Environmental Standards and Trade: Evidence from Indian Textile & Leather Industry*

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Abstract

We use a firm-level data set comprising of leather and textile sector of India for the period 1989-2003 to test the effect on industries dominated with small and medium-sized firms with respect to stringent compulsory technical environmental standards. We consider both foreign and domestic regulations. We also explored how the enforcement effect varies across firms of different size. We find (a) the regulations did add to the pollution-abatement cost of the firms' significantly, and also increased the export revenues, but exerted a negative influence on productivity level of the firms, (b) the pollution-abatement cost of a firm, its R&D expenditure, productivity and total cost significantly account for the exit decision of a firm, and (c) there is a significant amount of heterogeneity involved in the effect of the regulations on the different size categories of firms.

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1 Introduction

The increase in stringent environmental regulation costs in terms of "regulatory protectionism" (Baldwin, 2000) that firms must pay in order to access foreign markets, has the potential to impact trade flow both at the intensive and the extensive margin. The past couple of decades, due to the introduction of several liberalization policies, have witnessed a complex battle over the trade-offs between trade liberalization, economic growth and environmental compliances in the Indian textile and leather goods industry. This paper makes an empirical contribution to the emerging literature on exogenous shocks, in terms of environmental regulations or standards on firm dynamics and competitiveness. The paper's key empirical finding is that while the stringent standards or legislations did add to firm costs significantly, the widely presumed trade-off between compliance and trade competitiveness did not materialize.

With the production technologies that generate some of the most polluting chemical effluents, both the leather and textile sector emerged as a battleground for current environmental debates. The challenge for these labour-intensive developing country industries have been to find ways in which the firms could internalize those negative externalities, but without impending its various attributes, for e.g., export earnings, costs, productivity at the firm level. According to Tewari and Pillai (2005), two features of the global textile and leather industry have influenced this debate-first, the policy structure and the state of technology have become increasingly bi-modal worldwide, and, secondly, there have been some dramatic regulatory shifts in the industry, with the processing technologies been under greater scrutiny by the governments and consumer advocacy groups in the industrial economies. The proliferation of the global standards or market-access shocks, which in case of our study are, German regulations banning two commonly used chemicals (for the production of leather and textile goods), Pentachlorophenol (PCP) and Azo Dyes in 1989 and 1994 respectively. This was followed by a Supreme Court Legislation in 1996 completely prohibiting use of these two chemicals and compulsory attachment to either a Common Effluent Treatment Plant (CETP) or Individual Effluent Treatment Plant (ETP) in order to continue production, unleashed a debate of how and under what conditions can supplier firms in developing countries, especially firms in polluting industries such as leather and textile processing-which are also large employers- comply with the increasingly stringent environmental standards imposed by the global buyers without compromising their competitiveness. While there is a growing critical literature about how the local firms in developing countries, like India, would cope with those customary quality and environmental norms, much of the existing research on trade and environment remains either at the macro or qualitative and policy level. This paper tries to fill this gap by explicitly looking into some sector-specific bans to quantify the interface between firm-level attributes and both foreign and domestic legislations. Bown and Porto (2008) in a similar study, quantifies the impact of a trade shock in terms of safeguard barriers on Indian steel industry imposed by major importers such as U.S, EU and China. They suggest that the research in firm-level international trade using detailed micro-level data could generate important insights about firms' responses to the challenges and opportunities that globalization or trade-liberalization presents. The current study contributes to this small empirical firm-level literature by introducing trade policy shocks in terms of environmental compliance. This shocks could pose as an excellent controlled natural experiment, for which, the effects of a drastic change in trade rule can well be measured.

The issues of environmental regulation and international competitiveness mainly resolve around two basic fundamental questions: (a) applicability and harmonization of these standards compatible to the international regulations, and (b) the trade-off between trade liberalization, economic growth and the environmental consequences in the process of adjustments by the vulnerable Small and Medium Scale Enterprises (SMEs) firms of the developing countries, in our case, the Indian leather and textile firms. The background and the political economy in regard to the environment-related standards have been well documented by Jha (2005). The issue assumes importance in the light of the fact that the past decade has seen a global proliferation of environment and health related standards, along with the rise of trade in environmentally sensitive goods.[1] A UNCTAD report (UNCTAD, 2005) quotes a study by International Trade Commission (ITC) in 2002 that found 40% of exports from less developed countries were subject to non-tariff barriers, including standards.

The environment-related regulations can affect both the dimensions of the firm for a number of reasons: (i) governments in the importing countries can set standards based on domestic firms' technological capacity, which could raise the production costs for the exporters, (ii) existence of different standards in different markets could entail an individual fixed compliance cost for separate markets, which could severely limit the firms' production capacity and the number of the export destinations, and (iii) asymmetric information about standards and inefficiency in the domestic inspection process could also significantly raise implicit trade barriers to exporting firms (Chen et. al., 2006). Though, the effects of environment-related barriers on developing countries' exports have been penned down heavily in terms of qualitative case studies' approach,[2] but, neither the empirical nor the theoretical investigations in terms of assessing the effects of environmental regulations or NTBs at the micro-level data are very substantive.

I test different conjectures in the context of the bans by Germany, EU countries and the Supreme Court of India. All the three bans addressed the issue of compliance of the environment related trade barriers by introducing the role of standards and technical regulations, applicable particularly for the leather and textile industry of India. I directly estimate the impact of the imposition of these regulations on different important firm-level choice variables, like the environmental expenses, productivity and the exports of the Indian firms. Both these domestic and international bans provide a good source of arguably exogenous shocks, as they were independent decisions, labelled as demand-driven. The firm-level panel data set I employ for the Indian textile and leather firms from 1989 till 2003 to analyze is uncommon in the sense that it contains direct measures of earnings and spending in several dimen-

[1] For details, see Chaturvedi and Nagpal (2002).

[2] For details, see A Singhal (2000); V Bharucha (2000); D Chakraborty (2001); V Jha (2001); S Chaturvedi and G Nagpal (2002); Rajesh Mehta (2005); Kajli Bakshi (2005); Chakraborty (2009)

sions, namely, total sales, exports, imports, profits, gross value added, R&D, total cost, pollution expenses, labour, capital, intermediate goods, investment, etc. This permits me to build a direct and comprehensive measure of the expenditure the firm has incurred in order to make its product greener, i.e., environmental expenses and also productivity at the firm-level instead of relying on the estimation of residuals from the production function as proxies for the level of productivity. To the best of our knowledge, this is the first paper to utilize within-country firm-level environmental expenditure data for a developing country as an indicator for the compliance with the non-traditional export barriers.

To assess the impact of the bans on the environmental expenses decision for the firms and also on exports and productivity, I estimate the effect of these particular regulation dummies on these attributes at the firm level. I find that the firms experienced a significant change in their exports, productivity and environmental expenses due to the compulsory legislations imposed on them. I also found that both the change in environmental expenses for exporters are significantly different from the non-exporters, whereas the effect on productivity is the same for both the exporters and the non-exporters. The results indicate that the effect of all the bans were significantly different for the large firm's exports, except for the 1989 embargo. I also estimated the determinants of the probability of discontinuation of the firms due to these bans. I find that the most significant determinant which forces the firms to discontinue their production or exit from the market in the couple of years following the ban is the amount of pollution-abatement expenditure undertook by the firms. Our non-linear estimates also show that the bans forced both the firms of lower-ability and the small firms to discontnue their production. As for the other important reasons, lower profits or higher costs also did add significantly to the firm's decision of dis-continuing operation at the market. Finally, for different size of firms, I test the effect of the bans on the firm's exports, productivity and environmental expenses and also the exit decision of the firms'. The estimates suggest that the effects of the year dummies is heterogeneous, i.e., depends on both the quartile of the firm and the origin of the ban, i.e., if the ban is domestic or international. The year-specific bans also contributes significantly for the dis-continuing decision of the firms in all but the 4th quartile size distribution in case of the Supreme Court legislation.

The rest of paper is organized as follows. The following section gives a brief review of the literature and the importance of these sectors in the Indian economy, whereas section III previews the technical standards for cases pertaining to this particular study. A detailed description of the data along with the main variables of interest and some basic statistics is provided in Section IV. Section V and VI discusses the results by highlighting the empirical strategy. Section VII confirms the amount of heterogeneity involved in compliance with the bans. Section VIII checks the conformity of our result, while section IX concludes.

2 Literature Review

The first empirical paper to address the issue of environmental regulations was by Gollop and Roberts (1983). Analyzing the effect of sulfur dioxide emission restrictions on the rate of productivity growth in the electric power industry over the 1973-79 business cycles, the results indicated that emission regulations result in significantly higher generating costs, with the average rate of productivity growth reduced by 0.59 percentage points per year for constrained utilities. Among the other recent significant empirical studies, Maskus, Otsuki and Wilson (2005), Chen, Otsuki and Wilson (2006, 2008) employed a unique dataset created by the World Bank Technical Barriers to Trade Survey (2004),[3] to examine the importance of various types of standards in developing-country firms' export decisions. The findings indicate that the standards and technical regulations in the developed countries do negatively affect the firms' propensity to export in the developing countries.

Among the noteworthy theoretical studies explaining the impact of standards or regulations are Besanko, Donnenfeld and White (1988), Crampes and Hollander

[3]The firm-level survey carried out in 2002, solicited inputs from 619 firms in 25 agricultural and manufacturing industries and 17 developing countries about the technical barriers they encountered in developed countries.

(1995), Fischer and Serra (2000), Baldwin (2001) and Ganslandt and Markusen (2001). Fischer and Serra (2000) examined the behavior of a country that imposes a minimum standard (MS) on a good produced by a domestic firm and a foreign competitor. They found that the costs rise with the standard, and depending on the size of the foreign market and the fixed setup cost, the domestic firm will lobby for the lowest MS that excludes the foreign firm or for no standard at all. Baldwin (2001) and Ganslandt and Markusen (2001), assumed that meeting a standard in each export market requires both a fixed cost and a subsequent variable production cost. Therefore, increase in additional costs due to the imposition of technical regulations would impede their propensity to export and would likely compel them to diversify their export markets. In contrast, Porter (1991) and Porter and van der Linde (1995), logically asserts that stringent environmental regulations encourages firms to innovate and develop more cost effective methods of achieving regulatory compliance. In the process, firms may also discover new technologies that reduce pollution and production costs. Requate (1997) finds that a more stringent absolute emission standard always reduces the equilibrium number of firms. Farzin (2003), on the other hand, shows that if environmental quality is complementary to the consumption of industry product, then there may exist a positive relationship between the stringency of the standard and the equilibrium number of firms.

