Firm Heterogeneity and Costly Trade: A New Estimation Strategy and Policy Experiments.*

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Abstract

This paper models and estimates the responses of firms (who differ in their productivity and face firm and market specific demand shocks) to trade policies in different product and export destinations. The paper does three things. First, it builds a tractable partial equilibrium model in the spirit of Melitz (2003), which incorporates both of these dimensions of heterogeneity and is well-suited for empirical work. Second, it shows how to use this model to estimate the structural parameters of interest using only cross-sectional data. Third, it uses the model to perform counterfactual experiments regarding the effects of reducing costs, both fixed and marginal, or of trade preferences (with distortionary Rules of Origin) offered by an importing country. We find both have a catalytic effect which greatly increases exports to all markets. Our counterfactuals make a case for "trade as aid," as such polices can create a win-win scenario for all parties concerned and are less subject to the usual worries regarding the efficacy of direct foreign aid.

Keywords: Rules of Origin, Firm Heterogeneity, Demand Shocks, Policy Experiments

F12, F14, F17

1 Introduction

While motivated by a wealth of empirical evidence from longitudinal plant- or firm-level data, most of which highlight the productivity differences between domestic firms and exporters, heterogeneous firm models based on the flagship model of Melitz (2003) have yet to be estimated structurally in a way suited to trade policy applications. Our work takes a heterogeneous firm model literally and confronts it with micro data and actual trade policies to estimate all of its structural parameters, including the various levels of fixed costs. These fixed costs are at the core of the models and serve as hurdles that productive/fortunate firms choose to jump, while those that are less so do not. Our paper then uses the estimated model to evaluate the costs of the different kinds of trade polices used in practice.

In our model, there are two sources of firm heterogeneity: firm specific productivity as in the standard Melitz model, and firm and market specific demand shocks. This is motivated by what we observed in our data set. We use a firm level data set on Bangladesh garment producers, exporting mainly to the EU and US markets. Most firms follow the strict productivity hierarchy predicted in Melitz (2003), namely, that firms export to all markets that are easier than the toughest market they export to, and more productive firms export to tougher markets. However, there are a number of violators.[1] While these violators are small in terms of their numbers, they are large in terms of their output. This can be rationalized by introducing firm and market specific demand shocks. Such shocks allow us to explain why, given its productivity, a firm may be very successful in one market but not the other.[2] In addition to this two dimensional heterogeneity, we also incorporate, albeit simply, various real world trade policies, such as tariffs, preferences, rules of origin, and quotas, into our model. We focus only on the partial equilibrium interaction between Bangladeshi firms and take the prices and actions of other firms operating in the EU and US as fixed.

A closely related paper in the literature is the work of Eaton, Kortum and Kramarz (2008) (EKK from here on). EKK uses customs-level data to understand the patterns of

[1] These violations and what might explain them are the subject of Kee and Krishna (2008).

[2] Eaton, Kortum and Kramaz (2008) also observe similar anomalies in their French firm dataset and postulate the existence of firm specific demand shocks rather than firm and market specific demand shocks as we do.

French firms' exports. Their focus is on constructing the simplest model that fits most of the facts, and not on trade policy. They also add a reduced form version of Arkolakis's (2007) market access cost to explain the presence of many small firms with a limited attachment to the market. Since the firms in our data set are well established, we dispense with this additional wrinkle in our model. We see their work as very complementary to ours. They look at the "big picture" and try to match the patterns in firm-level exports by all French firms, in all industries, to all countries. As a result, their model is unsuited to zooming in on a particular industry and incorporating the relevant trade policy details as our model is constructed to do. Our paper is also related to Bernard, Redding and Schott (2009), which also features market demand shocks in order to determine the export behavior of multi-product firms.

The model we develop has two quite novel predictions, which are relevant for policy. First, it suggests that a small country can increase its exports enormously if granted preferences that are relatively easy to obtain, and through policies that reduce fixed costs. These fixed costs need not be monetary. They may simply be due to the red tape or corruption prevalent in many developing countries. Conversely, factors that raise export costs, like corruption or bad infrastructure, can really take a toll on exports. Second, the model suggests that preferences to developing countries can have a catalytic effect. Rather than diverting trade away from other markets as predicted in settings without fixed industry entry costs, preferences given by one developed country can significantly *raise* the exports to the other market. This occurs because preferences raise the return to entry in the industry. Once a firm has entered, it will serve all markets in which it gets an adequate demand shock. This effect could be large under circumstances relevant for many developing countries. The effects of such policies are likely to be blunted by the presence of quotas in other markets.

In our estimation, we simulate our model and then match the generated distributions to those in the data.[3] In this paper, we use only cross sectional price and quantity information and are able to generate standard errors for our estimates using the standard bootstrap

[3] Demidova, Kee and Krishna (2008) take advantage of a natural experiment in trade policy that provides clean predictions regarding how firms should sort themselves across markets in this augmented Melitz model. They then show that these predictions are consistent with the data.

(still work in progress).[4] The advantage of this approach is that such cross sectional data is commonly available, which makes our procedure widely applicable in contrasts to the structural dynamic approach taken in recent work, which is limited to where data is available over a period of time.

The paper proceeds as follows. Section 2 contains a brief discussion of the empirical application and the data. Section 3 lays out the model with the details of the derivations in the Appendix. Section 4 lays out the estimation outline. The results are presented in Section 5, while policy counterfactuals are presented in Section 6. Section 7 concludes.

2 The Empirical Application

The application is the apparel sector in Bangladesh. This has two major sub-sectors: garments made from woven cloth, and those made from non-woven material, namely, sweaters and knitwear. We focus on the woven sector in our estimation since, for reasons made clear below, we cannot estimate all the parameters in the model in the non-woven sector. We will describe the setting in some detail as it is the basis for how we incorporate the trade policy environment in our model.

2.1 The Trade Policy Environment

There are three main components of the trade environment: the trade policy of the US and EU, the trade preferences they granted to Bangladesh, and rules of origin upon which preferences are conditional. Rules of origin or ROOs specify constraints that must be met in order to obtain origin and thereby qualify for country specific quotas or trade preferences.[5] They can take a variety of forms. The important thing to note is that, whatever the form, if ROOs are binding then the choice of inputs used in production differs from the unconstrained level. Thus, from an analytical viewpoint ROOs raise the marginal costs of production when they are binding. In addition, they can raise the fixed cost of production as compliance with

[4] In an earlier version of this paper, we matched firm productivity and demand shocks estimated in a related paper, Demidova, Kee and Krishna (2008).

[5] For a relatively comprehensive and up to date survey see Krishna (2006).

ROOs must be documented, and a large part of these documentation costs involves learning the ropes and, thus, can be treated as a fixed cost. We explicitly allow for such costs of meeting ROOs in our model.

2.1.1 The US Environment

In 1999-2003, the US had tariffs of about 20% applied on a Most Favorite Nations (MFN) basis, as well as MFA quota restrictions in place in selected apparel categories for most developing countries, including Bangladesh. Quotas under the MFA were country specific, so exporting was contingent on obtaining origin: unless the good was shown to originate from Bangladesh, it could not enter under its quota. US ROOs regarding apparel products are governed by Section 334 of the Uruguay Round Agreements Act.[6] For the purpose of tariffs and quotas, an apparel product is considered as originating from a country if it is wholly assembled in the country. No local fabric requirement is necessary. Thus, the products of a Bangladeshi firm are not penalized if the firm chooses to use imported fabrics. Bangladesh did not have any trade preferences in the US market and had to compete with garment producers from other countries, such as India and China. However, since there were quotas on other exporters as well, full competition among supplying countries was still not the case.[7]

The agreement on Textiles and Clothing (ATC) of the Uruguay Round provided for a phaseout of MFA quotas, but the phaseout was heavily backloaded. Moreover, countries could and did choose to remove quotas that were less, or even not binding, before moving on to those that were more binding, making this backloading even more pronounced in effective terms. In the first stage, which started in January 1995, 16% of the imports in 1990 were to be moved out of quota with another 17% in the second stage, which started in 1998. By 2002, when the third stage started and a further 18% were to be phased out, these were

[6] For details, please, refer to the following website:
http://www.washingtonwatchdog.org/documents/usc/ttl19/ch22/subchIII/ptB/sec3592.html

[7] Note that less competitive countries are at less of an disadvantage in the US than they would be in the absence of the quota as the quota in effect guarantees them a niche as long as they are not too inefficient. Their inefficiency reduces the price of their quota licenses, while the quota licenses of a very competitive country would be highly priced.

beginning to bite. However, most of the phaseout was to occur in 2005 when the remaining 49% of the quotas were to be eliminated. Even quotas that were not eliminated had growth factors that made them less binding over time. Thus, during 1999-2003, Bangladeshi quotas for the US were growing. But Bangladesh faced increasing competition in the US markets from other exporters, especially China, whose quota also rose. The presumption was that once quotas were completely removed, China would dominate the US market.

We assume for modelling purposes in this paper that all of Bangladesh's exports to the US are under quota, and as these quotas are bilateral and product specific, firms have no choice but to meet origin. This is not a bad assumption: despite the ATC, over the period for which we have data, about 65-75% of Bangladeshi exports in value terms were under quota. Quota license prices varied over time but the average Bangladeshi price is reported to be around 7%. See Mlachila and Yang (2004) for more on this topic.

2.1.2 The EU Environment

During the same period, the EU had an MFN tariff rate of 12-15% on the various categories of apparel. Prior to 2001, apparel from Bangladesh entered the EU under the Least Developed Countries (LDCs) status of the General System of Preferences (GSP) program with a tariff preference of 100%. Thus, if the MFN tariff was 12%, under GSP, Bangladesh would face no tariff. There were no official quotas, but exports were under surveillance, so a surge would likely result in quotas. In 2000, the EU formally announced they would implement the "Everything-But-Arms" (EBA) initiative in 2001, in which Bangladesh, together with 48 other LDCs, would have access to the EU duty and quota free provided the ROOs were satisfied. This effectively removed any inklings of a quota and granted a 100% preference margin for garment exports of Bangladesh to the EU. It significantly improved the market environment, in which Bangladesh garment exporters operated.

EU ROOs on apparel products were considerably more restrictive than those in the US. According to Annex II of the GSP (Generalized System of Preferences) guidebook, which details ROOs of all products, for an apparel product to be considered as having originated from a country, it must start its local manufacturing process from yarn[8], i.e., the use of

[8]For the details, please, refer to the following websites:

imported fabrics in apparel products would result in the product failing to meet ROOs for the purpose of tariff and quota preferences under GSP or EBA for the case of LDCs. It would, thus, be subject to MFN tariffs of about 12% to 15%.

Firms making garments from woven material (woven firms) mostly assemble cut fabrics into garments. Given the limited domestic supply of woven cloth[9], it commands a premium price, so woven firms can meet ROOs only by paying a roughly 20% higher price for cloth, which translates into a significantly higher cost of production, as cloth is the lion's share of the input cost. The cost of cloth to FOB price is roughly 70-75% for shirts, dresses, and trousers[10], resulting in a 15% cost disadvantage.[11] For this reason, not all woven firms choose to meet ROOs and invoke preferences while exporting to the EU. This feature allows us to estimate the fixed documentation costs of invoking preferences and meeting ROOs.[12]

China and other better off developing countries faced EU quotas and did not have duty free access. See Brambilla et al. (2008) for more on China and the MFA and ATC. In addition, in 2000, the EU granted Bangladesh SAARC (South Asian Association for Regional Cooperation) cumulation.[13] This meant that as long as 50% of the value added was from Bangladesh, materials imported from SAARC countries (which included India with plenty of textile production) could be used while retaining Bangladeshi origin. Cumulation relaxed the constraint on using domestic cloth a little, but not fully as cloth could easily account for more than 50%. It may even have biased exports to the EU towards goods using cheaper cloth. It is worth noting that even if China and India could export to the EU quota free,

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EBA user guide: http://europa.eu.int/comm/trade/issues/global/gsp/eba/ug.htm; Annex II on GSP: http://europa.eu.int/comm/taxation_customs/common/publications/info_docs/customs/index_en.htm.

[9]Of 1320 million meters of total demand in 2001, only 190 was supplied locally in wovens, while 660 of 940 million meters of knit fabric was supplied locally according to a study by the company, Development Initiative, in 2005.

[10]See Table 33 in Development Initiative (2005).

[11]In contrast, India has the ability to meet its woven cloth needs domestically at competitive prices so that its firms can avail themselves of GSP preferences in the EU. As a result, Bangladeshi firms find themselves at a disadvantage in woven garments.

[12]We could not estimate documentation costs separately from other fixed costs of exporting if all firms choose to meet ROOs as in non-wovens. This is the main reason why we focus on the woven sector here.

[13]See Rahman and Bhattacharya (2000) for more on this.

the preferences granted to Bangladesh made the EU a safe haven. This is clearly reflected in the growth of Bangladeshi exports to the EU in this period relative to that to the US.

Note that an item exported to the US may be considered as a product of Bangladesh and imported under its quota allocation. However, the same item may fail to meet the ROOs of the EU and would not qualify for the 12-15% tariff preference under the EBA initiative.

2.2 The Data

We use two data sets. We have a survey of firms in the industry that constitutes roughly 10% of the population of exporters. The firm level survey was conducted from the period of November 2004 to April 2005. It covers 350 firms, which is about 10% of the total population of the garment firms currently operating in Bangladesh. It is a retrospective survey that obtains information from each firm for the period of 1999-2004.[14]

After cleaning the data to exclude outliers and firms with incomplete information, resampling to get a representative set of firms, and using only the firms making woven apparel, we are left with 1007 observations in our estimation. To this survey data we matched customs data on all apparel exports that allows us to see where the firms exported, how much they exported and what, and whether they obtained preferences or not.

