V_{ijl}) \quad = \quad \alpha_1 \widehat{k}_{ij} + \alpha_2 \log(GDPPC_j) + \alpha_3 \log(Population_j) + \alpha_{il} + \varepsilon_{ijl}$$

Table 4: Pareto Shape Estimates and Relative Exporter Size

	$\log(V_{ijl})$	
	(1)	(2)
$\widehat{k}_{ij}$	-0.344***	-0.082***
	(0.018)	(0.017)
$\log(GDPPC_j)$		1.492***
		(0.028)
$\log(Population_j)$		0.869***
		(0.016)
Within R^2	0.0325	0.3310

Notes: 21,887 Observations, 1,064 importer-industry fixed effects. The dependent variable is $\log(V_{ijl})$, which is the log of exports in industry i from exporter j to importer l in 1994. $\widehat{k}_{ij}$ are shape estimates for industry i in country j. Robust Standard Errors. *** p<0.01, ** p<0.05, * p<0.1

The results are presented in Table 4, where within importer-industry groups, the results indicate a strong and negative relationship between the Pareto shape parameter and total imports in industry i from exporter j. Though one-third the size, the association is still highly significant when controlling for exporter size and development. Overall, it appears that lower shape values do correlate with larger trade flows within import markets, and the implied responsiveness is consistent with a better group of exporting firms producing farther down the representative demand curve in that market.

Fixed Effects and Establishment Growth

To test the structure of the non-tariff exporter shocks, I evaluate the association of the two exporter shocks for industry i in exporter j, $\widetilde{n}^x_{ij}$ and $\widetilde{d}^x_{ij}$, with establishment growth in each country and industry. Establishment growth itself is not reported for many countries and industries, and also may not be specific to domestic firms entering each market. However, given that establishment growth is likely correlated with $\frac{dN_{ij}}{N_{ij}}$, we use it as a proxy for domestic entry. Further, given the structure of the model, establishment growth should correlate with $\widetilde{n}^x_{ij}$ but not $\widetilde{d}^x_{ij}$. Indeed, in Appendix B, I derive that $\widetilde{n}^x_{ij}$ is meant to absorb the effect of $\frac{dN_{ij}}{N_{ij}}$ on *total* trade values, and $\widetilde{d}^x_{ij}$ controls for the effect of exporter-specific shocks on the revenues and profits of the *average* exporter. The results in Table 5 confirm this structure of the exporter

Table 5: Fixed Effects and Establishment Growth

	$\log\left(N_{ij}^{00}/N_{ij}^{94}\right)$		
	(1)	(2)	(3)
$\widetilde{n}_{ij}^{x}$	0.103***		0.118***
	(0.021)		(0.023)
$\widetilde{d}_{ij}^{x}$		0.012	-0.025
		(0.018)	(0.019)
Observations	751	751	751
R^2	0.463	0.444	0.465
Industry Fixed?	Yes	Yes	Yes
Country Fixed?	Yes	Yes	Yes

Notes: $\log\left(N_{ij}^{00}/N_{ij}^{94}\right)$ is establishment growth, for industry i in country j, as reported in the Worldbank dataset. $\widetilde{n}_{i,j}^{x}$ and $\widetilde{d}_{i,j}^{x}$ are the recovered exporter shocks for industry i in country j. 751 Observations. Robust Standard Errors. *** p<0.01, ** p<0.05, * p<0.1

shocks, where higher $\widetilde{n}_{ij}^{x}$ is associated with higher firm growth within that industry, but $\widetilde{d}_{ij}^{x}$ is not.

5 Competition and Tariff Counterfactuals

In sections two and three, I derive how the effects of a set of tariff shocks can be written as a function of bilateral trade data and a vector of productivity shape parameters. In the appendix, I derive how within a two-country model the effects of a tariff cut can also be expressed using the shape parameters and the relative competitiveness of the countries involved in the liberalization. With the Pareto shape estimates by country-industry in-hand, I now use the shape parameters to estimate relative competition by country and industry, as well as changes to competition in response to tariff cuts.

5.1 Measuring Relative Competition

To begin, I derive two complementary procedures to estimate relative competition across markets. The first procedure relies on estimation of a structural trade equation, using the shape estimates that were discussed in section four as data. To begin, note that the equation for trade value from exporter j to market l can be rearranged as

$$V_{jl} = \frac{N_j \left(\frac{A_l}{s_l}\right)^{k_j+2} s_l}{2 b_l t_{jl}^{k_j+1}(k_j+2)(c_j^m)^{k_j}},$$

where the nature of competition will be reflected in the ratio $\frac{A_l}{s_l}$. While this is slightly different from the definition of competition in (3), it corresponds precisely with the domestic cost cutoff in country l. And ultimately, in the procedures outlined below, relative values of $\frac{A_l}{s_l}$ are the limit of what these techniques can identify.

Multiplying both sides of the equation by $t_{jl}^{k_j+1}$ and rearranging the right-hand side yields the following equation that can be fit with a Pseudo-Poisson estimator:

$$V_{jl} t_{jl}^{k_j+1} = \exp\left(\log\left(\frac{A_l}{s_l}\right) \cdot (k_j+2) + I_j^x + I_l^m\right) \tag{15}$$

where $I_j^x = \log N_j - \log(k_j+2) - k_j \log c_j^m$ and $I_l^m = \log s_l - \log 2 - \log b_l$. Since we have estimates for k_j, we can treat the k_j's as data and fit (15) via Psuedo-Poisson Maximum Likelihood as in Silva and Tenreyro (2006) and Fally (2012), including coefficients on (k_j+2) that vary by l. Recovering the estimates provides a measure of log differences of $\frac{A_l}{s_l}$ relative to some base group (which will be the US). Of course, there are issues with using (15) for anything but fitting the model since the k_j's are estimates and appear on both the right and left-hand sides of (15). As an alternative, I now outline a non-parametric technique to estimate relative values of $\frac{A_l}{s_l}$.

