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 is 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 the 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

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[1]These violations and what might explain them is 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, the model 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 the industry, 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. In this version of the paper, we match firm productivity and demand shocks estimated in a related paper, Demidova, Kee and Krishna (2008).[3] In ongoing research, we

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[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.

adapt the estimation procedure to use only revenue and quantity information which will also allow us to generate standard errors for our estimates using the standard bootstrap. The advantage of the latter approach is that such data is commonly available, and this makes our procedure much more widely applicable. Our procedure contrasts to the structural dynamic approach taken in recent work, which is limited to where data is available over a period of time. Due to our earlier work, Demidova, Kee and Krishna (2008), and Kee and Krishna (2008), we are confident the model we estimate is consistent with the data in its essential aspects and is not just being imposed on it.

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 below 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 the 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.[4] They can take a variety of forms. The important thing to note is that, whatever the form, if

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They then show that these predictions are consistent with the data.

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

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 ROOs must be documented, and a large part of these documentation costs involve 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: that is, unless the good was shown to originate from Bangladesh, it could not enter under its quota. US Rules of Origin (ROOs) regarding apparel products are governed by Section 334 of the Uruguay Round Agreements Act.[5] 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.[6]

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

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[5]For details, please, refer to the following website:

http://www.washingtonwatchdog.org/documents/usc/ttl19/ch22/subchIII/ptB/sec3592.html

[6]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.

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 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 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 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[7], i.e., the use of 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[8], it commands a premium price, so woven garment makers 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[9], which directly translates into a 15% cost disadvantage.[10] For this reason, not all firms choose to meet ROOs and invoke preferences while exporting woven products to the EU. This feature allows us to estimate the fixed documentation costs involved in invoking preferences and meeting ROOs.[11]

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.[12] This meant that as long as 50% of the value added was from

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

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.

[8]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.

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

[10]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.

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

[12]See Rahman and Bahattacharya (2000) for more on this.

Bangladesh, materials imported from SAARC countries (which included India that had 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, 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 the quota allocation of Bangladesh. 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. Unfortunately, the sample is not fully representative.[13] As a result, we expect our estimates to change in the next round when we will adjust the data set to be representative and estimate the model using price and quantity data.

After cleaning the data to exclude outliers and firms with incomplete information, and using only the firms making woven apparel we are left with roughly 765 observations in our

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[13]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 use the entire sample without adjusting it to make it fully representative.

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. In Kee and Krishna (2008), we 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, we find that, as predicted by the model, the probability a firm only exports to the EU decreases with increases in productivity, with favorable demand shocks in the US, and adverse demand shocks in the EU. Conversely, the probability a firm exports to both the EU and the US increases with increases in productivity and with favorable demand shocks in the US and the EU. We also find 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 the US (AUS firms). We use data on the estimated firm productivity and demand shock distributions we obtained in Demidova, Kee and Krishna (2008) in our estimation. However, since we are not using raw data, but constructs based on it, obtaining standard errors for our estimates is much more complicated. For this reason we do not report standard errors at this stage, but will do so in the future. As will become clear, it is possible to use just information on price, quantity, and the fractions of firms of the three types to estimate the parameters of interest in the model. Such data is usually available from custom records.

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. In the next section 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

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

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

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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. Each trading partner produces and sells a continuum of varieties indexed by ω. $q(\omega)$ is the quantity consumed and $z(\omega)$ is the demand shock for the variety ω. A higher value of z corresponds to a worse demand shock.

Let the sub-utility function also take the CES form so that

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

where $\Omega_{i,j}$ is the set of varieties from country i available to consumers in country j, and $\sigma_j = \frac{1}{1 - \rho_j} > 1$ 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 cost minimizing solution to this problem denoted by $a_{ij}(\omega)$, which is the unit input requirement of the variety needed to make a util:

$$\begin{aligned}
a_{ij}(\omega) &= z_{ij}(\omega)^{1-\sigma} \frac{(p_{ij}(\omega))^{-\sigma}}{P_{ij}^{-\sigma}} \\
&= v_{ij}(\omega) \frac{(p_{ij}(\omega))^{-\sigma}}{P_{ij}^{-\sigma}},
\end{aligned} \tag{5}$$

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

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

is the cost in country j of obtaining a util from country $i's$ exports.

As the demand for a variety is $a_{ij}(\omega)X_{ij}$, we get

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

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,

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

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

$$P_j = \left(\sum_{i \in \Omega_j} [P_{ij}]^{1-\sigma_j} \right)^{\frac{1}{1-\sigma_j}} \tag{8}$$

and R_j is the total expenditure on the product 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 their 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 this market entry cost is paid, they see the market specific demand shock (v_{US} and v_{EU}). These demand shocks are drawn from the distributions $H_j(v)$ for $j = EU, US$, 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.[14] It is also not inconsistent with the facts: the correlation between the estimates of demand shocks is close to zero. If firms decide to sell in market j, they also incur a fixed cost of production,

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[14]If demand shocks were correlated, then a firm may choose to enter a market just to get information on the state of demand.
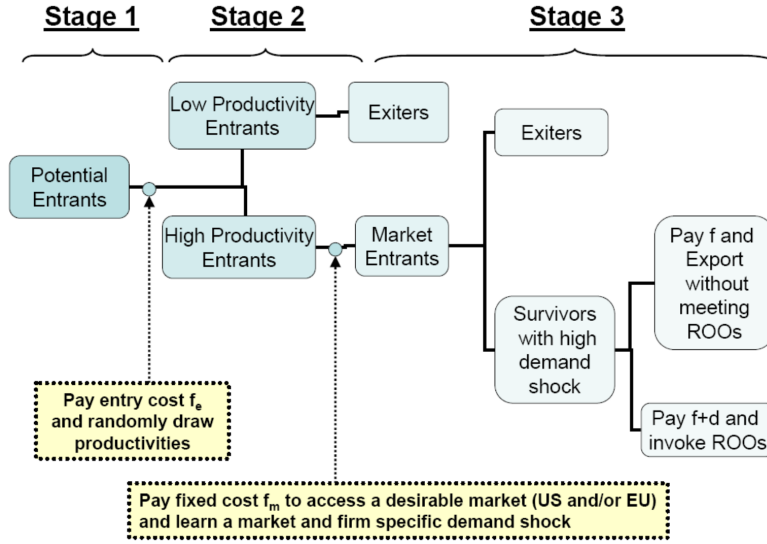
Figure 1: Production Structure for Bangladeshi Exporters.

f. If they further choose to meet ROOs, they pay $f + d^j$ rather than f, where d^j is the documentation cost of meeting ROOs.[15]

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

$$r_{ij}\left(\phi, v_{ij}\right) = \left(1 - t_{ij}\right)\left(q_{ij}\left(\phi\right)\right) p_{ij}\left(\phi\right) = \left(1 - t_{ij}\right) v_{ij} P_{ij}^{\sigma_j - 1} p_{ij}(\phi)^{1 - \sigma_j} R_{ij}, \qquad (9)$$

where $R_{ij} = P_{ij}X_{ij}$ is the total sales to market j and t_{ij} is the tariff on country i by country j. The ad-valorem tariff on Bangladesh by country j, $t_{BD,j}$ is levied on the *price* so the firm receives $(1 - t_{BD,j})p_{BD,j}$ per unit sold at the price $p_{BD,j}$ in market 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. Of course, trade policy and transport costs will also affect profits and

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

pricing. Profits are

$$\pi_{ij}\left(\phi, v_{ij}, t_{ij}, \tau_{ij}\right) = \left(1 - t_{ij}\right) q_{ij}\left(\phi\right) p_{ij}\left(\phi\right) - \frac{w\tau_{ij}}{\phi} q_{ij}\left(\phi\right) - f \tag{10}$$

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

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 $\left(1 - t_{ij}\right)$ of their variable profits. As usual, due to the CES framework, the price paid by consumers is $p\left(\phi\right) = \frac{\phi(1-t_{ij})}{\rho_j w \tau_{ij}}$. We set labor units to be such that wages (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 $v\left(\phi, P_{BD,j}\right)$, $j = US, EU$, 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 $v\left(\phi, P_{BD,j}\right)$ will sell in market j. In addition, for the EU market we define the demand shock $v^{ROO}\left(\phi, P_{BD,EU}\right)$ such that additional profits from invoking the EU ROOs just cover the documentation costs of meeting them.[16] From the zero profit conditions (see the Appendix for more detail) it can be shown that the relationship