The simultaneous empirical literature on heterogeneous firms identifies a variety of dimensions along which firms respond to a trade policy shock through adjustments in the form of technological upgradation, product-switching,[4] learning by exporting, etc. Theoretically, the effect of an exogenous trade policy shock (here, imposition of environmental standards) can go either way- on one hand, the induced impediments could increase the plant-level efficiency thereby helping in enhancing the future trade, while, on the other, high compliance costs may force a larger section of the plants to exit the market, resulting in impeded exchanges.

[4] Goldberg, Khandelwal, Pavcnik and Topalova (2008) examine the issue of product-switching using the Indian firm-level data, but they focus more generally on the response to differences associated with India's unilateral import market access liberalization shock of the 1990s.

India is one of the main exporters of leather and textile products and both the industry contributes significantly to India's export earnings. The latter, being the largest producer of jute and second largest producer of silk in the world; one of the largest employers in India, second only to agriculture, accounts for about 16 percent of India's total exports and 3.04 percent of world trade share (Textile Ministry, 2008); while, the former has an export figure of US$ 2.4 billion- third only to China and Italy, ranks 8th within the country in terms of export earnings and holds a share of around 5.16% of the world trade and provides employment to around 2.5 million people (CLE, 2008). Both leather and textile are two of the important sub-sectors of manufacturing identified by National Manufacturing Competitiveness Council (NMCC, 2006) and the exporting units consist of tiny, cottage, small and medium scale enterprises. The export intensity of these sectors has increased over the years thereby raising the importance of compliance with higher standards (Barua and Chakraborty, 2004).The stringency of the environmental standard and the export competitiveness of Indian firms is a long-researched question (Tewari and Pillai, 2005). Given this very brief background of how important these two sectors are, for the growth of the Indian economy, it is certainly worth examining the challenges encountered by the leather and textile sectors due to the safeguard measures issued for environmental and health reasons in the form of banning chemicals used for production.

3 Incidence of Standards to Trade

The phasing out of tariffs due to the GATT negotiations from the late 70s' onward led the major developed countries to resort to some kind of administered protection known as Non-Tariff Barriers/Measures (NTBs/NTMs)- quantitative restrictions, import licensing, antidumping/countervailing duties, technical barriers to trade, to name a few. Technical regulations or technical barriers to trade (TBTs), such as product certification requirements, performance standards, testing procedures, conformity assessments, labeling standards etc., are used by many developed countries to restrict imports (Wilson, 2006). Since, standards embodies information about technical knowledge, conformity to efficient standards encourages firms to improve the quality and reliability of their products. Despite their potential to expand competition and trade, standards may be set to achieve the opposite outcomes. Unilateral environmental measures,[5] termed 'environmental standards' are the responses and outcomes to society's increasing consciousness against the inappropriate usage of resources and the resulting adverse environmental impact. The term 'standard' commonly encompasses a well-defined protocol based on a laboratory test procedure which ascertains specific criteria that have a direct bearing on the quality of the product. Measures such as pesticide maximum residue levels permitted in foodstuffs, emission standards for machines, and packaging requirements impede the trade of developing countries, either implicitly or explicitly. Given the nature and depth of the existing regulatory structures in developed countries, the developing countries allege that these environmental measures often impede trade and market access.

With liberalization policies and economic augmentation materializing worldwide in the 1990's, a complex battle over the trade-offs between trade liberalization, economic growth and environmental compliances has been witnessed in the leather and textile goods industry. Both the industries are traditionally considered as a polluting industry in the tanning, dyeing and finishing stages of the production chain. Global standards set by importing countries affect the entry of the firms and increase the cost of market access to products of developing countries. For instance, the German ban on the import of leather items containing more than 5 mg / kg of Pentachlorophenol in 1989-90 and the ban on the import of leather (and textiles) treated with Azo dyes (benzidine) in 1994 are those, which are of our concern. It has been argued that the latter sanction was not compatible to the WTO framework (Mohanty and Manoharan, 2002).

The challenge of adapting these bans was complicated by the fact that over 90% of the processing is done by small firms- just the firms that are viewed in the literature

[5] Unilateral measures are those measures that are taken atomistically by a country in order to maximize its own domestic welfare and gain

as being the most vulnerable to a disruption of revenues, and lacking the resources to invest in costly technical or organizational changes to meet stringent environmental standards- the old growth versus environment debate. Despite these challenges, both the leather and textile sector adjusted to the new environmental standards by Germany in a relatively quickly and sustained way. Within three years of the first (PCP) ban only 7% of all leather samples tested more than 5mg/kg levels of PCPs compared to 46% in 1990, right after the ban; and while after the same number of years of the second ban (Azo dyes), in 1997 only 1 out of 129 samples failed the azo-dye test compared to nearly all in 1994 (Tewari, 2001). A number of eco-labels, such as MST, the German Textile Association, OTN 100, OEKOTEX from Austria, Clean Fashion and Steilmann are also being introduced around the same time in Europe. In some cases, these labels are used solely as marketing instrument and have little factual and technical substance. In response to these ecolabels, the government of India also introduced a voluntary eco-labeling scheme called Eco-Mark. In response to these trade policy shocks, the state level institutions and the exporters group working with leather and textile sector, took the following three important steps, which helped the firms to overcome the crisis in a quick span of time: (a) negotiations with German authorities for an additional year of adjustment (they already have given one year to adjust) window; (b) consultation with German authorities in transferring of technical assistance, and (c) slashing of import duties from 200% to 20% of the improved substitutable chemicals.

In 1996, adjudicating on complaints brought by farmers about groundwater polluted by effluents, the Supreme Court of India passed a legislation, which ordered absolute ban of use of the chemicals (PCPs and Azo Dyes) in the production of leather and textile goods even for domestic sales, and also prohibited both the import and manufacturing of these chemicals. By targeting the input industry, the government effectively, though inadvertently, turned an input industry (the chemical companies) into de facto diffusers of environmental compliance among a sprawling network of small-scale end-users of their products (Pillai and Tewari, 2005).[6] Unex-

[6]This targeting of an input industry though unusual has parallels in other countries, most notably

pectedly, this targeting of the input producers unleashed a process of innovation as firms experimented with new, PCP and Azo–dyes free dyes (in consultation with the major customers-the exporters). To get firms to adopt their products, the chemical companies diffused the new dyes as widely as possible among their potential clients-small and large processing firms and also offered technical assistance to small firms. The combined effect of these policies was to ensure that small firms were able to comply quickly and widely, with the German regulations. In short, the Indian bans on the production of the chemicals 'reinforced pre-existing co-operative ties between small units and chemical dye and manufacturers and led them to a greater degree of collaboration' and helped minimize the cost to smaller firms of switching to the new dyes (Pillai, 2000). Finally, this process led Central Leather Research Institute (CLRI) and Bombay Textile Research Association (BTRA), the supply-side agencies, to conduct R&D and training for the leather and textile sectors respectively, to 'upgrade' in response to requests from leading exporters, to act in a more demand-driven way and develop customized certification and testing procedures for PCPs and Azo dyes. To do so, the research institutes (both CLRI and BTRA) upgraded its technical facilities and developed relationship with a German research institute to establish mutually acceptable testing procedures. The government also introduced environmental auditing requirement for all textile and leather processing units. The Gujarat and Tamil Nadu state governments even put restrictions on Chemical Oxygen Demand (COD) in effluent treatment, while global requirement is only based on Biological Oxygen Demand (BOD).

As an immediate effect of the 1996 Supreme Court legislation, firms had three options: (a) to shut down its operations; (b) build their own effluent treatment plant (ETP); or (c) to join a group of firms in building a common effluent treatment plant (CETP). All firms-large or small faced the same dilemma- how to operate, meet their export orders and yet comply with the Supreme Court order in such a short period of time. Location and financial capability influenced how firms made their choices. As Kennedy (1999) points out, despite the short window of time available to firms,

the ban on CFCs in the United States.

a large consortium of firms (large, medium and small) chose to join CETPs, which become functional in a reasonably short period of three years. Although exports were disrupted, and some firms went out of the business, it is noteworthy that how collective action by the small and large firms, and the active involvement of the local public sector agencies led to a relatively successful response to an unforeseen crisis. Large firms and their financial clout played an important role in carrying out the CETP operation and because of the functional inter-linkages between small and large firms; small firms also formed an important part of the new institutions (Tewari, 2001). Kennedy (1999) also notes that rather than expecting government agencies to impose a solution to upgrade pollution control mechanisms in leather and textile clusters, local firms themselves were a crucial source of innovative initiatives. But, still in India environmental compliance varies across states depending on the degree of monitoring mechanism. For instance a well-planned process management framework in Chennai helped the tanneries facing water shortage to reduce their water consumption, while the same could not be achieved in Kanpur.

4 Data

4.1 The Indian Firm Level Data

The current study accesses the firm-level data from Prowess Database published by Centre for Monitoring Indian Economy (CMIE), which contains information primarily from the income statements and balance sheets of all the listed companies. This includes all the publicly traded firms in India. This data has been previously used by Topalova (2004) and Goldberg, Khandelwal, Pavcnik and Topalova (2008), Ahsan (2010) etc. Together the firms in the sample comprises of 60 to 70 per cent of the economic activity in the organized industrial sector in India and encompass 75 percent of corporate taxes and 95 percent of excise duty collected by the Government of India (CMIE) (Goldberg et. al., 2008). Prowess has important advantages over the Annual Survey of Industries (ASI), India's manufacturing census, for this study.

