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FIRM HETEROGENEITY AND COSTLY TRADE:
A NEW ESTIMATION STRATEGY AND POLICY EXPERIMENTS

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ABSTRACT

This paper builds a tractable partial equilibrium model in the spirit of Melitz (2003), which incorporates two dimensions of heterogeneity: firms specific productivity shocks and …rm-market specific… demand shocks. The structural parameters of interest are estimated using only cross-sectional data, and 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 are performed. Our counterfactuals make a case for "trade as aid,"as such policies can create a "win-win-win"scenario and are less subject to the usual worries regarding the efficacy of direct foreign aid. They also suggest that reducing fixed costs at various levels can be quite effective as export promotion devices, with the exports induced per dollar spent ranging from .4 to 25.

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1 Introduction

When the US granted duty-free and quota-free access to Madagascar under the African Growth and Opportunity Act 2000, exports from Madagascar exploded, from \$170 million in 2000 to \$500 million in 2004. Over the same period, Madagascar's exports to the rest of the world also increased, from \$750 million to \$875 million. Similarly, when the EU granted duty-free and quota-free access to Bangladesh under the Everything But Arms Initiative in 2001, knitwear exports from Bangladesh to the EU more than doubled, from \$1.3 billion in 2000 to \$3 billion in 2004. During the same period of time, knitwear exports from Bangladesh to the US also increased by \$30 million. Much to the surprise of many, such generous trade preferences resulted not in trade diversion from the rest of the world to the preference granting markets, but in trade creation to the rest of the world.

The model we develop and estimate in this paper predicts exactly this. Trade preferences given by one country have positive spillovers on exports to others in the presence of free entry: preferences given by the EU make the industry more attractive and create entry, and some of these firms also export to the US. We use customs data from Bangladesh to estimate a heterogeneous firm model based on the flagship model of Melitz (2003), but structured to be suitable for 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 effects of the different kinds of trade polices used in practice. Finally, we compare fixed cost subsidies of various kinds in terms of their effectiveness in promoting exports.

In our model, there are two sources of firm heterogeneity: firm specific productivity as in Melitz (2003), and firm and market specific demand shocks. This is motivated by the findings in Demidova, Kee and Krishna (2012). They use a firm level data set on Bangladeshi garment producers and show that firms roughly follow the productivity hierarchy predicted in Melitz (2003), namely, that firms export to all markets that are easier than the toughest one they export to, and more productive firms export to tougher markets. However, there are a number of violators. 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.[1] We chose not to use the approach of Arkolakis (2010), who argues that firms have a choice of penetration costs, which increase with the number of consumers firms want to access and decrease with the market size. This allows small exporters to exist, something that would be ruled out by large fixed costs of entry. However, even with his approach, but without the presence of firm and market specific demand shocks, there would be a very strong positive correlation in the size of the firm's market shares across export destinations, something we do not see in our data. For this feature of the data we need firm and market specific demand shocks as postulated here.

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 (2011) (EKK from here on). EKK use customs-level data to understand the patterns of 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 (2010) market access costs to explain the presence of many small firms with a limited attachment to the market, as well as firm and market specific demand shocks. 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 designed to do. Moreover, and perhaps more critically, their model, like

[1]Eaton, Kortum and Kramarz (2011) also postulate the existence of firm and market specific demand shocks. Kee and Krishna (2008) look at the patterns in the violations and what might explain them. Armenter and Miklos (2009) assume heterogeneity on the fixed cost side. They show that matching the share of exporters in a standard Melitz model to the data results in having exports per firm far larger than in the data. Fixed costs heterogeneity helps to reduce this mismatch and explain hierarchy violations.

that of Chaney (2008), assumes that the mass of firms that enter is fixed. In contrast, we treat the mass of entrants as endogenous. Since we show that this entry margin does most of the heavy lifting in the adjustments that occur in response to policy, this difference in our assumptions is worth emphasizing. Our paper is also related to Bernard, Redding and Schott (2011), which also features market demand shocks in order to determine the export behavior of multi-product firms.

Our model has two quite novel policy-relevant predictions. First, it suggests that a small country can increase its exports quite considerably if granted preferences that are relatively easy to access, and through cost-reducing policies. We explicitly show how to incorporate these preferences and the costs, both fixed and variable, associated with obtaining them into a structural model suitable for estimation and policy analysis. Conversely, factors that raise export costs, like corruption or bad infrastructure, can really take a toll on exports. Second, the model suggests that preferences to developing countries can have a catalytic effect. Rather than diverting trade away from other markets as predicted in settings without fixed industry entry costs, preferences given by one developed country can significantly *raise* the exports to the other market. This occurs because preferences raise the return to entry in the industry. Once a firm has entered, it will serve all markets in which it gets an adequate demand shock. This effect could be large under circumstances relevant for many developing countries. The effects of such policies are 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.[2] In this paper, we use only cross sectional price and quantity information and are able to generate bootstrap standard errors for our estimates. The advantage of this approach is that such cross sectional data is commonly available, which makes our procedure widely applicable in contrast to the structural dynamic approach taken in recent work, such as Das, Roberts and Tybout (2007) and Aw, Roberts and Xu (2011), which is limited to where data is available over a period of time.

The paper proceeds as follows. Section 2 contains a brief discussion of the empirical

[2]Demidova, Kee and Krishna (2012) take advantage of a natural experiment in trade policy that provides clean predictions regarding how firms should sort themselves across markets in this augmented Melitz model. They then show that these predictions are consistent with the data.

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

We use data on the woven apparel sector, and in particular, the subcategory Mens/Boys Cotton Trousers (HS 620342) in Bangladesh. Firms that produce garments from woven fabrics typically use imported or domestically produced fabrics to make apparel items such as men's cotton shirts or ladies dresses and export the finished products to the EU or US. Given that fabrics make up more than 50 percent of the costs, the origin of the fabric has implications for the tariffs faced by these products in each market due to the existence of trade preferences in some markets. We will describe the setting in some detail below as it is the basis for how we incorporate the trade policy environment into our model.[3]

We focus on this subcategory for two reasons. First, we want to have a relatively homogeneous product industry: woven apparel as a whole might be seen as too aggregated. Next, we want a fair number of firms to be present. Both requirements are met in this sector.[4]

2.1 The Trade Policy Environment

As summarized in Table 1, there are three main components of the trade environment: the trade policy of the US and EU, the trade preferences (if any) they grant to Bangladesh,

[3] The apparel sector of Bangladesh also produces non-woven products, but the production technique and the trade policy environment faced by the non-woven firms are vastly different from those of the woven apparel producers. Hence, we exclude them from this paper in order not to complicate the modelling and estimation. Please refer to Kee and Krishna (2008) and Demidova, Kee and Krishna (2012) for details. In both papers, we explicitly use the differences in production technique and trade policies between the woven and non-woven garment exporters to identify the sorting behavior of firms with unobserved heterogeneity in productivity and market demand shocks.

[4] This subcategory accounts for 31.3% of exports to the EU and 15.3% to the US. We have a total of about 800 firms that export to the US or EU in this category in 2004, and of the firms that export to the EU, 72.5% meet ROOs and invoke preferences.

and the Rules of Origin, or ROOs, upon which preferences are conditioned. ROOs specify conditions on production that must be met in order to obtain origin and thereby qualify for country specific quotas or trade preferences.[5] They can take a variety of forms. The important thing to note is that, whatever the form, if ROOs are binding, then the choice of inputs used in production differs from their unconstrained levels. Thus, from an analytical viewpoint binding ROOs must *raise* the marginal costs of production. In addition to this, ROOs can also raise the fixed cost of production as compliance with ROOs must be documented, and a large part of these documentation costs involves learning the ropes and, thus, can be treated as fixed. We explicitly allow for such costs of meeting ROOs in our model.

Table 1: Trade policy environment

Trade Barriers	USA	EU
(a) Quotas	Yes: ROOs required	No
(b) MFN tariffs	≈20%	≈12%
Trade Preferences	No preferences	Zero tariffs if ROOs met
ROOs	Locally assembly	Yarn forward rule

The US Environment In 2004, the US had tariffs of about 20% applied on a Most Favoured Nations (MFN) basis, as well as Multifibre Arrangement (MFA) quota restrictions in place for the imports of wovens from most developing countries, including Bangladesh. Quotas under the MFA were country specific, so exporting was contingent on obtaining origin: unless the good was shown to originate from Bangladesh, it could not enter under its quota. US ROOs regarding apparel products are governed by Section 334 of the Uruguay Round Agreements Act. For the purpose of tariffs and quotas, an apparel product is considered as originating from a country if it is wholly assembled there.[6] 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 and had to compete with producers from other countries, such as India and China. However, since

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

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

http://www.washingtonwatchdog.org/documents/usc/ttl19/ch22/subchIII/ptB/sec3592.html there were quotas on other exporters as well, full competition among supplying countries was still not the case.[7] In wovens, 65-75% of Bangladeshi exports to the US in value terms are under quota. For the subgroup we focus on this number is close to 100%. These quotas are bilateral and product specific, so firms have no choice but to meet origin.[8] A World Bank firm survey in Bangladesh conducted in 2004 gave the quota license price to be about 7%.

The EU Environment In 2004, the EU had an MFN tariff rate of 12%-15% on woven apparel. Under the "Everything-But-Arms" (EBA) initiative in 2001, Bangladesh, together with 48 other LDCs, may export a wide range of products, including this particular HS product, to the EU without any duty and quota, provided ROOs were satisfied. The EBA initiative 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 Bangladeshi garment exporters operated.

EU ROOs on apparel products were considerably more restrictive than the US ones. As such, an item exported to the US may be considered as a product of Bangladesh and imported under its quota allocation. However, the same item may fail to meet EU ROOs and would not qualify for the tariff preference under EBA. 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[9], i.e., the use of imported fabrics would result in the item 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

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[7] Note that less competitive countries are at less of a 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.

[8] The fill rate of the quota is close to 80% suggesting the quotas are binding.

[9] 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.

into garments. Given the limited domestic supply of woven cloth[10], it commands a premium price, so woven firms can meet ROOs only by paying a roughly 20% higher price for cloth, which translates into a significantly higher cost of production, as cloth is the lion's share of the input cost. The cost of cloth to FOB price is roughly 70-75% for shirts, dresses, and trousers[11], resulting in a 15% cost disadvantage.[12] For this reason, not all woven firms choose to meet ROOs and invoke preferences while exporting to the EU. This feature allows us to estimate the fixed documentation costs of invoking preferences and meeting ROOs.[13]

China and other better off developing countries faced EU quotas and did not have duty free access. 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. See Brambilla et al. (2010) for more on China and the MFA.

In 2000 the EU granted Bangladesh SAARC (South Asian Association for Regional Cooperation) cumulation,[14] meaning that as long as 50% of the value added was from Bangladesh, materials imported from SAARC countries (which included India with plenty of textile production) could be used while retaining Bangladeshi origin. Cumulation of origin would have relaxed the constraint on using domestic cloth. However, under the pressure from domestic textile firms,SAARC cumulation was not rectified by the Bangladeshi government in 2004.

2.2 The Data

We use customs data at the transaction level for the fiscal year 2004 as our main source. This has information on sales, quantity, product (at the HS 8 level), weight, currency of

[10] Of 1320 million meters of total demand in 2001, only 190 was supplied locally in wovens according to a study by Development Initiative in 2005.

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

[12] 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.

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

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

transaction as well as on a destination and a firm identifier. Since the customs data has no information on whether preferences were invoked or not, we obtained a list of firms that export woven apparel to the EU and obtain preferences for their exports. For these firms, we got information on their exports of wovens to the EU, their quantity and price. However, the firm IDs in the two data sets are not the same. To match the firms, we did the following. In our customs data, we aggregated the sales per firm to the EU of woven apparel, the quantity exported to the EU, and its unit value over the fiscal year. We then matched the firms according to sales and quantity.[15]

3 The Model

We develop a simple partial equilibrium setting based on the setup in Melitz (2003), to which we add another dimension of firm heterogeneity: firm and market specific demand shocks. Demidova, Kee and Krishna (2012) use the same setup to see how firms with different productivities, facing these 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 shown to be consistent with the model. For example, they find that, as predicted by the model, the probability a firm only exports to the EU falls with increases in productivity, favorable demand shocks in the US, and adverse demand shocks in the EU. Conversely, the probability a firm exports to both the EU and US rises with increases in productivity and favorable demand shocks in the US and EU. They also found evidence suggesting those firms that only export to the US (whose presence is impossible without demand shocks) are mainly driven by favorable demand shocks in the US together with adverse demand shocks in the EU, but not by productivity. The fact that the predictions of the model are seen in the data allows us to use it in a structural estimation procedure with a fair degree of confidence that it is not being arbitrarily imposed on the data.

While we explicitly model a small open economy partial equilibrium, Melitz (2003) has a general equilibrium model. We do not have the data to confidently estimate a general

[15] There is little need to worry about mismatches that might have occured in this procedure as we only match the share of firms that meet ROOs in our estimation procedure.

equilibrium model and for this reason we stick to partial equilibrium and make the equivalent of a "small country" assumption as explained in more detail later. We also focus only on the US and EU as export markets and do not model the domestic Bangladeshi market at all. The US and EU are most of the Bangladeshi export market and our firms do not produce much (about 3%) for the domestic market. This is not surprising as the domestic market demands different products from those exported.