Our theoretical model builds on the work of Melitz (2003), to which we add another dimension of firm heterogeneity: firm and market specific demand shocks. Kee and Krishna (2008) use this model to see how firms with different productivities, facing firm and market specific demand shocks, are predicted to sort themselves and behave as a result of differences in tariffs, quotas, and ROOs of the EU and US. The way in which they do so is then shown to be consistent with the model. For example, they find that, as predicted by the model, the probability a firm only exports to the EU falls with increases in productivity, favorable

[14]Unfortunately, the sample is not fully representative. First, it contains almost all the firms in export processing zones (EPZs), about 45 in number, as well as another 100 firms that were inherited from a previous survey. The remainder of the firms are sampled from the non EPZ firms. This sample is stratified by region (Dhaka and Chittagong) and capacity of the firm (above the mean and below the mean capacity as given in the registry of exporters). Large firms (defined to have a capacity above the mean) are sampled at a rate of 3 times that of small firms. In this version of the paper we adjust the sample to make it fully representative.

demand shocks in the US, and adverse demand shocks in the EU. Conversely, the probability a firm exports to both the EU and US rises with increases in productivity and favorable demand shocks in the US and EU. They also found evidence suggesting those firms that only export to the US (whose presence is impossible without demand shocks) are mainly driven by favorable demand shocks in the US together with adverse demand shocks in the EU, but not by productivity.

We define three kinds of firms: firms that sell to the US only (OUS firms), to the EU only (OEU firms), and those that sell to both the EU and US (AUS firms).

3 The Model

We develop a simple partial equilibrium setting based on the setup in Melitz (2003). There are two main differences between his work and ours. First, to match the facts reported above, we allow for an additional dimension of heterogeneity, which we interpret as demand shocks, though other interpretations are possible. Second, unlike Melitz (2003), whose model is a general equilibrium one, ours is explicitly a small open economy partial equilibrium one. We focus exclusively on the exports of Bangladeshi firms to the US and EU. We have no information at the firm level on the exports of other countries. Hence, all we can do is treat these exports as outside our model. We do so by assuming the price indices capturing the effects of sales from all but Bangladeshi firms in the US and EU are given, and that the US and EU are the only markets for Bangladesh. The latter is a good assumption as exports to these two markets make up about 93% of all exports in wovens. We also do not model the domestic Bangladeshi market at all. This is not as bad an assumption as it may seem, as our firms do not produce much (about 3%) for the domestic market. This is not surprising as the domestic market demands different products from those exported.

We first set up the demand side where we describe preferences and how we incorporate demand shocks into the model. Then, we explain the timing of decisions and model how firms behave in the presence of ROOs. Following this, we outline the equilibrium conditions in our partial equilibrium model. Next, we explain how we estimate our model and provide our estimation results. Finally, we explain the counterfactuals we run and what they mean.

3.1 Utility

Utility in country j (j = US, EU) is given by

$$U_j = (N_j)^{1-\beta} (C_j)^{\beta}, \tag{1}$$

where N_j is a competitively produced numeraire good, which is freely traded and takes a unit of effective labor to produce. C_j can be thought of as the services produced by consuming the exports of apparel from all trading partners. Thus:

$$C_j = \left(\sum_{i \in \Omega_j} [X_{ij}]^{(\sigma_j - 1)/\sigma_j} \right)^{\sigma_j/(\sigma_j - 1)}, \tag{2}$$

where Ω_j is the set of trading partners for country j. X_{ij} denotes the services produced by the exports of a trading partner i to country j that produces and sells a continuum of varieties indexed by ω. $q(\omega)$ is the quantity consumed and $z(\omega)$ is the demand shock for variety ω. A higher value of z corresponds to a worse demand shock. Let the sub-utility function be

$$X_{ij} = \left(\int_{\omega \in \Omega_{i,j}} [q_{ij}(\omega)/z_{ij}(\omega)]^{(\sigma_j - 1)/\sigma_j} \, d\omega \right)^{\sigma_j/(\sigma_j - 1)}, \tag{3}$$

where $\Omega_{i,j}$ is the set of varieties from country i available to consumers in country j, and $\sigma_j = 1/(1 - \rho_j) > 1$ is the elasticity of substitution between the varieties produced by country i for export to country j. We can derive the demand function for a variety $q_{ij}(\omega)$ most simply as follows. Minimize the cost of obtaining a util, i.e., minimize

$$\int_{\omega \in \Omega_{i,j}} p_{ij}(\omega) q_{ij}(\omega) \, d\omega \quad \text{s.t.} \quad X_{ij} = 1. \tag{4}$$

This gives the unit input requirement of the variety needed to make a util denoted by $a_{ij}(\omega)$:

$$a_{ij}(\omega) = z_{ij}(\omega)^{1-\sigma_j} P_{ij}^{\sigma_j} (p_{ij}(\omega))^{-\sigma_j} = v_{ij}(\omega) P_{ij}^{\sigma_j} (p_{ij}(\omega))^{-\sigma_j}, \tag{5}$$

where $v_{ij}(\omega) \equiv z_{ij}(\omega)^{1-\sigma_j}$, and

$$P_{ij} = \left[\int_{\omega \in \Omega_{ij}} [p_{ij}(\omega) z_{ij}(\omega)]^{1-\sigma_j} \, d\omega \right]^{1/(1-\sigma_j)} \tag{6}$$

is the cost in country j of getting a util from country i's exports. Then the demand is

$$q_{ij}(\omega) = a_{ij}(\omega) X_{ij} = v_{ij}(\omega) \left[\frac{p_{ij}(\omega)}{P_{ij}} \right]^{-\sigma_j} X_{ij}. \tag{7}$$

As z decreases, the demand shock v increases. Thus, our demand function looks just like the standard one a lá Melitz, except it has a multiplicative demand shock. Finally,

$$X_{ij} = \left[\frac{P_{ij}}{P_j} \right]^{-\sigma_j} \frac{R_j}{P_j}, \tag{8}$$

where P_j is the cost in country j of obtaining a util from all sources:

$$P_j = \left(\sum_{i \in \Omega_j} [P_{ij}]^{1-\sigma_j} \right)^{1/(1-\sigma_j)}, \tag{9}$$

and R_j is the total expenditure in country j. As we are considering Bangladeshi firms exporting to the US and EU, we now drop i as an index and set $j \in \{EU, US\}$.

3.2 Pricing and Equilibrium

Firms are heterogeneous in their productivity as well as their demand shocks. The production structure is summarized in Figure 1. Bangladeshi firms first pay f_e in order to get their productivity draw ϕ from the productivity distribution $G(\phi)$. After observing ϕ, they decide whether to enter the US and/or EU markets and pay a fixed cost of f_m^{US} and f_m^{EU}, respectively. Once entered, they see the market specific demand shocks, v_{US} and $v_{EU,}$ drawn from distributions $H_j(v)$, $j = EU, US$, where the draws for each firm are independent across markets. This assumption is convenient as it allows us to separate the decisions on entry made by a firm in each market.[15] It is also not inconsistent with the facts: the correlation between the estimates of demand shocks in Demidova, Kee and Krishna (2008) is close to 0.

[15] If demand shocks were correlated, a firm may enter just to get information on the state of demand.

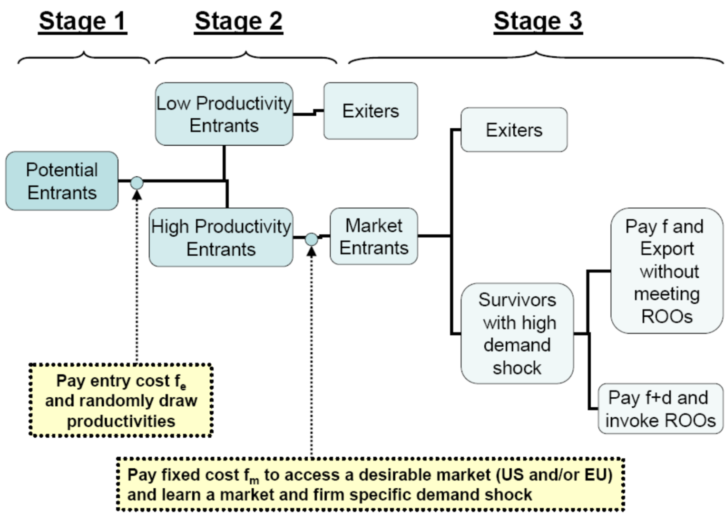

Figure 1: Production structure for Bangladeshi exporters.

If firms decide to sell in market j, they incur a fixed cost of production, f. If they further choose to meet ROOs, they pay in addition d^j, the documentation cost of meeting ROOs.[16]

A firm's decision on whether to sell in a market or not depends on its value of ϕ and v in the market. As all varieties are symmetric, while productivities and demand shocks differ across firms, we can drop ω from our notation, keeping only ϕ and v. A firm in country i with productivity ϕ and market demand shock v_{ij} in market j will earn revenue

$$r_{ij}\left(\phi, v_{ij}\right) = \left(1 - t_{ij}\right)\left(q_{ij}\left(\phi\right)\right) p_{ij}\left(\phi\right) = \left(1 - t_{ij}\right) v_{ij} P_{ij}^{\sigma_j - 1} p_{ij}(\phi)^{1-\sigma_j} R_{ij}, \tag{10}$$

where $R_{ij} = P_{ij} X_{ij}$ is the total sales from country i and t_{ij} is the tariff on country i by country j. The ad-valorem tariff on Bangladesh, $t_{BD,j}$, is levied on the *price* so the firm receives $(1 - t_{BD,j}) p_{BD,j}$ per unit sold at the price $p_{BD,j}$. As the demand shock is multiplicative, it does not affect the price set by a firm, so that a firm's price depends only on its productivity. The profits earned by a firm are

$$\pi_{ij} = \left(1 - t_{ij}\right) p_{ij}\left(\phi\right) q_{ij}\left(\phi\right) - \frac{w\tau_{ij}}{\phi} q_{ij}\left(\phi\right) - f = \left(1 - t_{ij}\right)\left[p_{ij}\left(\phi\right) - \frac{w\tau_{ij}}{\phi\left(1 - t_{ij}\right)}\right] q_{ij}\left(\phi\right) - f. \tag{11}$$

[16]Note that both the market entry costs and demand shock distributions can differ across markets.

It is easy to see that firms set consumer prices as if their marginal costs were $\xi = \frac{w}{\phi}\frac{\tau_{ij}}{(1-t_{ij})}$, while receiving only $(1-t_{ij})$ of their variable profits. As usual, due to the CES framework, the price paid by consumers is $p(\phi) = \frac{1}{(1-t_{ij})}\frac{\tau_{ij}w}{\rho_j\phi}$. We set labor units to be such that wage (w) is equal to a dollar in our partial equilibrium model. Thus, all fixed costs f, f_e, f_m^j, and d^j are in terms of labor units and are expressed in dollars.

To sell in a market, a firm has to pay a fixed production cost f and, if it chooses to meet ROOs, documentation costs d^j as well. However, meeting ROOs could raise direct marginal costs, and this possibility is allowed for by having direct marginal costs be $\frac{1}{\alpha\phi}$ when ROOs are met. Of course, $\alpha \leq 1$ as ROOs are costly to meet. In addition, there are transportation costs of the iceberg form $\tau_{BD,j} > 1$, $j = US, EU$, so that marginal costs are increased by this factor. As marginal costs remain constant despite these complications, we can look at the decision-making in each market separately.

3.2.1 Stage 3

As usual, the model is solved backwards. In Stage 3 we can define the minimal demand shock $v(\phi, P_{BD,j})$, $j = US, EU$, which allows a firm with productivity ϕ to earn zero profits in market j. Due to the fact that profits are increasing with demand shock in each market, all firms with a demand shock above $v(\phi, P_{BD,j})$ will sell in market j. In addition, for the EU market we define the demand shock $v^{ROO}(\phi, P_{BD,EU})$ such that additional profits from invoking EU ROOs just cover the documentation costs of meeting them.[17] From the zero profit conditions (see the Appendix for more detail) it can be shown that the relationship between $v(\phi, P_{BD,EU})$ and $v^{ROO}(\phi, P_{BD,EU})$ is

$$v^{ROO}(\phi, P_{BD,EU}) = C^{ROO} v(\phi, P_{BD,EU}), \tag{12}$$

where $C^{ROO} = \frac{d^{EU}}{f\left[\alpha^{\sigma_{EU}-1}\left(1-t_{BD,EU}\right)^{-\sigma_{EU}}-1\right]} > 1$ so that only a fraction of firms in the EU, the most advantaged ones, invoke ROOs. As expected, C^{ROO} rises, and this fraction falls, as preferences become less attractive: i.e., as tariffs are lowered, or the documentation costs or

[17] Note that there is no such shock for firms in the US market as all Bangladeshi exporters have to meet US ROOs since the US has country specific quotas.

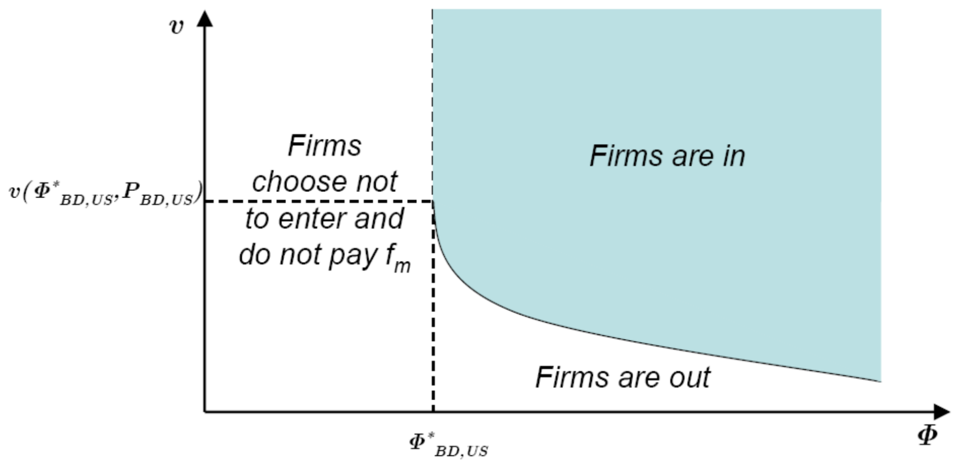

Figure 2: Demand Shock-Productivity Trade-off for the Exporters to the US.

marginal costs of meeting preferences increase. Equation (12) points out that once we know cutoff $v\left(\phi, P_{BD,EU}\right)$, we also know the corresponding one for meeting ROOs.

