NBER WORKING PAPER SERIES

# FIRM LEVEL HETEROGENEOUS PRODUCTIVITY AND DEMAND SHOCKS: EVIDENCE FROM BANGLADESH

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Working Paper 13698
http://www.nber.org/papers/w13698

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
December 2007

We are grateful to Jonathan Eaton, Caroline Freund, Bernard Hoekman, James Harrigan, Susumu Imai, Hajime Katayama, and participants at a seminar at Syracuse, at the World Bank, and at the joint NYU/NewYork Fed seminar for comments on earlier drafts. We thank the World Bank for providing research funding. Krishna thanks Princeton University for support as an International Economics Section Research Fellow for 2006-2007. The views expressed here are those of the authors and do not necessarily reflect those of the institutions to which they are affiliated.

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NBER Working Paper No. 13698
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JEL No. F12,F13


## ABSTRACT

This paper looks at the predictions of a standard heterogeneous firm model regarding the exports of firms across markets in response to a particular trade policy "experiment" and compares these predictions to the data. A unique feature of our data is that it has information on the exports of the same firm to different markets which allows us to look for a new set of predictions of such models. We argue that while certain predictions seem consistent with the data, others are not. We then describe the patterns found in the data and argue that firm and market specific demand shocks help explain a number of these anomalies. These parsimoniously capture factors, like business contacts or networks, or even fashion shocks, that make buyers more attracted to one firm rather than another in a particular market.



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This paper looks at the predictions of a standard heterogeneous firm model regarding the exports of firms across markets in response to a particular trade policy "experiment" and compares these predictions to the data. A unique feature of our data is that it has information on the exports of the same firm to different markets which allows us to look for a new set of predictions of such models. We argue that while certain predictions seem consistent with the data, others are not. We then describe the patterns found in the data and argue that firm and market specific demand shocks help explain a number of these anomalies. These parsimoniously capture factors, like business contacts or networks, or even fashion shocks, that make buyers more attracted to one firm rather than another in a particular market.

# I A Natural Policy Experiment

The apparel sector in Bangladesh has two sub-sectors: garments made from woven cloth, and those made from non-woven material, namely, sweaters and knitwear. These differ in terms of the "effective" trade policy put on them by the US and EU which are Bangladesh's main markets. The EU had an MFN tariff rate of 12-15% on the various categories of apparel with GSP preferences of 20%. But under the "Everything-But-Arms" (EBA) initiative implemented in 2001, Bangladesh had access to the EU, duty and quota free, provided that the rules of origin (ROOs) were satisfied. However, these ROOs were restrictive: for origin to be granted, the product had to start its local manufacturing process from yarn so that the use of imported cloth was precluded.[1] The US, on the other hand, had tariffs of about 20%, as well as quota restrictions in place on Bangladesh, but origin was granted as

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[1] See Svetlana Demidova, Hiau Looi Kee and Kala Krishna (2006) for more on this natural experiment.

long as the product was assembled in Bangladesh. Thus, imported cloth could be used when exporting to the US.

These ROOs have very different implications for the non-woven and woven garments. Due to current production techniques, non-woven (NW) firms are able to easily manufacture garments from yarn and domestic yarn is abundant. But woven (W) firms need to use domestic cloth, which commands a premium price, to obtain origin and meeting ROOs raises costs by about as much as the tariff. In a nutshell therefore, EU effective trade policy is slightly less restrictive than that of the US in wovens, but is much less restrictive in nonwovens. This is our natural experiment.

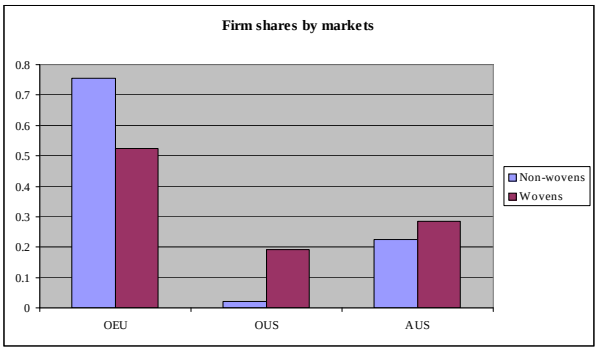
# II Implications of a Heterogeneous Firm Model