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

3.1 Utility

Utility in country j, $j \in \{US, EU\}$, is given by

$$U_j = (N_j)^{1-\beta} (C_j)^{\beta}, \quad 0 < \beta < 1, \tag{1}$$

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

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

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

$$X_{ij} = \int_{\omega \in \Omega_{ij}} v_{ij}(\omega)^{1/\sigma_j} q_{ij}(\omega)^{(\sigma_j - 1)/\sigma_j} d\omega \Bigg)^{\sigma_j/(\sigma_j - 1)}, \tag{3}$$

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

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

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

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

where the cost in country j of getting a util from country i's exports is

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

Then the demand is

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

Thus, our demand function looks just like the standard one á la Melitz, except it has a multiplicative demand shock.

It is worth emphasizing that the above specification implies that the expenditure on all the differentiated goods taken together will be constant. Thus, any increase in Bangladeshi exports must come at the expense of producers from other countries.[16]

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

[16] Had we allowed greater substitutability between C and N, we would have generated larger responses to policies that enhanced Bangladeshi competitiveness with a less adverse impact on other suppliers.

their productivity draw ϕ from the productivity distribution $G(\phi)$. After observing ϕ, they decide whether to enter the US and/or EU markets and pay a fixed cost of f_m^{US} and f_m^{EU}, respectively. Once entered, they see the market specific demand shocks, v_{US} and $v_{EU,}$ drawn from distributions $H_j(v)$, $j \in \{EU, US\}$, 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.[17] It is also consistent with the facts: the correlation between the estimates of demand shocks in Demidova, Kee and Krishna (2012) is close to 0. If firms decide to sell in market j, they incur a fixed cost of production, f. If they further choose to meet ROOs, they pay in addition d^j, the documentation cost of meeting ROOs.

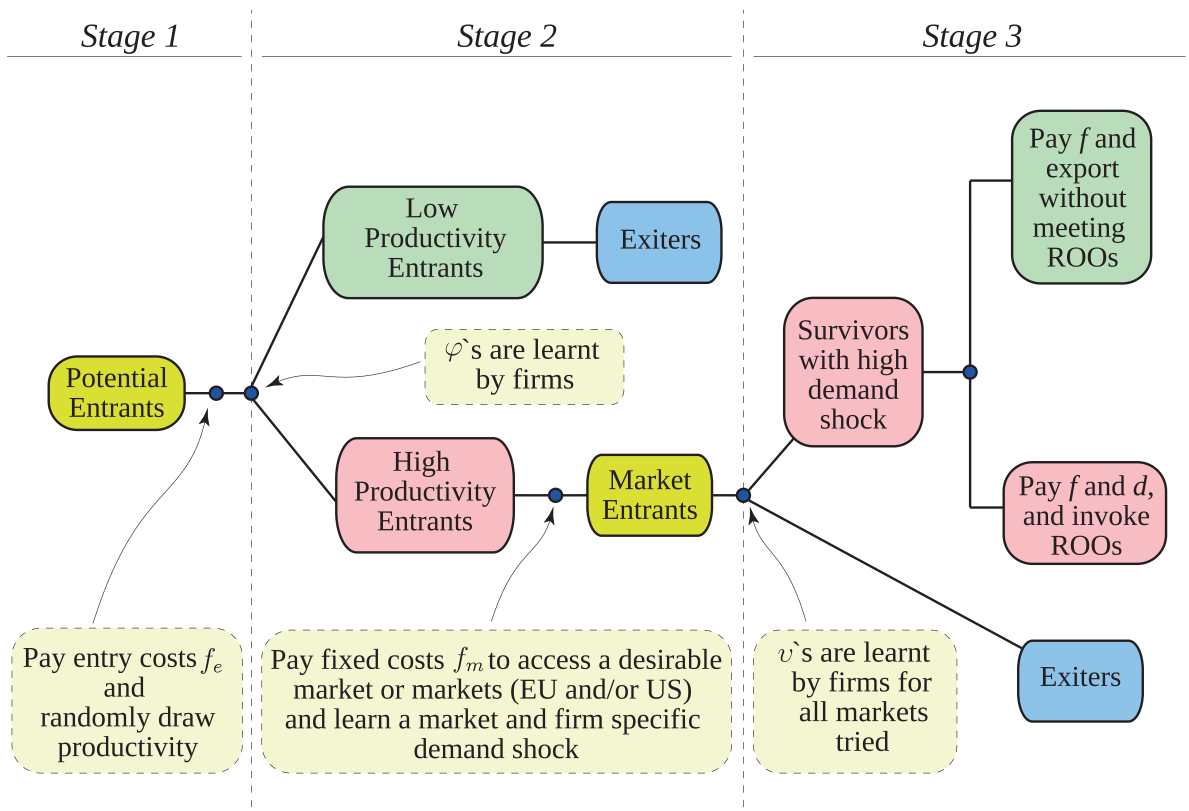

Figure 1: Production Structure for Bangladeshi Exporters.

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

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

across firms, we can drop ω from our notation, keeping only ϕ and v. A Bangladeshi firm with productivity ϕ and market demand shock $v_{BD,j}$ in market j will earn revenue

$$r_{BD,j}\left(\phi, v_{BD,j}\right) = \left(1 - t_{BD,j}\right) q_{BD,j}\left(\phi\right) p_{BD,j}\left(\phi\right) = \left(1 - t_{BD,j}\right) v_{BD,j} P_{BD,j}^{\sigma_j - 1} p_{BD,j}(\phi)^{1-\sigma_j} R_{BD,j}, \tag{8}$$

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

$$\pi_{BD,j} = \left(1 - t_{BD,j}\right) p_{BD,j}\left(\phi\right) q_{BD,j}\left(\phi\right) - \frac{w\tau_{BD,j}}{\phi} q_{BD,j}\left(\phi\right) - f \tag{9}$$

$$= \left(1 - t_{BD,j}\right) \left[p_{BD,j}\left(\phi\right) - \frac{w\tau_{BD,j}}{\phi\left(1 - t_{BD,j}\right)}\right] q_{BD,j}\left(\phi\right) - f. \tag{10}$$

It is easy to see that firms set consumer prices as if their marginal costs were $\frac{w}{\phi}\frac{\tau_{BD,j}}{\left(1 - t_{BD,j}\right)}$, while receiving only $(1 - t_{BD,j})$ of their variable profits. As usual, due to the CES framework, the price paid by consumers is $p\left(\phi\right) = \frac{1}{\left(1 - t_{BD,j}\right)}\frac{\tau_{BD,j} w}{\rho_j \phi}$.[18] We set labor units to be such that wage (w) is equal to a dollar in our partial equilibrium model. In effect, we assume that w is fixed and this can be rationalized by the existence of labor surplus in Bangladesh. 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 $\tau_{BD,j} > 1, j \in \{EU, US\}$, so that marginal costs are increased by this factor. Finally, to model binding quotas in the US we have marginal cost of an exporter to the US with productivity ϕ given by $\left(\tau_{BD,US} + \mu\right)/\phi$, where μ denotes the price of a quota

[18] Demidova, Kee and Krishna (2012) estimate TFP for each firm and show that, as predicted by the model, the correlation between TFP and price is negative and the shapes of two distributions are very similar.

license in ad-valorem form (i.e., $\mu = 0.07$).[19] 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 demand shock $v(\phi, P_{BD,j})$, which allows a Bangladeshi firm with productivity ϕ to earn zero profits in market j. As profits are increasing with v in each market, all firms with productivity ϕ and $v \geq v(\phi, P_{BD,j})$ sell in market j. In addition, for the EU market we define the demand shock $v^{ROO}(\phi, P_{BD,EU})$ such that additional profits from invoking EU ROOs just cover the documentation costs of meeting them.[20] From the zero profit conditions (see the Appendix for more detail), the relationship between $v(\phi, P_{BD,EU})$ and $v^{ROO}(\phi, P_{BD,EU})$ is

$$v^{ROO}(\phi, P_{BD,EU}) = C^{ROO} v(\phi, P_{BD,EU}), \tag{11}$$

where $C^{ROO} = \frac{d^{EU}}{f\left[\alpha^{\sigma_{EU}-1}\left(1-t_{BD,EU}\right)^{-\sigma_{EU}}-1\right]}$. If only some firms meet ROOs, $C^{ROO} > 1$. If $C^{ROO} \leq 1$, then all firms that enter the market meet ROOs. As expected, C^{ROO} rises, and the fraction of firms that meets the ROOs falls, as preferences become less attractive: i.e., as tariffs are lowered, or the documentation costs or marginal costs of meeting preferences increase. Equation (11) points out that once we know cutoff $v(\phi, P_{BD,EU})$, we also know the corresponding one for meeting ROOs.

3.2.2 Stage 2

In Stage 2, we define productivity $\phi^*_{BD,j}$ of the marginal Bangladeshi firm in market j. For any ϕ, the expected profit from selling in market j is the integral of profits over $v \geq v(\phi, P_{BD,j})$.

[19] We model license prices per unit in ad-valorem rather than specific terms to ease the analysis and avoid severe computational difficulties. This specification tends to reduce the tariff paid by more productive firms, as they charge lower prices and so pay a lower dollar tariff. Irarrazabal et al. (2010) argue that if trade barriers are of the per unit form, gains from trade liberalization may be significantly higher than if they are of the ad-valorem form.

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

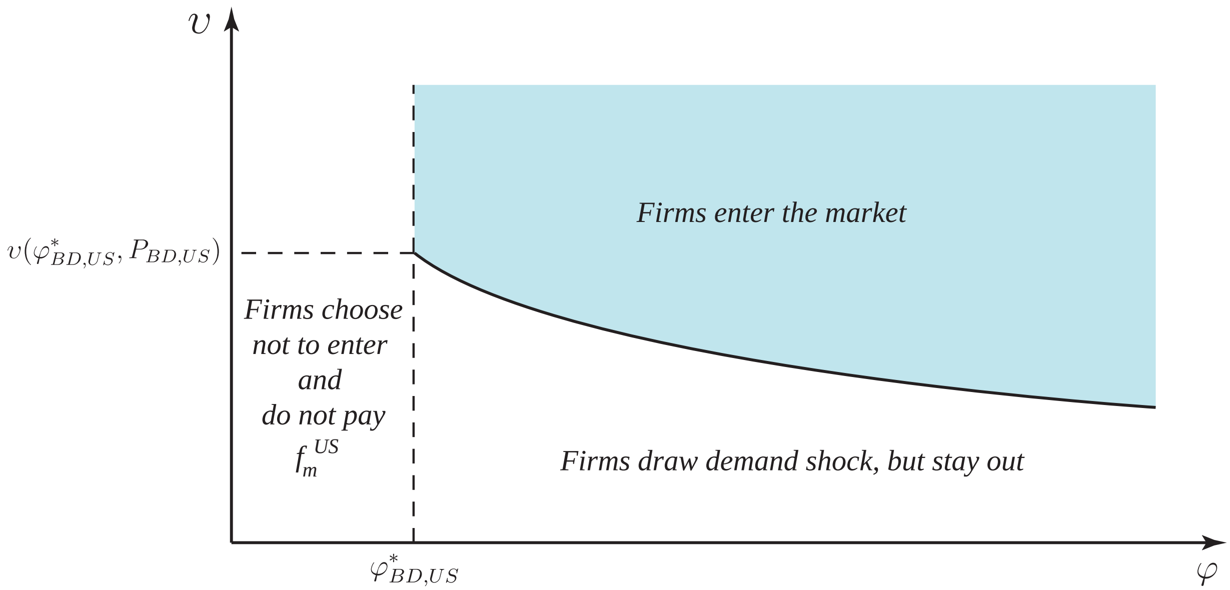

Figure 2: Demand Shock-Productivity Trade-off for the US market.

The firm with $\phi^*_{BD,j}$ is, by definition, indifferent between trying to access market j and not doing so, i.e., its expected profits from accessing market j are equal to the fixed cost f_m^j.[21] As expected, profits rise with ϕ: only firms with $\phi > \phi^*_{BD,j}$ earn non-negative profits on average once their demand shocks are realized, and hence, only such firms try their luck in market j. This gives the cutoff productivity $\phi^*_{BD,j}$ in terms of the model's parameters. (See equations (47) and (48) in the Appendix.) Knowing $\phi^*_{BD,j}$ and $v\left(\phi, P_{BD,j}\right)$ allows us to depict the trade-off between the demand shocks and productivities of firms in each market as done in Figures 2 and 3, where a downward sloping locus reflects the fact that the demand shock needs to be really low to force a very efficient firm to exit the market.

3.2.3 Stage 1

In Stage 1 we use the free entry condition to derive the mass of entrants in the equilibrium. Our solutions for $\phi^*_{BD,j}$, $j \in \{EU, US\}$, depend on the aggregate price indices in the markets. 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

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

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 (49) in the Appendix.) We will use the model and the available data on Bangladeshi firms to estimate the model's parameters. The solution of the model is described in the Appendix.