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

between $v\left(\phi, P_{BD,EU}\right)$ and $v^{ROO}\left(\phi, P_{BD,EU}\right)$ is

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

where

$$C^{ROO} = \frac{d^{EU}}{f\left[\alpha^{\sigma_{EU}-1}\left(1 - t_{BD,EU}\right)^{-\sigma_{EU}} - 1\right]} > 1, \qquad (13)$$

so that only a fraction of firms in the EU, the most advantaged ones, invoke ROOs. As expected, C^{ROO} increases, and this fraction decreases, as preferences become less attractive: i.e., as tariffs are lowered, or the documentation costs or marginal costs of meeting preferences increase. Equation (12) points out that once we know the demand shock 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 level 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 ϕ^*_{BDj} 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 f^j_m, the fixed cost of doing so.[17] As expected, profits are increasing in ϕ: only firms with productivity above $\phi^*_{BD,j}$ 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 ϕ^*_j in terms of the model's parameters. (See equations (17) and (20) in the Appendix.) Knowing $\phi^*_{BD,j}$ and $v\left(\phi, P_{BD,j}\right)$ in each market 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.

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[17]Note that the expected profits for the EU market consist of 2 parts: the expected profits from exporting without ROOs and the expected additional profits from invoking the EU ROOs multiplied by the probability of getting high enough demand shock.
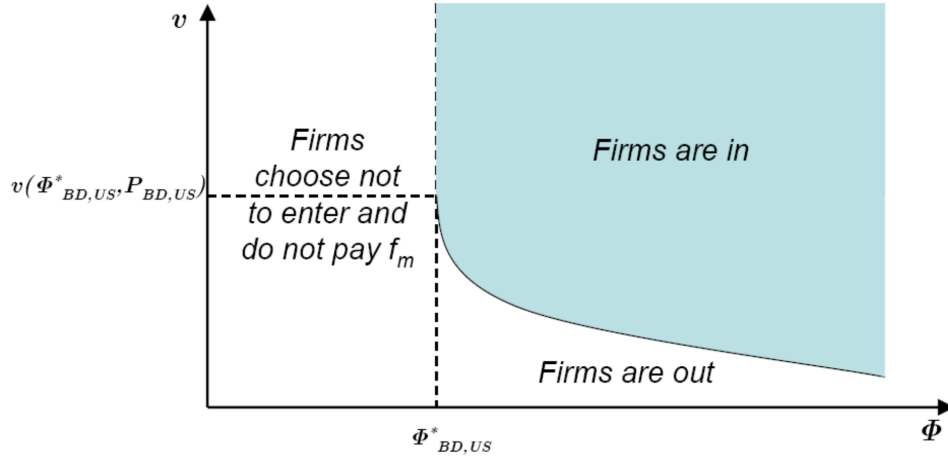
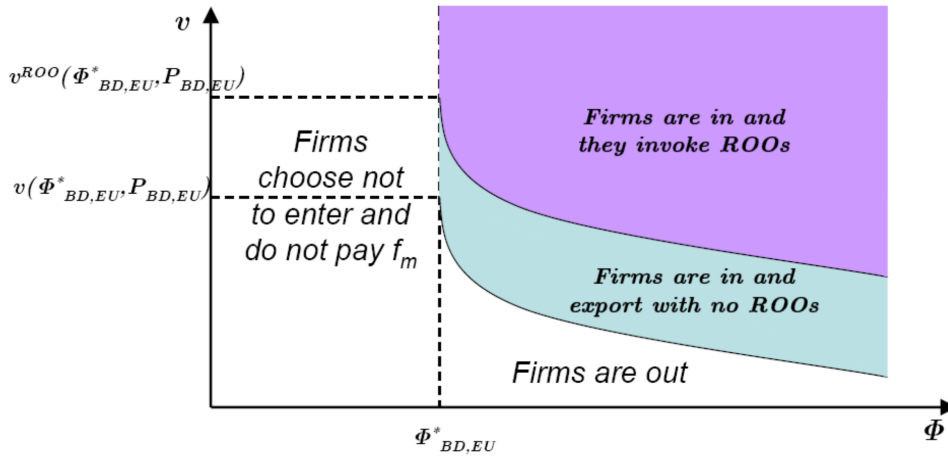Figure 2: Demand Shock-Productivity Trade-off for the Exporters to the US.

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 ϕ_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 (24) in the Appendix.) We will use the model and the available data on Bangladeshi firms to estimate the model's parameters. The estimation procedure is outlined next.

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 the sixteen countries in the EU or to the US. Relaxing this assumption would affect the ex-ante entry condition and would 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 that is approximated by a Weibull distribution

with density function

$$f(x) = \frac{\gamma}{\lambda} \left(\frac{x}{\lambda}\right)^{\gamma-1} e^{-\left(\frac{x}{\lambda}\right)^{\gamma}}, \tag{14}$$

where γ and λ are the shape and scale parameters for the Weibull. The two parameter Weibull 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 $G(\phi)$. Similarly, the distribution for demand shocks is denoted 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,[18] 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%[19] to a high of roughly 14%[20]. We set transport costs

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[18] 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%.

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

[20] See Gajeewski and Riley (2006), pg 6.

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 consist of 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 basically what we do here.

First, we guess values of σ_{EU}, σ_{US}, f_m^{EU}/f, f_m^{US}/f, d/f, γ_{EU}, λ_{EU}, γ_{US}, λ_{US}, γ_{TFP}, and λ_{TFP}. Given these eleven parameters and the ratio of the number of firms serving the EU to those serving the US from the data, 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. How exactly is made clear below. This tells the program where to truncate and is all the program needs to generate the distributions of TFP and productivity from the model. In addition, by guessing a value of f, we can generate the distribution of quantities. We then choose these twelve parameters to make the generated data as close to the actual data as possible. In our baseline estimation below, we choose to match the distributions of TFP, quantities and demand shocks for OUS, AUS, and OEU firms, as well as the shares of such firms in our data to those generated by the model.

How can knowledge of the eleven parameters and the ratio of the number of firms serving the EU to those serving the US from the data yield the required cutoffs? Take the expression for ex-ante profits from entering the EU market. This is given by equation (59) in the Appendix. It is obtained by taking the expected profits in the EU when no ROOs are invoked, adding the additional profits from meeting ROOs, when doing so is worthwhile, and setting this sum equal to the costs of entering the EU market. Some additional substitutions

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are also needed to obtain this expression: in particular, multiplying and dividing the variable profit expressions by the variable profits of the marginal firm allows variable profits to be expressed as a ratio of demand shocks times the relevant fixed costs. This is a consequence of variable profits being multiplicative in the demand shock and the variable profits of the marginal firm being equal to the relevant fixed costs. Then, dividing both sides by the relevant fixed costs gives the expression below that defines the cutoff productivity for the EU market:

$$\int_{v\left(\phi^*_{BD,EU},P_{BD,EU}\right)}^{+\infty} \left[\frac{v}{v\left(\phi^*_{BD,EU},P_{BD,EU}\right)} - 1\right] dH_{EU}(v)$$

$$+\frac{d^{EU}}{f}\int_{C^{ROO}v\left(\phi^*_{BD,EU},P_{BD,EU}\right)}^{+\infty} \left[\frac{v}{C^{ROO}v\left(\phi^*_{BD,EU},P_{BD,EU}\right)} - 1\right] dH_{EU}(v) = \frac{f_m^{EU}}{f}, \qquad (15)$$

$$C^{ROO} = \frac{d^{EU}}{f\left[\alpha^{\sigma_{EU}-1}\left(1 - t_{BD,EU}\right)^{-\sigma_{EU}} - 1\right]} > 1.$$

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, for the US market we have:

$$\int_{v\left(\phi^*_{BD,US},P_{BD,US}\right)}^{+\infty} \left[\frac{v}{v\left(\phi^*_{BD,US},P_{BD,US}\right)} - 1\right] dH_{US}(v) = \frac{f_m^{US}}{f}. \qquad (16)$$

(See the Appendix for equations (59) and (52) and their derivation.)