Firms make varieties of a good which enter utility in a symmetric manner. However, they have different productivities, and hence, different constant marginal costs of production. In such models, more restrictive trade policy makes the market tougher for a firm exporting to it for two reasons. First, there is the direct effect of more protection which reduces a firm's profits. Second, there is an indirect effect via the equilibrium aggregate price index in the market. Marc Melitz and Gianmarco I.P. Ottaviano (2005) show that in such models, as long as the fixed cost of exporting is large so that only the more productive firms export, a fact borne out in a number of studies, a more protectionist stance increases the market potential of a country and results in more firms locating there, more varieties competing with each other, and hence, a *lower* price index. But a lower price index means more competition and lower profits. Thus, more restrictive trade policy in a market results in lower profits to a firms exporting to it via both channels.[2]

Assuming that the US and EU are otherwise similar, this yields the result that profits to Bangladeshi firms from exporting to the US should be lower than those from exporting to

[2]Some evidence that this occurs in the data can be found in Imbs et. al. (2006) who show that for EU countries, trade openness seems to exert a competitive effect in the short run, with prices and markups falling. However, these effects diminish, and may even be reversed, in the longer run as more protected economies attract entry.

Figure 1: Composition of firms by export destinations




the EU (as the EU trade policy is more lax). As a result, the minimum productivity required to survive in the US should be higher than that for the EU, especially in nonwovens where their trade policy stand differs by more. Productivity, thus, provides a natural hierarchy of firms, with more productive firms being able to export to increasingly tougher markets.

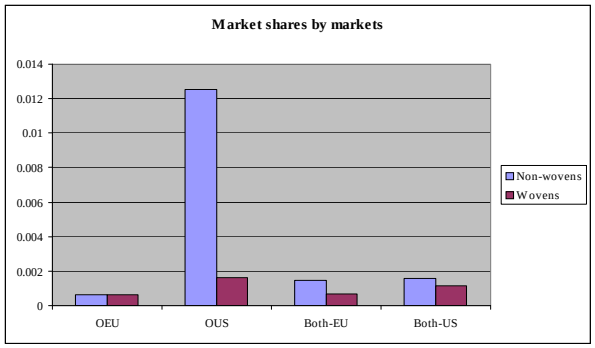
# A The Data and the Predictions

Next we look at the data we have, the predictions the standard model delivers for our natural experiment, and how the predictions fit with our data. We conduct our analysis based on a complete customs data set of Bangladeshi garment exporters. This data set consists on all firms exporting in 2004, with information on their total value and volume of export by the major markets, namely, the EU and the US. There are a total of 2387 firms, of which 2211 export to the EU, the US or both. By matching these firms to the garment firm directory in 2004, we were able to identify the industry origins of 1997 firms.

The model sketched above makes the following predictions:

1. As the EU is an easier market, especially in nonwovens, the fraction of firms in Bangladesh that export only to the EU (OEU firms) in nonwovens should exceed that in wovens while the reverse should be the case for firms that also export to the US (AUS firms). This prediction is consistent with our data. From Figure 1 it is clear that the fraction of OEU firms in nonwovens ($\approx 75\%$) exceeds that in wovens ($\approx 53\%$). The fraction of AUS firms in nonwovens ($\approx 22\%$) is smaller than in wovens ($\approx 28\%$).

Figure 2: Market shares of firms by export destinations




2. OEU firms should have smaller average market shares in the EU than AUS firms, especially in nonwovens, since OEU firms should be less productive than AUS ones, especially in nonwovens, and as market shares are higher for more productive firms. Figure 2 shows that, as predicted, the average market share of OEU firms is smaller than the average market share (in both the US and EU) of AUS firms, and this is more pronounced in nonwovens.

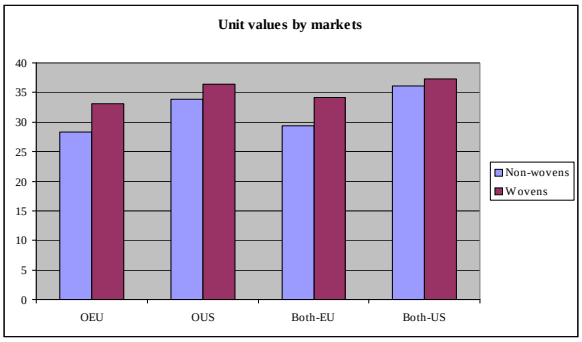
3. If a firm sells to the US it must also sell to the EU as the US is the tougher market. There can be no firms selling only to the US (OUS firms).[3] Here the data is clearly at odds with the theory. In both industries together a small fraction of firms export only to the US.[4] This might be classified as error, except for the fact that these firms are very different from the remainder. The average market share of firms that only export to the US in Figure 2 is an order of magnitude higher than that of the others, which would be a sign that they are very productive in the standard model, and which makes their not exporting to the EU even more of a puzzle! It is worth pointing out that the fraction OUS firms is far smaller and their share is much larger in nonwovens than in wovens.