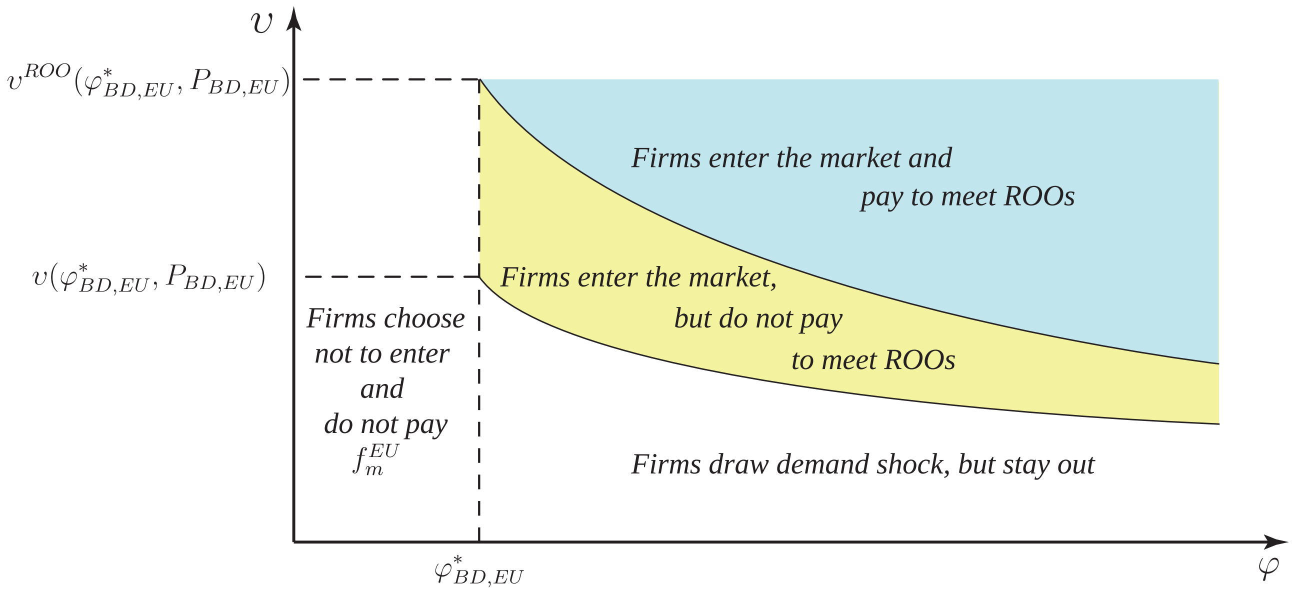

Figure 3: Demand Shock-Productivity Trade-off for the EU market.

4 Estimation Outline

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

$$h(x) = \frac{}{\lambda}\left(\frac{x}{\lambda}\right)^{\square 1} e^{\square\left(\frac{x}{\lambda}\right)}, \tag{12}$$

where and λ are the shape and scale parameters. Such a distribution has a very flexible form: it can approximate the exponential or log normal distributions and, when truncated as required by the model, closely fits the observed productivity distributions. We denote the distribution function for productivity shocks by $G(\phi)$, while those for demand shocks are given by $H_j(v)$, $j \in \{US, EU\}$.

4.1 Estimation Strategy

We distinguish between what we take as given, the data, and the parameters to be estimated. For the analysis below, we define three kinds of firms: firms that sell to the US only (OUS firms), to the EU only (OEU firms), and to both the EU and US (AUS firms).

4.1.1 Trade Policy Data

We take the values for α (the per-unit cost of meeting 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. 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 $d^{US} = 0$. 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,[22] which is denoted by μ below.

In the EU as only some firms meet ROOs, we can estimate d and f separately. Transport cost estimates for the apparel industry range from a low of about 8%[23] to a high of roughly 14%[24]. We set transport costs of 14% in our estimation. Tariffs are 12% and 20% in the EU and US, respectively, and t is set accordingly. This is all summarized in Table 2.

Table 2: 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 The Estimation Routine

Thirteen parameters we need to estimate are σ_j, f_m^j/f, d/f, f_e/f, $_j$, λ_j, $_{TFP}$, λ_{TFP}, and f, $j = US, EU$. In such procedures, the strategy is to guess the values of the parameters and generate data from the model given the guesses. The parameters are then chosen to best fit certain moments of the data. In other words, we use the method of moments in estimation.

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

What remains to be specified is the objective function being minimized in the above procedure. Let us denote vector of parameters by θ, the k-th percentile of the distribution

[22] In the survey administered by H.L. Kee to a sample of Bangladeshi woven firms the average cost increase from having to buy a license was 7%, which is in line with estimates in Mlachila and Yang (2004) for 2003.

[23] World Bank (2005), p. 110.

[24] See Gajewski and Riley (2006), p. 6.

of prices and quantities for firm type $b \in \{OEU, AUS, OUS\}$[25] in the simulation by $\dddot{p}_k^b$ and $\dddot{q}_k^b$, correspondingly, and the data set we have by X. The moment conditions for the distributions of prices and quantities for firm z, $z = 1, ..., Z$, are:

$$m_{zbk}^p(X, \theta) = I\left[p_{zb} \in \left[\dddot{p}_k^b(\theta), \dddot{p}_{k+\varepsilon}^b(\theta)\right]\right] \square \varepsilon, \quad \text{and} \quad m_{zbk}^q(X, \theta) = I\left[q_{zb} \in \left[\dddot{q}_k^b(\theta), \dddot{q}_{k+\varepsilon}^b(\theta)\right]\right] \square \varepsilon,$$

where ε is the bin size chosen, and I denotes an indicator function. In other words, given the parameters, θ, the model would have a fraction ε of the data in each bin, and $m_{zbk}^p(X, \theta)$ and $m_{zbk}^q(X, \theta)$ are the differences between the fraction of the data in each bin and ε. If the parameters are the true ones, these should have a mean of zero.

Unlike prices and quantity data, information on demand shocks is not readily available from the data set. We obtain demand shocks from the data as follows. Demand for a firm (which is its sales in the data) is a function of its own price (from the data), the price index (obtained from the simulation), the total exports to a given market (from the data), and the demand shock. This allows us to back out the demand shock for each firm. Let us denote percentile points of this distribution by $\ddot{\upsilon}_{bk}^1(\theta, X)$. At the same time, given a vector of parameters θ, we can also recover the model implied distribution of demand shocks for those firms that survive and its percentile points $\ddot{\upsilon}_{bk}^2(\theta, X)$. We minimize the difference between the data/model and model implied distributions of demand shocks in the same way as we did for the price and quantity distributions, and define moment conditions as:

$$m_{zbk}^{\upsilon}(X, \theta) = I\left[\upsilon_{zb} \in \left[\ddot{\upsilon}_{bk}^1(\theta, X), \ddot{\upsilon}_{bk+\varepsilon}^1(\theta, X)\right]\right] \square\, I\left[\upsilon_{zb} \in \left[\ddot{\upsilon}_{bk}^2(\theta, X), \ddot{\upsilon}_{bk+\varepsilon}^2(\theta, X)\right]\right].$$

We use seven bins total for each distribution we match. The first four bins have 20% of the data in each bin, and the next three bins have 10%, 7.5%, and 2.5% of the data, respectively.[26]

Finally, we denote the shares of firms (in percentages) that are of the OEU, AUS, and OUS types in the data by S_b^e. Similarly, let S_{ROO}^e denote the share of firms (in percentages)

[25] For AUS firms we distinguish between the distributions in each market and give them an equal weight.

[26] This choice of bins in essence puts more weight on matching the model and the data for the largest firms. In this we follow EKK, who similarly match 4 bins - from 0 to 50, from 50 to 75, from 75 to 95, and from 95 to 100.

that meet EU ROOs in the data. The moment condition for the share of AUS firms is:

$$m_{z,AUS}^{Share}(X,\theta) = I\left[Firm\ z\ is\ AUS, \theta\right] \square S_{AUS}^{e}.$$

$I\left[Firm\ z\ is\ AUS\right]$ equals unity if firm z is an AUS firm in the simulation. This occurs if its productivity is above the cut-off level for the tougher market and demand shock draws are above the corresponding cut-offs for both markets. The expectation of $m_{z,AUS}^{Share}(X,\theta)$ over the distributions of productivity and demand shocks for the true parameters should be zero. The moment conditions for OEU, OUS, and ROOs firms are defined analogously. Stacking moment conditions for price, quantity, demand shock distributions, and shares of different types of firms yields the vector of moment conditions $m_z(X,\theta)$ for firm z.

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 firms helps identify the parameters of the distributions of demand shocks. Matching the share of firms meeting ROOs identifies documentation costs, while matching the distributions of prices for each type of firms identifies the parameters of the TFP distributions. Matching the position of the quantity distributions helps pin down fixed costs of production. 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 (51) and (52) in the Appendix.

The objective function that we minimize with respect to θ is:

$$\left[\frac{1}{Z}\sum_{z=1}^{Z} m_z(X,\theta)\right]' W \left[\frac{1}{Z}\sum_{z=1}^{Z} m_z(X,\theta)\right],$$

where W is the weighting matrix. Following the literature we start with the unitary weighting matrix and obtain the set of estimates $\hat{\theta}_u$ of parameters θ.[27] Up to this moment our method

[27] We also tried to use a weighting matrix with higher weights on the moment conditions on shares. The estmation results are similar.

is an example of the classical general method of moments.

With the first step estimates in hand, we have to calculate the optimal weighting matrix. Theory proposes the use of the weighting matrix Q_{mm}, where

$$Q_{mm} = E\left[m(X,\theta)m(X,\theta)'\right],$$

which is usually approximated by

$$\widehat{Q}_{mm} = \frac{1}{Z}\sum_{z=1}^{Z} m_z(X,\widehat{\theta}_u)m_z(X,\widehat{\theta}_u)'.$$

To evaluate $\widehat{Q}_{mm}$, we employ a simulation based approach. Based on the first step estimates we simulate a large number of artificial firms (N_A). Knowing prices, quantities, and demand shocks for these firms, and combining these data with the real data, we calculate moment conditions $m^s(X,\theta)$ firm by firm. Then the optimal weighting matrix (for a given draw) is

$$\hat{W}_s = \left[\frac{1}{N_A}\sum_{k=1}^{N_A} m_k^s(X,\widehat{\theta})m_k^s(X,\widehat{\theta})'\right]^{\square 1}.$$

To minimize the effect of random sampling error, we take a large number of draws S and approximate $\hat{W}$ as: $\hat{W} = \frac{1}{S}\sum_{s=1}^{S}\hat{W}_s$.[28]

Standard errors for the estimates are obtained using bootstrap techniques. At each of 100 bootstrap iterations we repeat the estimation routine outlined above. Following Horowitz (1996, 2001) we re-center the moment conditions to achieve the asymptotic refinement, even though we do not use our standard error estimates for testing.

5 Results of the Estimation

The results of the estimation are presented below. Tables 3 and 4 show the estimated parameters for the TFP and demand shock distributions in the two countries, respectively.

The distributions of quantities, prices, and demand shocks in the data and from the

[28] Following EKK, we use the generalized inverse to calcualte the optimal weighting matrix.

estimated model are depicted in Figures 4, 5, and 6 in the Appendix, respectively. In these figures, the model generated data is represented by dashed lines, while the data itself is represented by solid lines. Our simulations predict a firm size distribution that has a heavier right tail compared to the data, see Figure 4. Note that in Figure 5 the distribution of prices, especially for multi market firms, has a larger right tail in the data than in the simulations.[29]

Table 3. TFP distribution		
	Estimate	Std. Err.
Shape (α_{TFP})	0.81	0.21
Scale (λ_{TFP})	0.42	0.15
Implied moments of the distribution		
Implied mean shock[30]	0.47	
Coefficient of Variation	1.24	

The distributions of demand shocks (normalized by their price index) are depicted in Figure 6. The means and standard deviations are reported in Table 4. The mean demand shocks in the US are larger than those in the EU and have a greater coefficient of variation. This is consistent with the differences in the distribution systems in the two countries. Large retailers, like Walmart, play a much bigger role in the US than in the EU. Firms that are lucky enough to land an order from such a large buyer will look like they had a higher positive demand shock. It is also consistent with the fact that the US is the older market for Bangladesh. This ties in with the work of Foster, Haltiwanger and Syverson (2008, 2012). They allow for both TFP and demand shock differences among firms and argue that younger firms tend to be at least as productive as old ones, but are smaller, i.e., have smaller demand shocks. They interpret this in terms of firms having "market capital" (due to advertising or consumer experience with their goods), which grows slowly over time.

[29] This may well be due to capacity constraints, which are not present in our model but may be present in the data. With them, firms may not be able to supply as much as they want to, making the quantity distributions in the data be to the left, and the price distribution be to the right, of those in the model.