Thus, for fixed values of the eleven parameters, equation (15) is a nonlinear equation in only one unknown, $(v(\phi^*_{BD,EU},P_{BD,EU})$. Similarly, equation (16) 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 $v(\phi^*_{BD,j},P_{BD,j})$.[21]

Next, we show how to 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. First, note that the price index of Bangladeshi exporters to the US (which is simpler to derive as

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[21]Note that since we have the demand shock cutoffs for the marginal firm, we also have the demand side cutoffs for all infra-marginal firms, see equations (53) and (60).

everyone has to meet US ROOs to obtain origin under MFA quotas) is given by

$$(P_{BD,US})^{1-\sigma_{US}} = M_E^{BD} \int_{\phi_{BD,US}^*}^{+\infty} \int_{v(\phi,P_{BD,US})}^{+\infty} v p_{BD,US}(\phi)^{1-\sigma_{US}} h_{US}(v) g(\phi) dv d\phi, \qquad (17)$$

where M_E^{BD} is the mass of Bangladeshi entrants. Similarly, the price index of exporters from Bangladesh to the EU (here some firms meet the ROOs and others do not) is given by

$$(P_{BD,EU})^{1-\sigma_{EU}} = M_E^{BD} \int_{\phi_{BD,EU}^*}^{+\infty} \int_{v(\phi,P_{BD,EU})}^{v^{ROO}(\phi,P_{BD,EU})} v p_{BD,EU}(\phi)^{1-\sigma_{EU}} h_{EU}(v) g(\phi) dv d\phi \qquad (18)$$
$$+ M_E^{BD} \int_{\phi_{BD,EU}^*}^{+\infty} \int_{v^{ROO}(\phi,P_{BD,EU})}^{+\infty} v p_{BD,EU}^{ROO}(\phi)^{1-\sigma_{EU}} h_{EU}(v) g(\phi) dv d\phi.$$

Thus, the ratio of price indexes is just:

$$\frac{(P_{BD,US})^{1-\sigma_{US}}}{(P_{BD,EU})^{1-\sigma_{EU}}} = \frac{\int_{\phi_{BD,US}^*}^{+\infty} \int_{v(\phi,P_{BD,US})}^{+\infty} v p_{BD,US}(\phi)^{1-\sigma_{US}} h_{US}(v) g(\phi) dv d\phi}{D(\phi_{BD,EU}^*, v(\phi, P_{BD,EU}))}, \qquad (19)$$

where $D(\phi_{BD,EU}^*, v(\phi, P_{BD,EU}))$ equals

$$\int_{\phi_{BD,EU}^*}^{+\infty} \int_{v(\phi,P_{BD,EU})}^{v^{ROO}(\phi,P_{BD,EU})} v p_{BD,EU}(\phi)^{1-\sigma_{EU}} h_{EU}(v) g(\phi) dv d\phi$$
$$+ \int_{\phi_{BD,EU}^*}^{+\infty} \int_{v^{ROO}(\phi,P_{BD,EU})}^{+\infty} v p_{BD,EU}^{ROO}(\phi)^{1-\sigma_{EU}} h_{EU}(v) g(\phi) dv d\phi. \qquad (20)$$

Note that the RHS of equation (19) depends only on the productivity cutoffs and the parameter values we have guessed, since the demand shock cutoffs depend on these. The LHS is yet to be found.

From the model, we also know that the ratio of the price indices is defined by two zero profit conditions (see equations (22) and (23)) so that:

$$\frac{P_{BD,US}^{(1-\sigma_{US})}}{P_{BD,EU}^{(1-\sigma_{EU})}} = \frac{\frac{v(\phi_{BD,US}^*,P_{BD,US})}{(1-t_{BD,EU})}}{\frac{v(\phi_{BD,EU}^*,P_{BD,EU})}{(1-t_{BD,US})}} \frac{\frac{\sigma_{EU}}{R_{BD,EU}}}{\frac{\sigma_{US}}{R_{BD,US}}} \frac{\left(\frac{(1-t_{BD,EU})\rho_{EU}}{\tau_{BD,EU}}\right)^{1-\sigma_{EU}}}{\left(\frac{(1-t_{BD,US})\rho_{US}\alpha}{\tau_{BD,US}}\right)^{1-\sigma_{US}}} \left(\frac{\left(\phi_{BD,EU}^*\right)^{1-\sigma_{EU}}}{\left(\phi_{BD,US}^*\right)^{1-\sigma_{US}}}\right). \qquad (21)$$

Equating the RHS of equations (19) and (21) gives one equation in two unknowns, $\phi_{BD,EU}^*$

and $\phi^*_{BD,US}$ as we know the demand shock cutoffs, $v(\phi^*_{BD,US}, P_{BD,US})$ and $v(\phi^*_{BD,EU}, P_{BD,EU})$ from the previous step. $R_{BD,US}$ and $R_{BD,EU}$ are obtained from data on total exports to the US and EU in woven apparel using the COMTRADE data base.

To obtain the second equation needed to solve for $\phi^*_{BD,EU}$ and $\phi^*_{BD,US}$, we use the ratio of the equations for the masses of Bangladeshi firms that export to the US and EU:

$$\frac{M_{BD,US}}{M_{BD,EU}} = \frac{M_E^{BD} \int_{\phi^*_{BD,US}}^{+\infty} \int_{v(\phi,P_{BD,US})}^{+\infty} h_{US}(v)g(\phi)dvd\phi}{M_E^{BD} \int_{\phi^*_{BD,EU}}^{+\infty} \int_{v(\phi,P_{BD,EU})}^{+\infty} h_{EU}(v)g(\phi)dvd\phi}. \tag{22}$$

From the Bangladeshi data we observe the ratio of the total number of the US exporters relative to that of the EU exporters, which describes the LHS of equation (22). This gives us a second equation in $\phi^*_{BD,EU}$ and $\phi^*_{BD,US}$. Together, they let us solve for the cutoff productivities. Of course, once we know these cutoff productivities, we can also calculate the ratio of price indices $\left(\frac{P_{BD,US}^{1-\sigma_{US}}}{P_{BD,EU}^{1-\sigma_{EU}}}\right)$.[22]

As we know the cutoffs for demand shocks and productivity, once we fix a level of f, we will know the level of the price index in each market from the zero profit condition in stage 3:

$$(1 - t_{ij}) \left[q_{ij}(\phi) p_{ij}(\phi) - \frac{w\tau_{ij}}{\phi(1 - t_{ij})} q_{ij}(\phi, P_{ij}) \right] - f = 0,$$

where

$$\begin{aligned} q_{ij}(\phi) &= \left[\frac{p_{ij}(\phi)}{P_{ij}} \right]^{-\sigma} \frac{R_{BD,j}}{P_{ij}} \\ &= P_{ij}^{\sigma-1} p_{ij}(\phi)^{-\sigma} R_{BD,j}. \end{aligned}$$

While $R_{BD,j}$ is data, only after f is pinned down can P_{ij} be solved for. Once we have P_{ij}, we have the output of each firm. In this way, the choice of f affects the the quantity distribution in the estimation. A larger f results in a larger P_{ij} which moves the generated

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[22]To obtain deciles of these distributions, we follow a multi step procedure. In contrast to EKK who use simulation techniques to derive the percentile points of the distributions so that there is a small error associated with their estimates, we numerically integrate to do so after finding starting points through simulation.

quantity distribution to the right.

In this manner, once we choose values for our thirteen key parameters, 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 TFP, demand shocks and quantities from the model that are the counterparts of those we choose to match from the data. In other words, we can fully solve the model. Then we can recover f_e from the free entry condition (see equation (69)).

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 the EU ROOs in the model and the data, respectively. Finally, we take the empirical distributions for TFP, demand shocks and quantity ($k \in \{TFP, DS, Q\}$) for each of the three groups of firms ($l \in \{OEU, AUS, OUS\}$).[23] 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 $\left[F^{e,k,l}(x_{i+20}) - F^{e,k,l}(x_i)\right]$, which we call Z_i^e. Of course, $Z_i = .2$ for all i.