4. As market share is increasing in productivity, which is firm specific, firms that sell to both markets should have market shares in the two markets that are strongly positively correlated. Consider the group of 548 firms that export to both the EU and the US in both industries. Let $s_{ij}^E$ be the market share of firm $i$ in the EU in industry $j$, while $s_{ij}^U$ is the

[3] This result is similar to Mark J. Melitz (2003), where all exporters must also sell in the domestic market, given that the cutoff productivity for exporting is higher.

[4] Jonathan Eaton, Samuel Kortum and Francis Kramarz (2004) have a similar finding: while more productive firms tend to export to more markets, a strict heirarchy does not emerge.

Figure 3: Unit values of firms by export destinations




market share of the same firm in the US. This market share is relative to Bangladeshi exports to the country in question. The model predicts that the log of the market shares of firm $i$ in both markets are positively correlated.[5] Let

$$\ln s_{ij}^{E} = D_j + \beta \ln s_{ij}^{U}, \;\; j = \{NW, W\}\,. \tag{1}$$

The data clearly rejects this prediction. Not only is $\beta$ not close to one, it is not even statistically different from zero. The estimated elasticity is 0.02 with a robust standard error of 0.04. Similar results are obtained when we run the regression separately by industries.

5. Since higher cost (lower productivity) firms can remain exporters to the EU, and as higher costs translate into higher prices, the price of OEU exporters should also be higher than that of AUS ones. This is not borne out in the data. Figure 3 plots the mean unit value of OEU firms, OUS firms, and AUS firms (here the unit value for US exports is given separately from the unit value of EU exports) in both wovens and nonwovens. The unit value of firms that export to the EU is slightly *less* than the unit value of EU exports of those firms that also export to the US, and this is less than the unit value of firms that export only to the US, which in turn is less than the unit value of US exports of those firms that also export to the EU. This pattern is the same for both wovens and nonwovens, though these differences are not statistically significant. An alternative explanation for more productive firms charging a higher price, namely they produce a higher quality good, is worth

[5] In the standard Marc J. Melitz (2003) framework it predicts that the coefficient $\beta$ below should be unity.

considering. Firm quality, like its productivity, is likely to be common across all the market served by a firm (as noted by Richard Baldwin and James Harrigan, 2007). If this were an important reason for unit values to vary, then we would expect that for AUS firms, their price in the EU market would be positively correlated with their prices in the US market. We regress the log of unit value in the EU market on the log of unit value in the US market for these firms, controlling for industry-year specific effects. The partial correlation between the two prices is not statistically significant, with a point estimate of 0.069 and a robust standard error of 0.044.

What could explain these facts? Below, we argue that firm and market specific shocks can provide such an explanation.

# III Demand Shocks

In what follows, we will look at the implications of the EU being an easier market than the US for Bangladeshi firms, assuming that everything else is the same in the two countries, and focusing on the price charged, $p$, productivity, $\phi$, and demand shock, $\mu$. The demand for a firm with shock $\mu$ is $q(p, \mu)$, with $q_\mu(p, \mu) > 0$. Both additive demand shocks $q(p) + \mu$, or multiplicative ones, $q(p)\mu$, are consistent with this specification. The profits of a firms with demand shock $\mu$ and productivity $\phi$ are given by

$$\pi(p, \phi, \mu) = [p - c(\phi)]\, q(p, \mu) - f.$$

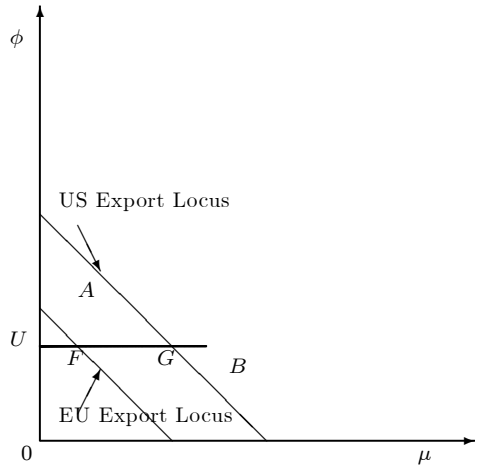
The profit maximizing price, $p(\phi, \mu)$, is given by the $p$ that solves $\pi_p(p, \phi, \mu) = 0$. Let

$$\pi(p(\phi, \mu), \phi, \mu) = [p(\phi, \mu) - c(\phi)]\, [q(p(\phi, \mu), \mu)] - f$$

be the maximized value of profits of the firm with (firm and market specific) demand shock $\mu$, where $p(\phi, \mu)$ is the profit maximizing price for such a firm.