First, unlike the repeated cross section in the ASI, the Prowess data is a panel of firms, which enables us to track firm performance over time. Second, Prowess records detailed product-level information at the firm level and can track changes in firm scope over the sample. Finally, the data span the entire period of imposition of both the international and domestic standards on India's leather and textile exports, i.e., from 1989-2003. Prowess is therefore particularly well suited for understanding how these particular firms adjust their production technology over time in response to both domestic and international legislations to change their input structure. All the variables are measured in Rs. Millions, except for employment, which is a count variable.

The advantages of this database allows us to examine the behavioural changes within firm due to trade policy shock initiated by Germany in 1989 & 1994, continued till 1996 by the Supreme Court of India. However, since the database consists of publicly traded firms, the data are not representative of small and informal Indian firms. A balanced panel over 1989 to 2003 is used for estimation purposes. A total of 1292, out of which, 1205 are textile and remaining are the leather firms, which are used for our empirical estimation. Table **1** describes the variables of interest and its sources.

4.2 Main Variables of Interest

The obtained data is first used to estimate firm-level productivity. The productivity of the firms has been estimated following the Levinshon-Petrin (2003) (LP, hereafter) methodology, which has been discussed in detail in Appendix III. Following the estimation of productivity, our empirical analysis focuses on the impact of the environmental compliance of the textile and leather firms of India. Moreover, the Prowess database does not report a separate variable accounting for environmental expenses of the firms. But, it reports the expenditures incurring on the account of (a) *plant and machinery* (which includes the expenditure on pollution treatment plants) and (b) *repairs of plant and machinery.* Since, both leather and textile are a subset of the pollution-generating industries; therefore, these expenses are actually undertaken by the firms for making their product greener and safer. Therefore, we hypothesize the sum of the expenses of *plant and machinery* and *repairs of plant and machinery* could be taken as a proxy for *pollution-abatement expenditure* of a firm. **Figure 1** sketches total *environmental expense* incurred by the firms over the period of our analysis. The figure clearly suggests increases in environmental expenditure in the post-ban periods, especially after 1996, when the Supreme Court of India legislation came into force. The year 2003 records a drastic decrease in expenses, which on account of missing data for almost 95% of our total sample of firms.

Figure 2, **3** and **4** highlights the total sales, exports and R&D expenditure for the sample of firms used for our analysis. These figures clearly demonstrated both an enhancement in the value of total sales, export earnings and R&D expenses, especially in the post ban periods, and also an increase in dispersion between firms in terms of these revenue and expenses, which implies that the impact of the bans were very much heterogeneous across firms within industry. In order to check the heterogeneity involved in our data, we calculated both 'within standard-deviation' and 'between standard-deviation' (not reported). The 'within standard-deviation' shows how the data varies within a group, i.e., between the year in a particular group, whereas, 'between standard-deviation' values explains how they vary between groups. All but R&D expenditure, Profits, Import of Raw Materials and Capital Goods and Employment values for the 'between standard-deviation' are greater than the 'within standard-deviation' suggesting involvment of ample amount of heterogeneity among firms in both the leather and textile sectors of India.

Table **2** demonstrates the summary statistics for the variables considered for our analysis. As the summary statistics reveal, an average firm exports 22.37% of its total sales. Moreover, a representative firm pays around 61.07% of its total cost as its expenditure towards clean technology, and while the same ratio is 0.23% and 46.57% for its research and development activities and raw material expenses, respectively. This indicates the importance of imbibing clean technology in order to undertake continued production. An average firm employs around 100 people, which designates that the firms listed in the Prowess database are not the typical small firms. So, our analysis is based primarily on the formal or corporate manufacturing sector of India, therefore, it is not a representation of the informal or unorganized sector of India. Further, we divide our sample of firms into exporters and non-exporters. The division into exporting and non-exporting group advocates that exporters score higher figures in all of the firm-level attributes over the non-exporters, for e.g., exporters have higher total sales, gross value added, capital, investment, profits, cost, wages, employment etc., except foreign equity. The higher value of foreign equity for non-exporters suggest that foreign-owned Indian leather and textile firms would like to concentrate much more on the large domestic market rather than competing on the international front. This is corroborated by the fact that, even the exporting firms' sale a huge share of their total sales in the domestic market (77.63%).

4.3 Basic Statistics

This section previews our empirical strategy by comparing the firms' attributes before and after the Supreme Court 1996 legislation. We consider the year 1996 as the most important structural break, because the Supreme Court regulation sums up all the previous bans imposed by the importing countries in addition to the new domestic environmental regulations. Secondly, this legislation was applied to all the firms operating in the industry, be it an exporter or a non-exporter, in contrast to the previous 1989 and 1994 bans imposed by Germany, which was confined only to the set of exporters. By comparing the firm-level characteristics, we would like to have a simple schematic presentation about the type of effect the environmental regulation had formed on the Indian leather and textile firms.

Table **4** confirms the graphical exhibition of environmental spending (**Figure 1**) at the firm level, i.e., an increase in the average environmental expenditures among the textile and leather firms over the years. Interestingly, the dispersion among the firms in terms of environmental expenses has decreased after the 1996 legislation, which was one of the foremost objective of the legislation, i.e., not only to increase the environmental spending at the average level but also subsequently raising it across the size distribution of firms. An average firm earned more revenues from selling in the post-1996 period with a significant increase in standard deviation. The increase in sales could be either due to an increase in prices or quantity. The CMIE database doesn't provide either the price or quantity information at the firm level, which restricts us to conclude about the exact reason behind the increase in sales. Similarly, the export earnings for an average textile or leather firm became more than double in the post-1996 period, with an equal increase in dispersion in terms of export earnings.

The raw material expenses of the firms- both the total and import, recorded an increase in the post-1996 period, whereas, interestingly, both mean productivity level and cash profits of a firm witnessed a significant decline in the post-legislation period as compared to the pre-1996 period. As for the mean productivity of an average firm, the decrease in the post-1996 period has been coupled with also a decrease in standard deviation of the productivity level. A decrease in standard deviation implied a convergence between firms in terms of productivity, but at a lower level. Further, average capital employed by a firm in their respective production function have also been amplified after 1996, whereas, investment have become more than double. Lastly, these firms spent on average Rs 0.18 million on account of R&D Expenditure, which was a significant 60% increase, as compared to the pre-1996 period. The increase in R&D expenditure by the firms was accompanied by a four-fold increase in dispersion among the firms in terms of undertaking this particular expenditure.

Next, we compare the activities of the firms in textile and leather industries of India based on a relatively new characteristic, coined as "*Environmental Intensity*". Comparing firms only on the basis of either exporters or non-exporters could lead to a biased picture about the impact of environmental regulations, which were both domestic as well as international. The basic idea here is that with the introduction of stronger environmental standards, some industries would be expected to increase their environmental expenses more than others. A major part of this differential response would likely to be explained by existing technological features of the firm that relates how important it is to undertake environmental expenses in these industries.

In this context, a natural firm-level measure of adoption of greener technology is the *environmental intensity*- or the *ratio of total environmental expenditure incurred by the firm to the sales* of that particular firm. Such a measure is based on the idea that in the background of very strong regulations, the firms would endogenously solve for the profit-maximizing level of environmental expenses, so that the ratio of environmental expenditure to sales reveals the importance of polluting expenditure. Second, we divide our sample of firms into- 'high environmental intensity' and 'low environmental intensity' according to the *median of environmental intensity*. *High Environmental Intensity* is referred to that set of firms, for which the value of their ratio of pollution expenditure to total sales exceeds the *median Environmental Intensity* for that particular industry, while, for *low environmental intensity* firms, the ratio is the lower than the *median*.

Table **5** compares the major firm level attributes in the pre and post-1996 period for both "high" and "low" *Environmental Intensity* textile and leather firms. It ascertains that the percentage increase in environmental spending for the "low" *Environmental Intensity* firms in the post-1996 period is more than its "high" counterpart. For the former group, the expenses just got doubled in the post-ban period, while for the latter, the increase was around 88-90%. This result highlights an important aspect of the legislation, which aimed at promoting environmental expenses across all sector of polluting firms. Interestingly, the percentage increase in total sales was also higher in case of the "low" *environmental intensity* firms, while, in case of export earnings, both of them experienced almost equal enhancement. The capital employed in the production function by the "high" *environmental intensity* firms is significantly large in both the scenarios. The R&D spending got doubled for the "low" *environmental intensity* firms. The technical assistance from both the German authorities and the local chemical firms and the simultaneous decrease in tariffs might have encouraged the small firms for the adoption of new environmental standards in a much more comfortable manner.

Three other interesting points have also been emphasized by Table **5**. Firstly, the mean productivity level is higher for "low" *environmental intensity* set of firms rather than the "high" ones, in both the pre-ban and post-ban scenario. Both the mean productivity levels decreased after the legislation but the fall in the case of "low" *environmental intensity* firms is little higher than that of "high" *environmental intensity* firms, the reduction being 28% and 25% respectively. Second, likewise the previous comparison, investment rose quite significantly for the "low" *environmental intensity* firms, in comparison to the "high" *environmental intensity* companies. The reason for this is obvious, the 'low' *environmental intensity* would need to invest more in order to upgrade its production structure than the 'high' *environmental intensity.* Third, cash profits decreased in the case of "high" *environmental intensity* firms in the post-domestic legislation period, rendering it to negative, whereas, for the "low" *environmental intensity* firms, it increased.

5 Effect of the Bans

5.1 Empirical Strategy

Following the comparison regarding the pre and post-ban period, we now evaluate the effects of the given environmental regulations (both international and domestic) on the three most important firm-level characteristics based on the following equations by estimating linear regressions of the fixed-effects type specification:

$$\log(w_{ijt}) = \beta_i Post_t + \delta_i Post_t * G_{ijt} + \tau_i G_{ijt} + \theta_i + \nu_t + \epsilon_{ijt}$$

$Post_t$ is a dummy variable indicating 1 for the years following the environmental regulations. We insert three separate $Post_t$ dummies, $Yr89$, $Yr94$, $Yr96$ in order to measure the effects of the different regulations separately. G_{ijt} includes a vector of control variables, which measures how the change in outcome varies according to the different categories of firm characteristics. w_{ijt} is either pollution abatement expenditure or total exports or total factor productivity measured at the firm level. We expect a positive effect of the $Post_t$ on exports and environmental expenses, where the effect on productivity is ambigous. Greenstone et. al., (2010) estimating the impact of environmental regulation on the competitiveness of US manufacturing, found that the environmental regulations led to a decline in Total Factor Productivity, while, Fleishman et. al., (2009) evaluating the effect of air quality policies on the efficiency of US power plants suggest mixed effects of regulations on power plant efficiency when pollution abatement and electricity generation are both included as outputs.