Specifically, suppose that country j sells to some country l and the US. Taking the ratio of the value of trade to l relative to the US, we get:

$$\frac{V_{jl} t_{jl}^{k_j+1}}{V_{jUS} t_{jUS}^{k_j+1}} = \frac{\left(\frac{A_l}{s_l}\right)^{k_j+2} s_l b_{US}}{\left(\frac{A_{US}}{s_{US}}\right)^{k_j+2} s_{US} b_l}$$

By taking this ratio, any effects specific to the exporter in V_{jl} are eliminated, leaving interactions between import market and exporter, and also import market effects. To get rid of the import market effects, we can divide this ratio by a similar ratio for some country r also selling to l and the US. Writing in log differences, we get the following solution for competitiveness in each market relative to the US.

$$\log\left(\frac{A_l}{s_l}\right)-\log\left(\frac{A_{US}}{s_{US}}\right) = \frac{1}{k_j-k_r}\left(\log\left(\frac{V_{jl}}{V_{jUS}}\right)-\log\left(\frac{V_{rl}}{V_{rUS}}\right)\right) + \frac{k_j+1}{k_j-k_r}\log\left(\frac{t_{jl}}{t_{jUS}}\right)-\frac{k_r+1}{k_j-k_r}\log\left(\frac{t_{rl}}{t_{rUS}}\right) \tag{16}$$

Clearly, the RHS of (16) can be constructed using any two countries j and r serving country l and the US within the same product, and hence, the statistic $\log\left(\frac{A_l}{s_l}\right)-\log\left(\frac{A_{US}}{s_{US}}\right)$ is over-identified. Hence, to construct an estimate for relative competition, for every import market l, I bootstrap the median of (16) using samples of country pairs that serve market l and the US.[22] This bootstrapped median approach also is advantageous in that measurement error may produce wild estimates of the average RHS of (16).[23]

The two techniques produce relative competition estimates that are highly correlated with one another.[24] Both measures suggest that the average ISIC market is 26% less competitive than the US market. To evaluate how relative competition relates to country-level observables and shape estimates, in Table 6, I regress the estimates for relative competition on the shape estimates that help generate them, log GDP per capita, and log population. The first three columns in Table 6 use the Bootstrap method of relative competition, and columns four through six use the Poisson approach. In all columns, the relationship between Pareto shape and relative competition is positive, which suggests that countries with a less productive shape of firms have a less competitive domestic market. Further, we find a negative association between GDP per capita and relative competition, suggesting that more developed markets have a more competitive market. However, these associations are only significant when using the bootstrap estimates for relative competition. Finally, there is no discernible relationship between country size and competition (after controlling for development).

Next, having shown that the estimates for relative competition are sensible when compared with shape parameters and development, I now compare the estimates of relative competition with changes in competition as outlined in equation (13). Note that this is *not* a counterfactual related to the Uruguay Round

[22]Specifically, for each importer-industry, I calculate the RHS of (16) for all pairs (j, r) of exporters that serve l and the US. Then, I resample with replacement 1000 bootstrap samples of 1000 exporter pairs, calculating the median for each sample. Then, I take the average of the bootstrap samples.

[23]This is due to the number of ratios with a denominator that may be close to zero,

[24]Unconditionally, and with either industry or exporter fixed effects, regressing the bootstrap estimates on the Poisson estimates yields a highly significant coefficient of approximately 0.20, and within R-squared of 0.14–0.31.

Table 6: Competition and Country-Industry Characteristics

	$\log\left(\frac{A_{il}/s_{il}}{A_{iUS}/s_{iUS}}\right)$					
	(1)	(2)	(3)	(4)	(5)	(6)
$\widehat{k}_{il}$	0.122***	0.145***	0.134***	0.158**	0.151***	0.111**
	(0.027)	(0.027)	(0.028)	(0.062)	(0.052)	(0.053)
log(GDP per Capita$_l$)	-0.186***	-0.192***		-0.112	-0.166	
	(0.068)	(0.066)		(0.137)	(0.112)	
log(Population$_l$)	-0.017	-0.017		0.001	-0.041	
	(0.043)	(0.042)		(0.091)	(0.084)	
Observations	544	544	544	611	611	611
R^2	0.060	0.202	0.238	0.016	0.317	0.362
ISIC Fixed?	No	Yes	Yes	No	Yes	Yes
Country Fixed?	No	No	Yes	No	No	Yes
Method		Bootstrap			Psuedo-Poisson	

Notes: The dependent variable is $\log\left(\frac{A_{il}/s_{il}}{A_{iUS}/s_{iUS}}\right)$, the estimated competitiveness of country l in industry i relative to the US. $\widehat{k}_{il}$ are shape estimates for industry i in country l. GDP per Capita and Population data sourced from the *Penn World Tables*. "Method" reports the estimation technique for relative competitiveness. Robust Standard Errors. *** p<0.01, ** p<0.05, * p<0.1

Table 7: Initial Competition and Competition Growth

	$d\log(A_{il}/s_{il})$					
	(1)	(2)	(3)	(4)	(5)	(6)
$\log\left(\frac{A_l/s_l}{A_{US}/s_{US}}\right)$	-0.183***	-0.210***	-0.211***	-0.049***	-0.075***	-0.077***
	(0.031)	(0.035)	(0.035)	(0.012)	(0.014)	(0.014)
Observations	544	544	544	611	611	611
R^2	0.096	0.173	0.237	0.032	0.108	0.162
ISIC Fixed?	No	Yes	Yes	No	Yes	Yes
Country Fixed?	No	No	Yes	No	No	Yes
Method		Bootstrap			Psuedo-Poisson	

Notes: The dependent variable is $d\log(A_{il}/s_{il})$, the estimated change to the domestic productivity cutoff of industry i in country l as calculated using (13). $\log\left(\frac{A_{il}/s_{il}}{A_{iUS}/s_{iUS}}\right)$ is the estimated competitiveness of country l in industry i relative to the US. "Method" reports the estimation technique for relative competitiveness. Robust Standard Errors. *** p<0.01, ** p<0.05, * p<0.1

tariff changes since we are including all estimated and observed shocks and their contribution to $\frac{dA_l}{A_l}$ via (13). However, it is useful to compare these measures since it will give a sense of where competition changed relative to initial conditions. The correlations between relative competition and changes in competition are presented in Table 7. Clearly, there is a significant negative correlation between initial competition and changes in competition during the period 1994-2000. That is, less competitive markets (higher A) experienced larger percent reductions in A over this period, suggesting that firms enter in markets where competition is less fierce.