The objective function has three components. Define

$$A = \left(\frac{OUS^m - OUS^e}{OUS^e}\right)^2 + \left(\frac{AUS^m - AUS^e}{AUS^e}\right)^2 + \left(\frac{OEU^m - OEU^e}{OEU^e}\right)^2, \qquad (23)$$

$$B = \left(\frac{ROO^m - ROO^e}{ROO^e}\right)^2, \qquad (24)$$

$$C = \sum_k \sum_l \sum_i \left[\left(Z_i^{e,k,l} - Z_i^{k,l}\right)^2\right]. \qquad (25)$$

Our objective function is then just the sum of these three or $A + B + C$.[24]

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

[24] We experiment with different weights to the different components and find that the results are relatively

The choice of which moments to fit comes from the need to identify all our parameters. It 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 helps identify documentation costs, while matching the distributions of TFP for each type of firm helps identify 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 (15) and (16).

As discussed above, this minimization process will deliver values of the parameters: σ_{EU}, σ_{US}, f_m^{EU}/f, f_m^{US}/f, d/f, γ_{EU}, λ_{EU}, γ_{US}, λ_{US}, γ_{TFP}, λ_{TFP}, and f. Then from equation (69) we obtain f_e.

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. These distributions are depicted below.

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insensitive to such changes.

Table 2. TFP distribution	
Shape (γ)	0.57
Scale (λ)	2.05
Implied mean shock[25]	3.31
Implied Std. Dev.	6.21

The distributions of productivity and demand shocks for AUS firms (in the EU and US) and of OEU and OUS firms are given in Figure 4 and 5, respectively. In these figures, the model generated data is represented by dashed lines, while the data itself is represented by solid lines. As is evident, the distributions for OUS firms fit the worst. In particular, our simulated data predicts that OUS firms are predominantly those with low productivities, while the data has fatter tails for such firms, so there are more OUS firms with high productivities in the data than in the simulated data. This very may well be, since our model has no capacity constraints. If capacity constraints are important, then OUS firms would tend to be those firms, which have a better US than EU demand shock, *independent of productivity*. This would fatten up the high productivity tail of the simulated data and better match the actual data. In essence, without capacity constraints, the model has a hard time explaining why high productivity firms do not export to both countries. Incorporating capacity constraints would help fit the data in this dimension.

The distributions of demand shocks are depicted in Figure 5. These distributions are given for the AUS firms in the EU and US and then for OEU and OUS types of firms, respectively. The means and standard deviations are reported in Table 3. The demand shocks in the US are larger than those in the EU with greater dispersion. 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

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[25]The mean equals $\lambda\Gamma(1 + \frac{1}{\gamma})$ where $\Gamma(.)$) denotes the standard gamma function and the variance equals $\lambda^2\Gamma(1 + \frac{2}{\gamma}) - \left(\lambda\Gamma(1 + \frac{1}{\gamma})\right)^2$.
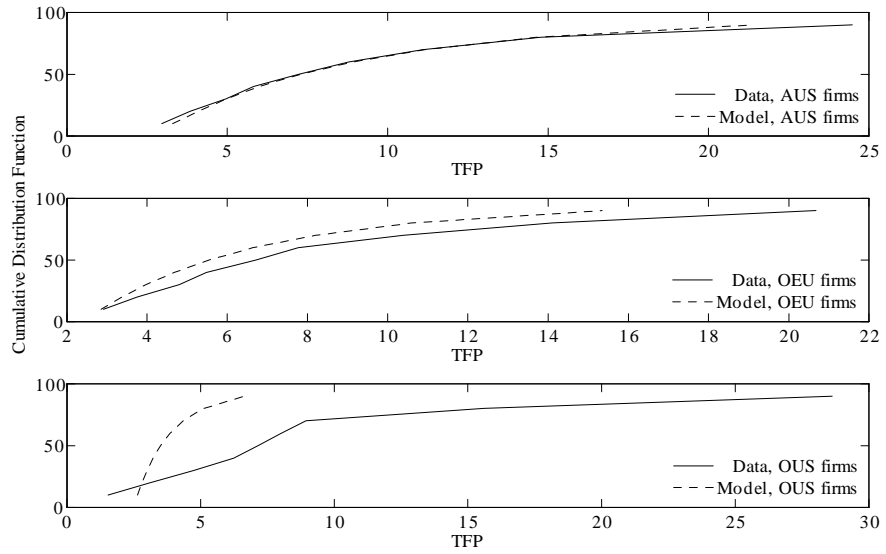
Figure 4: Productivity distributions.
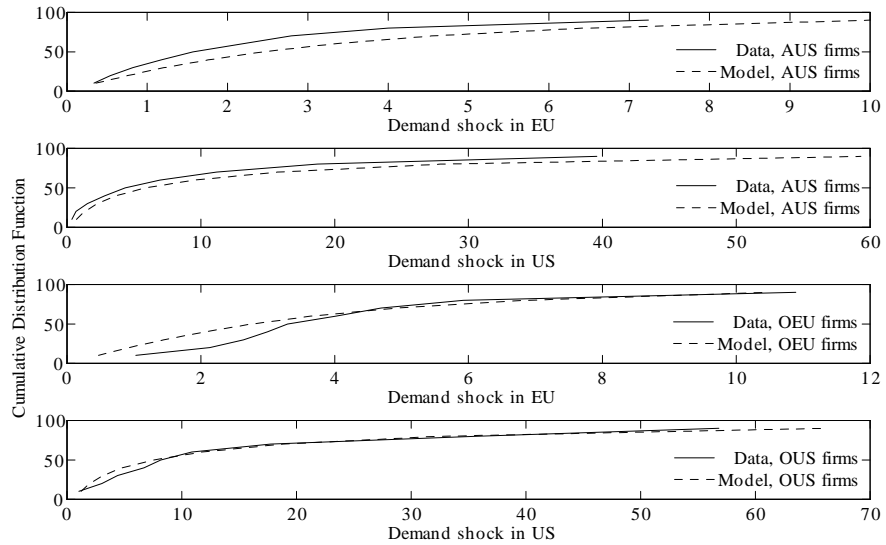
Figure 5: Demand shock distributions.
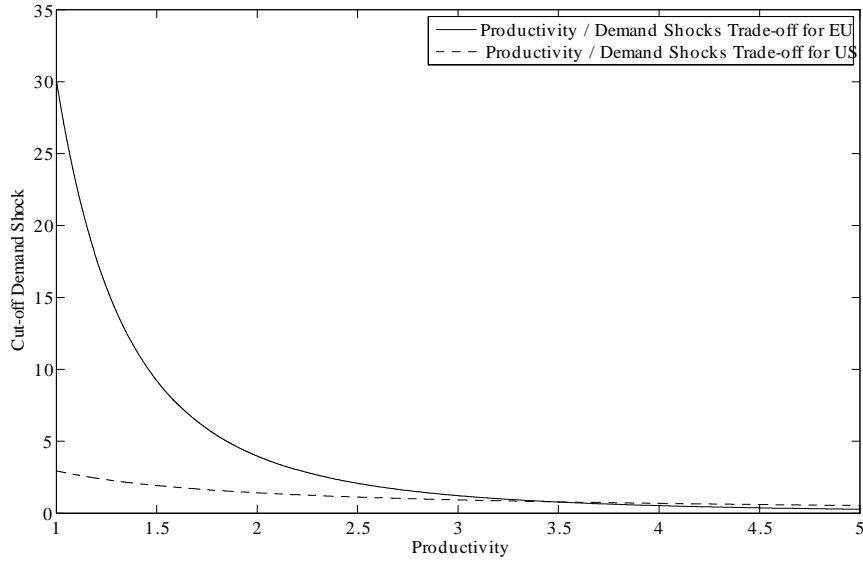
Figure 6: The trade-off between productivity and demand shock.

for both TFP and demand shock differences between 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 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
Shape (γ)	0.75	0.40
Scale (λ)	2.98	5.34
Implied mean shock	3.55	17.7
Implied Std. Dev.	4.80	55.7

The trade-off between the productivity and the cutoff demand shock in the US and EU markets (see Figures 2 and 3 for the theoretical pictures) is depicted in Figures 6 and 7. The cutoff line for the US is actually below that for the EU, but as their demand shock distributions are different, this cannot be interpreted as direct evidence that the US is the easier 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 0.22 and 0.26 for the US and EU, 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 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	3.92	2.05

The estimates of various fixed costs relative to f are given in Table 5. Market entry costs into the EU market tend to be roughly half the size of those in the US, suggesting that the US is the "big boys club" and much harder to enter. Also, fixed costs of entering the industry (f_e) are much higher than the cost of entering a market (f_m) in both the US and the EU.