5.2 Results

This section explains the effect of different environmental regulations on important firm-level outcomes, especially its pollution-abatement expenditure / environmental expenses, productivity and exports. The conventional wisdom summons that stricter environmental regulations may impose a drag on its production costs, productivity and competitiveness, thereby hindering firms from competing on international markets. This loss of competitiveness is believed to be reflected in declining exports and increasing imports (Jaffe, et. al., 1995). But, on the other hand, Porter (1991) and Porter and Van der Linde (1995) argues that stringent regulations can enhance productiviy growth thereby rendering a positive effect on competitiveness.

Table **6** summarizes our results concerning *Proposition 1*, i.e., the effects of three different bans (1989, 1994 and 1996) on the important firm-level attributes. One of the principal objectives of these regulations is to ban some chemicals used in the production process of both the operating textile and leather firms and substitute that with higher quality materials, whereas, for the Supreme Court regulation, it commands the firms to use better pollution-control technology or advanced production process, and also summing up the previous amendments in order to make their products of higher quality. Both these type of regulations could have significant impact on the firm-level pollution-abatement expenditures or productivity or exports.

The first panel explores the effect of those different international and domestic regulations on the environmental expenditures at the firm level. Here, we use logarithm of the annual pollution-abatement expenditures of the firm as the ratio of total sales as the outcome variable. The regressions include a full set of year dummies (which absorbs any shock) and industry or firm fixed effects (which absorb any unobserved heterogeneity among firms). The results confirm that all the three regulations had a significant impact on the pollution-abatement expenditure of a firm at the 1% level of significance. The coefficients indicate that these environmental regulations significantly increased the pollution abatement expednature of a firm by five-fold. Our regression outcome also supports the pattern of the pollution-abatement expenditure documented in Table 4. The coefficients signify that the environmental regulations, both international and domestic, significantly add to the production cost at the firm level. Porter and van der Linde (1995) provided case studies of firms which were required to adopt new technology in response to regulation and have appeared to gain from doing so, although some theorists claim that all environmental regulations do not generate significant innovation offsets.

The reason behind increase in pollution-abatement expenditure due to the inducement of environmental policy is as follows: as the envionmental standards originated from the demand out of the buyers in the export destinations, which were the biggest importers of Indian textile and leather goods, so moving to a less-stringent market wasn't a profitable option for the Indian producers. Other reasons could the lower marginal abatement cost schedule from induced innovation which could have helped the firms to achieve a greater level of pollution abatement (Jaffe et. al., 2002) or market-based instruments had actually encouraged firms to undertake pollution control efforts that are in their own interests and collectively met the policy goals (Stavins, 2001). The process led the state to completely ban the production of those banned chemicals and development of new improved chemicals and a substantial reduction of the tariff rates on the non-banned dyes. The adoption of the newly improved dyes either through import or from the CLRI or BTRA, by the concerned firms led to the increase in its pollution-abatement expenditure. Mohr

(2002) and Greaker (2006) discussed inter-firm mechanisms through which tougher environmental policies can push a group of firm to invest in new pollution abatement techniques, which could result in the increase in their pollution-abatement expenditure. Jha (2001) based on field-level investigations documented that the costs involved in substituting these chemicals were exorbitant. According to an OECD report (2006a, 2006b), one consequnce of these changes was that the general environmental performance of India's leather and textile has been improved. According to India's Council of Leather Exports, there is not a single tannery in Tamil Nadu, that does not have an access to an effluent treatment plant.

Following the significant effect of these regulations on the pollution-abatement expenditure of a firm, we investigates whether the exporting establishments are likely to incur more environmental expenditures than their domestic counterparts. In order to measure this effect, we interacted our regulation dummies with our exporter dummy. We use our exporter dummy to see whether the exposure to international competition or to satisfy the customers in the importing countries, the exporting firms did engage in increased environmental protection activity. The coefficients indicate that the effect of the regulations was statistically significantly different for the exporters at the 1% level. The estimated coefficients indicate that the environmental regulations led to an increase of more than 20-50% for the environmental expenditure of a exporting firm, as compared to a non-exporting unit.

The next panel examines the effect of the regulations on the export performance of the firms. We analyze this consequence specifically on exports and not on domestic sales, since the standards or the regulations originated initially from the exproting destinations, which were also successfully been implemented in the domestic market in order to technologically upgrade the industry. We use the *log of export revenue* as our dependent variable. The outcomes suggest that these environmental regulations have actually helped increase the export earnings of the firms around 8.8-11.2% and all the coefficients are significant at 1% level. Our results are in complete contrast to the conventional wisdom about hurting the competitiveness of the firms due to stringent environmental regulations. The regression coefficients draws support for the central premise of the Porter and Van der Linde (1995) hypothesis that environmental regulations could sometimes have a positive effect on the international competetivness of the firms, through regulation-induced innovation. The value of exports during 1991-92 to 1998-99 went up from 30360 INR Million to 64360 INR Million and 154836 INR Million to 401715 INR Million, for leather and textile respectively. On a different appraoch, Rodrigue and Soumonni (2011) estimated a dynamic model that highlights the interaction between firms' environmental investment and export decisions on the export demand using data from the Indonesian wood products industry. The result suggest that firm-level environmental investment does encourage growth in export demand.

The reason behind the increase in export revenues in case of the leather and the textile firms of India is as follows: the foreign regulations were basically the substitution of high-quality inputs in the production process for some low-quality ones. The usual argument is that since substitution of high-quality inputs adds up to large increase in production costs, which forces the price to increase and in the process the firms would lose their competitiveness. But, in this case, they succeeded because of the actions of the various actors, which helped lower the cost of adjustment, generated ongoing learning, which the prior presence of a network of local and regional agencies-public and private-helped diffuse widely across the value chain. Another reason why the exports didn't fall immediately was the due to the negotiation between the Ministry of Commerce, Govt. of India and Germany on account of longer window of compliance. In case of each of the bans, Germany had given all parties a year's adjustment time, whereas the Indian government bilaterally negotiated an additional year of transition time with the assurance that efforts would commence immediately to phase out the use of the banned chemicals. Another reason of the increase in exports could be that standards may also reduce transaction costs by increasing the transparency of products and components, through flow of information between producers and consumers regarding the inherent characteristics and quality of products which can help in fetching good prices for the exporting establishments (David and Greenstein, 1990; Jones and Hudson, 1996). Swann et. al. (1996) used counts of standards to measure the effective stock of technical specifications and found that British exports are positively correlated with the measurement of British national standards. Moenius (2005) adopts similar measure of standards to conclude that bilaterally shared standards promotes trade volumes significantly. Theoretically, Rothfels (2002) demonstrates that enforced compliance with an environmental standard can push the domestic firms to become leaders in the 'green' market, thereby boosting their competitiveness in comparison to the foreign rivals. Simpson and Bradford (1996) examine Porter's assertion using a model of international Cournot duopoly. They find regulation might indeed promote local industry if the resulting innovation generates a sufficiently large shift in the regulated firm's best response function. Copeland and Taylor (1995), Rauscher (1997) and McAusland (2003) all find that environmental regulation can promote exports if the pollution in question is a by-product of consuming, rather than producing, dirty goods. Therefore, the effect of the regulations on the competitiveness of the firms suggests that the effect depends specifically on the intricacies or nuances of the process of how the standards have been addressed and developed.

To examine, if the increase in export revenues were larger for the big firms, we interact our regulation dummy with the size of the firm. Total assets of a firm has been considered as the size of the firm. In contrast to established results, our coefficients suggest that the effect of the ban on exports for the smaller firms were marginally bigger than their larger counterparts to the tune of 1-1.03%. Given the nature of adjustment of the Indian firms in response to the regulations, the bigger effect on the smaller firms was nevertheless expected. The banning of the harmful chemicals produced by the chemical input industry through a legislation by the Government of India as a response to the international bans, the simultaneous reduction of the import duties on the substitute chemicals and a longer window of adjustment helped the small firms to get accustomed to the new situation. Pillai (2000) notes that the domestic ban was effective also because it re-inforced exisitng co-operative ties between the chemical companies and their small customers. These ties helped lower the cost of compliance to the small tanneries of adjustment, and the extensive technical assistance that small tanners received from the chemical companies helped sustain their switch to the substitutes. Therefore, all these factors would have helped the small firms to record a better performance in terms of export earnings in the post-regulation period.

The last block of Table 6 measures the nature of the effect due to these regulations on our estimated semi-parametric productivity estimates. The results signifiy that these bans had a statistically significant negative effect at 1% level on the productivity of the firms. The estimated decline in productivity due to the regulations was between 3.6-3.9%. Productivity is defined as output per unit of inputs, so abatement spending should reduce productivity: increasing inputs without creating more output. If firms are operating efficiently before the imposition of the environmental regulations, the new regulations will theoretically cause the firms to use more resources in the production process, which could have a negative effect on productivity. The reduction in productivtiy in our case due to regulations can be either due to one of the following reasons: (a) the measured productivity of the affected industries could fall because the inputs of capital, labour and energy are being diverted to the production of an additional output-environmental quality-that is not included in the conventional measures of output and hence productivity (Solow, 1992); (b) if the change undertook by the firms are a part of the process or management in response to environmental regulations, the functioning of the new practices may be less efficient than the old ones; (c) environmental investment could possible crowds out other investments by firms[7]; (d) environmental compliances increased the cost of production through fixed cost of investing in abatement technologies, which asserts a negative impact on firm efficiency. In addition to these constraints, most regulations force firms to use inputs directly for regulatory compliance: in our case the newly developed high-quality inputs or the effluent treatment plants. Chakraborty and Chakraborty (2007) employed Data Envelopment Analysis (DEA) to study the effect of the regulations on the productivity of the Indian leather firms. They found

[7] The empirical evidence here is mixed. Rose (1983) found pollution-control investments to reduce other investments by firms, whereas, Gray and Shadbegian (1993) finds the opposite correlation.

that the number of efficient firms operating on the production possibility frontier has decreased over time, specially after the regulations.