5.2 Counterfactuals - Multilateral and Unilateral Tariff Cuts

I now use the shape estimates in conjunction with trade data and tariff cuts over 1994-2000 to run two counterfactual experiments. In the first, I evaluate a hypothetical, unilateral change in tariffs. Though multilateral changes in tariffs are the predominant focus within current rounds of trade negotiations, unilateral tariff changes are an important input for the tariff-based prisoner's dilemma that trade agreements are designed to alleviate (Bagwell and Staiger (2009), Ossa (2010), and Bagwell and Staiger (2012)). Further, from Venables (1985) to Melitz and Ottaviano (2008), the literature makes the clear point that unilateral liberalization may lead to a less competitive market in the long-run. In section two, the answer is made precise by inputing a unilateral tariff cut in equation (11). Using this measure, in the right-most column for each country in Table 8, I calculate the percentage of industries for which unilateral liberalization increases competitiveness. The striking result in this column is that despite productivity heterogeneity, unilateral liberalization rarely increases competitiveness. When it does, this tends to happen in under-developed countries. Hence, at least via this particular counterfactual and the presented structural estimates, the data indicate that unilateral liberalization does in fact lead to a broad reduction in competition.

As a final exercise, I abstract from the estimated exporter and importer non-tariff shocks to calculate the degree to which tariff cuts increased or decreased competition over the period 1994-2000. Specifically, I am calculating the percent change in the demand level, $\frac{dA_l}{A_l}$, as presented in equation (11). In Table 8, for each country, I calculate the share of ISIC industries such that A falls due to the tariff cuts that occurred over this period. Overall, we find that A falls for 79% of country-industry pairs within the sample.

Developed nations such as the US exhibit a fall in A in all or nearly all industries.[25] Smaller, less-developed countries benefit rarely in terms of the level of competitiveness on the domestic market.

6 Conclusion

This paper has evaluated the effect of tariffs when allowing for variation in a broad set of domestic characteristics, especially the shape of the productivity distribution. I provide a novel structural measure for changes to competitiveness that is a function of a trade matrix and Pareto shape parameters. I find that larger and more developed markets are associated with firms skewed toward higher productivity, and that these markets with a better shape of firms also earn higher revenues on common markets. Using the shape estimates, I estimate relative competition across countries, where within-industries, less developed countries with a poor shape of firms tend to have less competitive markets. However, these markets experienced the largest predicted improvement in competition over the sample period, suggesting that firms enter where competition is less fierce. Counterfactuals indicate that tariff cuts over 1994-2000 increased competition in 80% of liberalizing markets, but that unilateral tariff cuts rarely increase competition.

I plan to extend this framework along a few dimensions. The first is evaluating the efficacy of this structural approach in the presence of FDI, as in Helpman, Melitz, and Yeaple (2004) and more recently Tintelnot (2012). Indeed, it is possible that the lower shape estimates for more developed countries are contaminated to some degree by these countries leveraged in higher levels of FDI. The second extension is related to exchange rates, and more macro-oriented models. While tariffs and other shocks are often stagnant, exchange rate movements and currency crises may have profound effects on entry, and over time, help identify the underlying fundamentals of firm movements in the international economy.

[25] This is consistent with the empirical work in Feenstra and Weinstein (2010), which shows that mark-ups in the US have fallen over this period.

Table 8: **Counterfactuals - Multilateral and Unilateral Tariff Cuts**

Country	**#ISIC**	**Decrease in A**		**Country**	**#ISIC**	**Decrease in A**	
		Uruguay Rnd	**Unilateral**			**Uruguay Rnd**	**Unilateral**
Argentina	20	0.95	0.00	**Lithuania**	14	0.93	0.07
Australia	20	0.95	0.00	**Latvia**	13	0.62	0.00
Austria	19	0.84	0.00	**Macedonia**	4	1.00	0.00
Benin	4	0.50	0.25	**Morocco**	20	0.35	0.00
Belgium-Lux.	4	0.00	0.00	**Moldova**	11	0.55	0.00
Bolivia	18	0.83	0.00	**Mexico**	17	0.94	0.00
Canada	26	0.96	0.00	**Malta**	14	0.14	0.00
Chile	27	1.00	0.04	**Malaysia**	21	0.81	0.00
China	24	0.88	0.00	**Netherlands**	15	1.00	0.00
Colombia	27	0.85	0.00	**Norway**	22	0.91	0.00
Costa Rica	18	0.61	0.00	**New Zealand**	4	1.00	0.00
Cyprus	21	0.24	0.00	**Oman**	15	0.33	0.07
Germany	24	1.00	0.00	**Panama**	19	0.84	0.00
Ecuador	26	0.96	0.00	**Poland**	10	0.40	0.00
Finland	26	0.96	0.00	**Portugal**	27	0.74	0.00
France	22	0.95	0.00	**Qatar**	11	0.45	0.09
Great Britain	26	0.96	0.00	**Romania**	22	0.05	0.00
Hong Kong	2	1.00	0.00	**Senegal**	15	0.40	0.13
Hungary	18	0.89	0.00	**Singapore**	9	1.00	0.00
Indonesia	17	0.94	0.06	**Slovakia**	12	1.00	0.00
India	25	0.80	0.04	**Slovenia**	3	0.00	0.00
Ireland	18	0.78	0.00	**Spain**	27	0.93	0.00
Israel	15	1.00	0.00	**Sri Lanka**	21	0.76	0.05
Italy	25	1.00	0.00	**Sweden**	22	1.00	0.00
Jordan	21	0.81	0.05	**Trinidad and Tob.**	16	0.50	0.06
Japan	28	0.96	0.00	**Tunisia**	17	0.59	0.06
Kenya	22	0.50	0.05	**Turkey**	26	0.88	0.04
Korea	27	0.93	0.00	**Uruguay**	22	0.95	0.00
Kuwait	19	0.58	0.00	**United States**	26	1.00	0.00
				Total	28	0.79	0.01

Notes: This table presents the counterfactual estimates of the influence of tariff cuts during the Uruguay Round (absent other shocks), and hypothetical unilateral reductions in tariffs. “Uruguay Rnd” reports the share of ISIC industries within a country in which markets were more competitive due to Uruguay Round tariff cuts. “Unilateral” reports the share of ISIC industries within a country in which markets are more competitive after a unilateral tariff cut.