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

Table 4. Distribution of demand shocks

	EU		US	
	Estimate	Std. Err.	Estimate	Std. Err.
Shape ( )	0.32	0.008	0.17	0.003
Scale (λ)	1.39	0.087	0.57	0.020
	Implied moments			
Implied mean shock	10.4		421.8	
Coefficient of variation	4.9		30.7	

Given our estimated distributions, we can check whether the US is a tougher market. To do this, we 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, the probability of trying the EU (US) market is 17% (13%), while the probability of surviving conditional on having tried the market is 60% (23%) for the EU (US). These numbers are consistent with the US being a tougher market and having a larger extent of failed entry.

Table 5. Elasticities of substitution

	EU	US
σ	1.34	1.45
Std. Error	0.033	0.027

Table 5 gives the demand elasticities in each market. These are more than unity and close to the estimates obtained in Demidova, Kee and Krishna (2012). They are a little higher in the US and are similar in magnitude to those found in other structural models like Foster, Haltiwanger and Syverson (2012).

The estimates of various fixed costs are given in Table 6. The costs of entering the industry are about \$77,000, which are about a third of the cost of entering the EU market and similar in magnitude to the cost of entering the US market. Fixed costs of production as well as the documentation costs are low. Note that these numbers, when added up, give a figure close to the sunk cost estimates in Das, Roberts and Tybout (2007) for knit wear (of about .5 million), which is a part of the non-woven apparel industry. Our estimates are, unfortunately, not directly comparable to theirs for two reasons. First, our numbers are for a particular subset of wovens, while theirs are for knit wear. Second, our numbers should be interpreted as annualized values since our model is static.

Table 6. Fixed costs in $

	Estimate	Std. Error
f	6,404	476
f_m^{EU}	251,250	19,054
d^{EU}	4,240	317
f_m^{US}	67,869	5,237
f_e	77,348	5,372

While interpreting our cost estimates, it is important to understand that they include all fixed costs, sunk and not sunk, monetary, opportunity, or psychic that the producer takes into account in making decisions. For example, if getting around corrupt officials to enter an industry creates costs in terms of bribes, time spent, or headaches, these would show up in industry entry costs.[31]

It is worth noting that market entry costs to the EU are quite high. As marginal costs of exporting to the US are higher than those of exporting to the EU (tariffs are higher and there are quotas), fixed costs of entering the US market are estimated to be low to help match the relatively large share of firms (37%) that export to the US. This makes sense in terms of the institutions as the presence of large US retailers from the US looking for suppliers abroad reduces the fixed cost of entering the US market. Conversely, for the EU: despite preferences and the absence of quotas, the share of firms exporting to the EU is only 60%. As a result, the EU market entry costs come out to be large. Documentation costs are low, which is consistent with a large share, 73%, of the firms that export to the EU choosing to meet ROOs. Fixed cost of production are also estimated to be low to account for the presence of small exporters. Finally, industry entry costs come from the free entry condition.

[31] According to the World Bank's Worldwide Governance Indicators, Bangladesh was among the most corrupt countries in the world. Doing-Business Indicators also consistently place Bangladesh among the countries with the highest costs of doing business. All of this is consistent with high fixed entry costs.

It is also 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.

6 Policy Experiments

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

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

$$R_{BD,j} = \frac{(P_{BD,j})^{1-\sigma_j}}{(P_{BD,j})^{1-\sigma_j} + \sum_{i\in\Omega_{(-BD),j}} [P_{i,j}]^{1-\sigma_j}} R_j, \tag{13}$$

where $\Omega_{(-BD),j}$ is the set of countries exporting to j excluding Bangladesh. $R_{BD,US}$ and R_{US} are approximated by the total Bangladeshi sales and total exports of woven apparel to the US, respectively. We can invert equation (13) to obtain $\sum_{i\in\Omega_{(-BD),j}} [P_{i,US}]^{1-\sigma_{US}}$ denoted by $\bar{P}_{-BD,US}$. We can obtain $\bar{P}_{-BD,EU}$ in an analogous manner.[32] In our simulations, we keep $\bar{P}_{-BD,EU}$ and $\bar{P}_{-BD,US}$ fixed in accordance with our partial equilibrium assumptions, as we assume that Bangladesh is a small country. However, it is worth exploring what is being missed by making this assumption. We argue below that this would result in *under estimating* the effects of policy on exports, while *over estimating* the effect of consumer surplus. Consider a policy that reduces $P_{BD,EU}$. This will raise Bangladeshi exports, while reducing the profits of non-Bangladeshi firms and causing their exit. This, in turn, would raise $\bar{P}_{-BD,EU}$, making Bangladeshi exports even more competitive. This argument suggests that the Bangladeshi export increases due to the policy (that reduced $P_{BD,EU}$ to begin with) that are predicted by our simulations would tend to be *under estimates*. However, because

[32] Note that even if we assume that instead of the term $\bar{P}_{-i,j}$ we have the price indices for other countries calculated with elasticities different from σ_j (i.e., $\sum_{i\in\ (-BD),j} [P_{i,j}]^{1-\sigma_{i,j}}$), our results will not be affected at all, since $\sum_{i\in\ (-BD),j} [P_{i,j}]^{1-\sigma_{i,j}}$ will be solved for exactly the same way as the $\bar{P}_{-i,j}$.

$\bar{P}_{\square BD,EU}$ would rise, while the simulations assume it is fixed, the consumer surplus gain in the EU would be *over estimated* in our simulations. In addition, as Bangladesh has a small share of the world market, there is an asymmetry that is worth noting. Any change in $P_{BD,EU}$ will evoke a small response in $\bar{P}_{\square BD,EU}$. However, even a small change in $\bar{P}_{\square BD,EU}$ will have large effects on Bangladeshi demand. It is also worth emphasizing that the increases in exports of Bangladesh would tend to come at the expense of other exporters. Thus, EU preferences to less developed countries including Bangladesh may end up hurting a possibly even poorer countries in Africa as Bangladesh is likely to be able to better take advantage of such preferences than some other developing countries.[33]

In our experiments below, we distinguish between "endogenous license price" and "exogenous license price" scenarios. We transform the license price for a quota into its ad-valorem equivalent in the model. In the presence of quotas, policy changes will affect the license price and its ad-valorem equivalent. In the "exogenous" scenario, we keep the license price fixed. In the "endogenous" one, we allow the equilibrium value of the license price to change. For each experiment we first check whether the US quota remains binding or not. If it is no longer binding, we set the new license price to be zero. If it remains binding, we find the license price that equates the demand for quota licenses at the new license price to the fixed supply of licenses. This keeps the quantity sold by Bangladeshi firms to the US constant.

We are now ready to look at some policy questions. Our first experiment deals with a question of considerable policy importance, namely, the costs of preferences. Developed countries typically give preferences to developing ones, but require that exporters meet origin requirements as done by the EU in the EBA. Thus, obtaining preferences can be quite costly. Consequently, such preferences can be much less generous than they seem. We use our model to quantify the impact of making such preferences easier/harder to obtain.[34] We show, for

[33] In our tables, we calculate welfare changes directly using indirect utility normalized so that the marginal utility of a dollar of income is unity. We use estimates of $12,465 and $11,855 billion dollars for the EU and US GDP in 2004 taken from the IMF World Economic Outlook Database (April 2012 Edition), tariff revenues of $105 and $308 million dollars collected by the EU and US, respectively, and their expenditure shares of 0.00024 and 0.0005 on woven apparel in our calculations.

[34] Mattoo et al. (2003) look at the Africal Growth and Opportunity Act and (based on back of the envelope calculations in a simple competitive model) argue that preferences are undone by restrictive ROOs.

example, that removing the home yarn requirement results in a surge of entry and exports.

The second set of experiments looks at the policy effectiveness of subsidies to fixed costs. Which subsidies are the 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." Also, exports may provide needed tax revenues, or more generally, may be a source of externalities. To examine this question, we 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). We consider both the short run effects (when the mass of entrants is fixed at the level before the policy change) and long run effects (when everything, including the mass of entrants, adjusts) and find that they can go in opposite directions. We also look at welfare and revenue effects. Our work suggests that in the absence of any response from other countries, as might be expected for a small country (with the given price index of competing products), a fall in the fixed costs firms face can greatly increase their exports. We discuss the reason for this and provide a decomposition of the relevant margins.

An interesting and novel finding is that liberalization in one country can raise rather than lower its exports in the other market as would be expected a priori. These cross market effects are very large. Also, while the effects of changes in trade policies in most standard models give welfare changes in the millions, the welfare changes our model generates are in the hundreds of millions of dollars. Dixit (1988) argues that the magnitude of welfare changes is in the billions only when there are large pre-existing distortions in other markets like those created by labor unions setting artificially high wages. However, in our model free entry magnifies the effects of trade policies, generating changes in the hundreds of millions rather than in the millions, even though the sector we are using accounts for a small part of expenditure. Of course, these effects are muted in the endogenous license price scenario.

We report the effects on Bangladesh focusing on the change in its exports. How might Bangladeshi welfare be affected by increases in exports? The average wage in wovens in 2003 is about \$530 per year, while GDP per capita is \$334. The sales to employment ratio is \$4,876 per worker, so an additional \$10,000 of exports creates 2 jobs, with a rent of about \$196 per job, resulting in a welfare gain of \$392 per \$10,000 increase in Bangladeshi exports.

6.1 Documentation Costs, Preferences, and ROOs

The preferences given to Bangladeshi exporters by the EU in the woven industry are costly 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 series of policies in the long run, i.e., when entry has time to occur. Table 7 looks at four policy changes and their effects in the long run (i.e., when entry adjusts). Most of the table deals with the endogenous quota price scenario, though the last few rows describe the key outcomes for the exogenous quota price scenarios.

Column 1 describes the outcome under the status quo. Column 2 looks at the effect of eliminating preferences. This involves making the tariff in the EU 12% for all Bangladeshi firms.[35] Column 3 shows the effects of doubling documentation costs. Column 4 captures the effect of policies, like regional cumulation,[36] which make ROOs less costly to meet. To approximate this, we make ROOs costless to meet in terms of marginal production costs in wovens.[37] Finally, Column 5 gives the effect of removing the documentation costs *and* the marginal cost of meeting ROOs.

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 cross-market effects that are particularly pronounced when the quota price is fixed. This emphasizes the role of existing quotas in limiting the efficacy of trade liberalization elsewhere. A more liberal policy in the EU results in a greater mass of entrants into the industry, which raises Bangladeshi

[35] In calculating welfare changes, we add the net increase in tariff revenues from Bangladeshi and from non-Bangladeshi firms as predicted by the model. Details of the calculations are available on request.

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

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

exporters' share in the US market and reduces the price index there. Quotas in the US blunt such effects reducing the impact of unilateral liberalization on the part of the EU.

An important thing to note in Tables 7 is that despite ROOs being costly to meet, the 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. If the quota price is fixed, entry falls, EU imports from Bangladesh fall from $482 million to $262 million as do US imports from $233.6 million to $136 million, highlighting the cross-market effects of the EU policies. When quota prices are endogenous, the fall in entry reduces the US quota price so that the fall in entry is lower than in the exogenous quota price scenario. As a result, EU imports fall by less, to only $330 million. US imports fall as well (to $206 million), and the quota becomes non-binding.

Doubling documentation costs (Column 3 of Table 7) also reduces EU imports (to $475 million, -1.5%) and US imports (to $233.4 million, -0.1%) in the endogenous quota price case. Note this is a far smaller effect than the removal of preferences. With exogenous quota prices, the exit induced is larger so that the fall in EU and US exports is more pronounced than when the quota price adjusts. The reason why raising documentation costs by a factor of two has a relatively small effect is that these have a limited effect on entry and operate through their effect on marginal firms choosing to use ROOs. Their impact is, thus, limited. Policies that affect marginal costs (like removal of preferences, as in Column 2, or reducing the cost of meeting preferences, as in Column 4) affect entry to a greater extent, and hence, firms of all types, and tend to have more bang than ones that affect only marginal firms.

When the home yarn requirement is removed as in Column 4 so that preferences are not costly to obtain, both EU and US imports rise. The model suggests this would result in exports to the EU of $565 million (+17.1%) and to the US of $236.1 million (+1.1%) when the quota price adjusts, and by 22.7% and 14.3% when the quota price is fixed.[38]

Finally, when both the marginal and fixed costs of meeting ROOs are removed (Column 5), the effects are slightly more pronounced: with endogenous (exogenous) quota prices, exports rise by 19% (25.5%) and 1.2% (16.1%) to the EU and US, respectively.

[38] In 2011, the EU changed its ROOs to require only one stage of processing to occur in the exporting country to obtain origin.