The outcomes on productivity are in contrast with the Porter's (1991, 1995) hypothesis, who suggested that these regulations would induce the firms to innovate new technology, which would help them to upgrade their productivity level. In contrast, Dutta and Narayanan (2005) found support for the 'win-win' hypothesis of Porter (1991), by examining the impact of environmental regulation on technical efficiency of the chemical industries in the city of Mumbai[8]. Lipscomb (2008) examining the effect of domestic environmental enforcement on product choice of the manufacturing firms across all indusries also found negative effect of enforcement on the productivity at the firm-level. Several studies have examined the impact of environmental regulations on productivity. Denison (1979) used compliance costs to calculate productivity effects, while other used econometric analysis with plant-level (Gollop and Roberts, 1983; Berman and Bui, 2001; Gray and Shadbegian, 1995) or industry level (Gray (1986; 1987), Barbera and McConnell (1986)) data to test for regulation's impact on productivity. All these studies found that regulation significantly affects productivity but negatively. According to Gray and Shadbegian (1995), exisitng measures of productivity do not distinguish between inputs used for production and inputs used for regulatory compliance, so inputs are overstated, while the productivity is understated. This 'mismeasurement' effect, added to the constraints described above, drive the prevailing view that firms facing more regulation should have lower productivity. Greenstone et. al. (2010) used detailed data for US manufacturing plants estimated the effects of environmental regulations, captured by the Clean Air Act Amendments' on manufacturing plants total factor productivity levels. The study concludes that the act led to 2.6 percent decline in productivity. Like the differential effect of the exporters on the pollution-abatement costs, we also estimated the effect of the bans on the productivity of the exporters was anything different. The coefficients convey that the non-exporters had a significant negative effect, whereas, the same was not true for the exporters. It is quite

[8]Capital of the western state of Maharastra

expected, since the exporters are the big and high-productive firms, therefore, the process of adjustment to a shock could be quite easy for them.

6 Survival Probabilities

6.1 Empirical Strategy

Melitz (2003) asserts that as the trade costs go down, the profits of the firms would rise, thereby enabling their chance to survive. Our model tests the opposite of Melitz's model, i.e., as the trade costs (both export and domestic) go up (in terms of abiding by the regulations), the chance of survivial in the market (both export and domestic) would go down. These regulations, which would add to the firm-level cost, would encourage the firms' to exit or dis-continue their production in the short-run. Since, the decision to discontinue exports or domestic sales is a discrete variable, which by definition equals 0 or 1, the conditional probit model with a discrete binary endogenous variable is appropriate. Hence the discontinuing probability of a firm i operating in industry j at time t is:

$$\Pr ob(X_{ijt} = 0/X_{ijt-1} > 0) = 1 \text{ if } \alpha_i G_{ijt} + \theta_i + \nu_t + \epsilon_{ijt} = 0$$
$$\Pr ob(X_{ijt} = 0/X_{ijt-1} > 0) = 0 \ otherwise$$

where G_{ijt} is a vector of control variables including environmental expenditure, productivity, total assets, R&D expenditure, gross value added, raw material expenses, investment, cash profits and total cost. The coefficients are estimated by maximum likelihood procedures. We estimate the above specification with a full set of year dummies (ν_t) and (θ_i) firm fixed effects. We denote our discontinuing decision as 1 if the export equals zero, if (a) for the years 1990 or 1991 due to the PCP ban, (b) 1995 or 1996 for the Azo-dyes ban, and (c) 1997-1998 for the Supreme Court of India regulation. But, we do control our binary dependent variable given its sale being positive the year on and before the regulation. We divide the discontinuity decision of the firm into domestic and export according to the type of regulation the firm faces.

Firm's environmental spending are expected to have a negative impact on discontinuing decision, i.e., the lower is the firm's environmental expenses, the higher is the probability to experience the damaging impact of the regulation. We also expect a negative sign on the productivity relation with the firm's discontinuing decision. The rationale for the expected negativeness of productivity is that the higher productivity firms would likely to continue to produce, while the lower ones would exit from the market. Similarly, we also presume a negative correlation with Investment, Total Assets, R&D expenditure, Gross Value Added and Cash Profits, Raw Material Expenses and Total Cost. The underlying principle of the negative correlation with the set of variables is that, a firm with high cash profits or value added would be better off to continue its operation in the market. The increase in raw material expenses or total cost due to the adjustments in chemical inputs would also likely to have a dampening effect on the exporting decision of the firm.

6.2 Results

According to Melitz (2003), the decrease in trade barriers due to trade liberalization would bear a positive effect on the exporters, which will consolidate their position in the market and increase their chance of survival. Environmental regulations on the other hand act as trade barriers to firms, which could increase the chance of the firms to discontinue its production temporarily in order to adjust to the regulation or completely exit the market. The environmental regulations could affect a regulated establishment in a variety of ways- impact the choice of technology, production scale, investment behaviour, changes in revenues and costs (e.g., due to acquisition of more capital, requirements to change inputs per unit of output) and profits. The changes in a firm structure due to the stringency of environmental regulations could lead to increase in chance of discontinuation of its operation. Biorn et. al. (1997) exploited a qualitative response model to study the interaction between environmental regulations and plant exit for three manufacturing sectors of Norway, which have been under strict environmental regulations. They found that the exit probability of regulated units are less than those of non-regulated ones and the firm characteristics plays an important role from being non-regulated to regulated. Lahiri and Ono (2007) found that the negative impact of environmental regulations on number of the firms, while, Conrad and Wang (1993) showed that the net effect of an increase in regulation on the equilibrium number of firms as ambiguous. Following the imposition of strict environmental standards, we can raise the following interesting concern: did environmental regulations have an impact on the exit decision of the units when other factor affecting the decision have been controlled for?

Column (1) regresses pollution abatement expenditure of a firm on its discontinuity decision, controlling for the productivity level of the firms'. The results show that mean effect of pollution abatement expenditure on the probability to exit from the markets is small, negative and statistically significant at 1% level. The estimates indicate that at the mean, survivors spend 0.5% more on their environmental expenditures to continue its operation in the export market after the imposition of the environmental regulations. It means that, the firms which are not producing high-quality products had either to stop their production, upgrade their facilities and then re-start their operation or exit from the market immediately following the ban. Since, the export-market regulations are demand-driven, so, if the products of any particular firm are using the banned chemicals, the product will not pass the testing procedures, leading to a rejection of the shipment from being sold to the export market, which would ultimately force the firm to discontinue its production in the short run. However, though the coefficient on total factor productivity is negative, but it is not statistically significant.

Column (2) introduces the size of the firm and its research and development expenditure as the factors explaining the survival probabilities of the firm, controlling for the pollution abatement expenditures. The coefficients on the size of the firm doesn't illustrate that the magnitude of a firm plays any crucial role in its exit decision. Yin et. al (2007), Nene (2010) found that surviving plants in response to the impact of environmental regulations were the larger ones, while, on the other hand, Ringleb and Wiggins (1990) and Becker and Henderson (1997) did not find any support for the conclusion that environmental regulations favours large firms.

The results divulge that for the firms whose mean investment is 26.7% more in R&D expenditure are likely to survive the negative effects of environmental regulations. The coefficient is significant at 5% level. Both Petrakis and Roy (1999), Sengupta (2010) proclaims that one of the crucial factors to respond to the environmental regulations in polluting industries is the investment in better abatement and compliance technology. Both the studies argue that investment in pollution-control technology would help generate inter-firm heterogeneity which modifies the optimal scale of the firms in order to continue its operation in the market. The mean R&D spending for all the firms increased more than 50% of its pre-regulation period, whereas for the 'low' *environmental intensity* firms, the increase was double. One of the main reasons, for the increase in R&D was the negotiation by the Indian Government with the German authorities after the regulation to upgrade its existing facilities and transfer of technology in order to ensure long-run compliance (Pillai and Tewari, 2005). These negotiations helped lower the cost of adjustment by helping to upgrade India's key R&D agencies operating with these industries.

In column (3), we used another measure of the size indicator of the firms, *gross value added.* The results still indicate that firm size doesn't effect the survival probablities of the firm. Column (3) also indicates that productivity of a firm is one of the important determinants affecting the discontinuity decision of a firm. The mean productivity level of a firm which survives in the export market is significantly 0.3% more than the non-surviving firm. In other words, the marginal effect of our productivity measure on the probability of exit is negative and significant. Bernard and Jensen (2007) found that surviving plants in the US manufacturing sector are 1% more productive than the average plant in the industry. Following Biorn et. al., (1997), we include *cash profits* to examine whether the profitability of a firm could explain its exit decision. The coefficients suggest that the present profitability of a firm have a significant impact on the exit behaviour at 5% level. A mean surviving firm records 0.01% more profits than an exiting firm. Column (5) introduces the raw material expenses of a firm. The substitution of higher-quality chemicals could have led to enormous increase in costs for some firms, which could have affected the exit decision of firms. However, the results doesn't indicate of any such significant impact. The reason could have been due to an enormous simultaneous reduction in tariff rates of the substituted chemicals. The tariff rates went down from 200% to 20%. Also, the domestic chemicals companies, which produced the substitute chemicals offered technical consultations to the firms in adopting the new standards. The cumulation of both these events would have helped the existing firms to reduce their compliance cost. We also included total cost as one of the decisive attribute in explaining the survival chance of the exporting establishments. The solution proclaims that total cost also doesn't significantly affect the exit decision of a firm. The pollution-abatement cost and the total factor productivity continues to significantly influence the survival probabilty of an exporting firm at 1% and 5% level, respectively.