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A Derivation for Constant-elasticity models

In this appendix, I derive the effects of a tariff shock on free entry for a constant elasticity demand system similar to Melitz (2003) and Chaney (2008).

To begin, assume that demand for each variety in country l is written as:

$$q_{i,l} = \frac{I_l p_i^{-\sigma}}{\int_{i\in\Omega_l} p_s^{1-\sigma} ds}$$

We hold I_l constant, which requires that I_l is the share of income spent on the differentiated sector in l, with another sector pinning down the wage.

Suppose that a firm serving market l from market j pays two costs in serving that market - a tariff τ_{jl} and a fixed cost F_{jl}.

$$\begin{aligned}
\pi_{i,jl} &= \underbrace{\frac{I_l}{\int_{i\in\Omega_l} p_s^{1-\sigma} ds}\frac{1}{\sigma}\left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma}}_{B_l} t_{jl}^{-\sigma} c^{1-\sigma} - F_{jl} \\
&= B_l t_{jl}^{-\sigma} c_i^{1-\sigma} - F_{jl}
\end{aligned}$$

where $t_{jl} = 1 + \tau_{jl}$. Given the properties of CES, trade value from l to j for firm i is written as:

$$v_{i,jl} \;=\; \sigma \pi_{i,jl}$$

Firms in j can earn profits in market l if profits are positive in doing so: $B_l c^{1-\sigma} > F_{jl}$. For any well-defined productivity distribution, this yields:

$$\overline{\pi}_{jl} \;=\; \int_0^{\left(\frac{F_{jl}}{B_l}\right)^{\frac{1}{1-\sigma}} t_{jl}^{\frac{\sigma}{1-\sigma}}} B_l t_{jl}^{-\sigma} c^{1-\sigma} - F_{jl} g_j(c) dc$$

Aggregating over all markets, allowing for a country specific elasticity of substitution, σ_l, and setting equal to a fixed cost of entry, we get:

$$\sum_{l=1..M} \int_0^{\left(\frac{F_{jl}}{B_l}\right)^{\frac{1}{1-\sigma_l}} t_{jl}^{\frac{\sigma_l}{1-\sigma_l}}} \left(B_l t_{jl}^{-\sigma_l} c^{1-\sigma_l} - F_{jl}\right) g_j(c)dc = F_j$$

Differentiating with respect to all t_{jl} and A_l's, we get:

$$\sum_{l=1..M} \frac{1}{\sigma_l}\frac{dB_l}{B_l} \int_0^{\left(\frac{F_{jl}}{B_l}\right)^{\frac{1}{1-\sigma_l}} t_{jl}^{\frac{\sigma_l}{1-\sigma_l}}} \sigma_l B_l t_{jl}^{-\sigma_l} c^{1-\sigma_l} g_j(c)dc - \sum_{l=1..M} \frac{dt_{jl}}{t_{jl}} \int_0^{\left(\frac{F_{jl}}{B_l}\right)^{\frac{1}{1-\sigma_l}} t_{jl}^{\frac{\sigma_l}{1-\sigma_l}}} \sigma_l B_l t_{jl}^{-\sigma_l} c^{1-\sigma_l} g_j(c)dc = 0$$

Of note, changes to the limits of integration are irrelevant since the integrands are equal to zero at the limits. Rearranging so there is a σ_l leading each integrand, and then multiplying both sides by N_j, we get:

$$\sum_{l=1..M} \frac{1}{\sigma_l}\frac{dB_l}{B_l} N_j \int_0^{\left(\frac{F_{jl}}{B_l}\right)^{\frac{1}{1-\sigma_l}} t_{jl}^{\frac{\sigma_l}{1-\sigma_l}}} \sigma_l B_l t_{jl}^{-\sigma_l} c^{1-\sigma_l} g_j(c)dc - \sum_{l=1..M} \frac{dt_{jl}}{t_{jl}} N_j \int_0^{\left(\frac{F_{jl}}{B_l}\right)^{\frac{1}{1-\sigma_l}} t_{jl}^{\frac{\sigma_l}{1-\sigma_l}}} \sigma_l B_l t_{jl}^{-\sigma_l} c^{1-\sigma_l} g_j(c)dc = 0$$

Writing as trade values:

$$\sum_{l=1..M} \frac{1}{\sigma_l}\frac{dB_l}{B_l} V_{jl} = \sum_{l=1..M} \frac{dt_{jl}}{t_{jl}} V_{jl}$$

Putting in matrix form, we have:

$$\begin{pmatrix} \frac{1}{\sigma_1}\frac{dB_1}{B_1} \\ \vdots \\ \frac{1}{\sigma_r}\frac{dB_r}{B_r} \\ \vdots \\ \frac{1}{\sigma_m}\frac{dB_m}{B_m} \end{pmatrix} = \begin{pmatrix} V_{11} & \dots & V_{1r} & \dots & V_{1m} \\ \vdots & \ddots & \vdots & & \vdots \\ V_{r1} & \dots & V_{rr} & \dots & V_{1r} \\ \vdots & & \vdots & \ddots & \vdots \\ V_{m1} & \dots & V_{rm} & \dots & V_{mm} \end{pmatrix}^{-1} \begin{pmatrix} \sum_{l=1..M} \frac{dt_{1l}}{t_{1l}} V_{1l} \\ \vdots \\ \sum_{l=1..M} \frac{dt_{rl}}{t_{rl}} V_{rl} \\ \vdots \\ \sum_{l=1..M} \frac{dt_{ml}}{t_{ml}} V_{ml} \end{pmatrix}$$

B Estimation with income effects and wages

In this technical appendix, I show that the strategy to estimate productivity shape parameters is the exact same without a numeraire outside good, and that the technique to control for other importer and exporter shocks properly controls for all importer and exporter shocks in the model.