Table 5. Fixed costs relative to f		
	EU	US
	Relative market entry costs	
f_m/f	0.82	11.14
	Relative documentation costs	
d/f	0.60	—
	Relative industry entry costs	
f_e/f	52.6	

As described in the estimation outline, at the second step of our estimation we recover f and, as a result, all market and industry entry costs. These numbers are summarized in Table 6. Note that these numbers, when added up, give a figure slightly lower than the sunk cost estimates in Das, Roberts and Tybout (2007) for knit wear, 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. Values of some key endogenous variables are given in Table 7.

Table 6. Fixed costs in $	
f	12,600
f_m^{EU}	10,300
$f_m^{EU} + d_{EU}$	10,300+7,600
f_m^{US}	140,300
f_e	662,300

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/calibration procedure above, we can obtain $P_{BD,US}^{\sigma_{US}-1}$ and $P_{BD,EU}^{\sigma_{EU}-1}$ as explained above.

Just as demand for a variety is the product of the variety's share of demand (which depends inversely on own price relative to the aggregate one) times total demand, own revenue is the product of the variety's share of revenue (which depends inversely on own price relative to the aggregate one) times total revenue as given below.

$$R_{BD,j} = \frac{(P_{BD,j})^{1-\sigma_j}}{(P_{BD,j})^{1-\sigma_j} + \sum_{i\in\Omega_{(-BD)}} [P_{i,j}]^{1-\sigma_j}} R_j. \tag{26}$$

For example, $R_{BD,US}$ and R_{US} are approximated by the total Bangladeshi sales of woven apparel to the US and the total exports of woven apparel to the US. Thus, we can invert equation (26) to obtain $\sum_{i\in\Omega_{(-BD)}} [P_{i,US}]^{1-\sigma_{US}}$, which is what we call $\bar{P}_{-BD,US}$. 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. As a result, obtaining these 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 reduction 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.

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[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 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).

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 a factor of ten 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, though not by as much as that in the EU. 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

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[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 EU FTA partners have to respect to gain preferential access to European market.

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 $2,351 million to $1,341 million and US imports from $435 million to $222 million, highlighting the cross market effects of EU policies.

Raising documentation costs by a factor of ten, as in Column 3, also reduces EU (to $2,067 million) and US imports (to $381 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 $17,760 million and to the US of $2,839 million. Of course, this is not seen in the data as US exports are still under quota in this period, and while SAARC cumulation might reduce the cost of meeting EU ROOs, it does not eliminate them.

The reason why raising documentation costs by a factor of ten 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). When exporting becomes less promising, as when documentation costs rise or preferences are removed, 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]

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[30]Note this is not a a full GE setup where firms choose which country to enter, Bangladesh, the US or

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,

$$
P_{EU} = \left[(P_{BD,EU})^{1-\sigma_{EU}} + \sum_{i \in \Omega_{(-BD)}} [P_{i,EU}]^{1-\sigma_{EU}} \right]^{\frac{1}{1-\sigma_{EU}}}, \tag{27}
$$

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 increases EU welfare by roughly 135 million dollars. Thus, it seems like giving preferences is not 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 the US and a fall in consumer surplus, but an increase in tariff revenue in the EU. While US welfare falls, EU welfare rises as the revenue effect dominates. Removing EU preferences reduces welfare in the US by about 45 million dollars, while raising it by about 135 million in the EU.

When documentation costs are raised, ex-ante profits fall as does the mass of entry. This raises prices, which acts to reduce welfare, but as fewer firms invoke ROOs, tariff revenues increase, which acts to raise welfare. The latter effect dominates so that welfare in the EU rises by about 33 million dollars, while welfare in the US falls by about 12 million dollars.

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the EU. In such settings, protection in a country raises the productivity cutoff.

Finally, removing the home yarn requirement raises ex-ante profits, and hence entry, with consequent increases in welfare and tariff revenue. Note that welfare rises in *both* the US and EU by 309 million and 513 million dollars, respectively.[31]

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.[32]

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

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[31]Giving preferences has less of a bang than removing the home yarn requirement as ROOs are quite strict and the tariff revenue losses from giving preferences are not outweighted by the consumer surplus gains.

[32]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.

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.

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.

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 ($1,000,000) 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 thirty 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 spillover effects.

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 ($t_{BD,EU}^{ROO}$)	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)	0.60	**0.00**	**6.0**	0.60
		Bangladeshi Exports		
EU imports from Bangladesh	2,351m	1,341m	2,067m	17,760m
US imports from Bangladesh	435m	222m	381m	2,839m
		Change in Bangladesh firms' market share, %		
Share of EU imports	5%	-43%	-12.1%	+655%
Share of US imports	1.4%	-49%	-12.4%	+553%
		Change in number of firms, %		
Implied # of entrants	2,583	-49.5%	-14.4%	+619%
Implied # of firms trying EU	859	-49.3%	-14.1%	+600%
Implied # of firms trying US	844	-49.3%	-14.3%	+584%
# of successful exporters to EU	682	-49.3%	-14.2%	+567%
# of successful exporters to US	563	-48.9%	-12.1%	+582%
		Change in Productivity cutoffs for exporters, %		
Productivity cutoff in EU	2.4347	-0.85%	-0.22%	+4.53%
Productivity cutoff in US	2.5025	-0.66%	-0.17%	+8.06%
		Change in Demand Shock cutoffs, %		
Demand shock cutoff in EU	2.2403	+0.25%	-0.00%	+34.1%
Demand shock cutoff in US	1.1186	0.00	0.00	0.00
		Share of firms invoking ROO		
Share of ROO firms (model)	43%	0%	13.4%	100%
		Share of AUS, OEU and OUS firms		
Share of AUS firms	61.8%	61.8%	61.8%	59.8%
Share of OEU firms	26.8%	26.9%	26.9%	27.0%
Share of OUS firms	11.4%	11.3%	11.3%	13.2%
		Change in EU and US price indices, %		
Price Index in EU	100%	+0.77%	+0.22%	-13.48%
Price Index in US	100%	+0.66%	+0.17%	-7.45%
		Change in tariff revenues, %		
Tariff Revenue in EU	7,506k	+2044%	+505%	-100%
Tariff Revenue in US	87,000k	-49%	-12%	+553%
		Approximated change in welfare		
Change in welfare in EU ($)	—	135,325k	+32,692k	+309,401k
Change in welfare in US ($)	—	-45,558k	-11,580k	+513,198k

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.[33] 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 the variable profits of the firm with the cutoff productivity 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 demand shock, the firm with the cutoff productivity has higher profits and sales than it needs to produce. As a result, the marginal and average firm tends 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

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[33]It is worth noting that in contrast to heterogeneous firm models without demand shocks, where this extensive margin cannot raise imports by very much as marginal firms are high cost and, hence, high price and low sales firms, here entrants *can* contribute significantly to exports. Even if their productivity is low or costs are high, a good demand shock can result in large exports!

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 cutoff for entry and for each market are that in period 0, while the demand shock cutoffs in each market for each productivity corresponds to those in period 1. The change in total exports can (by adding and subtracting the relevant terms) be decomposed as follows:

$$
\begin{aligned}
& X(M_1^e, \phi_1, v_1, x_1) - X(M_0^e, \phi_0, v_0, x_0) \\
= \ & [X(M_0^e, \phi_0, v_0, x_1) - X(M_0^e, \phi_0, v_0, x_0)] \quad \text{(Intensive Margin)} \\
& + [X(M_0^e, \phi_0, v_1, x_1) - X(M_0^e, \phi_0, v_0, x_1) \quad \text{(Extensive Margin:} \\
& + X(M_0^e, \phi_1, v_1, x_1) - X(M_0^e, \phi_0, v_1, x_1)] \quad \text{Via Cutoffs;} \\
& + [X(M_1^e, \phi_1, v_1, x_1) - X(M_0^e, \phi_1, v_1, x_1)] \quad \text{Via Entry)}. \quad (28)
\end{aligned}
$$

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.

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, a low elasticity of substitution 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

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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. Thus, 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).