Note that $\pi_{pp}(p, \phi, \mu) < 0$ by the second order conditions for a maximum, and $\pi_{p\mu}(p, \phi, \mu)$ is positive if demand shocks are additive but zero if they are multiplicative. Some simple com-

Figure 4: Export Cutoff Loci




parative statics results follow from these observations. First, firms with positive demand shocks charge higher prices if demand shocks are additive (since such shocks make demand less elastic) but the same prices if demand shocks are multiplicative (as such a shock results in a monotonic transformation of profits) while firms with a higher productivity always charge lower prices.

Second, assuming demand is positive, a positive demand shock raises sales, and hence, market share of the firm if demand shocks are multiplicative. If demand shocks are additive, then sales and market share may fall in this event. This follows from

$$\frac{dq\left(p(\phi,\mu),\mu\right)}{d\mu} = q_p\left(p(\phi,\mu),\mu\right)\frac{dp(\phi,\mu)}{d\mu} + q_\mu\left(p(\phi,\mu),\mu\right).$$

The first term above is zero if shocks are multiplicative, and as the second term is always positive, the result follows. If shocks are additive, the first term is negative from Result 1 and works against the second term.

Third, a positive demand shock or a higher productivity raises the maximized value of profits. This follows from the envelope theorem. As firms with profits high enough to cover fixed costs of exporting choose to export, the export productivity cutoff falls as the demand shock rises. This is depicted in Figure 4 where the demand shocks in the US and EU are both depicted on the horizontal axis and productivity is on the vertical one. The cutoffs for

exporting to the US are depicted by a downward sloping locus. Even less productive firms can afford to export to the tougher US market if they have a good enough demand shock. This locus is drawn to be linear but need not be.[6] The cutoff locus for exporting to the EU lies inside that for exporting to the US as the EU is the easier market.

It follows that for the same demand shock in both markets, firms that export to the US, which is the tougher market (whether as AUS or OUS firms), have higher productivity than those that export to the EU, and so have lower prices. For a given productivity, and assuming that the demand shocks for the US and EU are drawn from the same distribution, firms that export to the US (whether as AUS or OUS firms) have higher US demand shocks than the EU demand shocks of those firms that export to the EU (whether as OEU or AUS firms). This follows from the cutoff locus for the EU being inside that for the US as depicted in Figure 4 since the US is the tougher market. Of course, the distance between the loci is smaller for wovens than nonwovens since the trade policy stance of the EU is much more liberal than that of the US in non wovens.

# IV The Evidence Revisited

What does the augmented model with demand shocks predict, and are these predictions consistent with the evidence?

**Predictions 1 and 2**: Though the evidence is consistent with Predictions 1 and 2, these predictions need not hold due to the trade off between productivity and demand shocks in determining the export destinations of firms. For example, it is possible, without controlling for demand shocks, for the productivity of OEU exporters to exceed that of AUS firms if the US demand shocks of the AUS firms are large enough to compensate for their low productivity. For the same reason, the average market share of OEU firms could exceed that of AUS firms.

[6] For example, if demand shocks are multiplicative and preferences are CES, then this locus cannot intersect the axes. This follows from the observation that no matter what the productivity, and hence, cost, there will be some demand for each good when preferences take a CES form. However, if demand shocks are additive, this need not be the case.

Suppose, for example, that there are only high productivity firms and low productivity ones, with the former tending to receive low demand shocks, while the latter tending to receive high demand shocks.[7] In Figure 4, let the demand shocks in the US and EU for high productivity firms be clustered in the region around A while those for low productivity firms be clustered near B. Then both high and low productivity firms will export to the EU, but only low productivity firms will tend to have demand shocks high enough to export to the US. Note that the productivity of OEU exporters could easily exceed that of AUS firms if we do not control for demand shocks. Also, the average market shares of OEU firms need not be less than that of AUS ones since the greater productivity of the former raises their share, but their lower demand shock reduces it, so that the net effect is ambiguous.[8]

**Prediction 3:** With two dimensions of heterogeneity, it is possible for a firm to export to the US and not to the EU. In Figure 4, take a firm with productivity U and draw a horizontal line at this level. This line intersects the EU cutoff locus at F and the US one at G. If this firm gets a demand shock in the US above (below) G, then it will (will not) export to the US. Similarly, if this firm gets a demand shock in the EU above (below) F, then it will (will not) export to the EU. Thus, if it gets a bad demand shock (one that is below F) in the EU and a good demand shock (one that is above G) in the US, it will export to the US but not to the EU.