3.2.2 Stage 2

In Stage 2, we define the productivity level $\phi^*_{BD,j}$ of the marginal firm in market j. For any productivity ϕ, the expected profit from selling in market j is the integral of profits over the demand shocks exceeding $v\left(\phi, P_{BD,j}\right)$. The firm with productivity $\phi^*_{BD,j}$ is, by definition, indifferent between trying to access market j and not doing so. Hence, given its productivity, its expected profits from accessing market j equal to the fixed cost f^j_m.[18] As expected, profits are increasing in ϕ: only firms with $\phi > \phi^*_{BD,j}$ expect to earn non-negative profits on average once their demand shocks are realized, and hence, only such firms choose to try their luck in this market. This gives the cutoff productivity $\phi^*_{BD,j}$ in terms of the model's parameters. (See equations (52) and (53) in the Appendix.) Knowing $\phi^*_{BD,j}$ and $v\left(\phi, P_{BD,j}\right)$ allows us to depict the trade-off between the demand shocks and productivities of firms in each market as done in Figures 2 and 3, where a downward sloping locus reflects the fact that the demand shock needs to be really low to force a very efficient firm to exit the market.

[18] The expected profits for the EU market consist of 2 parts: the expected profits from exporting without ROOs and those from invoking ROOs multiplied by the probability of getting high enough demand shock.

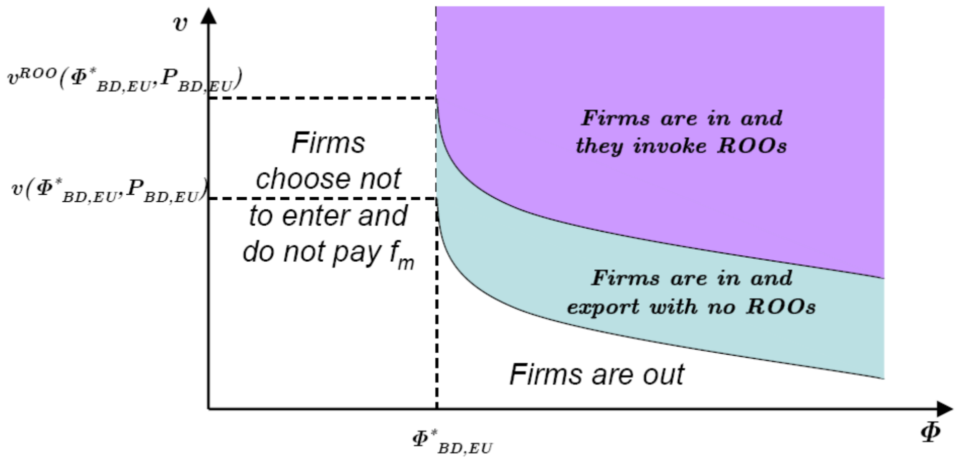

Figure 3: Demand shock-productivity trade-off for the exporters to the EU.

3.2.3 Stage 1

In Stage 1 we use the free entry condition to derive the mass of entrants in the equilibrium. Our solutions for $\phi^*_{BD,j}$, $j = US, EU$, depend on the aggregate price indices in the market. These price indices fall with increases in the mass of entrants. This reduces profits at any given ϕ and v, which shifts the cutoff locus upward and raises the cutoff productivity in each market, thereby reducing ex-ante expected profits from entry. The equilibrium entry level is such that the expected profits from entering the industry, obtaining a productivity draw, and choosing optimally from there onwards equal the cost of doing so, f_e. (See equation (54) in the Appendix.) We will use the model and the available data on Bangladeshi firms to estimate the model's parameters. The solution of the model is described in the Appendix.

4 Estimation Outline

Identification of the parameters is conditional on a number of basic assumptions stated and briefly discussed below. First, the model is structured so that decisions across markets are made separately. This simplifies the derivations significantly. However, the assumptions needed to do so may not hold strictly in the real world. For example, marginal costs may not be constant. They could decrease, or the firm could be subject to capacity constraints so that marginal costs would rise steeply at some point. In addition, incurring some fixed market entry costs may reduce or raise others, or demand shocks may be correlated across markets so that entering one market may provide information, which could be valuable in another. We abstract from *all* such issues and assume all costs are particular to the market and that there are no such spillovers across markets. Second, we assume the US and EU markets make up the entire world market for Bangladesh. This is not such a bad assumption as in 2004 about 93% of total Bangladeshi exports in apparel went to 16 countries in the EU or to the US. Relaxing this assumption would affect the ex-ante entry condition and tend to raise the estimate of f_e. Third, we make assumptions about the parametric form taken by the distributions we recover. We assume all entrants draw their productivities (as well as demand shocks) from a distribution approximated by a Weibull one with density function

$$f(x) = \frac{\gamma}{\lambda}\left(\frac{x}{\lambda}\right)^{\gamma-1} e^{-\left(\frac{x}{\lambda}\right)^{\gamma}}, \tag{13}$$

where γ and λ are the shape and scale parameters. Such distribution has a very flexible form: it can approximate the exponential or normal distribution and, when truncated as required by the model, closely fits the observed productivity distributions. We denote the distribution for productivity shocks by $G(\phi)$, while that for demand shocks by $H(v)$. Demand shock distributions are country specific, while productivity distributions are not.

4.1 Estimation Strategy

We distinguish between what we take as given, the data, and the parameters to be estimated.

4.1.1 Trade Policy Data

We take the values for α (the per-unit cost of meeting the ROOs), t (tariffs), and τ (transport costs) to be set at levels roughly in line with the specifics of the market. As ROOs involve using domestic cloth, which is about 20% more expensive than imported cloth in the woven industry, and as roughly 75% of the cost is the cloth, we assume a 15% cost increase from meeting ROOs and so set $\alpha = .85$ in wovens. The quotas in the US have a license price associated with them. As these quotas are binding, this license price is positive. It has been roughly estimated to be about 7% of costs,[19] which is denoted by μ below. As there are quotas in the US, ROOs must be met by all firms so that for the US market, we cannot separately estimate documentation and fixed costs. As ROOs are easy to document in the US since only assembly is required, we set $d^{US} = 0$. In the EU as some firms meet ROOs while others do not, we can estimate d and f separately. Transport cost estimates for the apparel industry range from a low of about 8%[20] to a high of roughly 14%[21]. We set transport costs of 14% in our estimation. Tariffs are 12% and 20% in the EU and US, respectively, and t is set accordingly. This is all summarized in Table 1.

Table 1: Trade Policy Parameters

	α	t	t^{ROO}	$\tau + \mu$
EU	0.85	0.12	0	1.14
US	1	0.2	0.2	1.14 + 0.07

4.2 Estimation Routine

The thirteen parameters we need to estimate are σ_{EU}, σ_{US}, f_m^{EU}/f, f_m^{US}/f, d/f, f_e/f, γ_{EU}, λ_{EU}, γ_{US}, λ_{US}, γ_{TFP}, λ_{TFP}, and f. Typically in such procedures, the strategy involves guessing the values of the parameters and generating data from the model given these guesses. The parameters are then chosen to fit certain moments of the data. This is what we do here.

First, we guess values of all the above parameters. Given these, we can solve numerically for the cutoff values for demand shocks for any given productivity as well as the cutoff productivity level in each market. (See Appendix for more detail.) Once we do this, we know which firms will actually produce in each market, the price indices in each market, the share of OUS/OEU/AUS firms, the fraction of firms meeting ROOs, and are able to generate the distributions of prices, demand shocks, and quantities from the model that are the counterparts of those we choose to match from the data. We then choose parameters to

[19] In the survey administered by H.L. Kee to a sample of Bangladeshi firms in the woven sector the average cost increase from having to buy a license was 7%. This is also in line with estimates in Mlachila and Yang (2004) for 2003, though their estimates for 2001 and 2002 are higher at about 20%.

[20] World Bank (2005), pg. 110.

[21] See Gajewski and Riley (2006), pg 6.

make generated data as close to the actual data as possible.

What remains to be specified is the objective function being minimized in the above procedure. We define the share of firms (in percentages) that are of the OUS, AUS, and OEU types in the simulated data from the model by OUS^m, AUS^m, and OEU^m, while OUS^e, AUS^e, and OEU^e denote their empirical counterparts. Similarly, let ROO^m and ROO^e define the shares of firms (in percentages) that meet EU ROOs in the model and the data, respectively. Finally, we take the empirical distributions for price, quantity, and demand shocks ($k \in \{p, q, ds\}$) for each of the three groups of firms ($l \in \{OEU, AUS, OUS\}$).[22] We obtain the demand shocks in the data as follows. Demand for a firm (which is its sales in the data) is a function of its own price (obtained from the data), the price index (obtained from the simulation), the total exports to a given market (from the data), and the demand shock. This allows us to back out the demand shock for each firm.

We define five bins for each distribution with the bounds of a bin given by $[x_i, x_{i+20}]$, with $i = \{0, 20, 40, 60, 80\}$. We define the bounds so that exactly 20% of the mass of each empirical distribution lies in each bin. We calculate the mass that lies in each bin from firms of type k of the generated distributions $\left[F^{m,k,l}(x_{i+20}) - F^{m,k,l}(x_i)\right]$, which we call $Z_i^{m,k,l}$. Of course, $Z_i = .2$ for all i.

The objective function has three components. Define

$$A = \left(\frac{OUS^m - OUS^e}{OUS^e}\right)^2 + \left(\frac{AUS^m - AUS^e}{AUS^e}\right)^2 + \left(\frac{OEU^m - OEU^e}{OEU^e}\right)^2, \tag{14}$$

$$B = \left(\frac{ROO^m - ROO^e}{ROO^e}\right)^2, \tag{15}$$

$$C = \sum_k \sum_l \sum_i \left[\left(Z_i^{m,k,l} - Z_i\right)^2\right]. \tag{16}$$

Our objective function is then just the sum of these three or $A + B + C$.[23]

The choice of which moments to fit comes from the need to identify all our parameters. It

[22] For firms that sell to both markets (AUS firms) we distinguish between the distributions in each market and give each one equal weight.

[23] We experiment with different weights to the components and find the results relatively insensitive to such changes.

is worth providing some intuition on how all the parameters are being identified. Matching the shares of the different types of firms and the distributions of demand shocks for each type of firm helps identify the parameters of the distributions of demand shocks. Matching the share of firms meeting ROOs identifies documentation costs, while matching the distributions of price for each type of firm identifies the parameters of the TFP distributions. Matching the position of the quantity distributions helps pin down fixed costs of production as explained above. The value of the elasticity of substitution affects price and, hence, quantity so that matching quantity distributions for the different kinds of firms also helps pin down these parameters. The shape of the demand shock distribution in a market, in turn, helps pin down the fixed market entry costs as is evident from equations (56) and (57) in the Appendix.

5 Results of the Estimation

In the core estimation, we estimate the following parameters: σ_{EU}, σ_{US}, f_m^{EU}/f, f_m^{US}/f, d/f, f_e/f, γ_{EU}, λ_{EU}, γ_{US}, λ_{US}, γ_{TFP}, λ_{TFP}, and f. The results are given below. Table 2 gives the estimated parameters for the TFP distribution, while Table 3 gives the estimated parameters for the demand shock distributions in the two countries that are depicted below.

Table 2. TFP distribution

	Estimate	Std. Err.
Shape (γ_{TFP})	1.75	0.11
Scale (λ_{TFP})	5.71	0.53
Implied mean shock[24]	5.08	
Implied Std. Dev.	3.00	

The distributions of prices, demand shocks, and quantities for AUS firms (in the EU and US) and of OEU and OUS firms are given in Figures 4, 5, and 6, respectively. In these figures, the model generated data is represented by dashed lines, while the data itself is

[24] The mean equals $\lambda\Gamma(1+\frac{1}{\gamma})$, where $\Gamma(.)$ denotes the standard gamma function and the variance equals $\lambda^2\Gamma(1+\frac{2}{\gamma}) - \left(\lambda\Gamma(1+\frac{1}{\gamma})\right)^2$.

represented by solid lines. Our simulated data predicts that a firm size is greater, especially for firms selling to both markets or OUS firms, than in the data.[25]

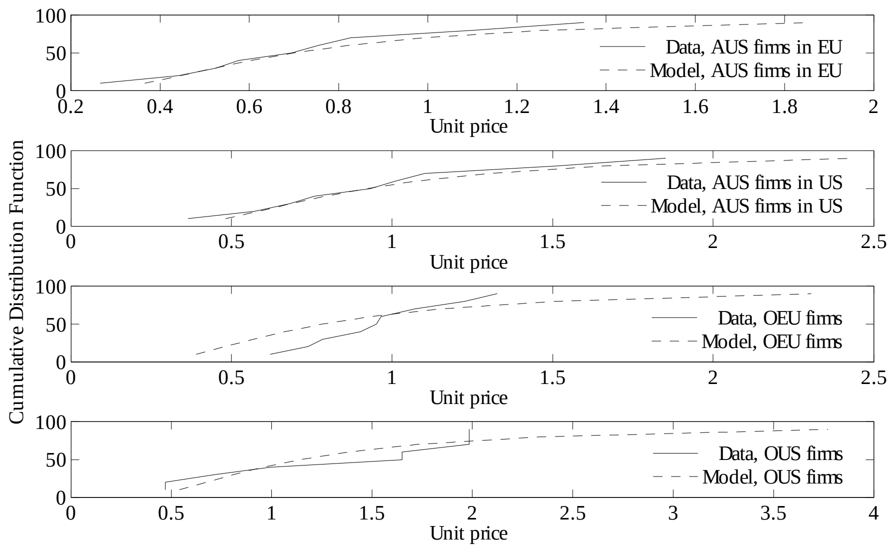

Figure 4: Unit price distibutions.

The distributions of demand shocks are depicted in Figure 5. The means and standard deviations are reported in Table 3. The demand shocks in the US are larger than those in the EU and have the greater coefficient of variation. This is consistent with the differences in the distribution systems in the two countries. Large retailers, like Walmart, play a much bigger role in the US than in the EU. Firms that are lucky enough to land an order from such a large buyer will look like they had a higher positive demand shock. It is also consistent with the fact that the US is the older market for Bangladesh. This ties in with the work of Foster, Haltiwanger and Syverson (2008, 2008a). They allow for both TFP and demand shock differences among firms and argue that younger firms tend to be at least as productive as old ones, but are smaller, i.e., have smaller demand shocks. They interpret this in terms of

[25] This may well be due to capacity constraints, which are not present in our model but may be present in the data. With capacity constraint, firms may not be able to sell as much as they want and this would result in the quantity distributions in the data being lower than those in the model, especially in situations when firms are more likely to be capacity constrained (i.e., when they have good demand shocks).