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)	0.60	**0.00**	**6.0**	0.60
		Change in Bangladesh firms' market share, %		
Share of EU imports	5%	+9.77%	+1.81%	+55.6%
		Change in mass of firms, %		
Implied # of entrants	2,583	fixed	fixed	fixed
Implied # of firms trying EU	859	fixed	fixed	fixed
# of successful exporters to EU	682	-0.15%	0.00	-0.44%
		Change in Productivity cutoffs for exporters, %		
Cutoff in EU	2.4347	0.00	0.00	0.00
		Change in Demand Shock cutoff, %		
Demand shock cutoff in EU	2.2403	+0.52%	0.00%	+3.01%
		Change in price index in EU		
Aggregate price index in EU	100%	-0.17%	-0.03%	-1.01%
		Change in tariff revenues collected		
Tariff revenues in EU	7,506k	+4026%	+605%	-100%
		Change in Bangladesh revenues before tariff		
Value of Bangladeshi Exports: $R_{BD,EU}$	2,351k	+9.77%	+1.81%	+55.6%
		Change in Bangladesh revenues after tariff		
Revenue of BD firms: $(1-t_{BD,EU})R_{BD,EU}$	2,344k	-3.09%	-0.12%	+56.1%
		Approximated change in welfare		
Change in welfare in EU ($)	—	+306,192k	+46,007k	+16,137k

Table 9

Woven Sector	Baseline case	Government spends $1 million (±1%) on compensation on total				
		Industry entry costs	EU market entry costs	US market entry costs	Documentation costs	Fixed Costs
Original (estimated)	—	662,645	10,328	140,242	7,609	12,592
After Compensation	—	662,262	9,198	139,082	4,809	11,812
$ Compensation per firm / entrant	—	383	1130	1160	2,800	780
Approx. amount to be spent	—	1000k	997k	996k	998k	996k
Change in Bangladesh market share						
EU market	5%	+1.18%	+1.17%	+1.16%	+1.06%	+1.16%
US market	1.4%	+1.59%	+1.57%	+1.71%	+1.44%	+1.62%
Change in number of firms						
Implied # of Entrants into Industry	2,583	+1.12%	+1.12%	+1.12%	+1.12%	+1.12%
Implied # of firms *trying* EU market	859	+1.05%	+2.74%	+1.05%	+1.05%	+1.62%
Implied # of firms *trying* US market	844	+1.09%	+1.09%	+1.66%	+1.09%	+1.38%
# of *successful* EU exporters	682	+1.06%	+1.77%	+1.06%	+1.06%	+2.13%
# of *successful* US exporters	563	+1.73%	+1.73%	+2.16%	+1.73%	+3.03%
Cutoff productivities						
Productivity cutoff for EU	2.4347	+0.02%	-2.49%	+0.02%	+0.01%	-0.74%
Productivity cutoff for US	2.5025	+0.02%	+0.02%	-0.73%	+0.01%	-0.28%
Cutoff demand shocks						
Demand shock cutoff in EU	2.2403	0.00%	+7.70%	0.00%	+0.02%	-4.08%
Demand shock cutoff in US	1.1186	0.00%	0.00%	+0.80%	0.00%	-5.90%
Share of firms using ROO						
Share of EU firms invoking ROO	43.41%	43.41%	43.0%	43.41%	51.7%	42.9%
Tariff revenue change						
Tariff revenue in EU	7,506k	+4.09%	+4.74%	+4.07%	-34.46%	+4.47%
Tariff revenue in US	87,000k	+1.59%	+1.57%	+1.71%	+1.44%	+1.15%
Change in Revenue of Bangladesh firms after tariffs						
Revenue from EU market after tariff	2,343k	+1.16%	+1.16%	+1.15%	+1.17%	+1.15%
Revenue from US market after tariff	348k	+1.57%	+1.57%	+1.71%	+1.44%	+1.62%
Change of price index in the EU and in the US						
Price index in EU	100%	-0.02%	-0.02%	-0.01%	-0.01%	-0.01%
Price index in US	100%	-0.18%	-0.18%	-0.18%	-0.18%	-0.18%
Approximated change in welfare						
Change in welfare in EU ($)	—	+666k	+710k	+657k	-2,278k	+685k
Change in welfare in US ($)	—	+2,172k	+2,154k	+2,288k	+2,035k	+2,207k
Policy Efficiency Measure						
Market size gain (after tariff) per dollar given to the firms / entrants	—	32.9	32.6	33.1	32.6	32.6

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 market. 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

8.1 Model Derivations

This Appendix contains the detailed derivations of the equilibrium conditions for the model described in the paper. 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.[34] They have to pay the tariff of 20%. As a result, the firm maximizes

$$\max_{p_{BD,US}} \pi_{BD,US}(\phi,v) = (1-t_{BD,US})\, p_{BD,US} q_{BD,US}(p_{BD,US},v) - \frac{\tau_{BD,US}}{\alpha\phi} q_{BD,US}(p_{BD,US},v) - f, \tag{29}$$

where

$$q_{BD,US}(p_{BD,US},v) = v \left[\frac{p_{BD,US}}{P_{BD,US}}\right]^{-\sigma_{US}} \frac{R_{BD,US}}{P_{BD,US}}, \tag{30}$$

so that the firm charges

$$p_{BD,US} = \frac{1}{(1-t_{BD,US})} \frac{\tau_{BD,US}}{\rho_{US}\alpha\phi}, \tag{31}$$

and earns the following profits:

$$\pi_{BD,US}(\phi,v) = \frac{r_{BD,US}(\phi,v)}{\sigma_{US}} - f \tag{32}$$

where

$$r_{BD,US}(\phi,v) = (1-t_{BD,US})\, v R_{BD,US} (P_{BD,US})^{\sigma_{US}-1} \left[\frac{1}{(1-t_{BD,US})} \frac{\tau_{BD,US}}{\rho_{US}\alpha\phi}\right]^{1-\sigma_{US}}. \tag{33}$$

---

[34]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 $\alpha = 1$.

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

$$\pi_{BD,US}(\phi, v(\phi, P_{BD,US})) = 0, \tag{34}$$

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

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

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

$$M_{BD,US} = M_E^{BD} \int_{\phi_{BD,US}^*}^{+\infty} \int_{v(\phi,P_{BD,US})}^{+\infty} h_{US}(v) g(\phi) dv d\phi, \tag{36}$$

where M_E^{BD} denotes the mass of entrants in Bangladesh.

Exporting to the EU   Now, we consider Bangladeshi exporters to the EU. This is slightly more complicated than the US case since when Bangladeshi firms export to the EU they have an additional choice. They can export invoking the 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

$$\max \left[0, \pi_{BD,EU}(\phi, v), \pi_{BD,EU}^{ROO}(\phi, v) \right], \tag{37}$$

where

$$\pi_{BD,EU}(\phi, v) = \max_{p_{BD,EU}} \left\{ (1 - t_{BD,EU}) p_{BD,EU} q_{BD,EU}(p_{BD,EU}, v) - \frac{\tau_{BD,EU}}{\phi} q_{BD,EU}(p_{BD,EU}, v) - f \right\},$$

$$\pi_{BD,EU}^{ROO}(\phi, v) = \max_{p_{BD,EU}^{ROO}} \left\{ p_{BD,EU}^{ROO} q_{BD,EU}(p_{BD,EU}^{ROO}, v) - \frac{\tau_{BD,EU}}{\alpha \phi} q_{BD,EU}(p_{BD,EU}^{ROO}, v) - (f + d^{EU}) \right\} \tag{38}$$

The pricing rule for each type of exporter is:

$$p_{BD,EU} = \frac{1}{1 - t_{BD,EU}} \frac{\tau_{BD,EU}}{\rho_{EU}\phi} \quad \text{and} \quad p_{BD,EU}^{ROO} = \frac{\tau_{BD,EU}}{\rho_{EU}\alpha\phi}. \tag{39}$$