Now, we seek to find out the factors behind the survival probabilities in response of the domestic regulation targeted to the leather and textile firms. The domestic regulation binds to all the firms operating in both these industries, unlike the regulations from the EU countries, which catered only to the exporters. Column (7) regresses environmental expenditure and productivity of a firm on our binary dependent variable. The numbers suggest that the survivors in the domestic market due to the Supreme Court legislation spend 51.6% more towards its pollution abatement in comparison to a firm, which withdrew its operations as a result of the legislation. The coefficient is statistically significant at 10% level. The estimates also conclude that the surviving firms are significantly 37.8% more productive at 5% level. The reason behind the large difference between the surviving firms and the exited firms is due to the mandates of the Supreme Court legislation. It clearly states that each of the firm in order to continue its production must be connected to the effluent treatment plant, otherwise, the firm needs to close down with immediate effect. Further, the regulation also directed the firms to follow some stipulated labour standards in their respective plants. Both these requirements needs sufficient capital expenditure in order to continue its operation.

Column (8) introduces the size of the firm. We used gross value added of a firm in order to measure the size characteristics of firm. The result indicates that unlike the export market, in case of the domestic regulation, the size factor played an significant role in the survival probabilities of a firm. The survivng probabilitiy of a mean firm is 5.2% more. As we know, the environmental regulations did decrease the profits of an average firm, we regressed the *log* of *cash profits* of a firm on its exit decision. A mean surviving textile and leather firm earned significantly 10% more profits than that of its counterparts. Therefore, like the export market, the profitability of a firm convincingly decides its survival chance at 1% level of significance in the domestic market. Further, column (10) explores whether the increase in total cost of a firm significantly contributes to its decision of discontinuity from the market, controlling for the pollution-abatement cost and the productivity of a firm. The results confirm that a firms' total cost is one of the considerable parameters in the determination of its survial chance. A surviving firm accounted for 15% less cost of a non-surviving firm at 5% level of significance. Therefore, the above results suggest that compliance cost of the domestic regulation was much more than that of the exporting regulations.

The coefficients from survival probability analysis testifies a contrast in the outcomes determining the survival chance of a firm due to both exporting and domestic regulations. The pollution-abatement expenditure and R&D seems to be significantly affecting the firms' decision in order to comply with exporting regulations, whereas, in case of domestic regulation, envrionmental expenditure, productivity, total cost and profitability played an important role. The varying dimension of the factors' is due to the difference in characteristics of the regulations. The exporting regulations required to substitute some inputs, which is an important ingredient of the production process. To do these, firms either need to buy those expensive safe chemicals from domestic chemical companies or import them or increase their own R&D facilities in order to develop the newly suggested improved chemicals. Whereas, to comply with the Supreme court environmental regulation, the firms' need to incur some ample amount of pollution-abatement and capital expenditure in order to upgrade itself technologically to continue its production.

7 Heterogeneity

7.1 Empirical Strategy

This section tests the effect of the regulations on the size distributions of the firms to see whether effect is heterogenous. I divide the entire sample into four quartiles, according to the *total assets* of a firm, which we consider as the size indicator for the firms. The different size categories of firms are indicated by a dummy variable, if a particular falls into that cluster. For e.g., if a firm's total assets of a particular firm falls below the 25th percentile of the total assets of the industry, then the firm belongs to the 1st quartile and the variable would indicate 1 for that particular firm, and zero otherwise. Likewise, if a firm's total assets' falls between 25th percentile to 50th percentile, 50th percentile to 75th percentile and above of 75th percentile, the firm will respectively fall into the categories of 2nd quartile, 3rd quartile and 4th quartile. We interact our different quartile dummies with the regulation indicators to measure the effect of environmental regulation on that particular quartile of firms with respect to the crucial firm-level outcomes. We estimate the effects on the different quartiles of the firms in three separate ways: (a) firstly, we directly estimate the impact of the regulations on the three important firm outcomes:

$$\log(w_{ijt}) = \sum_{r=1}^{4} \beta_i^r * (Post_t * Q_{ijt}^r) + \sum_{r=1}^{4} Q_{ijt}^r + \tau_i Post_t + \delta_i G_{ijt} + \theta_i + \nu_t + \epsilon_{ijt}$$

where r indexes each of the four quartiles of the size distribution and Q_{ijt}^r are dummy variables taking the value of 1 when firm i belongs to quartile r. We conjecture that the impact of the regulations should vary according to the size of the firms and also with the regulations.

(b) secondly, we re-estimate our firm-exit equations in order to evaluate the difference in reasons for different quartiles which led to the discontinuing decision of the firms:

$\Pr ob(X_{ijt} = 0/X_{ijt-1} > 0) = 1$ if $\sum_{r=1}^{4} \beta_i^r * (Q_{ijt}^r * G_{ijt}) + \sum_{r=1}^{4} Q_{ijt}^r + \tau_i G_{ijt} + \theta_i + \nu_t + \epsilon_{ijt} = 0$

$\Pr ob(X_{ijt} = 0/X_{ijt-1} > 0) = 0 \; otherwise$

where G_{ijt} is the vector of control variables affecting the firms' decision to discontinue its operation. We expect the determinants of the firms's exit decision to vary according to the size distribution of the firms.

(c) lastly, we estimate the significance of the environmental regulations on the exit decisions of the firms across different quartiles:

$\Pr ob(X_{ijt} = 0/X_{ijt-1} > 0) = 1$ if $\sum_{r=1}^{4} \beta_i^r * (Post_t * Q_{ijt}^r) + \sum_{r=1}^{4} Q_{ijt}^r + \tau_i Post_t + \delta_i G_{ijt} + \theta_i + \nu_t + \epsilon_{ijt} = 0$

$\Pr ob(X_{ijt} = 0/X_{ijt-1} > 0) = 0 \; otherwise$

The effects of the environmental regulations on the exit decisions of the firms should be highest for the firms belonging to the lower or 1st quartile of size distribution, irrespective of the type of environmental regulations and should decrease as the firm size decreases.

7.2 Results

7.2.1 Effect of the Environmental Regulations

Table **8** confirms that the effect of the environmental regulations was indeed heterogeneous. Pashigian (1984) and Nene et al. (2010) developed an empirically testable model to address the long-run impact of environmental regulations on different size classes of firms. Millimet (2003) also suspected environmental regulations of having differential effects on establishments of varying sizes. The overall results show that environmental regulations does indeed have dissimilar impacts as predicted by the heterogeneous theory of firms a la Melitz (2003). We repeat our exercise as of Table **6** by dividing the firms into several sizes and measuring the consequences of the different regulations on the important firm-level attributes, like environmental expenses, exports and productivity of a firm.

The first panel of Table **8** reports the results of the regression of the environmental expenses of a firm on the interacted variables of the environmental regulations with the four different quartiles of the firms. Firstly, we measured the consequences of the 1989 environmental regulation targeted at the substitution of PCP dyes in the production process. The results indicate that the small exporters experienced a significant increase in their pollution abatement expenditure due to the bans as opposed to the large exporting units. The numbers suggest that the small exporting establishments experienced more than double increase in their expenditure towards pollution-abatement, and the estimates are significant at 5% and 10% for the 1st and 2nd quartile of firms, respectively. The result is quite expected given the heterogeneous theory of firm behaviour. The reason for non-significance of the effect for the large firms is as follows: the largest exporters which are the most efficient firms, are already producing high quality goods. They are more capital-intensive and utilize advanced process technologies, thereby complying with the regulation without significantly increasing its pollution-abatement expenditure. The 1994 environmental regulation also did have a significant large impact on the environmental units of the smaller exporting units. But, in the case of 1994 regulation, the exporters belonging to the 4th quartile, i.e., the largest exporters also saw a consequential increase in its pollution-abatement expenditure. The reason could likely be the degree of the effectiveness of the ban. It compelled the biggest exporters to significantly increase its pollution abatement expenditure in order to comply with the exporting norms. But, surprisingly, there was no significant impact on the exporting firms corresponding to 3rd quartile. Lastly, the effect of the 1996 Supreme Court of India legislation on the biggest establishments is the largest. The reason being the effective implementation of the regulations as outlined by the Supreme Court order. For e.g., most of the large firms established their own individual effluent treatment plants, whereas the small and the medium sized firms build a consortium in order to assemble a common effluent treatment plant (TERI, 2005). Therefore, the expenses incurred towards the establishment of a common effluent treatment would be much less than incurred for employing an individual effluent treatment plant.

The next plank reports the result concerning the effect of firm level export earnings on the interacted dummies of the various sizes of firms'. The numbers point out that both the 1989 and 1994 regulations did increase the export revenues of the four different quartiles of firms, with the largest increase recorded for the biggest exporters, whereas the smallest ones had the least among the others, as expected. The reason could be simply either due to the large increase in prices for the products of the biggest exporters or increase in demand in the export market for the higher quality goods. All the coefficients are significant at 1% level. As for the domestic regulation, the effect remains the same. The export revenues of the largest firms significantly increased around seven-fold times with respect to the pre-regulation situation.

The last column declares the outcomes of the regression results of productivity on the different size categories of the leather and textile firms due to the environmental regulations. For the 1989 regulation, unexpectedly, the 1st quartile of firms, i.e., the smallest exporters had the least effect, whereas the biggest ones bear the highest negative effect. All the coefficients are significant at 1% level. The reason may be due to the significant undertaking of environmental expenses by the smaller exporters as opposed to the larger ones. This could be due to the flexilibility of the small firms in adjusting to a new situation due to the size of its scale of operation. The largest exporters may had to adjust the new chemicals within its existing process of production, which could have led to reduction in its productivity much greater than the smaller ones. But, as for both the 1994 and 1996 regulation, the smaller firms, i.e., belonging to the 1st quartile significantly experienced the most negative impact.

7.2.2 Determinants of Exit Decisions

We extend our disaggregated impact analysis to investigate whether the reasons of the exit decisions for different size categories of firms are the same or it varies according to different tiers. We run conditional probit regression, where our dependent variable is binary. It takes the value 1, if the firm's exports or domestic sales is recorded as zero in the following two years of the respective regulations, and zero otherwise. Table **9** reports the determinants of the survival chances of the different cohorts of the firms. We interact our different quartile dummies with the crucial factors, which are supposed to influence the firms' decision of discontinuing the production due to the imposed non-tariff barriers. Again, we divide the exit decision of the firms into two broad categories- (a) from the export market due to 1989 and 1994 regulations, and (b) from the domestic market due to 1996 regulation. Table **9** highlights the crucial factors affecting the exit decisions of the different tier of firms.