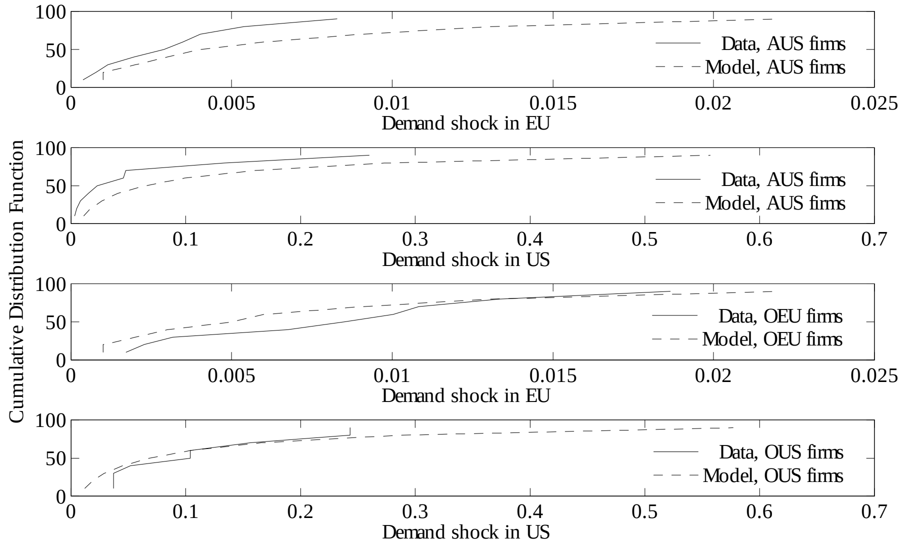

Figure 5: Demand shock distributions.

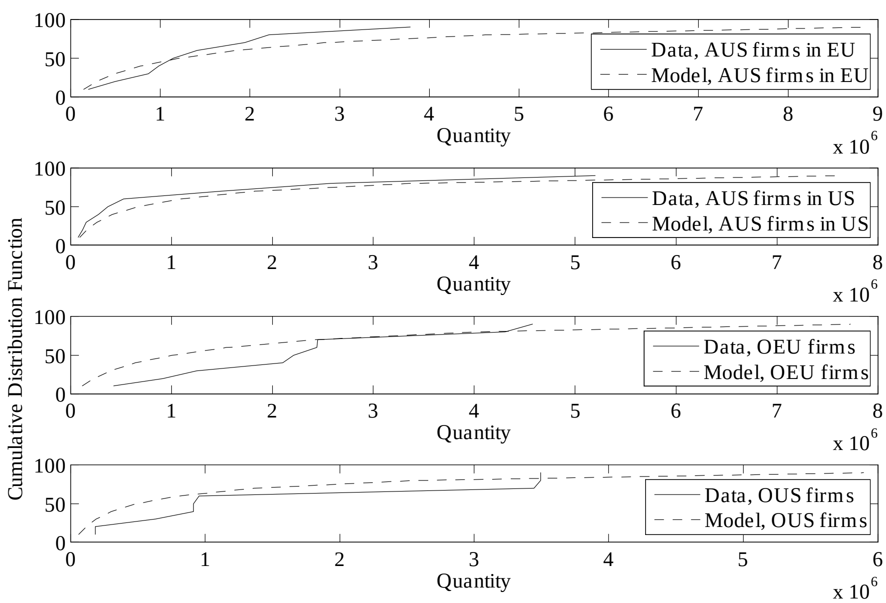

Figure 6: Quantity distributions

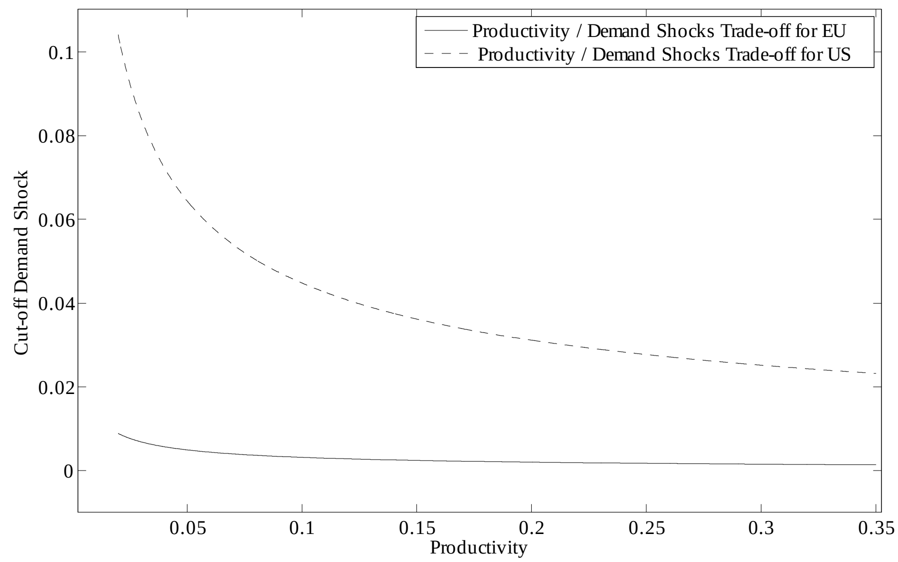

Figure 7: The trade-off between productivity and demand shock.

firms having "market capital" (due to advertising or consumer experience with their goods), which grows slowly over time.

Table 3. Distribution of demand shocks				
	EU		US	
	Estimate	Std. Err.	Estimate	Std. Err.
Shape (γ)	0.697	0.042	0.420	0.021
Scale (λ)	0.006	0.001	0.049	0.007
	Implied means and std. deviation			
Implied mean shock	0.008		0.142	
Implied Std. Dev.	0.011		0.411	
Std.dev / mean	1.38		2.89	

Figure 7 shows the trade-off between the productivity and the cutoff demand shock in the US and EU (see Figures 2 and 3 for the theoretical pictures). The cutoff line for the US is higher, but as the demand shock distributions are different, this cannot be interpreted as direct evidence that the US is a tougher market. Rather, one should compare the probability of being active in the US market versus the EU market by integrating over the relevant demand and productivity shocks. In our estimates, these numbers are roughly .62 and .86 for the US and EU, respectively, consistent with the US being a tougher market.

Table 4 gives the demand elasticities in each market. These are more than unity and close to the estimates obtained in Demidova, Kee and Krishna (2008). They are a little higher in the EU (statistically insignificant difference) and are similar in magnitude to those found in other structural models like Foster, Haltiwanger and Syverson (2008a).

Table 4. Elasticities of substitution

	EU	US
σ	1.60	1.52
Std. Error	0.08	0.05

The estimates of various fixed costs relative to f are given in Table 5. Market entry costs into the EU are about the same as for the US. Also, fixed costs of entering an industry (f_e) are much higher than the cost of entering a market (f_m) in both the US and EU.

Table 5. Fixed costs relative to f

	EU	US
	Relative market entry costs	
f_m/f	2.08	1.49
Std. Error	0.30	0.15
	Relative documentation costs	
d/f	2.07	—
Std. Error	0.21	—
	Relative industry entry costs	
f_e/f	39.8	
Std. Error	5.8	

Table 6 gives the absolute levels of these costs. Note that these numbers, when added up, give a figure higher than the sunk cost estimates in Das, Roberts and Tybout (2007) for knit wear (of about .5 million), which is a part of the non-woven apparel industry. Our estimates are, unfortunately, not directly comparable to theirs for two reasons. First, our numbers are for wovens, while theirs are for knit wear. Second, our numbers should be interpreted as annualized values since our model is static. It is worth noting that such a rich structure of fixed costs is rarely estimated. Estimates for documentation costs, for example, are almost impossible to find. A strength of our approach is the ability to provide such estimates.

Table 6. Fixed costs in $

	Estimate	Std. Error
f	35,947	3,876
f_m^{EU}	74,630	17,728
d_{EU}	74,590	7,395
f_m^{US}	53,450	5,667
f_e	1,432,045	136,641

6 Policy Experiments

Before turning to the policy experiments, we need to outline how the partial equilibrium assumption is implemented in the simulations. From the estimation procedure, we can obtain price indices of Bangladeshi firms exporting to EU and US: $P_{BD,US}^{\sigma_{US}-1}$ and $P_{BD,EU}^{\sigma_{EU}-1}$.

Just as demand for a variety is the product of the variety's share of demand times total demand, own revenue is the product of the variety's share of revenue times total revenue:

$$R_{BD,j} = \frac{(P_{BD,j})^{1-\sigma_j}}{(P_{BD,j})^{1-\sigma_j} + \sum_{i \in \Omega_{(-BD)}} [P_{i,j}]^{1-\sigma_j}} R_j. \tag{17}$$

$R_{BD,US}$ and R_{US} are approximated by the total Bangladeshi sales and total exports of woven apparel to the US, respectively. We can invert equation (17) to obtain $\sum_{i \in \Omega_{(-BD)}} [P_{i,US}]^{1-\sigma_{US}}$ denoted by $\bar{P}_{-BD,US}$. We can obtain $\bar{P}_{-BD,EU}$ in an analogous manner. In our simulations, we keep $\bar{P}_{-BD,EU}$ and $\bar{P}_{-BD,US}$ fixed in accordance with our partial equilibrium assumptions.

We are now ready to look at some policy questions. Our first experiment deals with a question of considerable policy importance, namely, the costs of preferences. Developed countries typically give preferences to developing ones, but require that exporters meet origin requirements as done by the EU in the EBA. Thus, obtaining preferences can be quite costly. Consequently, such preferences can be much less generous than they seem. We use our model to quantify the impact of making such preferences easier/harder to obtain.[26] We show, for example, that removing the home yarn requirement results in a surge of entry and exports.

The second experiment looks at the effects of subsidies to fixed costs. Here, the issue is that of policy effectiveness. Which subsidies are most effective in terms of promoting exports? This is relevant for developing countries for a number of reasons. Foreign exchange may be valuable in itself due to the existence of a "foreign exchange gap". Moreover, exports may provide needed tax revenues, or more generally, may be a source of externalities. To examine this question, we first look at the effectiveness of a given dollar value of a subsidy to different kinds of fixed costs, as in Das, Roberts and Tybout (2007). Here, we consider both the short and long run effects and find they can go in opposite directions. We also look at welfare and revenue effects.[27] Our work suggests that in the absence of any response from other countries, as might be expected for a small country (recall the price index of competing products is given in the model), a fall in the fixed costs firms face can greatly increase their exports. We discuss the reason for this and provide a decomposition of the relevant margins.

A interesting and novel finding is that liberalization in one country can raise exports to the other rather than lowering them as would be expected a priori. These cross market effects are very large.

6.1 Documentation Costs, Preferences, and ROOs

The preferences given to Bangladeshi exporters by the EU in the woven industry are restrictive for two reasons. First, there is the requirement of using more expensive domestic fabric. Second, there are documentation costs involved (see Table 6).

[26] Mattoo, Roy and Subramaniam (2002) look at the AGOA (the Africal Growth and Opportunity Act) and (on the basis of back of the envelope calculations based on a simple competitive model) argue that preferences are undone to a large extent by restrictive ROOs.

[27] We also decompose the effects into those on the mass of entry (intensive margin on number of firms), the cutoffs (extensive margin on firms), and the output per firm (intensive margin on output).

6.1.1 Long Run Effects

We begin by considering the effects of a series of policies in the long run, i.e., when entry has time to occur. Table 7 looks at three policy changes and their effects in the long run (i.e., when entry adjusts). Column 1 has the status quo, namely, preferences in the EU that are costly to meet in wovens. Column 2 looks at the effect of removing these preferences completely. This means making the tariff in the EU 12% for all Bangladeshi firms. Column 3 shows the effects of raising documentation costs by two times relative to the status quo. Column 4 shows the effect of keeping preferences as in the status quo, but removing the cost of meeting them in terms of higher priced cloth. To approximate this, we make the ROOs costless to meet in terms of marginal production costs in wovens. This is a simple way of capturing policies, like regional cumulation,[28] which makes ROOs less costly to meet.[29]

All reductions in costs make Bangladeshi firms more optimistic about their expected profits, and hence, the mass of entrants rises. In addition, more relaxed EU ROOs allow a greater share of Bangladeshi exporters to meet them. This effect also expands the market share of Bangladeshi exporters in the EU market. There are also strong cross-market effects. A more liberal policy in the EU results in a greater mass of entrants into the industry, which raises Bangladeshi exporters' share in the US market and reduces the price index there. Of course, quotas in the US (which we have not yet fully incorporated) will blunt such effects reducing the impact of unilateral liberalization on the part of the EU.

An important thing to note in Table 7 is that despite ROOs being costly to meet, the woven apparel industry relies greatly on the presence of the EU preferences. Our model suggests that in the absence of these preferences, as shown in Column 2, entry would fall considerably. Consequently, EU imports from Bangladesh would fall from $1,628 million to $21 million and US imports from $1,343 million to $17 million, highlighting the cross market effects of the EU policies. The reason is the large industry entry costs, which can only be covered by the most fortunate (high TFP and high demand shock) firms when preferences

[28] For example, if cheap Indian cloth could be used in production without compromising Bangladeshi origin, costs of meeting ROOs would fall.

[29] Bombarda and Gamberoni (2009) focus on such issues in the context of the Pan European system of cumulation that the EU FTA partners have to respect to gain preferential access to the European market.

are removed. This reduces the mass of firms that enter.

Doubling documentation costs, as done in Column 3, also reduces EU (to \$990 million) and US imports (to \$856 million) from the status quo. Note this is a far smaller effect than the removal of preferences. Finally, when the home yarn requirement is removed so that preferences are not costly to obtain, both EU and US imports explode. The model suggests this would result in exports to the EU of \$4,460 million and to the US of \$3,294 million. Had we incorporated US quotas which were binding in this period, these numbers would have been much smaller.

The reason why raising documentation costs by a factor of two has a relatively small effect is that marginal firms (who are smaller and have lower productivity and so lower sales) are the ones more affected by this change. This suggests that policies that affect marginal costs (like removal of preferences, as in Column 2, or reducing the cost of meeting preferences, as in Column 4) also affect entry, and hence, firms of all types, and tend to have more bang than ones that affect only marginal firms.