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

	Baseline	No preferences	Higher doc. costs	No home yarn req.	Costless pref.
Tariff in EU ($t_{BD,EU}$)	12%	*12%*	*12%*	*12%*	**0%**
Tariff in EU, ROO ($t^{ROO}_{BD,EU}$)	0%	**12%**	*0%*	*0%*	*0%*
Tariff in US ($t_{BD,US}$)	20%	*20%*	*20%*	*20%*	*20%*
Cost disadvantage (α)	0.85	**1.00**	*0.85*	**1.00**	**1.00**
Documentation costs (d^{EU}/f)	0.66	**0.00**	**1.32**	*0.66*	**0.00**
		Endogenous quota price case			
		Change in quota price in US, %			
Change in quota price in US	0.070	-100%	-5.7%	+43.4%	+49.3%
		Change in Bangladeshi exports, %			
EU imports from Bangladesh	482.3m	-31.7%	-1.5%	+17.1%	+19.0%
US imports from Bangladesh	233.6m	-11.9%	-0.1%	+1.1%	+1.2%
		Change in mass of entrants, %			
Implied mass of entrants	4,712	-22.3%	-0.7%	+5.8%	+6.6%
		Change in productivity cutoffs, %			
Productivity cutoff in EU	0.8508	+15.9%	+0.91%	-6.06%	-7.42%
Productivity cutoff in US	1.0355	-6.8%	-0.34%	+2.61%	+2.97%
		Change in demand shock cutoffs, %			
Demand shock cutoff in EU	0.1866	-10.24%	-0.59%	+5.55%	-10.24%
Demand shock cutoff in US	6.9570	0.00	0.00	0.00	0.00
		Share of firms invoking ROO, %			
Share of ROO firms (model)	70.2%	0%	57.0%	77.7%	100%
		Change in EU and US price indices, %			
Price index in EU	100%	+19.1%	+0.87%	-9.38%	-10.41%
Price index in US	100%	+1.1%	+0.01%	-0.10%	-0.11%
		Change in tariff revenues, %			
Tariff revenue in EU	447k	+8,742%	+125.9%	-34.2%	-100%
Tariff revenue in US	46,728k	-11.9%	-0.1%	+1.1%	+1.2%
		Change in welfare, $			
Change in welfare in EU ($)	—	-480,935k	-25,208k	293,418k	327,162k
Change in welfare in US ($)	—	-68,538k	-709k	6,191k	6,964k
		Exogenous quota price case			
		Change in Bangladeshi exports, %			
EU imports from Bangladesh	482.3m	-45.5%	-2.24%	+22.7%	+25.5%
US imports from Bangladesh	233.6m	-41.6%	-1.94%	+14.3%	+16.1%
		Change in EU and US price indices, %			
Price index in EU	100%	+28.15%	+1.28%	-12.39%	-13.8%
Price index in US	100%	+3.84%	+0.18%	-1.30%	-1.5%
		Change in mass of entrants, %			
Implied mass of entrants	4,712	-45.5%	-2.3%	+16.9%	+19.0%
		Change in welfare, $			
Change in welfare in EU ($)	—	-707,594k	-37,343k	393,918k	441,279k
Change in welfare in US ($)	—	-238,328k	-11,193k	82,661k	92,933k

When exporting becomes less promising, the direct effect on profits in the EU is negative, which raises the productivity cutoff there. However, there is a fall in entry of Bangladeshi firms that raises the price index in both the US and EU (as evident in Table 7), making profits swing upwards, which, in turn, acts to reduce the cutoff productivity. The former effect dominates in the EU, while in the US, only the latter operates so that the cutoff falls.

Giving preferences results in substantial effects (both in the US and EU), even when there are restrictive ROOs, compared to back of the envelope calculations that ignore the role of entry like Mattoo et al. (2003). Our numbers for effects on trade and welfare below are larger because entry does most of the heavy lifting in such experiments. It is also worth emphasizing that when the quota price is endogenous, the effects are qualitatively similar, but muted, suggesting that quotas maintained by the US may have significantly hindered the ability of the EU to help Bangladeshi exports. At the same time, since US quotas are product and country specific, they insulate Bangladesh from competition by others.

6.1.2 Long Run Welfare Consequences

What about welfare effects of these policies? There are two main channels through which policy regarding Bangladesh affects 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 through the number of Bangladeshi exporters who pay a tariff and through the volume of their sales. In addition, policy changes affect the EU price index. In particular,

$$P_{EU} = \left[(P_{BD,EU})^{1-\sigma_{EU}} + \sum_{i \in \Omega_{(-BD),EU}} [P_{i,EU}]^{1-\sigma_{EU}} \right]^{\frac{1}{1-\sigma_{EU}}}, \quad (14)$$

where $\sum_{i \in \Omega_{(-BD),EU}} [P_{i,EU}]^{1-\sigma_{EU}} = \bar{P}_{-BD,EU}$. Recall that $\bar{P}_{-BD,EU}$ 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 effect on tariff revenue and the percentage change in the price index are reported in Table 7.

When the quota price adjusts (does not adjust) removing preferences given to Bangladesh by the EU decreases EU welfare by roughly \$481 (\$708) million dollars. Thus, it giving preferences is in the EU's own narrow self interest. The removal of preferences reduces ex-ante profits and, hence, entry. This reduction in the mass of entrants results in a large fall in exports to both the EU and US, with a consequent fall in consumer surplus and tariff revenue. Removing EU preferences reduces US welfare by about \$69 million when quota prices adjust and by \$238 million when they do not. Thus, there are positive spillovers to the US of the EU liberalization, and negative spillovers of the US quota on the EU.

When documentation costs are raised, ex-ante profits fall as does the mass of entry. This raises prices, which acts to reduce surplus, but as fewer firms invoke ROOs, tariff revenues increase, raising welfare. The former effect dominates when the quota price adjusts so that welfare in the EU falls by about 25 million dollars, while welfare in the US decreases by about 0.7 million dollars. Finally, removing the home yarn requirement raises ex-ante profits, and, hence, entry, with consequent increases in surplus and tariff revenue. Note that welfare rises in both the US and EU by 293 million and 6 million dollars, respectively. Removing the documentation costs as well in Column 5 raises welfare even more. As expected, all effects are larger when the quota price is exogenous as can be seen in Table 7.

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.

Preferences and Documentation Costs Before we begin, note that as defined, the price charged, $p_j(\phi)$, is the price consumers pay. Firms give part of what consumers pay to the government. In the short run, without preferences $p_j(\phi) = \frac{1}{\rho(1 - t_{ij})\phi}$ while with preferences it is $\frac{1}{\rho\alpha\phi}$. Since tariffs are 12%, $((1 - t_{ij}) = .88)$, while the cost disadvantage is 15% $(\alpha = .85)$, the price paid by consumers falls when preferences are removed! This is what lies behind the fall in the price index when preferences are removed. It also raises the sales of Bangladeshi firms and their share in EU imports but reduces the revenues after tariffs which results in exit in the long run.[39] Tariff revenues rise quite considerably in the short run, but this will only be temporary. Note that the welfare effects in the short run are the opposite of those in the long run as we have turned off the main channel, namely, entry/exit.

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

	Baseline	No preferences	Higher doc. costs	No home yarn req.	Costless pref.
Tariff in EU ($t_{BD,EU}$)	12%	*12%*	*12%*	*12%*	**0%**
Tariff in EU, ROO ($t^{ROO}_{BD,EU}$)	0%	**12%**	*0%*	*0%*	*0%*
Cost disadvantage (α)	0.85	**1.00**	*0.85*	**1.00**	**1.00**
Relative doc. costs (d^{EU}/f)	0.66	**0.00**	**1.32**	*0.66*	**0.00**
		Change in mass of firms, %			
Mass of successful exporters to EU	485	0.00%	0.00%	-0.21%	-0.21%
		Change in demand shock cutoff, %			
Demand shock cutoff in EU	0.1866	+0.37%	0.00	+0.37%	+0.37%
		Change in price index in EU, %			
Aggregate price index in EU	100%	-1.63%	-1.09%	-3.67%	-3.68%
		Change in tariff revenues collected, %			
Tariff revenues in EU	447k	+12,964%	+130%	-43.0%	-100%
		Change in Bangladeshi exports			
Bangladeshi exports, $R_{BD,EU}$	482.3m	+0.97%	+0.01%	+4.64%	+4.65%
		Change in revenues of Bangladeshi firms			
Revenue of Bangladeshi firms	481.8m	-11.06%	-0.11%	+4.68%	+4.75%
		Change in welfare			
Change in welfare in EU ($)	—	*107,433k*	*33,712k*	*111,610k*	*111,627k*

Documentation costs do not affect marginal costs but make some firms choose not to meet ROOs. As not meeting ROOs reduces cost and price, the overall price index falls slightly. As a result, Bangladeshi sales rise, though their revenues (net of tariffs) fall.

With no home yarn requirement, more firms meet ROOs and as there is no marginal cost disadvantage associated with doing so, their prices fall. As a result, the price index falls. Their sales rise as do their revenues. With costless preferences, there is an additional effect as all firms meet ROOs. In all the experiments, welfare in the EU rises. In Columns 2 and 3 of Table 8, the driving forces are a rise in consumer surplus and tariff revenues, while in Columns 4 and 5 welfare rises despite a fall in tariff revenues.

It is worth emphasizing the difference in the long run export effects (both in the US and EU) of preferences, even when there are restrictive ROOs, and the short run ones in Table

[39] Of course, as entry is fixed, there are no effects on the US market so we ignore it for the time being.

8. Back of the envelope calculations that ignore the role of entry like Mattoo et al. (2003) as well as more sophisticated calculations based on models with the fixed mass of entrants[40], could easily underestimate these long run effects, or even get the effect on welfare reversed.

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 ($1,500,000) of a subsidy to different kinds of fixed costs. In this, it follows Das, Roberts and Tybout (2007). The results suggest the export effects vary considerably depending on where the subsidy is applied. A policy maker wanting to raise exports would get up to a $25 ($81) increase in export revenue for every dollar spent reducing fixed costs when the quota price is endogenous (exogenous). In general, applying the subsidy at a later stage so that it is not wasted on firms that end up exiting produces greater results. Thus, subsidies to market entry are the least efficient (with $.4 increase in exports per dollar spent), while compensating fixed costs of production raises exports the most (by $24.8 per dollar spent). Also, subsidizing market entry costs for markets, where the market share is lower, gives more leverage as firms can "steal" business from a greater fraction of competitors. Thus, subsidizing US entry with the Bangladeshi market share around 4% gives $11.4 per dollar spent, while doing the same for the EU with Bangladeshi market share around 16% gives only $5.5.

We also find that cross market effects are large: if the EU market entry is subsidized, the US exports (and tariff revenue) rise but only when the quota price is exogenous. As expected, these effects are much more muted when the quota price is endogenous. Thus, policies have large cross market effects, though quotas dilute these effects considerably.

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.

[40] Recall this assumption is made in Eaton, Kortum and Kramarz (2011) and Chaney (2008).

Table 9. Fixed costs compensation: Government spends \$1.5 million (±2%).

	Baseline case	Industry entry costs	EU market entry costs	US market entry costs	Documentation costs	Fixed Costs
\$ compensation per firm / entrant	—	318	1,826	2,328	3,192	2,117
		Endogenous quota price case				
		Change in quota price in US, %				
Quota price in the US		+1.43%	+3.67%	+61.3%	+2.85%	+98.6%
		Change in Bangladeshi exports,%				
EU imports from Bangladesh	482.3m	+0.11%	+1.68%	+1.30%	+1.37%	+6.54%
US imports from Bangladesh	233.6m	+0.04%	+0.08%	+5.78%	+0.06%	+3.19%
		Change in mass of firms,%				
Implied mass of entrants into industry	4712	+0.22%	+0.47%	+2.62%	+0.39%	+12.34%
		Change in productivity cutoffs, %				
Productivity cutoff for EU	0.8508	+0.06%	-1.16%	+0.74%	-0.95%	+3.25%
Productivity cutoff for US	1.0355	+0.09%	+0.22%	-3.52%	+0.17%	+4.37%
		Change in demand shock cutoffs, %				
Demand shock cutoff in EU	0.1856	0.00%	+0.72%	0.00%	+0.58%	-32.9%
Demand shock cutoff in US	6.9570	0.00%	0.00%	+3.48%	0.00%	-32.6%
		Share of firms invoking ROOs, %				
Share of ROOs firms (model)	70.2%	70.2%	70.2%	70.2%	95.4%	58.6%
		Change in tariff revenues, %				
Tariff revenue in EU	447k	+0.12%	+2.14%	+1.49%	-93.14%	+86.26%
Tariff revenue in US	46,728k	+0.04%	+0.08%	+5.78%	+0.06%	+3.19%
		Change in EU and US price indices, %				
Price index in EU	100%	-0.06%	-0.95%	-0.74%	-0.78%	-3.67%
Price index in US	100%	-0.004%	-0.01%	-0.53%	-0.01%	-0.29%
		Change in welfare, \$				
Change in welfare in EU (\$)	—	*1,887k*	*28,533k*	*22,077k*	*22,782k*	*111,733k*
Change in welfare in US (\$)	—	*241.3k*	*456.6k*	*33,409k*	*367.6k*	*18,403k*
		Policy efficiency (dollars of extra net exports per dollar of subsidy)				
Policy efficiency	—	0.4	5.5	11.4	4.8	24.8
		Exogenous quota price case				
\$ compensation per firm / entrant		317	1,820	2,001	3,185	1,912
		Change in Bangladeshi exports, %				
EU imports from Bangladesh	482.3m	+0.28%	+2.07%	+8.59%	+1.76%	+14.69%
US imports from Bangladesh	233.6m	+0.46%	+1.04%	+23.6%	+0.95%	+27.75%
		Change in EU and US price indices, %				
Price index in EU	100%	-0.16%	-1.17%	-4.80%	-1.00%	-8.12%
Price index in US	100%	-0.04%	-0.10%	-2.14%	-0.09%	-2.50%
		Change in welfare, \$				
Change in welfare in EU (\$)	—	*4,808k*	*35,173k*	*146,585k*	*29,402k*	*252,637k*
Change in welfare in US (\$)	—	*2,643k*	*6,019k*	*136,785k*	*5,497k*	*159,761k*
		Policy efficiency (dollars of extra net exports per dollar of subsidy)				
Policy efficiency	—	1.5	8.3	57.1	7.1	81.2

When subsidies attract firms into the industry, these entrants export not just to the EU, but wherever they have a good demand shock. This is in contrast to what happens in simple competitive settings, where the EU preferences given to Bangladesh would raise exports to the EU but reduce them to the US. Third, due to demand shocks, the marginal and average firms are large. Without shocks, variable profits of the marginal firm just cover its fixed costs of production. With demand shocks, this is true only at the cutoff demand shock for each firm in the economy. Hence, at all demand shocks above the cutoff one, the firm with the cutoff productivity has higher profits and sales than it needs to produce. Thus, the marginal and average firms tend to be larger in the presence of demand shocks. This also helps explain why exports rise greatly with rising mass of firms. Finally, we look at small interventions. The efficacy of the intervention declines with its size as marginal returns fall.