The first panel explores the reasons behind the decision of discontinuity of the varying firm sizes from the export market. The coefficients indicate that the most significant cause for the exit decision of large firms, i.e., the ones which belong to 3rd and 4th quartile are the drop its pollution-abatement expenditure and productivity. The surviving big firms in the market have on average 1.9% and 0.7% more pollution abatement expenditure and higher productivity, respectively. The continuing firms from the upper two quartiles are the high ability ones, which are produce higher quality goods. The productivity of a firm, which belongs to upper two quartiles, and its adoption of compliance mechanism are two of the most core issues, which helps the firms to continue its operation. The investment and total cost doesn't seem to be a problem for the establishments belonging to the upper two quartiles, as the big firms are the always high cost firms and they have an easy accesss to finance to incurinvestments needed to overcome any barrier. As for the firms pertain to the bottom two quartiles, i.e., for the small exporting firms, the investment seems to be the major contributor to their discontnutiy decision. The small exporters affiliated to the 1st and 2nd quartiles, which survived the aftermath of environmental regulations did invest 1.8% and 0.4% more than the discontinued ones. The smallest exporters facing the environmental regulations are not the highly capital intensive, technologically upgraded firms. Therefore, in order comply with the environmental regulations, i.e., to incur the compliance cost, they need to upgrade their production process in order to use the newly suggested inputs in order to manufacture safe and higher quality goods. Therefore, in order to upgrade its production structure to abide by the regulations, the firms need to incur investment, which could be instrumental in the exit decision of the firms. Investment by a firm crucially depends on its access to finance. And, since access to credit varies positively with firm size, therefore, liquidity constraints could make the small firms more vulnerable, in achieving compliance with the environmental regulations. Many recent empirical studies focusing on the heterogeneous theory of firms also confirm that investment seems to be an important constraint for the small firms or exporters. To enquire, whether the cost component also played a crucial role in the survival chance of the firms, we also interacted the cost variable with the four different quartiles of the firms. We found no evidence of cost element playing an important role in the discontinuity of the firms' manufacturing process.

We now divert our concentration on the crucial elements affecting the exit decision of several bins of firms from the domestic market due to the Supreme Court legislation passed in the year 1996. Neither the pollution-abatement expenditure nor the productivity of any cohort of firms seems to play an important role in influencing them to stop the production and quit the domestic market. But, investment still seems to a significant contributor for the survival probabilities of the small firms. This is quite expected, as the crucial aspect of the legislation was to either connect to a common effluent treatment plant or set up an individual effluent treatment plant in order to continue production. And, therefore to upgrade the technological capacity of the firms, investment plays a central role. Since, the small firms have limited capacity to invest for upgrading its production technology, it contributes significantly to the exit decision of the firms. The smallest surviving firm did 2.5% more investment and the result is significant at 1% level. Kennedy (1999) points out that many small leather firms did exit the industry because of the sudden shock of an exhorbitant capital investment. The increase in total cost partly due to the compliance of the environmental regulations seems to be another important factor influencing the discontinuity of the operational process of the firms of all the size cohorts. As expected, the effect is least for the big firms. The non-surviving firms in the 4th quartile experienced a significant 16.9% increase in total cost than the survivors. Therefore, as for the domestic regulation, which originated as a result of the previous export barriers, investment and cost structure seems to contend a compelling factor in the survival probabilities of the firm.

7.2.3 Effect of Regulations on the Exit Decisions

Table **10** displays the effect of the different regulations on the survival chances of the different size classes of leather and textile firms. In this section, we explore the heterogeneity of the impact of the environmental regulations imposed both by the importers and the Supreme Court of India in order to upgrade the production structure of the Indian leather and textile firms. We analyze the effect by employing conditional probit regression, where the dependent variable is the exit decision of the firms from both the export and the domestic market. The independent variables are the interactions of the environmental regulations dummy with the different quartiles of the firms to measure the variance of the effect on the disparate size clusters of the firms.

The first panel produces the results of the effect of 1989 and 1994 regulations. The numbers confirm the seminal work of Melitz (2003). According to him, the smallest firms are most vulnerable towards any trade policy shock or in response to consumption of any fixed cost for operating in the market. The smaller exports have a 51.1% chance of exiting the market due to the 1989 environmental regulation at 1% level of significance. The survival probabilities decreases as the size of the firm increases. One of the contributing factors could be the economies of scale of the firms. It can explain the uneven impact of the environmental regulations on the different firm sizes. Yin et. al., (2007) argue that economies of scale give the large firms a greater comparative advantage because it is more difficult for small firms to pass on the compliance costs. Nene et al. (2010) also showed size bias about the effect of environmental regulations. As for the 1994 regulations, the survival probabilities are significantly less for the larger firms as compared to the smaller ones, which is quite surprising. Table **5** points out that the mean profitability of a large firm after the regulations declined enormously, while for the smaller ones, it increased. Therefore, it could be that some of the large exporters completely exited the market to avoid the compliance or could change their course of action by increasing their share of product portfolios allocated to clean products (Lipscomb, 2008). It could also be due to the flexibility advantage of the small firms unlike the large firms. The smallest exporters have on average around 53% chance of exiting the market, whereas the firms belonging to the 3rd and 4th quartiles have 35.5% and 99.3%, respectively. All the coefficients are significant at 1% level.

Lastly, we consider the effect of the 1996 Supreme Court legislation on the frms belonging to the four different quartiles. The results are quite as expected. The survival chance increases as the firm size increases, thereby supporting the fact that economies of scale play an important role in response to the environmental regulations. The marginal effect of 1996 regulation on the small, i.e., the firms belonging to 1st quartile is 99.5%, and is significant at 1% level. That is, the probability of exit for a small firm is close to 1. We found no significant impact of the domestic regulation on the largest firms operating in the textile and leather sector. A mean firm corresponding to 2nd and 3rd quartile faces 60.5% and 57.9% probability of exiting the market due to the envrionmental regulations. Therefore, our results on the whole, support the theory of differential effects on different size of firms with respect to the envrionmental regulations.

8 More Robustness Checks

This section measures the upstream effects of the discussed environmental regulations. We do this exercise in order to legimatise the direction and magnitude of the effects. To do this, we exploit the data for the chemical firms of India which produce and sell their products to the textile and leather sector firms. The purpose of the regulations was to upgrade the production structure of the textile and leather firms in order to make more improved, safe, high-quality products. The regulations included banning of certain harmful chemicals from their production process, so that the leather and textile firms could use the newly upgraded substitutes. This could result in an indirect effect on the chemical firms. These chemical firms produce and sell textile and leather dyes might experience a situation of declining demand from particularly the leather and textile industries, which could assert a corresponding negative effect on their domestic sales. Further, the chemical firms in order to re-capture the market, i.e., to increase their future sales, would try to develop the newly suggested improved chemicals, and this could render a positive effect on the firms' research and development expenditure and investment. Table **11** reports those results.

We consider three crucial attributes of the firms', to investigate possible effects rendered by the environmental regulations through the textile and the leather firms. Those are domestic sales, research and development expenditure and investment of the chemical firms. Domestic sales is the most likely to get effected due to the drop in demand for substituting the banned chemical with new upgraded ones by the textile and leather firms. As a result of that, the chemical firms need to innovate new chemicals in order to substitute the existing banned harmful ones. Further in order to produce the newly subsituted safe chemicals the firms also need to increase its investment in upgrading the production process. The results displayed in table 11 confirms our conjectures about the upstream effects due to the environmental regulations.

All but the 1989 ban had a statistically significant negative effect on the domestic sales of the chemical firms at 1% level. This implies that the regulations corresponding to the years 1994 and 1996 are the most binding ones. The 1996 Supreme Court legislation had the by far the largest impact on the domestic sales. The domestic sales went down by more than 135%. This is quite expected, given the format of the legislation. The 1996 legislation following the export regulations in the previous years totally banned the domestic production of the chemicals. This explains why the effect due to the Supreme Court regulation is larger on the sales on the domestic firms, as compared to the previous regulations. As for the effect on the innovative expenditures of the firm, we found a statistically significant correlation between the regulations dummy and the R&D expenditure of the firms. The coefficients are significant at 5% level. But, still the effect is not significant as regards to the 1989 regulation. As Pillai and Tewari (2005) notes, the substitutes of the PCP chemicals, which were banned in 1989 were very easily developed by the firms and were readily available in the market. The easy availability of the substituted chemicals might not have affected the R&D of the chemical firms significantly. Both the 1994 and 1996 regulations nearly doubled the R&D expenditure of the chemical firms. Lastly, we also estimated the effect of these several different regulations on the investment pattern of the chemical firms. All three regulations have found to have a significant effect on the investment activity of the firms at the 1% level. These regulations led to a five-fold increase in investment of the chemical firms.

9 Conclusion

The paper explores the effect of environmental regulations specifically designed for the Indian textile and leather firms'. The regulations had a significant positive effect on the environmental expenditure and exports of a firm, where it did reduce the productivity levels of the firms. The pollution-abatement expenditure, productivity, R&D and the size of the firm played a major role in the discontinuing decision of the firms. We also explored the heterogeneity in the effect of the regulations. The results suggest that the effects were dissimilar in proportion to the firm size.