It is worth pointing out that giving preferences results in enormous effects (both in the US and EU), even when there are restrictive ROOs, compared to back of the envelope calculations that ignore the role of entry like Mattoo et. al. (2003). Our numbers for effects on trade and welfare below are so much larger because entry does most of the heavy lifting in such experiments.

When exporting becomes less promising, as when documentation costs rise or preferences are removed, cutoffs fall. The direct effect on profits is negative, which raises the productivity cutoff. As a result, there is a fall in entry of Bangladeshi firms. This fall in entry raises the price index in both the US and EU (as is evident in Table 7), making profits swing upwards, which, in turn, acts to reduce the cutoff productivity. The latter effect on the cutoff dominates empirically so that when exporting becomes less promising, productivity cutoffs of Bangladeshi firms fall in both the US and EU.[30]

[30]Note this is not a full GE setup, where firms choose which country to enter, Bangladesh, the US, or the EU. In such settings, protection in a country raises the productivity cutoff.

6.1.2 Long Run Welfare Consequences

What about the welfare effects of these policies? There are two main channels through which policy regarding Bangladeshi firms affects the welfare of the EU households: via consumer surplus and tariff revenue. Changing policies impacts the value of tariff revenues, TR_{EU}, earned by the EU both via the number of Bangladeshi exporters who pay a tariff and via the volume of their sales. In addition, policy changes affect the EU price index. In particular,

$$P_{EU} = \left[(P_{BD,EU})^{1-\sigma_{EU}} + \sum_{i \in \Omega_{(-BD)}} [P_{i,EU}]^{1-\sigma_{EU}} \right]^{\frac{1}{1-\sigma_{EU}}}, \tag{18}$$

where $\sum_{i \in \Omega_{(-BD)}} [P_{i,EU}]^{1-\sigma_{EU}} = \bar{P}_{-BD,US}$. Recall that $\bar{P}_{-BD,US}$ was calculated earlier and is held fixed at this level in our counterfactual experiments. However, $(P_{BD,EU})^{1-\sigma_{EU}}$ changes as we change the EU policies. The change in welfare is approximately the change in tariff revenue plus the change in consumer surplus. The latter is roughly equal to the consumption of the aggregate good (services) times the change in the aggregate price. The effect on tariff revenue and the percentage change in the price index are also reported in Table 7.

As is evident, removing preferences given to Bangladesh by the EU decreases EU welfare by roughly 102 million dollars. Thus, it seems like giving preferences is in the EU's own narrow self interest. The removal of preferences reduces ex-ante profits and, hence, entry. This reduction in the mass of entering firms results in a very large fall in exports to both the EU and US, with a consequent fall in consumer surplus and tariff revenue in both the US and EU. US and EU welfare fall. Removing EU preferences reduces welfare in the US by about 364 million dollars.

When documentation costs are raised, ex-ante profits fall as does the mass of entry. This raises prices, which acts to reduce surplus, but as fewer firms invoke ROOs, tariff revenues increase, raising welfare. The former effect dominates so that welfare in the EU falls by about 25 million dollars, while welfare in the US decreases by about 133 million dollars.

Finally, removing the home yarn requirement raises ex-ante profits, and, hence, entry, with consequent increases in surplus and tariff revenue. Note that welfare rises in *both* the US and EU by 529 million and 138 million dollars, respectively.

6.1.3 Short Run Results

Table 8 looks at the same policy changes, but limits the analysis to the short run. In calculating these impact effect estimates, we turn off the entry channel and look at the effect on firms that have already decided to be in an industry and market. Hence, we keep the mass of firms that enter the industry and the productivity cutoff of firms that enter a particular market fixed at their initial estimated levels and allow the experiment only to affect the position of the productivity-demand shock trade-offs, and via this, all other variables.[31]

Preferences and Documentation Costs In the short run, removing preferences makes the market directly less attractive. As a result, the demand shock cutoff for any given productivity rises. Since each active firm has lower marginal costs (recall ROOs raised marginal cost when met), the price it charges falls. However, firms now pay tariffs, which raises the price consumers pay. Since tariffs are 12%, while the cost disadvantage is 15%, the price charged to consumers falls, which reduces the price index. This fall in the price index raises the sales of Bangladeshi firms, and their share in EU imports. But what they receive post tariff falls, and this is what results in exit in the long run. Tariff revenues rise quite considerably in the short run, but from comparing them to those in Table 7, we see this will only be temporary. Bangladeshi export revenues fall when preferences are removed, since each firm sells less and some do not sell at all. However, these effects are muted as we have turned off the main channel, namely, entry/exit. It is worth emphasizing the difference in the long run export effects (both in the US and EU) of preferences, even when there are restrictive ROOs, and the short run ones in Table 8. Back of the envelope calculations that ignore the role of entry like Mattoo et. al. (2003) could easily underestimate these long run effects, or even get the effect on welfare reversed. Documentation cost increases have similar effects, except that they do not affect the demand shock cutoff, only the margin where firms make use of ROOs.

[31] Another way to say this is that we have bygones be bygones: firms that have entered the industry and market only choose whether they can cover their variable and fixed costs of production. Those that have too low a demand shock to do so exit. Thus, the productivity cutoff is not affected unless there is no demand shock, at which a firm with the cutoff productivity level wants to export.

Table 7. Long-run equilibrium implications of policy changes (value in dollars)

	Baseline	No preferences	Higher doc. costs	No home yarn req.
Tariff in EU ($t_{BD,EU}$)	*12%*	*12%*	*12%*	*12%*
Tariff in EU, ROO ($t^{ROO}_{BD,EU}$)	*0%*	**12%**	*0%*	*0%*
Tariff in US ($t_{BD,US}$)	*20%*	20%	*20%*	*20%*
Cost disadvantage (α)	*0.85*	**1.00**	*0.85*	**1.00**
Relative documentation costs (d/f)	*2.075*	**0.00**	**4.15**	*2.075*
		Bangladeshi exports		
EU imports from Bangladesh	*1,628m*	*21.4m*	*990m*	*4,460m*
US imports from Bangladesh	*1,343m*	*17.0m*	*856m*	*3,294m*
		Change in Bangladesh firms' market share, %		
Share of EU imports	*2.9%*	*-98.7%*	*-39.2%*	*+173.9%*
Share of US imports	*3.6%*	*-98.7%*	*-36.3%*	*+145.2%*
		Change in number of firms, %		
Implied # of entrants	*1,056*	*-98.8%*	*-37.1%*	*+159.4%*
Implied # of firms trying EU	*1,055*	*-98.8%*	*-37.1%*	*+158.1%*
Implied # of firms trying US	*1,056*	*-98.8%*	*-37.2%*	*+159.5%*
# of successful exporters to EU	*913*	*-99.5%*	*-37.1%*	*+158.1%*
# of successful exporters to US	*681*	*-98.8%*	*-36.9%*	*+156.8%*
		Change in productivity cutoffs for exporters, %		
Productivity cutoff in EU	*0.1244*	*-4.11%*	*-1.38%*	*+4.41%*
Productivity cutoff in US	*0.0567*	*-6.84%*	*-2.60%*	*+11.54%*
		Change in demand shock cutoffs, %		
Demand shock cutoff in EU	*0.0027*	*-0.34%*	*-0.31%*	*+2.71%*
Demand shock cutoff in US	*0.0636*	*0.00*	*0.00*	*0.00*
		Share of firms invoking ROO		
Share of ROO firms (model)	*41.9%*	*0%*	*23.6%*	*60.1%*
		Share of AUS, OEU, and OUS firms		
Share of AUS firms	*58.7%*	*59.2%*	*58.9%*	*58.0%*
Share of OEU firms	*32.7%*	*32.4%*	*32.6%*	*33.3%*
Share of OUS firms	*8.5%*	*8.4%*	*8.5%*	*8.8%*
		Change in EU and US price indices, %		
Price index in EU	*100%*	*+4.88%*	*+1.93%*	*-8.38%*
Price index in US	*100%*	*+7.35%*	*+2.67%*	*-10.35%*
		Change in tariff revenues, %		
Tariff revenue in EU	*25,260k*	*-89.9%*	*+26.5%*	*+6.4%*
Tariff revenue in US	*268,600k*	*-98.7%*	*-36.3%*	*+145.2%*
		Approximated change in welfare		
Change in welfare in EU ($)	—	*-102,187k*	*-24,678k*	*+138,013k*
Change in welfare in US ($)	—	*-363,868k*	*-133,270k*	*+529,006k*

Allowing the Use of Imported Cloth Removing the no home yarn requirement has a somewhat surprising effect. Here, the demand shock cutoff rises, while the price index falls. The reason is that allowing foreign cloth to be used reduces the marginal cost of firms that meet ROOs. This lower cost of production for firms that used to meet ROOs and continue to do so reduces their price. In addition, more firms choose to meet ROOs, and these firms also reduce their price as they do not pay tariffs and do not have to use costly domestic cloth. Thus, the aggregate price index falls. This raises the demand shock cutoff the marginal exporter (not the marginal firm meeting ROOs) requires to export. Bangladeshi export revenue rises, but again, the effects are muted in the short run.

Table 8. Short-run equilibrium implications of policy changes.

	Baseline	No preferences	Higher doc. costs	No home yarn req.
Tariff in EU ($t_{BD,EU}$)	*12%*	*12%*	*12%*	*12%*
Tariff in EU, ROO ($t_{BD,EU}^{ROO}$)	*0%*	**12%**	*0%*	*0%*
Cost disadvantage (α)	*0.85*	**1.00**	*0.85*	**1.00**
Relative documentation costs (d/f)	*2.075*	**0.00**	**4.15**	*2.075*
		Change in Bangladesh firms' market share, %		
Share of EU imports	*2.9%*	+4.02%	-2.67%	+11.3%
		Change in mass of firms, %		
Implied # of entrants	*1,056*	*fixed*	*fixed*	*fixed*
Implied # of firms trying EU	*1,055*	*fixed*	*fixed*	*fixed*
# of successful exporters to EU	*913*	*-0.01%*	*0.00*	-0.12%
		Change in productivity cutoffs for exporters, %		
Cutoff in EU	*0.1244*	*0.00*	*0.00*	0.00
		Change in demand shock cutoff, %		
Demand shock cutoff in EU	*0.0027*	*+0.13%*	*0.00*	*+0.33%*
		Change in price index in EU		
Aggregate price index in EU	100%	*-0.22%*	*+0.21%*	*-0.54%*
		Change in tariff revenues collected		
Tariff revenues in EU	*25,260k*	*+708%*	*+101%*	*-59%*
		Change in Bangladesh revenues before tariff		
Value of Bangladeshi exports: $R_{BD,EU}$	*1,628m*	*+4.44%*	*-4.27%*	*+11.1%*
		Change in Bangladesh revenues after tariff		
Revenue of Bangaldeshi firms	*1,603m*	*-6.64%*	*-5.93%*	*+12.20%*
		Approximated change in welfare		
Change in welfare in EU ($)	—	*+182,325k*	*+22,208k*	*-6,109k*

6.2 Subsidizing Fixed Costs

Which fixed costs should be subsidized? Is there a difference? Table 9 looks at this question in terms of promoting exports. It compares the effectiveness of a given dollar value ($5,000,000) of a subsidy to different kinds of fixed costs. In this, it follows Das, Roberts and Tybout (2007). The results suggest the export effects are very large but of roughly the same size irrespective of the fixed costs being subsidized. A policy maker wanting to increase exports would get about a forty dollar increase in export revenue for every dollar spent reducing fixed costs. We also find that cross market effects are large: if the EU market entry is subsidized, the US market entry (and tariff revenue) rises by almost as much as the EU market entry (and tariff revenue). Thus, policies have large cross market effects.

6.3 The Responsiveness of Trade Flows to Trade Barriers

It is worth explaining how we get such a large effect on exports given there is free entry. First, subsidies raise the mass of entrants considerably. Second, spillover effects of policies across markets magnify the export increase due to any given increase in entry. When subsidies attract firms into the Apparel industry, these entrants export not just to the EU, but wherever they have a good demand shock. Third, due to the presence of demand shocks, the marginal and average firms are large. With or without demand shocks, the marginal firm producing has variable profits that just cover its fixed costs of production. Without demand shocks, this means that its variable profits just equal its fixed costs of producing. With demand shocks, this is true only at the cutoff demand shock for each firm, including the firm with the cutoff productivity. At all better demand shocks greater than the cutoff one, the firm with the cutoff productivity has higher profits and sales than it needs to produce. As a result, the marginal and average firms tend to be larger in the presence of demand shocks. This also helps explain why exports rise greatly when the mass of firms rises.

6.3.1 The Relevant Margins

We want to decompose export changes due to policy in our counterfactuals into their component parts. The basic idea is quite simple. We ask how much of the exports change is due to changes in the exports of existing firms (the intensive margin), how much is due to cutoffs changing (one part of the extensive margin), and how much is due to the entry of firms (the entry margin, which is the other part of the extensive margin).

Let total exports be X. Let x denote the exports of the individual firm. Total exports differ in the two periods, 0 and 1, as the mass, productivity, and demand shock cutoffs change, which results in the changing of exports per firm. Thus, $X(M_1^e, \phi_1, v_1, x_1)$ denotes total exports when M_1^e mass of firms enter, the productivity and demand shock cutoffs are those in period 1, and the output per firm corresponds to that in period 1. Similarly, $X(M_0^e, \phi_0, v_1, x_1)$ denotes total exports when M_0^e mass of firms enter, the productivity cutoffs for entry and for each market are that in period 0, while the demand shock cutoffs in each market for each productivity correspond to those in period 1. The change in total exports can (by adding and subtracting the relevant terms) be decomposed as follows:

$$
\begin{aligned}
& X(M_1^e, \phi_1, v_1, x_1) - X(M_0^e, \phi_0, v_0, x_0) \\
= \; & [X(M_0^e, \phi_0, v_0, x_1) - X(M_0^e, \phi_0, v_0, x_0)] \quad \text{(Intensive Margin)} && (19) \\
& + [X(M_0^e, \phi_0, v_1, x_1) - X(M_0^e, \phi_0, v_0, x_1) \quad \text{(Extensive Margin} && (20) \\
& + X(M_0^e, \phi_1, v_1, x_1) - X(M_0^e, \phi_0, v_1, x_1)] \quad \text{Via Cutoffs;} && (21) \\
& + [X(M_1^e, \phi_1, v_1, x_1) - X(M_0^e, \phi_1, v_1, x_1)] \quad \text{Via Entry).} && (22)
\end{aligned}
$$

What would we expect to happen through these margins? Any policy will have an impact on exports via the exports of existing firms, i.e., the *intensive margin.* In addition to the direct effect on exports of the policy, changes in the price index in response to the policy will also affect the exports of existing firms. If, for example, the price index of Bangladeshi apparel falls, each Bangladeshi firm faces more competition from other Bangladeshi firms as the price index of Bangladeshi apparel is lower and this lowers the aggregate price index. This force works to *reduce* an existing firm's exports at any given price. This is captured in the intensive margin in our decomposition. In our simulations, independent of what they are, the exports of existing firms do not change very much in response to policy, so that this intensive margin counts for little. In addition, the changes in entry affect the price index via the *extensive margin* in terms of the demand shock and productivity cutoffs. Again, these effects are small. It is the exports of new entrants that drives over 90% of the increase in exports, i.e., the *entry margin*, in the decomposition.