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 changes in cutoffs (the extensive margin via cutoffs), and how much is due to the entry of firms (the extensive margin via entry).

Let total exports be X. Let x denote the exports of an 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 changes of exports per firm. The change in total exports can (by adding and subtracting the relevant terms) be decomposed as follows:

$$
\begin{aligned}
& X(M_1^e, \phi_1, v_1, x_1) - X(M_0^e, \phi_0, v_0, x_0) \\
= \; & [X(M_0^e, \phi_0, v_0, x_1) - X(M_0^e, \phi_0, v_0, x_0)] \quad \text{(Intensive Margin)} \qquad (15) \\
& + [X(M_0^e, \phi_0, v_1, x_1) - X(M_0^e, \phi_0, v_0, x_1) \quad \text{(Extensive Margin} \qquad (16) \\
& + X(M_0^e, \phi_1, v_1, x_1) - X(M_0^e, \phi_0, v_1, x_1)] \quad \text{via Cutoffs;} \qquad (17) \\
& + [X(M_1^e, \phi_1, v_1, x_1) - X(M_0^e, \phi_1, v_1, x_1)] \quad \text{via Entry),} \qquad (18)
\end{aligned}
$$

where $X(M_1^e, \phi_1, v_1, x_1)$ denotes total exports when M_1^e mass of firms enter, the productivity and demand shock cutoffs are those in period 1, and the output per firm corresponds to that in period 1. Similarly, $X(M_0^e, \phi_0, v_1, x_1)$ denotes total exports when M_0^e mass of firms enter, the productivity cutoffs for entry and for each market are that in period 0, while the demand shock cutoffs in each market for each productivity correspond to those in period 1.

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 and this lowers the aggregate price index. This force works to *reduce* an existing firm's exports at any given price, which 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 tend to be small. For example, when quotas are exogenous, new entrants drive over 78% of the increase in exports.

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 other exporters to steal consumers away from) and when σ is low so that firms make room for themselves in the market since they produce unique products. 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

What is the relation between the estimated low values of σ and the predominance of the entry channel we find? Krugman (1980) predicts that in a homogeneous firm setup, low σ makes demand inelastic, *reducing* the impact of trade barriers on trade flows. In other words, the effect of trade barriers via the *intensive* margin is *weak* when substitution is limited.

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

However, Chaney (2008) (and for that matter, Eaton, Kortum and Kramarz (2011)) assumes the mass of entrants 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 product space. Thus, trade barriers which shift ex-ante profits will have a large effect on entry and trade flows. Hence, both cutoff and entry margins are more powerful when σ is low.

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

7 Conclusion

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

The policy implications inherent in our counterfactual simulations are quite provocative. We think of these as making a case for "trade as aid." Recently, there have been serious doubts cast on the efficacy of direct aid. It may be diverted to the pockets of those in power or used ineffectively. Giving aid and having it be effective in terms of growth or a reduction in poverty are two very different things. For example, governments may cut back their own support for the poor as aid grows. In contrast, "trade aid" works through market forces. For example, in our application, preferences given by the EU are responsible for a huge increase in export flows from Bangladesh to the EU *and* to the US, rather than diverting trade away from the US market to the EU one if there had been no US quotas (exogenous quota price). 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 but this effect is sharply attenuated by the presence of quotas in other importing countries.

Our counterfactuals also suggest where subsidies might be the most effective in increasing exports. The rule seems to be to subsidize late in the process so that subsidies are not wasted on failed firms and to subsidize where existing market share is low so that there is more room to poach from foreign competitors.

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

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

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8 Appendix

This Appendix contains the detailed derivations of the equilibrium conditions for the model described in the paper as well as the way of solving the model numerically. As usual, the model is solved backwards. We begin with Stage 3.

8.1 Model Derivations

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. (Recall that we assume that documentation costs are zero in the US and that as only assembly is required for origin, meeting ROOs is costless so $\alpha = 1$.) They have to pay the tariff of 20%. As a result, the firm sells quantity

$$q_{BD,US}\left(p_{BD,US}, v\right) = v\left[\frac{p_{BD,US}}{P_{BD,US}}\right]^{-\sigma_{US}} \frac{R_{BD,US}}{P_{BD,US}}, \quad p_{BD,US} = \frac{1}{\left(1 - t_{BD,US}\right)} \frac{\tau_{BD,US} + \mu}{\rho_{US}\phi}, \tag{19}$$

and earns the following revenues and profits:

$$r_{BD,US}\left(\phi, v\right) = \left(1 - t_{BD,US}\right) v R_{BD,US} \left(P_{BD,US}\right)^{\sigma_{US}-1} \left[\frac{1}{\left(1 - t_{BD,US}\right)} \frac{\tau_{BD,US} + \mu}{\rho_{US}\phi}\right]^{1-\sigma_{US}}, \tag{20}$$

$$\pi_{BD,US}\left(\phi, v\right) = r_{BD,US}\left(\phi, v\right) / \sigma_{US} - f. \tag{21}$$

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

$$\pi_{BD,US}\left(\phi, v\left(\phi, P_{BD,US}\right)\right) = 0, \quad \text{so that from (20),} \tag{22}$$

$$v\left(\phi, P_{BD,US}\right) = \frac{\sigma_{US} f}{\left(1 - t_{BD,US}\right) R_{BD,US} \left(P_{BD,US}\right)^{\sigma_{US}-1}} \left[\frac{1}{1 - t_{BD,US}} \frac{\tau_{BD,US} + \mu}{\rho_{US}\phi}\right]^{\sigma_{US}-1}. \tag{23}$$

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

$$M_{BD,US} = M_E^{BD} \int_{\phi^*_{BD,US}}^{+\infty} \int_{v(\phi, P_{BD,US})}^{+\infty} h_{US}(v) g(\phi) dv d\phi, \tag{24}$$

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

Exporting to the EU When Bangladeshi firms export to the EU, they have an additional choice: invoke 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^{EU} 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 meet EU ROOs.

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

$$\begin{aligned} \pi_{BD,EU}(\phi, v) &= \max_{p_{BD,EU}} \left\{ (1 - t_{BD,EU}) p_{BD,EU} q_{BD,EU}(p_{BD,EU}, v) - \frac{\tau_{BD,EU}}{\phi} q_{BD,EU}(p_{BD,EU}, v) - f \right\}, \\ \pi^{ROO}_{BD,EU}(\phi, v) &= \max_{p^{ROO}_{BD,EU}} \left\{ p^{ROO}_{BD,EU} q_{BD,EU}\left(p^{ROO}_{BD,EU}, v\right) - \frac{\tau_{BD,EU}}{\alpha\phi} q_{BD,EU}\left(p^{ROO}_{BD,EU}, v\right) - \left(f + d^{EU}\right) \right\} \end{aligned} \tag{25}$$

The pricing rule for each type of exporter is $p_{BD,EU} = \frac{1}{1 - t_{BD,EU}} \frac{\tau_{BD,EU}}{\rho_{EU}\phi}$ and $p^{ROO}_{BD,EU} = \frac{\tau_{BD,EU}}{\rho_{EU}\alpha\phi}$. Exporters that do not invoke preferences earn the following revenues and profits:

$$r_{BD,EU}(\phi, v) = (1 - t_{BD,EU}) v R_{BD,EU}(P_{BD,EU})^{\sigma_{EU} - 1} \left[\frac{1}{1 - t_{BD,EU}} \frac{\tau_{BD,EU}}{\rho_{EU}\phi}\right]^{1 - \sigma_{EU}}, \tag{26}$$

$$\pi_{BD,EU}(\phi, v) = \frac{r_{BD,EU}(\phi, v)}{\sigma_{EU}} - f, \tag{27}$$

while exporters that invoke the EU ROOs have

$$\begin{aligned} r^{ROO}_{BD,EU}(\phi, v) &= v R_{BD,EU}(P_{BD,EU})^{\sigma_{EU} - 1} \left[\frac{\tau_{BD,EU}}{\rho_{EU}\alpha\phi}\right]^{1 - \sigma_{EU}}, \\ \pi^{ROO}_{BD,EU}(\phi, v) &= \frac{r^{ROO}_{BD,EU}(\phi, v)}{\sigma_{EU}} - \left(f + d^{EU}\right). \end{aligned} \tag{28}$$

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

$$\pi_{BD,EU}\left(\phi, v\left(\phi, P_{BD,EU}\right)\right) = 0, \tag{29}$$

$$\pi^{ROO}_{BD,EU}\left(\phi, v^{ROO}\left(\phi, P_{BD,EU}\right)\right) - \pi_{BD,EU}\left(\phi, v^{ROO}\left(\phi, P_{BD,EU}\right)\right) = 0, \tag{30}$$

where (30) comes from setting the additional profits from invoking EU ROOs to zero. Thus,

$$v\left(\phi, P_{BD,EU}\right) = \frac{\sigma_{EU} f}{\left(1 - t_{BD,EU}\right) R_{BD,EU}\left(P_{BD,EU}\right)^{\sigma_{EU}-1}} \left[\frac{1}{1 - t_{BD,EU}} \frac{\tau_{BD,EU}}{\rho_{EU}\phi}\right]^{\sigma_{EU}-1}, \tag{31}$$

$$v^{ROO}\left(\phi, P_{BD,EU}\right) = \frac{\sigma_{EU} d^{EU}\left[\frac{\tau_{BD,EU}}{\rho_{EU}\phi}\right]^{\sigma_{EU}-1}}{\left(\alpha^{\sigma_{EU}-1} - \left(1 - t_{BD,EU}\right)^{\sigma_{EU}}\right) R_{BD,EU}\left(P_{BD,EU}\right)^{\sigma_{EU}-1}}, \text{ or} \tag{32}$$

$$v^{ROO}\left(\phi, P_{BD,EU}\right) = C^{ROO} v\left(\phi, P_{BD,EU}\right), \text{ where } C^{ROO} = \frac{d^{EU}}{f\left[\alpha^{\sigma_{EU}-1}\left(1 - t_{BD,EU}\right)^{-\sigma_{EU}} - 1\right]} > 1. \tag{33}$$

Note that from (32) and (33), $v^{ROO}(\phi, P_{BD,EU})$ and $v(\phi, P_{BD,EU})$ are decreasing in ϕ.