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

$$r_{BD,EU}(\phi, v) = (1 - t_{BD,EU}) v R_{BD,EU} (P_{BD,EU})^{\sigma_{EU}-1} \left[\frac{1}{1 - t_{BD,EU}} \frac{\tau_{BD,EU}}{\rho_{EU}\phi} \right]^{1-\sigma_{EU}} \tag{40}$$

$$\pi_{BD,EU}(\phi, v) = \frac{r_{BD,EU}(\phi, v)}{\sigma_{EU}} - f, \tag{41}$$

while exporters that invoke the EU ROOs have

$$r_{BD,EU}^{ROO}(\phi, v) = v R_{BD,EU} (P_{BD,EU})^{\sigma_{EU}-1} \left[\frac{\tau_{BD,EU}}{\rho_{EU}\alpha\phi} \right]^{1-\sigma_{EU}},$$

$$\pi_{BD,EU}^{ROO}(\phi, v) = \frac{r_{BD,EU}^{ROO}(\phi, v)}{\sigma_{EU}} - (f + d^{EU}). \tag{42}$$

Consider a firm with productivity ϕ. We can define 2 demand shock cutoffs, $v(\phi, P_{BD,EU})$ and $v^{ROO}(\phi, P_{BD,EU})$. Firms with $v \in [v(\phi, P_{BD,EU}), v^{ROO}(\phi, P_{BD,EU})]$ 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 $v \in (v^{ROO}(\phi, P_{BD,EU}), \infty)$ find it worthwhile to meet the EU ROOs. These shocks are implicitly defined by

$$\pi_{BD,EU}(\phi, v(\phi, P_{BD,EU})) = 0,$$

$$\pi_{BD,EU}^{ROO}(\phi, v^{ROO}(\phi, P_{BD,EU})) - \pi_{BD,EU}(\phi, v^{ROO}(\phi, P_{BD,EU})) = 0, \tag{43}$$

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

$$v(\phi, P_{BD,EU}) = \frac{\sigma_{EU}f}{(1 - t_{BD,EU}) R_{BD,EU} (P_{BD,EU})^{\sigma_{EU}-1}} \left[\frac{1}{1 - t_{BD,EU}} \frac{\tau_{BD,EU}}{\rho_{EU}\phi} \right]^{\sigma_{EU}-1}, \tag{44}$$

and:

$$
\begin{aligned}
v^{ROO}\left(\phi, P_{BD,EU}\right) &= \frac{\sigma_{EU} d^{EU}}{\left(\alpha^{\sigma_{EU}-1} - (1-t_{BD,EU})^{\sigma_{EU}}\right) R_{BD,EU}\left(P_{BD,EU}\right)^{\sigma_{EU}-1}} \left[\frac{\tau_{BD,EU}}{\rho_{EU}\phi}\right]^{\sigma_{EU}-1} \\
&= \frac{(1-t_{BD,EU})^{\sigma_{EU}}}{\left(\alpha^{\sigma_{EU}-1} - (1-t_{BD,EU})^{\sigma_{EU}}\right)} \frac{d^{EU}}{f} v\left(\phi, P_{BD,EU}\right),
\end{aligned}
\tag{45}
$$

or

$$
v^{ROO}\left(\phi, P_{BD,EU}\right) = C^{ROO} v\left(\phi, P_{BD,EU}\right),
\tag{46}
$$

where

$$
C^{ROO} = \frac{d^{EU}}{f\left[\alpha^{\sigma_{EU}-1}\left(1-t_{BD,EU}\right)^{-\sigma_{EU}} - 1\right]} > 1.
\tag{47}
$$

Note that from the expressions above, $v^{ROO}\left(\phi, P_{BD,EU}\right)$ and $v\left(\phi, P_{BD,EU}\right)$ are decreasing in ϕ.

In the case of the US exporters, only firms with a productivity above $\phi^*_{BD,US}$ will try to access the US market, while those with a productivity above the cutoff level $\phi^*_{BD,EU}$ will try to access the EU market. These cutoffs are defined below in the stage 2 problem.

The masses of exporters that sell in the EU, but do not or do meet the ROOs are, respectively:

$$
\begin{aligned}
M_{BD,EU} &= M_E^{BD} \int_{\phi^*_{BD,EU}}^{+\infty} \int_{v(\phi, P_{BD,EU})}^{v^{ROO}(\phi, P_{BD,EU})} h_{EU}(v) g(\phi) dv d\phi, \\
M_{BD,EU}^{ROO} &= M_E^{BD} \int_{\phi^*_{BD,EU}}^{+\infty} \int_{v^{ROO}(\phi, P_{BD,EU})}^{+\infty} h_{EU}(v) g(\phi) dv d\phi.
\end{aligned}
\tag{48}
$$

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. Again, we first look at the US market first.

The US Market For a Bangladeshi firm with productivity ϕ, the expected profit of entering the US market is

$$E_v\left[\pi_{BD,US}\left(\phi,v\right)\right] - f_m^{US} = \int_{v\left(\phi,P_{BD,US}\right)}^{+\infty} \pi_{BD,US}\left(\phi,v\right) dH_{US}\left(v\right) - f_m^{US}. \tag{49}$$

Note that

$$
\begin{aligned}
\pi_{BD,US}\left(\phi,v\right) &= \frac{\left(1-t_{BD,US}\right) v R_{BD,US}\left(P_{BD,US}\right)^{\sigma_{US}-1}\left[\frac{1}{1-t_{BD,US}}\frac{\tau_{BD,US}}{\rho_{US}\alpha\phi}\right]^{1-\sigma_{US}}}{\sigma_{US}} - f \\
&= \frac{r_{BD,US}\left(\phi,v\right)}{\sigma_{US}} - f \\
&= \frac{r_{BD,US}\left(\phi,v\right)}{r_{BD,US}\left(\phi,v\left(\phi,P_{BD,US}\right)\right)}f - f \\
&= f\left[\frac{v}{v\left(\phi,P_{BD,US}\right)} - 1\right]. \tag{50}
\end{aligned}
$$

Thus

$$E_v\left[\pi_{BD,US}\left(\phi,v\right)\right] - f_m^{US} = f\int_{v\left(\phi,P_{BD,US}\right)}^{+\infty}\left[\frac{v}{v\left(\phi,P_{BD,US}\right)} - 1\right] dH_{US}\left(v\right) - f_m^{US}. \tag{51}$$

The expected profits of accessing the US market are increasing in ϕ since $v\left(\phi,P_{BD,US}\right)$ is decreasing in ϕ. Let the productivity of the marginal Bangladeshi firm, which is indifferent between accessing the US market or not, be denoted by $\phi_{BD,US}^*$. All firms with productivity above $\phi_{BD,US}^*$ expect to earn non-negative profits and, therefore, will try to access the US market. $\phi_{BD,US}^*$ is defined by

$$E_v\left[\pi_{BD,US}\left(\phi_{BD,US}^*,v\right)\right] = f_m^{US}, \Longleftrightarrow$$
$$\int_{v\left(\phi_{BD,US}^*,P_{BD,US}\right)}^{+\infty}\left[\frac{v}{v\left(\phi_{BD,US}^*,P_{BD,US}\right)} - 1\right] dH_{US}\left(v\right) = \frac{f_m^{US}}{f}. \tag{52}$$

Equation (52) 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 prcedure. Second, it shows 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 the cutoff productivity $\phi_{BD,US}^*$. To see this, note that from the definition of $v(\phi, P_{BD,US})$ in equation (35):

$$\frac{v(\phi, P_{BD,US})}{v\left(\phi_{BD,US}^*, P_{BD,US}\right)} = \left(\frac{\phi_{BD,US}^*}{\phi}\right)^{\sigma_{US}-1}, \tag{53}$$

so that

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

$$= f \int_{\left(\frac{\phi_{BD,US}^*}{\phi}\right)^{\sigma_{US}-1} v\left(\phi_{BD,US}^*, P_{BD,US}\right)}^{+\infty} \left[\frac{v}{\left(\frac{\phi_{BD,US}^*}{\phi}\right)^{\sigma_{US}-1} v\left(\phi_{BD,US}^*, P_{BD,US}\right)} - 1\right] dH_{US}(v). \tag{54}$$