Table 9

		Government spends \$5 million (±1%) on compensation on total				
Woven Sector	Baseline case	Industry entry costs	EU market entry costs	US market entry costs	Documentation costs	Fixed Costs
Original (estimated)	—	*1,432,045*	*74,630*	*53,449*	*74,591*	*35,947*
After compensation	—	*1,427,675*	*70,255*	*49,079*	*63,616*	*33,077*
\$ compensation per firm / entrant	—	*4,370*	*4,375*	*4,370*	*10,975*	*2,870*
Approx. amount to be spent	—	*4,999k*	*5,004k*	*5,002k*	*5,000k*	*5,006k*
		Change in Bangladesh market share				
EU market	*1,628m*	*+8.12%*	*+8.14%*	*+8.12%*	*+8.03%*	*+8.00%*
US market	*1,343m*	*+8.06%*	*+8.05%*	*+8.06%*	*+7.42%*	*+7.99%*
		Change in number of firms				
Implied # of entrants into industry	*1,056*	*+8.33%*	*+8.33%*	*+8.33%*	*+7.67%*	*+8.24%*
Implied # of firms *trying* EU market	*1,055*	*+8.44%*	*+8.44%*	*+8.44%*	*+7.78%*	*+8.25%*
Implied # of firms *trying* US market	*1,056*	*+8.44%*	*+8.44%*	*+8.44%*	*+7.77%*	*+8.25%*
# of *successful* EU exporters	*913*	*+8.32%*	*+8.32%*	*+8.32%*	*+7.67%*	*+9.09%*
# of *successful* US exporters	*681*	*+8.40%*	*+8.40%*	*+8.40%*	*+7.65%*	*+8.90%*
		Cutoff productivities				
Productivity cutoff for EU	*0.1244*	*+0.40%*	*-7.12%*	*+0.40%*	*+0.10%*	*-2.42%*
Productivity cutoff for US	*0.0567*	*+0.59%*	*+0.59%*	*-12.10%*	*+0.54%*	*-2.23%*
		Cutoff demand shocks				
Demand shock cutoff in EU	*0.0027*	*0.00%*	*+4.80%*	*0.00%*	*+0.18%*	*-6.39%*
Demand shock cutoff in US	*0.0636*	*0.00%*	*0.00%*	*+7.21%*	*0.00%*	*-6.63%*
		Share of firms using ROO				
Share of EU firms invoking ROO	*41.9%*	*41.9%*	*41.9%*	*41.9%*	*46.3%*	*41.5%*
		Tariff revenue change				
Tariff revenue in EU	*25,260k*	*+8.45%*	*+8.44%*	*+8.45%*	*-11.06%*	*+8.34%*
Tariff revenue in US	*268,600k*	*+8.06%*	*+8.05%*	*+8.06%*	*+7.42%*	*+7.99%*
		Change in revenue of Bangladesh firms after tariffs				
Revenue from EU market after tariff	*1,603m*	*+8.12%*	*+8.13%*	*+8.12%*	*+8.33%*	*+8.00%*
Revenue from US market after tariff	*1,074m*	*+8.06%*	*+8.05%*	*+8.06%*	*+7.42%*	*+7.99%*
		Change of price index in the EU and US				
Price index in EU	*100%*	*-0.40%*	*-0.40%*	*-0.40%*	*-0.39%*	*-0.39%*
Price index in US	*100%*	*-0.59%*	*-0.59%*	*-0.59%*	*-0.54%*	*-0.58%*
		Approximated change in welfare				
Change in welfare in EU (\$)	—	*+8,611k*	*+8,617k*	*+8,612k*	*+3,603k*	*+8,486k*
Change in welfare in US (\$)	—	*+29,563k*	*+29,513k*	*+29,560k*	*+27,208k*	*+29,312k*
		Policy efficiency measure				
Market size gain (after tariff) per dollar given to the firms / entrants	—	*43.4*	*43.3*	*43.3*	*42.6*	*42.8*

The question still remains how such a small subsidy could result in such a large increase in entry. The answer is that the relationship between profits ex-ante and the mass of firms is very flat in the estimated model. As the mass of firms that enter rises, profits fall off very slowly. A subsidy, for example, shifts these ex-ante profits upwards. As the above mentioned curve is flat, even a small shift up results in a large change in the intersection of the curve with the x axis (which is the zero profit condition pinning down entry).

This curve is likely to be flat when Bangladeshi firms are a small part of the world's exports (so that there are a lot of such other exporters to steal consumers away from). Simulations revealed that this is indeed the case: as the share of Bangladesh in exports rises, the increase in exports in this kind of a simulation falls very fast. This suggests that developing countries, especially small ones whose exports are not large enough to disrupt markets, might be able to raise exports a lot by focusing on policies that reduce entry costs of various kinds. These polices need not even be subsidies. Nor do they need to be very costly to implement. For example, promoting export fairs that allow buyers and sellers to meet more easily could reduce fixed costs of exporting, as could workshops on how to institute the quality requirements needed by foreign buyers. Putting the needed documentation for obtaining preferences on the web to reduce documentation costs is another example of a potentially low cost, high return policy.

6.3.2 The Role of σ

How much of our results are due to the fact that our estimated elasticities of substitution are quite low? Krugman (1980) predicts that in a homogeneous firm setup, low σ makes demand inelastic, *reducing* the impact of trade barriers on trade flows. In other words, the effect of trade barriers via the intensive margin is weak when substitution is limited.

Chaney (2008) argues that a low elasticity of substitution between goods magnifies the effect of trade barriers on trade flows when firm heterogeneity is added to the model. Note this is exactly the *opposite* of what Krugman predicts. In the presence of firm heterogeneity, there are additional effects via the productivity cutoffs. Trade barriers raise prices and this, in turn, raises the price index. The increase in the price index allows less productive firms to survive. When elasticity of substitution is low, such firms are not at a severe disadvantage, as their products differ considerably from those of other firms. As a result, these firms can sell a good deal so that trade flows are very responsive to trade barriers via the extensive margin with a low elasticity of substitution. In other words, the extensive margin effects on trade flows are strong when σ is low, and these dominate in the comparison.

However, Chaney (2008) assumes the mass of entry is fixed and so ignores the entry margin completely. When σ is low, the ex-ante profit condition is quite flat as new entrant's products do not compete directly with those of existing firms: their goods make room for themselves in the product space. Thus, trade barriers which shift ex-ante profits will have a large effect on entry and trade flows. Hence, both cutoff and entry margins are more powerful when σ is low.

But most of the action on trade flows, at least empirically, comes from the entry margin, not the cutoff or intensive one. Thus, while it is fair to say that the low value of σ estimated makes trade flows more responsive to trade barriers, which, in turn, translates into large leverage for policy in our counterfactual experiments, the channel by which it does so empirically is not the margin emphasized in Chaney (2008).

7 Conclusion

We provide a simple way of estimating the structural parameters of a heterogeneous firm model. One of the advantages of our approach is that it uses only cross sectional data to recover all the structural parameters of the model, including fixed costs at different levels. These include entry costs at the industry and market levels as well as fixed costs of production and documentation costs needed to obtain preferences. Moreover, all our estimates seem reasonable and roughly in line with previous work.

The policy implications inherent in our counterfactual simulations are quite provocative. We think of these as making a case for "trade as aid". Recently, there have been serious doubts cast on the efficacy of direct aid. It may be diverted to the pockets of those in power or used ineffectively. Giving aid and having it be effective in terms of growth or a reduction in poverty are two very different things. For example, governments may cut back their own support for the poor as aid grows.

In contrast, “trade aid” works through market forces. For example, in our application, preferences given by the EU are responsible for a huge increase in export flows from Bangladesh to the EU *and* to the US, rather than diverting trade away from the US market to the EU one. In this manner, trade preferences or other forms of trade facilitation by one country can have a powerful effect on exports to all markets, and on output, exports, and employment in the recipient developing country.

It is worth emphasizing that trade aid is a form of aid that can easily create a win-win scenario which is much easier to sell to all parties concerned. The developed country giving preferences wins as its consumers face lower prices and it still obtains some tariff revenues from those firms that choose not to invoke preferences. Other developed countries also stand to gain as entry reduces the price of the goods they import so they would not have any reason to complain. In addition, the developing country gets to increase its exports, earning foreign exchange and employing its labor force.

Our results have some lessons for developing and transition countries. Corruption and bureaucracy raise fixed and marginal costs facing by firms. Our work suggests that even small increases in such costs can result in huge reductions in entry, production, and exports of a country. Conversely, reining in such costs can do much good. Our work can also be seen as highlighting the importance of other initiatives that reduce search costs or inherent uncertainties in the market that raise costs. Thus, export fairs, tribunals for dealing with complaints about product quality, and other policies that reduce the costs of doing business in developing countries may have unexpectedly large effects.

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8 Appendix

This Appendix contains the detailed derivations of the equilibrium conditions for the model described in the paper as well as the way of solving the model numerically.

8.1 Model Derivations

As usual, the model is solved backwards. We begin with Stage 3.

8.1.1 Stage 3: Production Decisions

Exporting to the US Consider a Bangladeshi exporter with productivity ϕ and demand shock v. The US does not give tariff preferences to Bangladeshi garments, and the presence of country-specific quotas in most categories makes meeting ROOs mandatory for exports. This means that Bangladeshi firms exporting to the US have no choice but to meet ROOs.[32] They have to pay the tariff of 20%. As a result, the firm sells quantity

$$q_{BD,US}\left(p_{BD,US},v\right)=v\left[\frac{p_{BD,US}}{P_{BD,US}}\right]^{-\sigma_{US}}\frac{R_{BD,US}}{P_{BD,US}}, \tag{23}$$

at the price $p_{BD,US}=\frac{1}{\left(1-t_{BD,US}\right)}\frac{\tau_{BD,US}}{\rho_{US}\phi}$ and earns the following revenues and profits:

$$r_{BD,US}\left(\phi,v\right)=\left(1-t_{BD,US}\right)vR_{BD,US}\left(P_{BD,US}\right)^{\sigma_{US}-1}\left[\frac{1}{\left(1-t_{BD,US}\right)}\frac{\tau_{BD,US}}{\rho_{US}\phi}\right]^{1-\sigma_{US}}, \tag{24}$$

$$\pi_{BD,US}\left(\phi,v\right)=\frac{r_{BD,US}\left(\phi,v\right)}{\sigma_{US}}-f. \tag{25}$$

The price set by a firm does not depend on its market specific shock v. However, v affects the firm's profits. In particular, for any productivity level ϕ, there exists a minimal demand shock $v\left(\phi,P_{BD,US}\right)$, such that

$$\pi_{BD,US}\left(\phi,v\left(\phi,P_{BD,US}\right)\right)=0, \tag{26}$$

[32] We assume documentation is easy so that documentation costs are zero in the US and that as only assembly is required for origin, meeting ROOs is costless so $\alpha=1$.

and by using (24), we get an equation for $v(\phi, P_{BD,US})$:

$$v(\phi, P_{BD,US}) = \frac{\sigma_{US} f}{(1 - t_{BD,US}) R_{BD,US} (P_{BD,US})^{\sigma_{US}-1}} \left[\frac{1}{1 - t_{BD,US}} \frac{\tau_{BD,US}}{\rho_{US} \phi} \right]^{\sigma_{US}-1}. \quad (27)$$

The mass of Bangladeshi exporters selling in the US is, thus:

$$M_{BD,US} = M_E^{BD} \int_{\phi^*_{BD,US}}^{+\infty} \int_{v(\phi, P_{BD,US})}^{+\infty} h_{US}(v) g(\phi) dv d\phi, \quad (28)$$

where M_E^{BD} denotes the mass of entrants in Bangladesh and $\phi_{BD,US}$ is defined below.

Exporting to the EU When Bangladeshi firms export to the EU they have an additional choice. They can export invoking ROOs and pay zero tariffs, or ignore the preferences and pay the tariff $t_{BD,EU}$ without meeting ROOs. If firms meet ROOs, they incur an additional documentation cost of d as well as an increase in marginal costs due to not using the least cost input mix. As a result, only firms with very favorable demand shocks will choose to pay d and meet the EU ROOs.