To see this, suppose that our utility function did not have a numeraire good, and was written as:

$$U_l = \theta_l \int_{i\in\Omega_l} q_{i,l}^c di - \frac{1}{2}\eta \left(\int_{i\in\Omega_l} q_{i,l}^c di\right)^2 - \frac{1}{2}\gamma \int_{i\in\Omega_l} \left(q_{i,l}^c\right)^2 di,$$

Note that we could also aggregate over a number of differentiated industries, though the analysis is the exact same. The budget constraint faced by consumers in country l is written as:

$$\int_{i\in\Omega_j} p_{i,l}^c q_{i,l}^c di \leq w_l$$

where $p_{i,l}^c$ is the delivered consumer price of variety i to l, and w_l is the wage earned by the representative consumer in l. Under this setup, the inverse demand function for a given variety i is derived as:

$$p_{i,l}^c = \frac{1}{\lambda_l}\left(A_l - b_l q_{i,l}\right)$$

where the only change from (3) is the addition of the marginal utility of income, λ_l, which is no longer pinned down by a numeraire.

Firms

Without the numeraire that pins down wages internationally, we must re-write the firm's problem when wages must be paid for marginal and fixed costs. Firms still choose quantities to maximize profits in serving each market, where the maximization problem for firm i from j exporting to l is written as:

$$\pi_{i,jl}\left(c_i\right) = \max_{q_{i,jl}} \left\{ \frac{1}{t_{jl} s_l \lambda_l} \left(A_l - \frac{\gamma}{L_l} q_{i,jl}\right) \cdot q_{i,jl} - w_j c_i q_{i,jl} \right\}.$$

Note that this maximization problem is adjusted in two ways. First, demand is now subject to the marginal utility of income in l, λ_l, which has a similar effect to s_l. Second, marginal costs are now scaled by w_j, which assumes that the only factor of production is labor, and c_i the unit labor requirement of firm i. Hence, the optimal quantity in selling to l from j is written as,

$$q_{jl}(c) = \frac{A_l - w_j c t_{jl} s_l \lambda_l}{2b_l},$$

producer revenues are written as

$$v_{jl}(c) = \frac{A_l^2 - (w_j c t_{jl} s_l \lambda_l)^2}{4b_l t_{jl} s_l \lambda_l},$$

and profits are written as

$$\pi_{jl}(c) = \frac{(A_l - w_j c t_{jl} s_l \lambda_l)^2}{4b_l t_{jl} s_l \lambda_l}.$$

Aggregation and Free Entry

Imposing the Pareto assumption in (4), and also noting that fixed costs of entry are also paid in units of labor, the free entry condition for firms in country j is written as:

$$\sum_l \frac{A_l^{k_j+2}}{2b_l(k_j+2)(k_j+1)w_j^{k_j}(c_j^m)^{k_j} t_{jl}^{k_j+1}(\lambda_l s_l)^{k_j+1}} = w_j F_j$$

Next, we transform variables to into like components. First, defining $Z_l = \frac{A_l}{\lambda_l s_l}$, the free entry condition can be re-written as:

$$\sum_l \frac{Z_l^{k_j+2}\lambda_l s_l / b_l}{2(k_j+2)(k_j+1)w_j^{k_j}(c_j^m)^{k_j} t_{jl}^{k_j+1}} = w_j F_j$$

Next, dividing both sides by $w_j F_j$, we have:

$$\sum_l \frac{Z_l^{k_j+2}\lambda_l s_l / b_l}{2(k_j+2)(k_j+1)w_j^{k_j+1}(c_j^m)^{k_j} F_j t_{jl}^{k_j+1}} = 1$$

Collecting importer terms and writing as $m_l = \lambda_l s_l / b_l$, and (some) exporter terms as $x_j = w_j^{k_j+1}(c_j^m)^{k_j} F_j$, we have:

$$\sum_l \frac{Z_l^{k_j+2} m_l}{2(k_j+2)(k_j+1)x_j t_{jl}^{k_j+1}} = 1 \tag{17}$$

Next, the value of trade is written as:

$$V_{jl} = \frac{N_j A_l^{k_j+2}}{2b_l(k_j+2)(w_j c_j^m)^{k_j} t_{jl}^{k_j+1} (\lambda_l s_l)^{k_j+1}}.$$

Using similar transformations as above, we get:

$$V_{jl} = \frac{N_j w_j F_j Z_l^{k_j+2} m_l}{2(k_j+2)x_j t_{jl}^{k_j+1}}.$$

Empirical Specification Equivalence

To derive our empirical specification, log differentiate all non-shape terms in (18) to get

$$\sum_l \frac{Z_l^{k_j+2} m_l}{2(k_j+2)x_j t_{jl}^{k_j+1}} \frac{k_j+2}{k_j+1} \frac{dZ_l}{Z_l} = \sum_l \frac{Z_l^{k_j+2} m_l}{2(k_j+2)x_j t_{jl}^{k_j+1}} \left(\frac{dt_{jl}}{t_{jl}} + \frac{1}{k_j+1}\frac{dx_j}{x_j} - \frac{1}{k_j+1}\frac{dm_l}{m_l} \right)$$

Multiplying both sides by $\frac{k_j+1}{k_j+2} N_j w_j F_j$ and then imposing values, we get:

$$\sum_l V_{jl} \frac{dZ_l}{Z_l} = \frac{k_j+1}{k_j+2} \sum_l V_{jl} \left(\frac{dt_{jl}}{t_{jl}} + \frac{1}{k_j+1}\frac{dx_j}{x_j} - \frac{1}{k_j+1}\frac{dm_l}{m_l} \right)$$

Next, log differentiating the trade flow equation, we get:

$$\frac{dV_{jl}}{V_{jl}} = (k_j+2)\frac{dZ_l}{Z_l} - (k_j+1)\frac{dt_{jl}}{t_{jl}} + \frac{dN_j}{N_j} + \frac{dw_j}{w_j} + \frac{dF_j}{F_j} + \frac{dm_l}{m_l} - \frac{dx_j}{x_j}$$

We have two sets of exporter shocks in the trade flow equation: $n_j^x = \frac{dN_j}{N_j} + \frac{dw_j}{w_j} + \frac{dF_j}{F_j}$, and $d_j^x = \frac{dx_j}{x_j}$. We also have an importer shock: $d_l^m = \frac{dm_l}{m_l}$. Further, d_l^m and d_j^x are multiplied by $\frac{1}{k_j+1}$ in the inner equation. Hence, we have an estimating equation of the same form as in (14).