Thus, the expected profits of a firm depends 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   For a firm with productivity ϕ, the expected profit of entering the EU market is

$$E_v\left[\max\left\{\pi_{BD,EU}(\phi, v), \pi_{BD,EU}^{ROO}(\phi, v)\right\}\right] - f_m^{EU}$$

$$= \int_{v(\phi, P_{BD,EU})}^{v^{ROO}(\phi, P_{BD,EU})} \pi_{BD,EU}(\phi, v) dH_{EU}(v) + \int_{v^{ROO}(\phi, P_{BD,EU})}^{+\infty} \pi_{BD,EU}^{ROO}(\phi, v) dH_{EU}(v) - f_m^{EU}$$

$$= \int_{v(\phi, P_{BD,EU})}^{+\infty} \pi_{BD,EU}(\phi, v) dH_{EU}(v)$$

$$+ \int_{v^{ROO}(\phi, P_{BD,EU})}^{+\infty} \left[\pi_{BD,EU}^{ROO}(\phi, v) - \pi_{BD,EU}(\phi, v)\right] dH_{EU}(v) - f_m^{EU}. \tag{55}$$

As in the US case,

$$\pi_{BD,EU}\left(\phi,v\right) = f\left[\frac{v}{v\left(\phi,P_{BD,EU}\right)} - 1\right],\tag{56}$$

while

$$\pi_{BD,EU}^{ROO}\left(\phi,v\right) - \pi_{BD,EU}\left(\phi,v\right) = d^{EU}\left[\frac{v}{v^{ROO}\left(\phi,P_{BD,EU}\right)} - 1\right].\tag{57}$$

Hence

$$\begin{aligned}
&E_v\left[\max\left\{\pi_{BD,EU}\left(\phi,v\right),\pi_{BD,EU}^{ROO}\left(\phi,v\right)\right\}\right] - f_m^{EU}\\
&= f\int_{v\left(\phi,P_{BD,EU}\right)}^{+\infty}\left[\frac{v}{v\left(\phi,P_{BD,EU}\right)} - 1\right]dH_{EU}\left(v\right)\\
&\quad + d^{EU}\int_{v^{ROO}\left(\phi,P_{BD,EU}\right)}^{+\infty}\left[\frac{v}{v^{ROO}\left(\phi,P_{BD,EU}\right)} - 1\right]dH_{EU}\left(v\right) - f_m^{EU}.
\end{aligned}\tag{58}$$

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 Bangladeshi firm exporting to the EU by $\phi_{BD,EU}^*$, then all firms with productivity above $\phi_{BD,EU}^*$ will try to access the EU market. The equation for $\phi_{BD,EU}^*$ is given by

$$E_v\left[\max\left\{\pi_{BD,EU}\left(\phi_{BD,EU}^*,v\right),\pi_{BD,EU}^{ROO}\left(\phi_{BD,EU}^*,v\right)\right\}\right] = f_m^{EU},\quad\text{or}$$

$$\begin{aligned}
&\int_{v\left(\phi_{BD,EU}^*,P_{BD,EU}\right)}^{+\infty}\left[\frac{v}{v\left(\phi_{BD,EU}^*,P_{BD,EU}\right)} - 1\right]dH_{EU}\left(v\right)\\
&+ \frac{d^{EU}}{f}\int_{v^{ROO}\left(\phi_{BD,EU}^*,P_{BD,EU}\right)}^{+\infty}\left[\frac{v}{v^{ROO}\left(\phi_{BD,EU}^*,P_{BD,EU}\right)} - 1\right]dH_{EU}\left(v\right) = \frac{f_m^{EU}}{f}.
\end{aligned}\tag{59}$$

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 the cutoff productivity $\phi^*_{BD,EU}$. To see this, note that

$$v\left(\phi, P_{BD,EU}\right) = \left(\frac{\phi^*_{BD,EU}}{\phi}\right)^{\sigma_{EU}-1} v\left(\phi^*_{BD,EU}, P_{BD,EU}\right), \tag{60}$$

so that

$$E_v\left[\pi_{BD,EU}\left(\phi, v\right)\right] \tag{61}$$

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

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

$$E_v\left[\pi^{ROO}_{BD,EU}\left(\phi, v\right) - \pi_{BD,EU}\left(\phi, v\right)\right] \tag{62}$$

$$= d^{EU} \int_{\left(\frac{\phi^*_{BD,EU}}{\phi}\right)^{\sigma_{EU}-1} v^{ROO}\left(\phi^*_{BD,EU}, P_{BD,EU}\right)}^{+\infty} \left[\frac{v}{\left(\frac{\phi^*_{BD,EU}}{\phi}\right)^{\sigma_{EU}-1} v^{ROO}\left(\phi^*_{BD,EU}, P_{BD,EU}\right)} - 1\right] dH_{EU}\left(v\right),$$

where, from the analysis above,

$$v^{ROO}\left(\phi^*_{BD,EU}, P_{BD,EU}\right) = C^{ROO} v\left(\phi^*_{BD,EU}, P_{BD,EU}\right), \quad C^{ROO} = \frac{d^{EU}}{f\left[\alpha^{\sigma_{EU}-1}\left(1 - t_{BD,EU}\right)^{-\sigma_{EU}} - 1\right]} > 1. \tag{63}$$

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 the productivity cutoffs in both the US and EU markets. Recall that for a marginal US exporter, we have

$$\pi_{BD,US}\left(\phi^*_{BD,US}, v\left(\phi^*_{BD,US}, P_{BD,US}\right)\right) = 0, \tag{64}$$

or

$$\frac{(1 - t_{BD,US}) \, v\left(\phi^*_{BD,US}, P_{BD,US}\right) R_{BD,US} \left(P_{BD,US}\right)^{\sigma_{US}-1} \left[\frac{1}{1-t_{BD,US}} \frac{\tau_{BD,US}}{\rho_{US}\alpha\phi^*_{BD,US}}\right]^{1-\sigma_{US}}}{\sigma_{US}} = f.$$
(65)

Thus,

$$\phi^*_{BD,US} = \left[v\left(\phi^*_{BD,US}, P_{BD,US}\right) \frac{(1 - t_{BD,US}) R_{BD,US} \left(P_{BD,US}\right)^{\sigma_{US}-1}}{f\sigma_{US}}\right]^{\frac{1}{1-\sigma_{US}}} \frac{1}{(1 - t_{BD,US})} \frac{\tau_{BD,US}}{\rho_{US}\alpha}.$$
(66)

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

$$\phi^*_{BD,EU} = \left[v\left(\phi^*_{BD,EU}, P_{BD,EU}\right) \frac{\left(1 - t^{BD,EU}\right) R_{BD,EU} \left(P_{BD,EU}\right)^{\sigma_{EU}-1}}{\sigma_{EU} f}\right]^{\frac{1}{1-\sigma_{EU}}} \frac{1}{(1 - t_{BD,EU})} \frac{\tau_{BD,EU}}{\rho_{EU}}.$$
(67)

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 equals entry costs:

$$E_\phi \left[\max\left\{E_v\left[\pi^{BD,US}(\phi, v)\right] - f^{US}_m, 0\right\}\right]$$
(68)
$$+ E_\phi \left[\max\left\{E_v\left[\max\left(\pi_{BD,EU}\left(\phi^*_{BD,EU}, v\right), \pi^{ROO}_{BD,EU}\left(\phi^*_{BD,EU}, v\right)\right)\right] - f^{EU}_m, 0\right\}\right] = f_e.$$

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

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

$$
\left. - \frac{f_m^{US}}{f} \right] dG(\phi)
$$

$$
+ \int_{\phi_{BD,EU}^*}^{+\infty} \left\{ \int_{v\left(\phi_{BD,EU}, P_{BD,EU}\right)}^{+\infty} \left[\frac{v}{v\left(\phi_{BD,EU}, P_{BD,EU}\right)} - 1 \right] dH_{EU}(v) \right.
$$

$$
+ \frac{d^{EU}}{f} \int_{v^{ROO}\left(\phi_{BD,EU}, P_{BD,EU}\right)}^{+\infty} \left[\frac{v}{v^{ROO}\left(\phi_{BD,EU}, P_{BD,EU}\right)} - 1 \right] dH_{EU}(v) - \frac{f_m^{EU}}{f} \right\} dG(\phi) = \frac{f_e}{f},
$$

$$(69)$$

where

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

and

$$
\left(\frac{\phi_{BD,EU}^*}{\phi} \right)^{\sigma_{EU}-1} v^{ROO}\left(\phi_{BD,EU}^*, P_{BD,EU}\right) = v^{ROO}\left(\phi_{BD,EU}, P_{BD,EU}\right).
$$