Does the augmented model offer anything else to look for in the data? For a firm to export only to the US it needs to have a demand shock in the US that is large enough and a demand shock in the EU that is small enough. The less restrictive trade policy is in the EU, or the more restrictive trade policy is in the US, the less likely this is to happen. Thus, this outcome will be more likely in wovens than in nonwovens. Consistent with this, in the data, the fraction of firms in nonwovens that export only to the US is much smaller (2.1%) than the fraction of firms in wovens that do so (19%).

[7] This could happen, for example, in a transition country. Low productivity firms in transition countries are old firms. However, they have access to a good network of buyers, and so tend to have better demand shocks than new entrants who have higher productivity.

[8] Loosely speaking, predictions 1 and 2 will tend to hold if productivities and demand shocks are positively correlated, or if most of the variation is in productivities, rather than demand shocks.

Moreover, as higher demand shocks result in larger market shares, the market share of OUS exporters should be higher than that of others, especially in nonwovens, where OEU firms need to have far more positive demand shocks in the US than in the EU. Consistent with this, the distribution of market shares in nonwovens of OUS firms is far to the right of that for OEU firms with a mean of 1.3% versus 0.01%.[9] The distribution of market shares in wovens is much closer together. The mean market share for firms that only export to the EU is 0.1%, while that of firms only exporting to the US is 0.2%, or about double.

**Prediction 4:** With demand shocks, it is no longer necessary for larger market shares to reflect higher productivity or for the market shares of firms that export to both $EU$ and $US$ to be strongly positively correlated, as market shares could be higher because of better demand shocks. By omitting the relative US demand shock in (1) , which is positively correlated with the US market share and negatively correlated with the EU market share, the least square estimate is biased toward zero which could explain our findings in this regard.

In the absence of capacity constraints, market shares in one market should be independent of demand shocks in the other, but with capacity constraints, market shares across markets would be negatively correlated and larger capacity associated with serving more markets.[10] Suppose capacity constraints make marginal costs vertical when they become binding. A firm would then look at the horizontal sum of its demands in the two markets and equate the marginal revenue associated with this total demand curve to marginal costs. Given productivity, a firm with a larger capacity would be more likely to sell to both markets and a better relative demand shock in one market would raise a firm's market share in that market while reducing it in the other one. This would provide another source of downward bias in $\beta$.

**Prediction 5**: OEU firms have lower demand shocks as well as productivities. The former predicts higher prices for them, but the latter predicts lower prices if demand shocks are additive. The unit values of OEU firms being lower than the unit value of EU exports of AUS firms is consistent with the latter effect dominating and the unit values of OUS firms

[9] All the mean values are calculated after removing outliers at the tail ends of the distributions.
[10] This might provide a new test for the existence of capacity constraints in such models.

exceeding those of other firms is consistent with their having more positive demand shocks.

# V Conclusions

Firm heterogeneity is likely to be multifaceted, with firm and market specific demand shocks playing a prominent role. We provide supporting evidence for the importance of demand shocks looking at unit values and the market shares of all exporters using a complete custom data of these exporters. We cannot estimate TFP for these firms, but by looking at the data on market shares and unit values, we paint a picture that is inconsistent with heterogeneity in productivity alone and much more in line with both demand shocks and productivity being important.

Recognizing the importance of firm demand shocks has several important implications for work in this area. First, it implies that the standard approach taken of estimating firm productivity ignoring demand shocks is likely to produce biased estimates and any subsequent analysis based on such estimates may not be meaningful. In the revised version of Demidova, Kee and Krishna (2006), we address these estimation issues in detail and are also able to back out estimates of these market specific demand shocks. Second, one can interpret demand shocks in a static model in terms of access to a network of buyers in a market. This would make such shocks persistent but market specific (compared to firm specific productivity shocks which are common across markets). Small young firms would tend to have lower access to such a network and so have less persistent shocks. This could help explain why exporter status changes so often for such firms, while it is more permanent for older firms as documented by Jonathan Eaton et. al. (2008). Third, trade liberalization will move resources from the less productive firms to more productive ones and from firms with unfavorable demand shocks to those that have favorable ones. If these two are positively correlated, then gains from trade may be larger than in the absence of demand shocks, while if they are negatively correlated, as may well be the case in transition countries or countries with an old, inefficient, but well connected public sector, they could be smaller.

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