C Two-country Model: Online Only

In this appendix, I restrict the model from section two such that trade occurs between two countries, labeled 1 and 2. Focusing on changes to tariffs levied by country 1, and writing the elasticity of the demand level in l with respect to the tariff in country 1 as ϵ_{A_l,t_1} the solution to (11) is written as:

$$\begin{pmatrix} \epsilon_{A_1,t_1} \\ \epsilon_{A_2,t_1} \end{pmatrix} = \begin{pmatrix} V_{11} & V_{12} \\ V_{21} & V_{22} \end{pmatrix}^{-1} \begin{pmatrix} 0 \\ \frac{k_2+1}{k_2+2} V_{21} \end{pmatrix} = \frac{k_2+1}{k_2+2} \begin{pmatrix} -\frac{V_{12}V_{21}}{V_{11}V_{22}-V_{12}V_{21}} \\ \frac{V_{11}V_{21}}{V_{11}V_{22}-V_{12}V_{21}} \end{pmatrix} \tag{18}$$

Clearly, changes to the demand intercepts in countries 1 and 2 depend on the sign of the determinant of V, $V_{11}V_{22} - V_{12}V_{21}$. This result is summarized in the following Lemma.

Lemma 1 *If $V_{11}V_{22} > V_{12}V_{21}$, then higher tariffs in country 1 makes country 1 more competitive and country 2 less competitive. Precisely, if $V_{11}V_{22} > V_{12}V_{21}$, then $\epsilon_{A_1,t_1} < 0$ and $\epsilon_{A_2,t_1} > 0$.*

Proof. Immediate from (18). ■

The intuition for the result in Lemma 1 relates to how the demand shocks subsequent to liberalization affect each country. As detailed in the derivation of (11), the effect of demand shocks on expected profits are proportional to firm-level revenues in serving each market. Focusing on expected profits for firms in country 2, a demand shock in country 1 has a larger effect than a demand shock in country 2 if $V_{21} > V_{22}$. A similar condition exists for expected profits in country 1. Overall, within the employed Pareto specification, it follows that $V_{11}V_{22} > V_{12}V_{21} \Leftrightarrow \frac{\partial E\Pi_{11}}{\partial A_1}\frac{\partial E\Pi_{22}}{\partial A_2} > \frac{\partial E\Pi_{12}}{\partial A_2}\frac{\partial E\Pi_{21}}{\partial A_1}$. Shocks to expected profits determine the Jacobian of the expected profit matrix with respect to aggregate terms, and these shocks determine the overall effect of liberalization.

Though proven rigorously in a moment, $V_{11}V_{22} > V_{12}V_{21}$ will hold in equilibrium under quite reasonable circumstances. For example, similar to the assumptions used in Venables (1985), Bagwell and Staiger (2009), Ossa (2010), and Bagwell and Staiger (2012), if there are positive trade costs though otherwise identical markets, then $V_{11}V_{22} > V_{12}V_{21}$. Hence, the obvious next step is evaluating under what conditions (if any) it is possible that $V_{12}V_{21} > V_{11}V_{22}$. To begin, note that $\frac{V_{12}V_{21}}{V_{11}V_{22}}$ can be written as a function of model parameters as:

$$\frac{\frac{\partial E\Pi_{12}}{\partial A_2}\frac{\partial E\Pi_{21}}{\partial A_1}}{\frac{\partial E\Pi_{11}}{\partial A_1}\frac{\partial E\Pi_{22}}{\partial A_2}} = \frac{V_{12}V_{21}}{V_{11}V_{22}} = \frac{1}{t_1^{k_2+1}t_2^{k_1+1}}\left(\frac{A_1/s_1}{A_2/s_2}\right)^{k_2-k_1} \tag{19}$$

The term in (19) evaluates the geometric "average" of demand shocks on exporters, $\frac{\partial E\Pi_{12}}{\partial A_2}\cdot\frac{\partial E\Pi_{21}}{\partial A_1}$, against the geometric average of demand shocks on home firms $\frac{\partial E\Pi_{11}}{\partial A_1}\cdot\frac{\partial E\Pi_{22}}{\partial A_2}$. Within the parameterized model, this comparison will be a function of the effective size of the shock through relative demand, $\frac{A_1/s_1}{A_2/s_2}$ and the relative elasticity of entering firms through the Pareto shape parameter, $k_2 - k_1$. If shape parameters are the same across countries, then the demand shock in country 1 is effectively the same for countries 1 and 2, and the term in (19) is determined by whether or not tariffs mute the effect of the demand shock on exporters. However, if country 2 has an inferior shape of the productivity distribution, the effective demand shock will not be the same due to the elasticity of the extensive margin (survival in any given market) being larger in country 2 (ie. $k_2 > k_1$). A similar issue is also present for any subsequent shocks in country 2, and hence, the question is how the relative shock in each market interacts with the elasticity of survival for exporters and domestic firms.

In terms of the response to the demand shock, suppose that $1 > \frac{1}{t_1^{k_2+1}t_2^{k_1+1}}\left(\frac{A_1/s_1}{A_2/s_2}\right)^{k_2-k_1}$. This condition is satisfied when tariffs are relatively high or the market is relatively competitive in country 1 (A_1/s_1 is small compared to A_2/s_2). We discuss the role of market competition in a moment, but supposing that $1 > \frac{1}{t_1^{k_2+1}t_2^{k_1+1}}\left(\frac{A_1/s_1}{A_2/s_2}\right)^{k_2-k_1}$ is satisfied, the increase in competitiveness subsequent to liberalization has a larger effect on profits in country 1, thereby reducing the number of entrants into country 1. The opposite happens in country 2, where additional firms enter by virtue of higher export profits and lower competition from country 1 firms. This cycle continues until a new equilibrium is reached, resulting in a higher A_1 and lower A_2. Alternatively, when $\frac{1}{t_1^{k_2+1}t_2^{k_1+1}}\left(\frac{A_1/s_1}{A_2/s_2}\right)^{k_2-k_1} > 1$, the initial increase in competitiveness in 1 has a larger effect on firms in country 2, and the cycle is reversed, resulting in a lower A_1 and higher A_2. Overall, the effects of liberalization depend on the type of equilibrium we are in, and hence, we need to evaluate all equilibrium conditions to ascertain whether unilateral liberalization makes a market more or less competitive.