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

$$M^{NROO}_{BD,EU} = M^{BD}_E \int_{\phi^*_{BD,EU}}^{+\infty} \int_{v(\phi, P_{BD,EU})}^{v^{ROO}(\phi, P_{BD,EU})} dH_{EU}(v) dG(\phi), \tag{34}$$

$$M^{ROO}_{BD,EU} = M^{BD}_E \int_{\phi^*_{BD,EU}}^{+\infty} \int_{v^{ROO}(\phi, P_{BD,EU})}^{+\infty} dH_{EU}(v) dG(\phi). \tag{35}$$

8.1.2 Stage 2: Market Entry Decision

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

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

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

Thus, the expected profit of entering the US market is

$$E_v\left[\pi_{BD,US}(\phi,v)\right]-f_m^{US} = \int_{v(\phi,P_{BD,US})}^{+\infty}\pi_{BD,US}(\phi,v)\,dH_{US}(v)-f_m^{US} \tag{36}$$
$$= f\int_{v(\phi,P_{BD,US})}^{+\infty}\left[\frac{v}{v(\phi,P_{BD,US})}-1\right]dH_{US}(v)-f_m^{US}.$$

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

$$E_v\left[\pi_{BD,US}\left(\phi^*_{BD,US},v\right)\right]=f_m^{US},\Longleftrightarrow \tag{37}$$
$$\int_{v\left(\phi^*_{BD,US},P_{BD,US}\right)}^{+\infty}\left[\frac{v}{v\left(\phi^*_{BD,US},P_{BD,US}\right)}-1\right]dH_{US}(v)=\frac{f_m^{US}}{f}.$$

Equation (37) is important for several reasons. First, by solving it, we obtain the minimal demand shock for the marginal firm from Bangladesh, $v\left(\phi^*_{BD,US},P_{BD,US}\right)$, which is a key step in the estimation procedure. Second, it shows that this demand shock *does not* depend on the per-unit costs of selling there, only on $\frac{f_m^{US}}{f}$ and the demand shock distribution $H_{US}(v)$. Finally, knowing $v\left(\phi^*_{BD,US},P_{BD,US}\right)$, we can express the expected profits at Stage 2 for *any firm* as a function of its own productivity ϕ and $\phi^*_{BD,US}$. To see this, note that from the definition of $v(\phi, P_{BD,US})$ in equation (23):

$$\frac{v(\phi,P_{BD,US})}{v\left(\phi^*_{BD,US},P_{BD,US}\right)}=\left(\frac{\phi^*_{BD,US}}{\phi}\right)^{\sigma_{US}-1}, \tag{38}$$

$$E_v\left[\pi_{BD,US}(\phi,v)\right]=f\int_{v(\phi,P_{BD,US})}^{+\infty}\left[\frac{v}{v(\phi,P_{BD,US})}-1\right]dH_{US}(v) \tag{39}$$
$$=f\int_{\left(\frac{\phi^*_{BD,US}}{\phi}\right)^{\sigma_{US}-1}v\left(\phi^*_{BD,US},P_{BD,US}\right)}^{+\infty}\left[\frac{v}{\left(\frac{\phi^*_{BD,US}}{\phi}\right)^{\sigma_{US}-1}v\left(\phi^*_{BD,US},P_{BD,US}\right)}-1\right]dH_{US}(v).$$

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

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

$$\pi_{BD,EU}(\phi, v) = f\left[\frac{v}{v(\phi, P_{BD,EU})} - 1\right], \tag{40}$$

$$\pi^{ROO}_{BD,EU}(\phi, v) - \pi_{BD,EU}(\phi, v) = d^{EU}\left[\frac{v}{v^{ROO}(\phi, P_{BD,EU})} - 1\right]. \tag{41}$$

Thus, the expected profit of entering the EU market is

$$\begin{aligned} & E_v\left[\max\left\{\pi_{BD,EU}(\phi, v), \pi^{ROO}_{BD,EU}(\phi, v)\right\}\right] - f^{EU}_m \qquad (42) \\ = & \int_{v(\phi, P_{BD,EU})}^{v^{ROO}(\phi, P_{BD,EU})} \pi_{BD,EU}(\phi, v)\, dH_{EU}(v) + \int_{v^{ROO}(\phi, P_{BD,EU})}^{+\infty} \pi^{ROO}_{BD,EU}(\phi, v)\, dH_{EU}(v) - f^{EU}_m \\ = & \int_{v(\phi, P_{BD,EU})}^{+\infty} \pi_{BD,EU}(\phi, v)\, dH_{EU}(v) \\ & + \int_{v^{ROO}(\phi, P_{BD,EU})}^{+\infty} \left[\pi^{ROO}_{BD,EU}(\phi, v) - \pi_{BD,EU}(\phi, v)\right] dH_{EU}(v) - f^{EU}_m \\ = & f \int_{v(\phi, P_{BD,EU})}^{+\infty} \left[\frac{v}{v(\phi, P_{BD,EU})} - 1\right] dH_{EU}(v) \\ & + d^{EU} \int_{v^{ROO}(\phi, P_{BD,EU})}^{+\infty} \left[\frac{v}{v^{ROO}(\phi, P_{BD,EU})} - 1\right] dH_{EU}(v) - f^{EU}_m. \end{aligned}$$

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

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

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

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

$$E_v\left[\max\left\{\pi_{BD,EU}\left(\phi^*_{BD,EU}, v\right), \pi^{ROO}_{BD,EU}\left(\phi^*_{BD,EU}, v\right)\right\}\right] = f^{EU}_m, \quad \text{or}$$

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

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

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

$$v(\phi, P_{BD,EU}) = \left(\frac{\phi^*_{BD,EU}}{\phi}\right)^{\sigma_{EU}-1} v\left(\phi^*_{BD,EU}, P_{BD,EU}\right), \tag{44}$$

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

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

$$E_v\left[\pi^{ROO}_{BD,EU}(\phi, v) - \pi_{BD,EU}(\phi, v)\right] \tag{45}$$
$$= d^{EU}\int_{\left(\frac{\phi^*_{BD,EU}}{\phi}\right)^{\sigma_{EU}-1} v^{ROO}\left(\phi^*_{BD,EU}, P_{BD,EU}\right)}^{+\infty}\left[\frac{v}{\left(\frac{\phi^*_{BD,EU}}{\phi}\right)^{\sigma_{EU}-1} v^{ROO}\left(\phi^*_{BD,EU}, P_{BD,EU}\right)} - 1\right] dH_{EU}(v),$$

where, from the analysis above,

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

For our estimation exercise, we use the analysis of Stage 2 with the data available to calculate $\phi^*_{BD,US}$ and $\phi^*_{BD,EU}$. Using (22) together with (20) and (21),

$$\phi^*_{BD,US} = \left[v\left(\phi^*_{BD,US}, P_{BD,US}\right) \frac{(1 - t_{BD,US})\, R_{BD,US}\, (P_{BD,US})^{\sigma_{US}-1}}{f\sigma_{US}} \right]^{\frac{1}{1-\sigma_{US}}} \frac{\tau_{BD,US}+\mu}{(1-t_{BD,US})\,\rho_{US}}. \tag{47}$$

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

$$\phi^*_{BD,EU} = \left[v\left(\phi^*_{BD,EU}, P_{BD,EU}\right) \frac{(1 - t_{BD,EU})\, R_{BD,EU}\, (P_{BD,EU})^{\sigma_{EU}-1}}{\sigma_{EU} f} \right]^{\frac{1}{1-\sigma_{EU}}} \frac{\tau_{BD,EU}}{(1-t_{BD,EU})\,\alpha\rho_{EU}}. \tag{48}$$

8.1.3 Stage 1: Entering the Industry

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

$$\begin{aligned} & E_\phi \left[\max\left\{E_v\left[\pi_{BD,US}(\phi,v)\right] - f_m^{US}, 0\right\}\right] \\ & + E_\phi \left[\max\left\{E_v\left[\max\left(\pi_{BD,EU}(\phi,v), \pi^{ROO}_{BD,EU}(\phi,v)\right)\right] - f_m^{EU}, 0\right\}\right] = f_e. \end{aligned} \tag{49}$$

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

$$\begin{aligned} & \int_{\phi^*_{BD,US}}^{+\infty} \left[\int_{\left(\frac{\phi^*_{BD,US}}{\phi}\right)^{\sigma_{US}-1} v\left(\phi^*_{BD,US}, P_{BD,US}\right)}^{+\infty} \left[\frac{v}{\left(\frac{\phi^*_{BD,US}}{\phi}\right)^{\sigma_{US}-1} v\left(\phi^*_{BD,US}, P_{BD,US}\right)} - 1 \right] dH_{US}(v) \right. \\ & \left. - \frac{f_m^{US}}{f} \right] dG(\phi) \\ & + \int_{\phi^*_{BD,EU}}^{+\infty} \left\{ \int_{v\left(\phi, P_{BD,EU}\right)}^{+\infty} \left[\frac{v}{v\left(\phi, P_{BD,EU}\right)} - 1 \right] dH_{EU}(v) \right. \\ & \left. + \frac{d^{EU}}{f} \int_{v^{ROO}\left(\phi, P_{BD,EU}\right)}^{+\infty} \left[\frac{v}{v^{ROO}\left(\phi, P_{BD,EU}\right)} - 1 \right] dH_{EU}(v) - \frac{f_m^{EU}}{f} \right\} dG(\phi) = \frac{f_e}{f}. \end{aligned} \tag{50}$$

8.2 Solving the Model Numerically

Given 13 guessed parameters, how can we solve the model? Take the expression for ex-ante profits from entering EU market, given by equation (43):

$$\int_{v\left(\phi^*_{BD,EU},P_{BD,EU}\right)}^{+\infty}\left[\frac{v}{v\left(\phi^*_{BD,EU},P_{BD,EU}\right)}-1\right]dH_{EU}\left(v\right)$$
$$+\frac{d^{EU}}{f}\int_{C^{ROO}v\left(\phi^*_{BD,EU},P_{BD,EU}\right)}^{+\infty}\left[\frac{v}{C^{ROO}v\left(\phi^*_{BD,EU},P_{BD,EU}\right)}-1\right]dH_{EU}\left(v\right)=\frac{f_m^{EU}}{f}. \tag{51}$$

Note that the LHS depends only on the cutoff demand shock for the marginal firm, $v\left(\phi^*_{BD,EU},P_{BD,EU}\right)$, (think of this as a number), while the RHS equals one of the parameters we have set. Similarly, if ROOs must be met for the US market, we have (see equation (37)):

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

Thus, for fixed values of the eleven parameters, equation (51) is a nonlinear equation in only one unknown, $v(\phi^*_{BD,EU},P_{BD,EU})$. Similarly, equation (52) is a nonlinear equation in only one unknown, $v(\phi^*_{BD,US},P_{BD,US})$. Each has at most one solution as the LHS is a decreasing function in $v(\phi^*_{BD,j},P_{BD,j})$. As shown in (44) and (38), $v\left(\phi_{BD,j},P_{BD,j}\right)=\left(\frac{\phi^*_{BD,j}}{\phi}\right)^{\sigma_j-1}v\left(\phi^*_{BD,j},P_{BD,j}\right)$ so that $v\left(\phi_{BD,j},P_{BD,j}\right)$ can now be written as a function of only $\phi^*_{BD,j}$ and ϕ. This is the key in what follows.

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

The first relation between productivity cutoffs: The price index of exporters from Bangladesh to the EU (where some firms meet ROOs and others do not) is given by

$$\begin{aligned}(P_{BD,EU})^{1-\sigma_{EU}} &= M_E^{BD}\int_{\phi^*_{BD,EU}}^{+\infty}\int_{v(\phi,P_{BD,EU})}^{v^{ROO}(\phi,P_{BD,EU})}vp_{BD,EU}(\phi)^{1-\sigma_{EU}}h_{EU}(v)g(\phi)dvd\phi\\ &\quad+M_E^{BD}\int_{\phi^*_{BD,EU}}^{+\infty}\int_{v^{ROO}\left(\phi,P_{BD,EU}\right)}^{+\infty}vp^{ROO}_{BD,EU}(\phi)^{1-\sigma_{EU}}h_{EU}(v)g(\phi)dvd\phi\\ &\equiv M_E^{BD}D(\phi^*_{BD,EU}),\end{aligned} \tag{53}$$

where M_E^{BD} is the mass of entrants in Bangladesh. Similarly, the price index of exporters from Bangladesh to the US (where everyone has to meet ROOs to obtain origin) is given by

$$
\begin{aligned}
(P_{BD,US})^{1-\sigma_{US}} &= M_E^{BD}\int_{\phi^*_{BD,US}}^{+\infty}\int_{\upsilon(\phi,P_{BD,US})}^{+\infty}\upsilon p_{BD,US}(\phi)^{1-\sigma_{US}}h_{US}(\upsilon)g(\phi)d\upsilon d\phi \\
&\equiv M_E^{BD}D(\phi^*_{BD,US}).
\end{aligned} \tag{54}
$$

Recall that $D(\phi^*_{BD,j})$ does not depend on $P_{BD,j}$ as we solved for $\upsilon(\phi, P_{BD,j})$ in terms of $\phi^*_{BD,j}/\phi$ and $\upsilon\left(\phi^*_{BD,j}, P_{BD,j}\right)$. Thus, from (54) and (53), the ratio of the price indices is just:

$$
\frac{(P_{BD,EU})^{1-\sigma_{EU}}}{(P_{BD,US})^{1-\sigma_{US}}} = \frac{D(\phi^*_{BD,EU})}{D(\phi^*_{BD,US})}. \tag{55}
$$

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

From the model, we also know that the ratio of the price indices is defined by two zero profit conditions (see equations (23) and (31)) so that:

$$
\frac{(P_{BD,EU})^{1-\sigma_{EU}}}{(P_{BD,US})^{1-\sigma_{US}}} = \frac{(1-t_{BD,EU})\,\upsilon\left(\phi^*_{BD,EU}, P_{BD,EU}\right)\frac{\sigma_{US}}{R_{BD,US}}\left(\frac{\tau_{BD,EU}}{(1-t_{BD,EU})\rho_{EU}}\right)^{1-\sigma_{EU}}}{(1-t_{BD,US})\,\upsilon\left(\phi^*_{BD,US}, P_{BD,US}\right)\frac{\sigma_{EU}}{R_{BD,EU}}\left(\frac{\tau_{BD,US}+\mu}{(1-t_{BD,US})\rho_{US}}\right)^{1-\sigma_{US}}}\left(\frac{\left(\phi^*_{BD,EU}\right)^{\sigma_{EU}-1}}{\left(\phi^*_{BD,US}\right)^{\sigma_{US}-1}}\right). \tag{56}
$$

Again, $\upsilon(\phi^*_{BD,j}, P_{BD,j})$ is solved for. Then the RHS is a function of the cutoffs alone. Equating the RHS of (55) and (56) gives one equation in 2 unknowns, $\phi^*_{BD,EU}$ and $\phi^*_{BD,US}$:

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

$R_{BD,US}$ and $R_{BD,EU}$ are approximated by total Bangladeshi exports of wovens to the US and EU. Also, since $\left(\phi^*_{BD,j}\right)^{1-\sigma_j}D(\phi^*_{BD,j})$ falls with $\phi^*_{BD,j}$, this equation gives a negative relation between $\phi^*_{BD,EU}$ and $\phi^*_{BD,US}$.