The firm maximizes $\max \left[0, \pi_{BD,EU}(\phi, v), \pi_{BD,EU}^{ROO}(\phi, v)\right]$, where

$$\begin{aligned} \pi_{BD,EU}(\phi, v) &= \max_{p_{BD,EU}} \left\{ (1 - t_{BD,EU}) p_{BD,EU} q_{BD,EU}(p_{BD,EU}, v) - \frac{\tau_{BD,EU}}{\phi} q_{BD,EU}(p_{BD,EU}, v) - f \right\}, \\ \pi_{BD,EU}^{ROO}(\phi, v) &= \max_{p_{BD,EU}^{ROO}} \left\{ p_{BD,EU}^{ROO} q_{BD,EU}\left(p_{BD,EU}^{ROO}, v\right) - \frac{\tau_{BD,EU}}{\alpha \phi} q_{BD,EU}\left(p_{BD,EU}^{ROO}, v\right) - \left(f + d^{EU}\right) \right\} \end{aligned} \quad (29)$$

The pricing rule for each type of exporter is:

$$p_{BD,EU} = \frac{1}{1 - t_{BD,EU}} \frac{\tau_{BD,EU}}{\rho_{EU} \phi} \quad \text{and} \quad p_{BD,EU}^{ROO} = \frac{\tau_{BD,EU}}{\rho_{EU} \alpha \phi}. \quad (30)$$

Exporters that do not invoke preferences earn the following revenues and profits:

$$\begin{aligned} r_{BD,EU}(\phi, v) &= (1 - t_{BD,EU}) v R_{BD,EU} (P_{BD,EU})^{\sigma_{EU}-1} \left[\frac{1}{1 - t_{BD,EU}} \frac{\tau_{BD,EU}}{\rho_{EU} \phi} \right]^{1-\sigma_{EU}}, \quad (31) \\ \pi_{BD,EU}(\phi, v) &= \frac{r_{BD,EU}(\phi, v)}{\sigma_{EU}} - f, \quad (32) \end{aligned}$$

while exporters that invoke the EU ROOs have

$$\begin{aligned} r^{ROO}_{BD,EU}(\phi, v) &= vR_{BD,EU}(P_{BD,EU})^{\sigma_{EU}-1}\left[\frac{\tau_{BD,EU}}{\rho_{EU}\alpha\phi}\right]^{1-\sigma_{EU}}, \\ \pi^{ROO}_{BD,EU}(\phi, v) &= \frac{r^{ROO}_{BD,EU}(\phi, v)}{\sigma_{EU}} - \left(f + d^{EU}\right). \end{aligned} \tag{33}$$

For any productivity ϕ, we can define 2 demand shock cutoffs, $v(\phi, P_{BD,EU})$ and $v^{ROO}(\phi, P_{BD,EU})$. Firms with $v \in \left[v(\phi, P_{BD,EU}), v^{ROO}(\phi, P_{BD,EU})\right]$ do not invoke ROOs as their demand shock and, hence, their market is small so that it is not worth their while to incur d^{EU}. Firms with $v \in \left(v^{ROO}(\phi, P_{BD,EU}), \infty\right)$ find it worthwhile to meet EU ROOs. The shocks are defined by

$$\begin{aligned} \pi_{BD,EU}(\phi, v(\phi, P_{BD,EU})) &= 0, \\ \pi^{ROO}_{BD,EU}\left(\phi, v^{ROO}(\phi, P_{BD,EU})\right) - \pi_{BD,EU}\left(\phi, v^{ROO}(\phi, P_{BD,EU})\right) &= 0, \end{aligned} \tag{34}$$

where the second equation comes from setting the additional profits from invoking EU ROOs to zero. Thus, we have:

$$v(\phi, P_{BD,EU}) = \frac{\sigma_{EU} f}{(1 - t_{BD,EU}) R_{BD,EU}(P_{BD,EU})^{\sigma_{EU}-1}}\left[\frac{1}{1 - t_{BD,EU}}\frac{\tau_{BD,EU}}{\rho_{EU}\phi}\right]^{\sigma_{EU}-1}, \tag{35}$$

$$v^{ROO}(\phi, P_{BD,EU}) = \frac{\sigma_{EU} d^{EU}\left[\frac{\tau_{BD,EU}}{\rho_{EU}\phi}\right]^{\sigma_{EU}-1}}{\left(\alpha^{\sigma_{EU}-1} - (1 - t_{BD,EU})^{\sigma_{EU}}\right) R_{BD,EU}(P_{BD,EU})^{\sigma_{EU}-1}}, \text{ or} \tag{36}$$

$$v^{ROO}(\phi, P_{BD,EU}) = C^{ROO} v(\phi, P_{BD,EU}), \text{ where } C^{ROO} = \frac{d^{EU}}{f\left[\alpha^{\sigma_{EU}-1}(1 - t_{BD,EU})^{-\sigma_{EU}} - 1\right]} > 1. \tag{37}$$

Note that from (36) and (37), $v^{ROO}(\phi, P_{BD,EU})$ and $v(\phi, P_{BD,EU})$ are decreasing in ϕ.

As shown below, only firms with productivity $\phi > \phi^*_{BD,j}$ will try to access market j, where cutoffs $\phi_{BD,j}$ are defined below in the stage 2 problem. Thus, the masses of exporters that sell in the EU, but do not or do meet the EU ROOs are, respectively:

$$\begin{aligned} M^{NROO}_{BD,EU} &= M^{BD}_{E}\int_{\phi^*_{BD,EU}}^{+\infty}\int_{v(\phi,P_{BD,EU})}^{v^{ROO}(\phi,P_{BD,EU})} h_{EU}(v)g(\phi)dvd\phi, \\ M^{ROO}_{BD,EU} &= M^{BD}_{E}\int_{\phi^*_{BD,EU}}^{+\infty}\int_{v^{ROO}(\phi,P_{BD,EU})}^{+\infty} h_{EU}(v)g(\phi)dvd\phi. \end{aligned} \tag{38}$$

8.1.2 Stage 2: Market Entry Decision

Consider a firm who has drawn a productivity level and has to decide whether to enter a market. Firms who expect non-negative profits from trying to enter market j will do so.

The US Market For any ϕ and v, the profit of selling in the US is

$$\begin{aligned} \pi_{BD,US}(\phi,v) &= \frac{r_{BD,US}(\phi,v)}{\sigma_{US}} - f = \frac{r_{BD,US}(\phi,v)}{r_{BD,US}(\phi,v(\phi,P_{BD,US}))}f - f \\ &= f\left[\frac{v}{v(\phi,P_{BD,US})} - 1\right]. \end{aligned} \tag{39}$$

Thus, the expected profit of entering the US market is

$$\begin{aligned} E_v\left[\pi_{BD,US}(\phi,v)\right] - f^{US}_m &= \int_{v(\phi,P_{BD,US})}^{+\infty} \pi_{BD,US}(\phi,v)\,dH_{US}(v) - f^{US}_m \\ &= f\int_{v(\phi,P_{BD,US})}^{+\infty}\left[\frac{v}{v(\phi,P_{BD,US})} - 1\right]dH_{US}(v) - f^{US}_m. \end{aligned} \tag{40}$$

The expected profits of accessing the US market are increasing in ϕ, since $v(\phi, P_{BD,US})$ is decreasing in ϕ. Denote the productivity of a marginal Bangladeshi firm, which is indifferent between accessing the US market or not, by $\phi^*_{BD,US}$. Then all firms with $\phi > \phi^*_{BD,US}$ will try to access the US market. $\phi^*_{BD,US}$ is defined by

$$\begin{gathered} E_v\left[\pi_{BD,US}\left(\phi^*_{BD,US},v\right)\right] = f^{US}_m, \Longleftrightarrow \\ \int_{v\left(\phi^*_{BD,US},P_{BD,US}\right)}^{+\infty}\left[\frac{v}{v\left(\phi^*_{BD,US},P_{BD,US}\right)} - 1\right]dH_{US}(v) = \frac{f^{US}_m}{f}. \end{gathered} \tag{41}$$

Equation (41) is important for several reasons. First, by solving it, we obtain the minimal demand shock for the marginal firm from Bangladesh, $v\left(\phi^*_{BD,US}, P_{BD,US}\right)$, which is a key step in the estimation procedure. Second, it shows that this demand shock *does not* depend on the per-unit costs of selling there, only on $\frac{f_m^{US}}{f}$ and the demand shock distribution $H_{US}(v)$. Finally, knowing $v\left(\phi^*_{BD,US}, P_{BD,US}\right)$, we can express the expected profits at Stage 2 for *any firm* as a function of its own productivity ϕ and $\phi^*_{BD,US}$. To see this, note that from the definition of $v(\phi, P_{BD,US})$ in equation (27):

$$\frac{v\left(\phi, P_{BD,US}\right)}{v\left(\phi^*_{BD,US}, P_{BD,US}\right)} = \left(\frac{\phi^*_{BD,US}}{\phi}\right)^{\sigma_{US}-1}, \tag{42}$$

so that

$$E_v\left[\pi_{BD,US}(\phi, v)\right] = f\int_{v\left(\phi, P_{BD,US}\right)}^{+\infty}\left[\frac{v}{v\left(\phi, P_{BD,US}\right)} - 1\right] dH_{US}(v)$$

$$= f\int_{\left(\frac{\phi^*_{BD,US}}{\phi}\right)^{\sigma_{US}-1} v\left(\phi^*_{BD,US}, P_{BD,US}\right)}^{+\infty}\left[\frac{v}{\left(\frac{\phi^*_{BD,US}}{\phi}\right)^{\sigma_{US}-1} v\left(\phi^*_{BD,US}, P_{BD,US}\right)} - 1\right] dH_{US}(v). \tag{43}$$

Thus, the expected profits of a firm depend on its own productivity ϕ, the cutoff productivity level, $\phi^*_{BD,US}$, the demand shock for that level, $v\left(\phi^*_{BD,US}, P_{BD,US}\right)$, and, of course, the distribution of demand shocks. Now let us look at the exporters to the EU.

The EU Market As in the US case, for a firm with productivity ϕ,

$$\pi_{BD,EU}(\phi, v) = f\left[\frac{v}{v\left(\phi, P_{BD,EU}\right)} - 1\right], \tag{44}$$

$$\pi^{ROO}_{BD,EU}(\phi, v) - \pi_{BD,EU}(\phi, v) = d^{EU}\left[\frac{v}{v^{ROO}\left(\phi, P_{BD,EU}\right)} - 1\right]. \tag{45}$$

Thus, the expected profit of entering the EU market is

$$\begin{aligned}
& E_v\left[\max\left\{\pi_{BD,EU}(\phi,v),\pi^{ROO}_{BD,EU}(\phi,v)\right\}\right]-f^{EU}_m \\
= & \int_{v\left(\phi,P_{BD,EU}\right)}^{v^{ROO}\left(\phi,P_{BD,EU}\right)}\pi_{BD,EU}(\phi,v)\,dH_{EU}(v)+\int_{v^{ROO}\left(\phi,P_{BD,EU}\right)}^{+\infty}\pi^{ROO}_{BD,EU}(\phi,v)\,dH_{EU}(v)-f^{EU}_m \\
= & \int_{v\left(\phi,P_{BD,EU}\right)}^{+\infty}\pi_{BD,EU}(\phi,v)\,dH_{EU}(v) \\
& +\int_{v^{ROO}\left(\phi,P_{BD,EU}\right)}^{+\infty}\left[\pi^{ROO}_{BD,EU}(\phi,v)-\pi_{BD,EU}(\phi,v)\right]dH_{EU}(v)-f^{EU}_m \\
= & f\int_{v\left(\phi,P_{BD,EU}\right)}^{+\infty}\left[\frac{v}{v\left(\phi,P_{BD,EU}\right)}-1\right]dH_{EU}(v) \\
& +d^{EU}\int_{v^{ROO}\left(\phi,P_{BD,EU}\right)}^{+\infty}\left[\frac{v}{v^{ROO}\left(\phi,P_{BD,EU}\right)}-1\right]dH_{EU}(v)-f^{EU}_m. \qquad (46)
\end{aligned}$$

The careful reader may wonder what ensures that the above maximum of two functions can be written in this simple way. This follows from the fact that

$$v^{ROO}\left(\phi_{BD,EU},P_{BD,EU}\right)=C^{ROO}v\left(\phi^*_{BD,EU},P_{BD,EU}\right),$$

so that, as long as $C^{ROO}>1$, at all values of ϕ, the demand shock cutoff line in Figure 3 lies below the demand shock cutoff line to invoke ROOs.

From the expression above, the expected profits of accessing the EU market are increasing in ϕ, so if we denote the productivity of a marginal firm exporting to the EU by $\phi^*_{BD,EU}$, then all firms with $\phi>\phi^*_{BD,EU}$ will try to access the EU market. $\phi^*_{BD,EU}$ is defined by

$$\begin{aligned}
E_v\left[\max\left\{\pi_{BD,EU}\left(\phi^*_{BD,EU},v\right),\pi^{ROO}_{BD,EU}\left(\phi^*_{BD,EU},v\right)\right\}\right]=f^{EU}_m, \quad \text{or} \\
\int_{v\left(\phi^*_{BD,EU},P_{BD,EU}\right)}^{+\infty}\left[\frac{v}{v\left(\phi^*_{BD,EU},P_{BD,EU}\right)}-1\right]dH_{EU}(v) \\
+\frac{d^{EU}}{f}\int_{v^{ROO}\left(\phi^*_{BD,EU},P_{BD,EU}\right)}^{+\infty}\left[\frac{v}{v^{ROO}\left(\phi^*_{BD,EU},P_{BD,EU}\right)}-1\right]dH_{EU}(v)=\frac{f^{EU}_m}{f}. \qquad (47)
\end{aligned}$$

Again, solving the equation above for $v\left(\phi^*_{BD,EU},P_{BD,EU}\right)$, we can express the expected profits at Stage 2 for any firm as a function of its own productivity ϕ and $\phi^*_{BD,EU}$:

$$v\left(\phi, P_{BD,EU}\right) = \left(\frac{\phi^*_{BD,EU}}{\phi}\right)^{\sigma_{EU}-1} v\left(\phi^*_{BD,EU}, P_{BD,EU}\right), \tag{48}$$

so that

$$\begin{aligned} & E_v\left[\pi_{BD,EU}\left(\phi, v\right)\right] \\ = \; & f\int_{\left(\frac{\phi^*_{BD,EU}}{\phi}\right)^{\sigma_{EU}-1} v\left(\phi^*_{BD,EU}, P_{BD,EU}\right)}^{+\infty} \left[\frac{v}{\left(\frac{\phi^*_{BD,EU}}{\phi}\right)^{\sigma_{EU}-1} v\left(\phi^*_{BD,EU}, P_{BD,EU}\right)} - 1\right] dH_{EU}\left(v\right). \end{aligned} \tag{49}$$