Equilibrium Effects of Tariffs

To prove that both types of equilibria are possible - thus justifying the structural approach to facilitate counterfactual analysis - I now focus on the role of taste variation across countries via θ_1 and θ_2. Recall from above that θ_1 and θ_2 measure the fundamental willingness to pay for the differentiated good in each country, relative to the numeraire. While these terms are completely subsumed by A's in the free entry conditions, they affect when the free entry solution is consistent with a positive number of entering firms in each country. The following proposition, proven below, details when values of relative taste parameters are consistent with the equilibrium response to tariffs described above:

Proposition 1 *Suppose that $t_l = 1$ and $s_l = 1$ for all l. There exists a range of $\theta_2 > \theta_1$ such that a trading equilibrium with $N_1 > 0$ and $N_2 > 0$ exists and yields $\epsilon_{A_1,t_1} < 0$. In contrast, there exists a range of $\theta_1 > \theta_2$ such that a trading equilibrium with $N_1 > 0$ and $N_2 > 0$ exists and yields $\epsilon_{A_1,t_1} > 0$*

In Proposition 1, the differences in the equilibrium response to tariffs are driven by the relative competitiveness of country 1 to country 2 in the differentiated industry. Normally, the country with the more competitive sector is the country with the more productive firms. All else equal, this yields an effectively smaller market for each variety, or lower A. Indeed, this is crucial as the relative size of A's dictate the sign of ϵ_{A_1,t_1} in the presence of shape heterogeneity. However, when allowing for differences in tastes, one can decouple the relationship between average productivity and A's. That is, the relatively unproductive country can have a smaller effective market when taste for the differentiated good is relatively low. And, when the country with the poorly shaped firms has a *smaller* effective market for each variety, the importance of foreign shocks on that country's exporters are relatively pronounced.

Proof of Proposition 1

To prove Proposition 1 in the paper, we first need to prove an auxiliary result identifying the necessary and sufficient conditions for $N_1 > 0$ and $N_2 > 0$. Using the equation in (9) for country 1 and 2, the following Lemma details precisely when $N_1 > 0$ and $N_2 > 0$:

Lemma 2 *$N_1 > 0$ and $N_2 > 0$ if and only if either of the following conditions hold:*

$$\left(\frac{A_1/s_1}{A_2/s_2}\right)^{k_2+1}\frac{1}{t_1^{k_2}}\frac{s_1}{s_2} \quad < \quad \frac{\theta_1 - A_1}{\theta_2 - A_2} < t_2^{k_1}\frac{s_1}{s_2}\left(\frac{A_1/s_1}{A_2/s_2}\right)^{k_1+1} \tag{20}$$

$$\left(\frac{A_1/s_1}{A_2/s_2}\right)^{k_2+1}\frac{1}{t_1^{k_2}}\frac{s_1}{s_2} \quad > \quad \frac{\theta_1 - A_1}{\theta_2 - A_2} > t_2^{k_1}\frac{s_1}{s_2}\left(\frac{A_1/s_1}{A_2/s_2}\right)^{k_1+1} \tag{21}$$

To prove this lemma, we first solve for N_1 and N_2 using (9) for countries 1 and 2 as follows:

$$N_1 \quad = \quad \frac{\gamma(k_1+1)c_m^{k_1}s_1^{k_1}\left(Y_1 - Y_2\frac{s_1}{s_2}\frac{1}{t_1^{k_2}}\left(\frac{A_1/s_1}{A_2/s_2}\right)^{k_2+1}\right)}{A_1^{k_1+1}\left(1-\frac{1}{t_1^{k_1}}\frac{1}{t_2^{k_2}}\left(\frac{A_1/s_1}{A_2/s_2}\right)^{k_2-k_1}\right)} \tag{22}$$

$$N_2 \quad = \quad \frac{\gamma(k_2+1)c_m^{k_2}s_2^{k_2}\left(Y_2 - Y_1\frac{s_2}{s_1}\frac{1}{t_2^{k_1}}\left(\frac{A_2/s_2}{A_1/s_1}\right)^{k_1+1}\right)}{A_2^{k_2+1}\left(1-\frac{1}{t_1^{k_1}}\frac{1}{t_2^{k_2}}\left(\frac{A_1/s_1}{A_2/s_2}\right)^{k_2-k_1}\right)} \tag{23}$$

Here, we have defined $Y_1 = \theta_1 - A_1$ and $Y_2 = \theta_2 - A_2$. In Lemma 2, (20) is written as:

$$\left(\frac{A_1/s_1}{A_2/s_2}\right)^{k_2+1}\frac{1}{t_1^{k_2}}\frac{s_1}{s_2} \quad < \quad \frac{Y_1}{Y_2} < t_2^{k_1}\frac{s_1}{s_2}\left(\frac{A_1/s_1}{A_2/s_2}\right)^{k_1+1} \tag{24}$$

The lower-bound of (20) can be rearranged as

$$\left(\frac{A_1/s_1}{A_2/s_2}\right)^{k_2+1}\frac{1}{t_1^{k_2}}\frac{s_1}{s_2}Y_2 \quad < \quad Y_1$$

which is the condition such that the numerator of N_1 is positive. The upper bound of (20) is written as

$$Y_1 < Y_2 t_2^{k_1}\frac{s_1}{s_2}\left(\frac{A_1/s_1}{A_2/s_2}\right)^{k_1+1} \tag{25}$$

which is the condition such that the numerator of N_2 is positive. Finally, note that the upper-bound is higher than the lower-bound in (20) if:

$$\left(\frac{A_1/s_1}{A_2/s_2}\right)^{k_2+1}\frac{1}{t_1^{k_2}}\frac{s_1}{s_2} \quad < \quad t_2^{k_1}\frac{s_1}{s_2}\left(\frac{A_1/s_1}{A_2/s_2}\right)^{k_1+1} \tag{26}$$

$$\rightarrow\left(\frac{A_1/s_1}{A_2/s_2}\right)^{k_2+k_1}\frac{1}{t_1^{k_2}t_2^{k_1}} \quad < \quad 1 \tag{27}$$

This is precisely when the denominator of N_1 and N_2 are positive. Hence, if (20) holds, then $N_1 > 0$ and $N_2 > 0$. A similar proof applies for (21), except all inequalities are reversed and the numerators and denominators of N_1 and N_2 are negative, leading to $N_1 > 0$ and $N_2 > 0$.