The second relation between productivity cutoffs: The second equation we use is the free entry condition (50). It gives a negative relation between $\phi^*_{BD,EU}$ and $\phi^*_{BD,US}$: if one cutoff rises, the expected profits from that market decline. To keep ex-ante profits constant, the expected profits from the other market must rise, i.e., its productivity cutoff must fall.

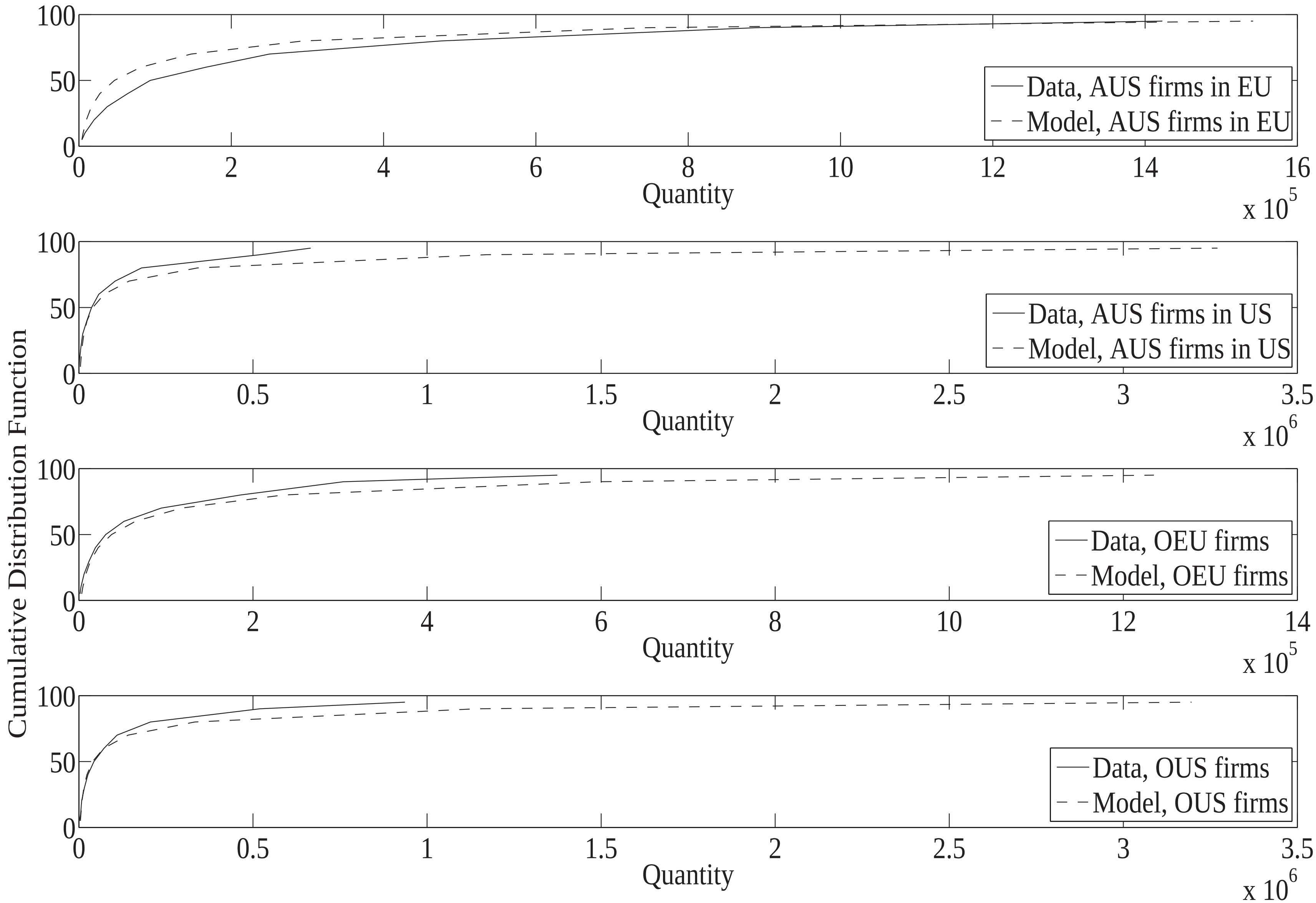

Figure 4: Distributions of Quantities Exported by Firm Type and Market (AUS-EU, AUS-US, OEU, OUS).

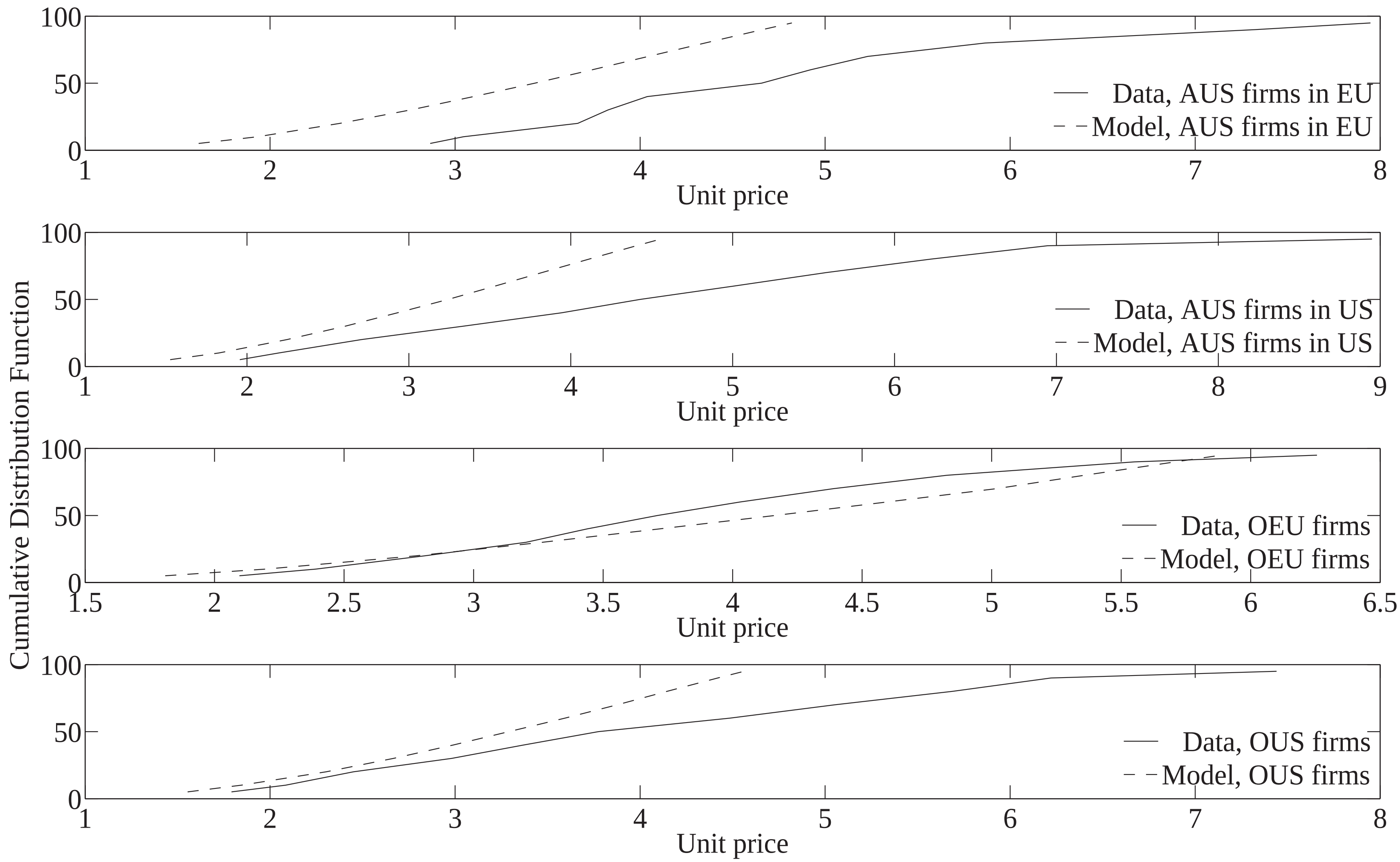

Figure 5: Distributions of Unit Prices by Firm Type and Market (AUS-EU, AUS-US, OEU, OUS).

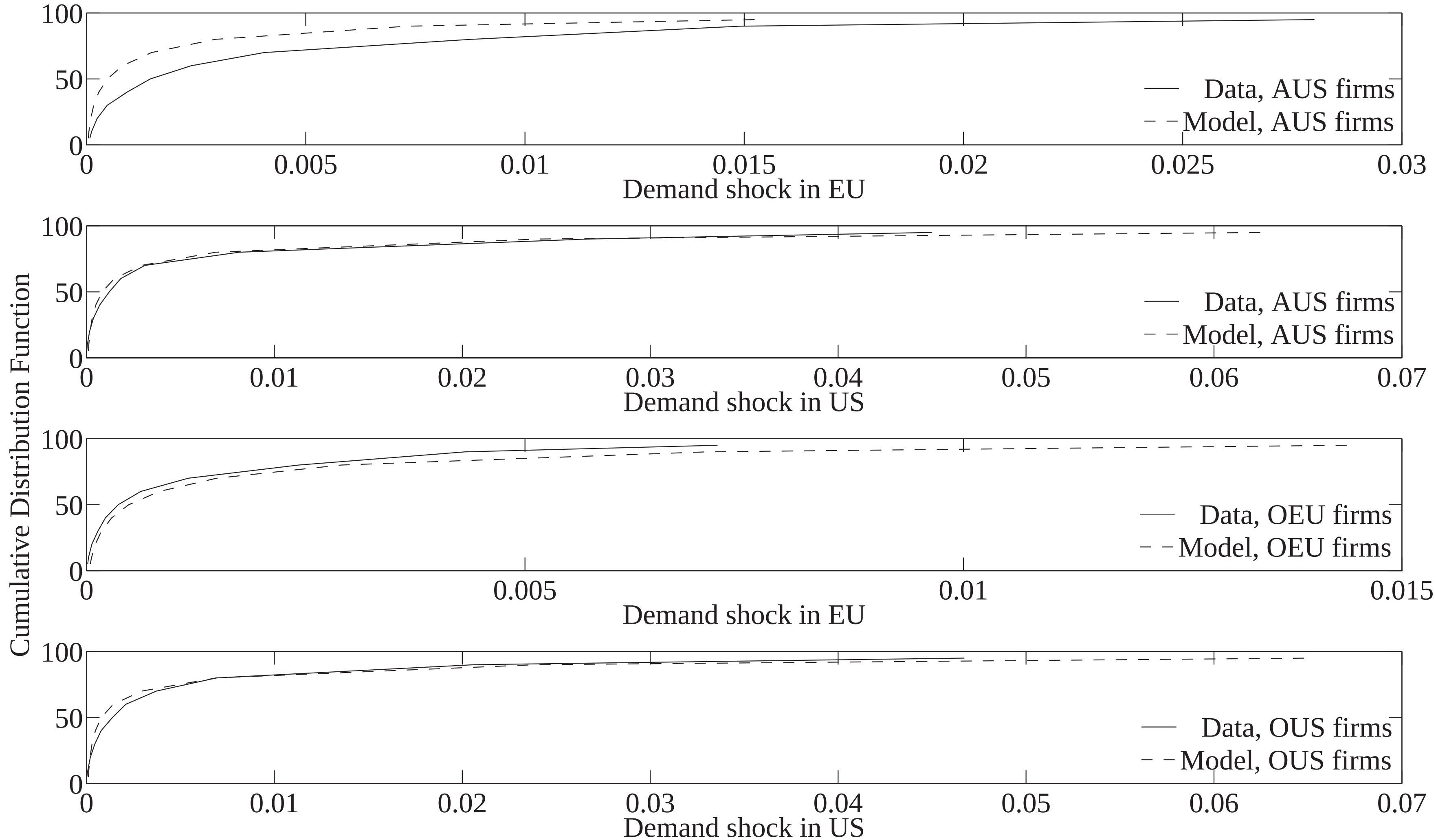

Figure 6: Distributions of Demand Shocks (Normalized by Price Indices) by Firm Type and Market (AUS-EU, AUS-US, OEU, OUS).