Moreover, the expected additional profits coming from the possibility of getting a favorable enough demand shock to invoke ROOs can be expressed as

$$\begin{aligned} & E_v\left[\pi^{ROO}_{BD,EU}\left(\phi, v\right) - \pi_{BD,EU}\left(\phi, v\right)\right] \\ = \; & d^{EU}\int_{\left(\frac{\phi^*_{BD,EU}}{\phi}\right)^{\sigma_{EU}-1} v^{ROO}\left(\phi^*_{BD,EU}, P_{BD,EU}\right)}^{+\infty} \left[\frac{v}{\left(\frac{\phi^*_{BD,EU}}{\phi}\right)^{\sigma_{EU}-1} v^{ROO}\left(\phi^*_{BD,EU}, P_{BD,EU}\right)} - 1\right] dH_{EU}\left(v\right), \end{aligned} \tag{50}$$

where, from the analysis above,

$$v^{ROO}\left(\phi^*_{BD,EU}, P_{BD,EU}\right) = C^{ROO} v\left(\phi^*_{BD,EU}, P_{BD,EU}\right), \;\; C^{ROO} = \frac{d^{EU}}{f\left[\alpha^{\sigma_{EU}-1}\left(1 - t_{BD,EU}\right)^{-\sigma_{EU}} - 1\right]} > 1. \tag{51}$$

For our estimation exercise, it is useful to show here how the analysis of Stage 2 can be used together with the data available to calculate $\phi_{BD,US}$ and $\phi_{BD,EU}$. Using (26) together with (24) and (25),

$$\phi^*_{BD,US} = \left[v\left(\phi^*_{BD,US}, P_{BD,US}\right) \frac{\left(1 - t_{BD,US}\right) R_{BD,US}\left(P_{BD,US}\right)^{\sigma_{US}-1}}{f\sigma_{US}}\right]^{\frac{1}{1-\sigma_{US}}} \frac{1}{\left(1 - t_{BD,US}\right)} \frac{\tau_{BD,US}}{\rho_{US}}. \tag{52}$$

Similarly, the productivity of a marginal EU exporter is given by

$$\phi^*_{BD,EU} = \left[v\left(\phi^*_{BD,EU}, P_{BD,EU}\right) \frac{\left(1 - t^{BD,EU}\right) R_{BD,EU} \left(P_{BD,EU}\right)^{\sigma_{EU}-1}}{\sigma_{EU} f} \right]^{\frac{1}{1-\sigma_{EU}}} \frac{1}{\left(1 - t_{BD,EU}\right)} \frac{\tau_{BD,EU}}{\alpha \rho_{EU}}. \tag{53}$$

8.1.3 Stage 1: Entering the Industry

Entry occurs until the expected profits that could be earned by a Bangladeshi firms in all their potential markets equal entry costs:

$$\begin{aligned} & E_\phi \left[\max\left\{E_v\left[\pi^{BD,US}(\phi, v)\right] - f_m^{US}, 0\right\}\right] \qquad (54) \\ & + E_\phi \left[\max\left\{E_v\left[\max\left(\pi_{BD,EU}\left(\phi^*_{BD,EU}, v\right), \pi^{ROO}_{BD,EU}\left(\phi^*_{BD,EU}, v\right)\right)\right] - f_m^{EU}, 0\right\}\right] = f_e. \end{aligned}$$

Using the analysis of Stage 2, we can rewrite this expression as

$$\begin{aligned} & \int_{\phi^*_{BD,US}}^{+\infty} \left[\int_{\left(\frac{\phi^*_{BD,US}}{\phi}\right)^{\sigma_{US}-1} v\left(\phi^*_{BD,US}, P_{BD,US}\right)}^{+\infty} \left[\frac{v}{\left(\frac{\phi^*_{BD,US}}{\phi}\right)^{\sigma_{US}-1} v\left(\phi^*_{BD,US}, P_{BD,US}\right)} - 1 \right] dH_{US}(v) \right. \\ & \qquad \left. - \frac{f_m^{US}}{f} \right] dG(\phi) \\ & + \int_{\phi^*_{BD,EU}}^{+\infty} \left\{ \int_{v\left(\phi_{BD,EU}, P_{BD,EU}\right)}^{+\infty} \left[\frac{v}{v\left(\phi_{BD,EU}, P_{BD,EU}\right)} - 1 \right] dH_{EU}(v) \right. \\ & + \left. \frac{d^{EU}}{f} \int_{v^{ROO}\left(\phi_{BD,EU}, P_{BD,EU}\right)}^{+\infty} \left[\frac{v}{v^{ROO}\left(\phi_{BD,EU}, P_{BD,EU}\right)} - 1 \right] dH_{EU}(v) - \frac{f_m^{EU}}{f} \right\} dG(\phi) = \frac{f_e}{f}, \end{aligned} \tag{55}$$

where $v\left(\phi_{BD,EU}, P_{BD,EU}\right)$ and $v^{ROO}\left(\phi_{BD,EU}, P_{BD,EU}\right)$ are defined in (42) and (48).

8.2 Solving the Model Numerically

Given the parameters σ_{EU}, σ_{US}, f_m^{EU}/f, f_m^{US}/f, d/f, f_e/f, γ_{EU}, λ_{EU}, γ_{US}, λ_{US}, γ_{TFP}, λ_{TFP}, and f, how can we solve the model?

Take the expression for ex-ante profits from entering EU market, given by equation (47):

$$\int_{v\left(\phi^*_{BD,EU},P_{BD,EU}\right)}^{+\infty}\left[\frac{v}{v\left(\phi^*_{BD,EU},P_{BD,EU}\right)}-1\right]dH_{EU}\left(v\right)$$
$$+\frac{d^{EU}}{f}\int_{C^{ROO}v\left(\phi^*_{BD,EU},P_{BD,EU}\right)}^{+\infty}\left[\frac{v}{C^{ROO}v\left(\phi^*_{BD,EU},P_{BD,EU}\right)}-1\right]dH_{EU}\left(v\right)=\frac{f_m^{EU}}{f}, \tag{56}$$
$$C^{ROO}=\frac{d^{EU}}{f\left[\alpha^{\sigma_{EU}-1}\left(1-t_{BD,EU}\right)^{-\sigma_{EU}}-1\right]}>1.$$

Note that the LHS depends only on the cutoff demand shock for the marginal firm, $v\left(\phi^*_{BD,EU},P_{BD,EU}\right)$, (think of this as a number), while the RHS equals one of the parameters we have set. Similarly, if ROOs must be met for the US market we have (see equation (41)):

$$\int_{v\left(\phi^*_{BD,US},P_{BD,US}\right)}^{+\infty}\left[\frac{v}{v\left(\phi^*_{BD,US},P_{BD,US}\right)}-1\right]dH_{US}\left(v\right)=\frac{f_m^{US}}{f}. \tag{57}$$

Thus, for fixed values of the eleven parameters, equation (56) is a nonlinear equation in only one unknown, $v(\phi^*_{BD,EU},P_{BD,EU})$. Similarly, equation (57) is a nonlinear equation in only one unknown, $v(\phi^*_{BD,US},P_{BD,US})$. Each has at most one solution as the LHS is a decreasing function in $v(\phi^*_{BD,j},P_{BD,j})$. As shown in (48) and (42), $v\left(\phi_{BD,j},P_{BD,j}\right)=\left(\frac{\phi^*_{BD,j}}{\phi}\right)^{\sigma_j-1}v\left(\phi^*_{BD,j},P_{BD,j}\right)$ so that $v\left(\phi_{BD,j},P_{BD,j}\right)$ can now be written as a function of only $\phi^*_{BD,j}$ and ϕ. This is key in what follows.

Next, we will derive the cutoff productivities $\phi^*_{BD,EU}$ and $\phi^*_{BD,US}$. To solve for the productivity cutoffs, we define a system of two equations with two unknowns.

The first relation between productivity cutoffs: The price index of exporters from BD toUS (where everyone has to meet ROOs to obtain origin) is given by

$$\left(P_{BD,US}\right)^{1-\sigma_{US}}=M_E^{BD}\int_{\phi^*_{BD,US}}^{+\infty}\int_{v(\phi,P_{BD,US})}^{+\infty}\upsilon p_{BD,US}(\phi)^{1-\sigma_{US}}h_{US}(\upsilon)g(\phi)d\upsilon d\phi, \tag{58}$$

where M_E^{BD} is the mass of entrants in Bangladesh. Thus,

$$M_E^{BD}=\frac{\left(P_{BD,US}\right)^{1-\sigma_{US}}}{\int_{\phi^*_{BD,US}}^{+\infty}\int_{v(\phi,P_{BD,US})}^{+\infty}\upsilon p_{BD,US}(\phi)^{1-\sigma_{US}}h_{US}(\upsilon)g(\phi)d\upsilon d\phi},$$

Similarly, the price index of exporters from BD to EU (where some firms meet the ROOs and others do not) is given by

$$\begin{aligned}(P_{BD,EU})^{1-\sigma_{EU}} &= M_E^{BD}\int_{\phi^*_{BD,EU}}^{+\infty}\int_{\upsilon(\phi,P_{BD,EU})}^{\upsilon^{ROO}(\phi,P_{BD,EU})} \upsilon p_{BD,EU}(\phi)^{1-\sigma_{EU}} h_{EU}(\upsilon)g(\phi)d\upsilon d\phi \\ &+M_E^{BD}\int_{\phi^*_{BD,EU}}^{+\infty}\int_{\upsilon^{ROO}\left(\phi,P_{BD,EU}\right)}^{+\infty} \upsilon p^{ROO}_{BD,EU}(\phi)^{1-\sigma_{EU}} h_{EU}(\upsilon)g(\phi)d\upsilon d\phi.\end{aligned} \quad (59)$$

Hence,

$$M_E^{BD} = \frac{(P_{BD,EU})^{1-\sigma_{EU}}}{D(\phi^*_{BD,EU})} = \frac{(P_{BD,US})^{1-\sigma_{US}}}{D(\phi^*_{BD,US})}$$

where

$$\begin{aligned}D(\phi^*_{BD,EU}) &= \int_{\phi^*_{BD,EU}}^{+\infty}\int_{\upsilon(\phi,P_{BD,EU})}^{\upsilon^{ROO}(\phi,P_{BD,EU})} \upsilon p_{BD,EU}(\phi)^{1-\sigma_{EU}} h_{EU}(\upsilon)g(\phi)d\upsilon d\phi \\ &+\int_{\phi^*_{BD,EU}}^{+\infty}\int_{\upsilon^{ROO}\left(\phi,P_{BD,EU}\right)}^{+\infty} \upsilon p^{ROO}_{BD,EU}(\phi)^{1-\sigma_{EU}} h_{EU}(\upsilon)g(\phi)d\upsilon d\phi, \quad \text{and}\end{aligned} \quad (60)$$

$$D(\phi^*_{BD,US}) = \int_{\phi^*_{BD,US}}^{+\infty}\int_{\upsilon(\phi,P_{BD,US})}^{+\infty} \upsilon p_{BD,US}(\phi)^{1-\sigma_{US}} h_{US}(\upsilon)g(\phi)d\upsilon d\phi.$$

Recall that $D(\phi^*_{BD,j})$ does not depend on $P_{BD,j}$ as we have solved for $\upsilon(\phi, P_{BD,j})$ in terms of $\frac{\phi^*_{BD,j}}{\phi}$ and $\upsilon\left(\phi^*_{BD,j}, P_{BD,j}\right)$. Thus, the ratio of the price indices is just:

$$\frac{(P_{BD,EU})^{1-\sigma_{EU}}}{(P_{BD,US})^{1-\sigma_{US}}} = \frac{D(\phi^*_{BD,EU})}{D(\phi^*_{BD,US})}. \quad (61)$$

Since $\upsilon(\phi, P_{BD,j})$ is pinned down once we know $\phi^*_{BD,j}$, this gives one relation between the price index ratios and the productivity cutoffs. Also, $D(\phi^*)$ rises as ϕ^* falls.

From the model, we also know that the ratio of the price indices is defined by two zero profit conditions (see equations (27) and (35)) so that:

$$\frac{(P_{BD,EU})^{1-\sigma_{EU}}}{(P_{BD,US})^{1-\sigma_{US}}} = \frac{(1-t_{BD,EU})\,\upsilon\left(\phi^*_{BD,EU}, P_{BD,EU}\right)\frac{\sigma_{US}}{R_{BD,US}}\left(\frac{\tau_{BD,EU}}{(1-t_{BD,EU})\rho_{EU}}\right)^{1-\sigma_{EU}}}{(1-t_{BD,US})\,\upsilon\left(\phi^*_{BD,US}, P_{BD,US}\right)\frac{\sigma_{EU}}{R_{BD,EU}}\left(\frac{\tau_{BD,US}}{(1-t_{BD,US})\rho_{US}}\right)^{1-\sigma_{US}}}\left(\frac{\left(\phi^*_{BD,EU}\right)^{\sigma_{EU}-1}}{\left(\phi^*_{BD,US}\right)^{\sigma_{US}-1}}\right). \quad (62)$$

Again, $\upsilon(\phi^*_{BD,j}, P_{BD,j})$ is solved for. So the RHS is a function of the cutoffs alone.

Equating the RHS of (61) and (62) gives one equation in 2 unknowns, $\phi^*_{BD,EU}$ and $\phi^*_{BD,US}$:

$$\frac{v\left(\phi^*_{BD,EU}, P_{BD,EU}\right)}{v\left(\phi^*_{BD,US}, P_{BD,US}\right)} \frac{\left(1 - t_{BD,EU}\right)\sigma_{US} R_{BD,EU}}{\left(1 - t_{BD,US}\right)\sigma_{EU} R_{BD,US}} \frac{\left(\frac{\tau_{BD,EU}}{(1-t_{BD,EU})\rho_{EU}}\right)^{1-\sigma_{EU}}}{\left(\frac{\tau_{BD,US}}{(1-t_{BD,US})\rho_{US}}\right)^{1-\sigma_{US}}} = \frac{\left(\phi^*_{BD,EU}\right)^{1-\sigma_{EU}} D(\phi^*_{BD,EU})}{\left(\phi^*_{BD,US}\right)^{1-\sigma_{US}} D(\phi^*_{BD,US})}.$$

$R_{BD,US}$ and $R_{BD,EU}$ are approximated by total Bangladeshi exports of woven apparel to the US and EU.[33]

The second relation between productivity cutoffs: As the second equation, we use the ex-ante zero profit condition (55). The LHS of it is downward sloping because the expected profits in the two markets together are fixed. If one cutoff rises, the expected profits from that market decline. To keep profits constant, the expected profits from the other market must rise, i.e., its productivity cutoff must fall.

[33] Since $(\phi^*_{ik})^{1-\sigma_k} D(\phi^*_{ik})$ is monotonic in ϕ^*_{ik}, this equation gives an increasing relation in ϕ^*_{ik} and ϕ^*_{ij}.