To show that these are also necessary conditions, suppose that $N_1 > 0$ and $N_2 > 0$. This requires that if $1 > \frac{1}{t_1^{k_1}}\frac{1}{t_2^{k_2}}\left(\frac{A_1/s_1}{A_2/s_2}\right)^{k_2-k_1}$, then $Y_1 > \left(\frac{A_1/s_1}{A_2/s_2}\right)^{k_2+1}\frac{1}{t_1^{k_2}}\frac{s_1}{s_2}Y_2$ and $Y_2 t_2^{k_1}\frac{s_1}{s_2}\left(\frac{A_1/s_1}{A_2/s_2}\right)^{k_1+1} > Y_1$. As above, these latter two inequalities yield (20). However, $N_1 > 0$ and $N_2 > 0$ also imply that if $\frac{1}{t_1^{k_1}}\frac{1}{t_2^{k_2}}\left(\frac{A_1/s_1}{A_2/s_2}\right)^{k_2-k_1} > 1$, then $\left(\frac{A_1/s_1}{A_2/s_2}\right)^{k_2+1}\frac{1}{t_1^{k_2}}\frac{s_1}{s_2}Y_2 > Y_1$ and $Y_1 > Y_2 t_2^{k_1}\frac{s_1}{s_2}\left(\frac{A_1/s_1}{A_2/s_2}\right)^{k_1+1}$. These latter two inequalities yield (21).

Proposition 1

With Lemma 2 in hand, we can now prove Proposition 1. Recall that as a function of model parameters, the condition on the determinant of the trade matrix in (18) is written as:

$$D = 1 - \frac{1}{t_1^{k_2+1}t_2^{k_1+1}}\left(\frac{A_1/s_1}{A_2/s_2}\right)^{k_2-k_1}$$

The Proposition indicates that any equilibria subject to $t_2 > 1$ and $t_1 > 1$ and constant θ's must yield $D = 1 - \frac{1}{t_1^{k_2+1}t_2^{k_1+1}}\left(\frac{A_1}{A_2}\right)^{k_2-k_1} > 0$. We will label this condition as type A, and the alternative type B.

$$1 \quad > \quad \frac{1}{t_1^{k_2+1}t_2^{k_1+1}}\left(\frac{A_1/s_1}{A_2/s_2}\right)^{k_2-k_1} \qquad \textit{Type A}$$

$$1 \quad < \quad \frac{1}{t_1^{k_2+1}t_2^{k_1+1}}\left(\frac{A_1/s_1}{A_2/s_2}\right)^{k_2-k_1} \qquad \textit{Type B}$$

The overall goal of the proof is show how the conditions in (20) and (21) that guarantee $N_1 > 0$ and $N_2 > 0$ correspond with the sign of the determinant (and hence the effects of unilateral liberalization).

Restricting the model to free trade, $t_1 = 1$ and $t_2 = 1$, we find that type A equilibria occur when $\frac{A_2}{A_1} > 1$. Again recalling the two conditions that (individually) yield a positive number of entering firms in each country.

$$\left(\frac{A_1}{A_2}\right)^{k_2+1} < \frac{Y_1}{Y_2} < \left(\frac{A_1}{A_2}\right)^{k_1+1} \tag{28}$$

$$\left(\frac{A_1}{A_2}\right)^{k_2+1} > \frac{Y_1}{Y_2} > \left(\frac{A_1}{A_2}\right)^{k_1+1} \tag{29}$$

It is clear that (28) is the relevant condition for Type A equilibria, since $\left(\frac{A_1}{A_2}\right)^{k_1+1} > \left(\frac{A_1}{A_2}\right)^{k_2+1}$. Under what conditions is $\frac{Y_1}{Y_2}$ within this range? Substituting the definition for $\frac{Y_1}{Y_2}$, we get:

$$\left(\frac{A_1}{A_2}\right)^{k_2+1} < \frac{\theta_1 - A_1}{\theta_2 - A_2} < \left(\frac{A_1}{A_2}\right)^{k_1+1}$$

Since the right-hand bound is now below 1, $\frac{\theta_1 - A_1}{\theta_2 - A_2} < 1$ for there to be a positive number of firms entering in each country in equilibrium. Hence, since $\frac{A_1}{A_2} < 1$, the only values of θ_1 and θ_2 that satisfy $\frac{\theta_1 - A_1}{\theta_2 - A_2} < 1$ are those such that $\theta_1 < \theta_2$. Moving to type B equilibria, it must be the case that $\frac{A_1}{A_2} > 1$, and hence the condition for a positive number of entering firms is:

$$\left(\frac{A_1}{A_2}\right)^{k_2+1} > \frac{Y_1}{Y_2} > \left(\frac{A_1}{A_2}\right)^{k_1+1}$$

Imposing the definition of $\frac{Y_1}{Y_2}$, we get:

$$\left(\frac{A_1}{A_2}\right)^{k_2+1} > \frac{\theta_1 - A_1}{\theta_2 - A_2} > \left(\frac{A_1}{A_2}\right)^{k_1+1}$$

Since $A_1 > A_2$, the only values of θ_1 and θ_2 that satisfy $\frac{\theta_1 - A_1}{\theta_2 - A_2} > 1$ are those such that $\theta_1 > \theta_2$.