There is large debate about whether the environmental regulations do help or hurt the competitiveness of the firms. And, our paper is small empirical contribution in this literature. Though, our paper doesn't test the Porter's hypothesis (1991) directly, but it explores somewhat similar issues. The paper's results went beyond the assumed trade-off between the environmental compliance and the competitiveness of the firms and have proved that firms from the developing countries can also comply with stringent global standards that are increasingly becoming associated with trade, without necessarily undermining their competitiveness. The paper found that broad-based compliance by India's leather and textile industry to the bans was the result in part of a deep process of negotiated collective action among the small and the large firms and also between the Indian state and the firms. The state played a very important role in helping the firms overcoming the crises by simultaneously negotiating with the importers, from where the ban was originated, about the technical support and adjustment window, whereas on the other hand, reduced the import duties simultaneously in order to help the firms to lower their cost of compliance. The Indian government's regulatory actions in response to those of Germany were also important in the transformation of the firms. Our result suggests that both the large exporters and also the small firms were successful in adjusting to trade-related environmental standards. This was not due to any automatic result of the market discipline that the trade-related ban imposed on the exporters, nor due to any traditional command and control apparatus of the state. They succeeded because the actions of the various actors and state institutions involved actually helped lower the cost of adjustment, generated ongoing learning and also helped to diffuse the shock widely across the value chain (Tewari and Pillai, 2005). Finally, though our study concerning the leather and textile sector of India adds further fuel to the debate concerning the literature about the environmental regulations and trade, but in the process, the regulations helped these Indian industries to upgrade and made their presence felt in the global market.

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Appendix I

Figure 1 Environmental Expenditure of the Firms

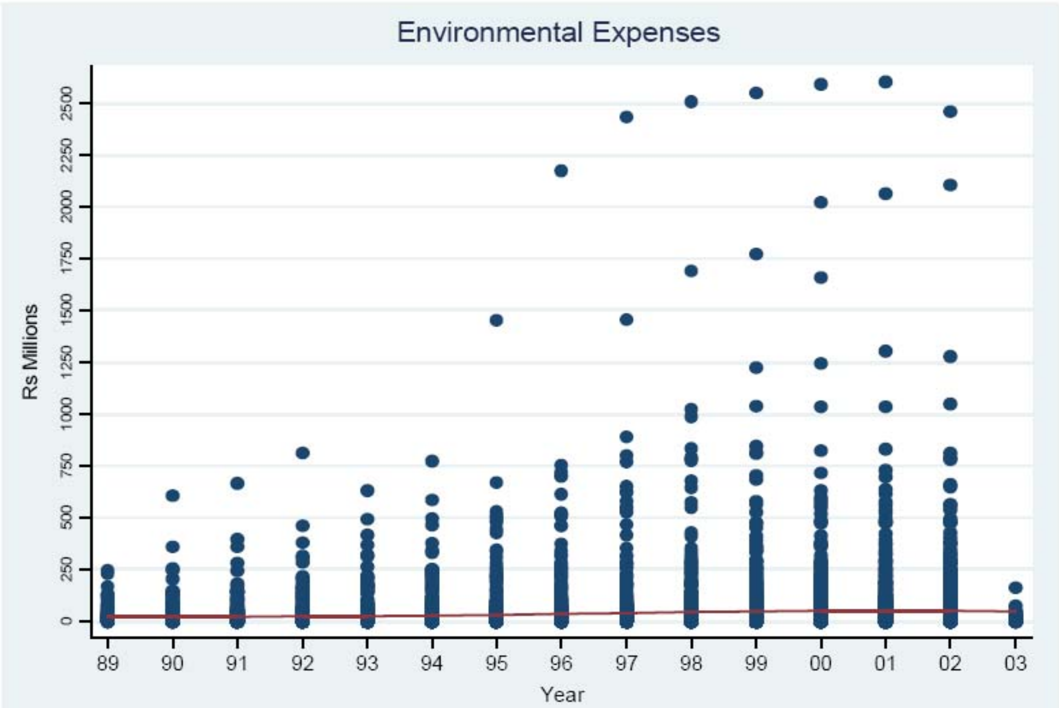


Figure 2 Total Sales of the Firms

Figure 3 Exports of the Firms

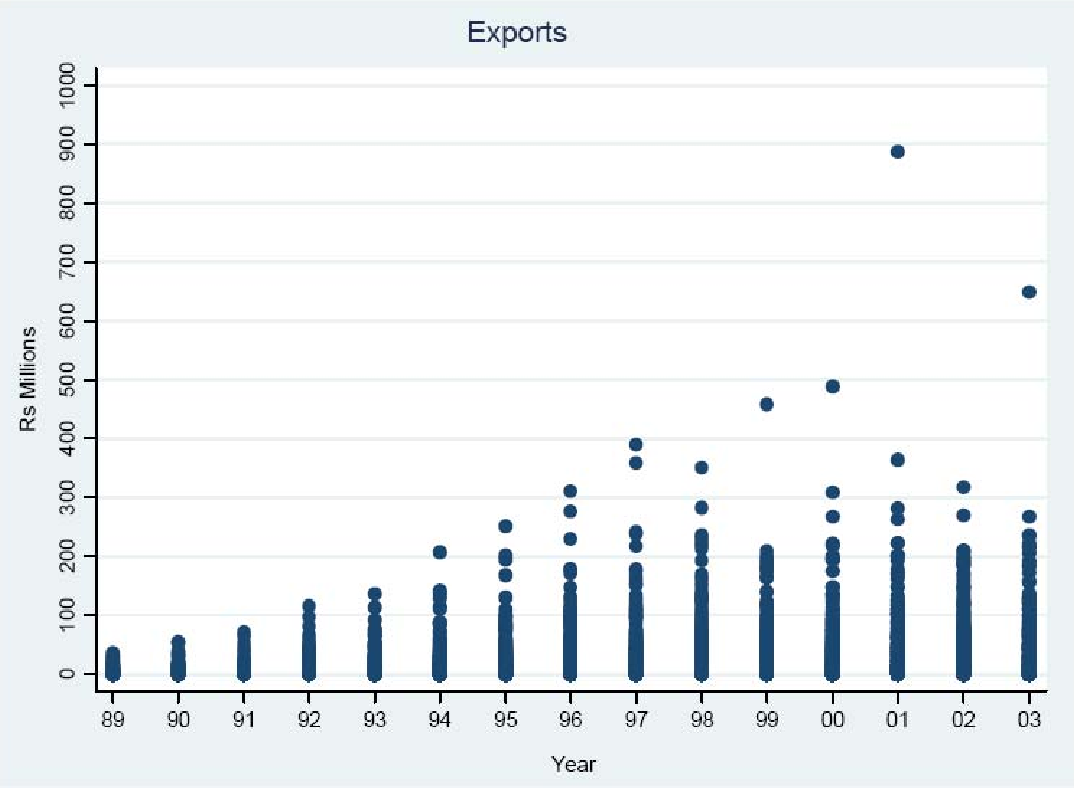
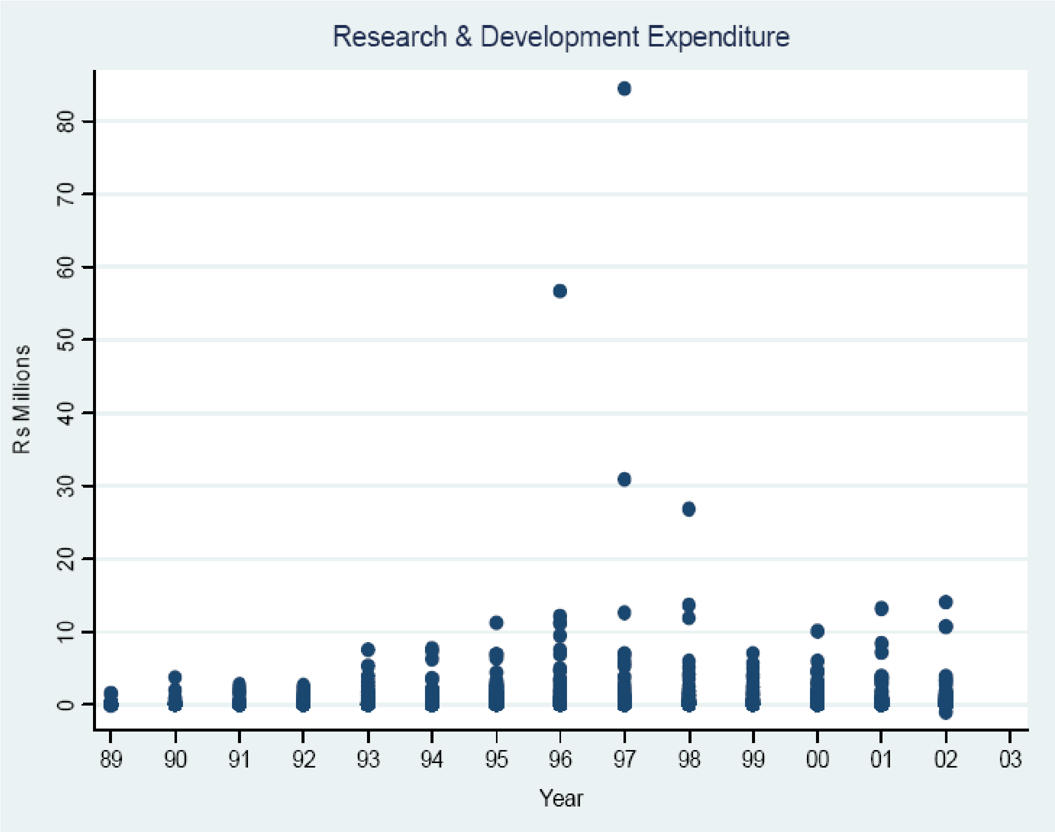


Figure 4 Research & Development Expenditure of the Firms



Appendix II

Table 1 Variable Definitions

Variable	Definition
Sales	*Prowess Firm Total Sales (in Million INRs)*
Wages & Salaries	*Prowess Firm Total Wages & Salaries (in Million INRs)*
Power, Fuel and Electricity Charges	*Prowess Firm Power, Fuel and Electricity Charges (in Million INRs)*
Capital	*Prowess Firm Capital (in Million INRs)*
Investment	*Prowess Firm Investment (in Million INRs)*
Exports	*Prowess Firm Total Exports (in Million INRs)*
Domestic Sales	*Prowess Firm Total Sales – Prowess Firm Total Exports (in Million INRs)*
Gross Value Added	*Prowess Firm Gross Value Added (in Million INRs)*
Advertising Expenses	*Prowess Firm Advertising Expenses (in Million INRs)*
Total Research & Development (R&D) Expenditure	*Prowess Firm Total R&D Expenditure = Prowess Firm R&D Capital Expenditure + Prowess Firm R&D Current Expenditure + Prowess Firm Foreign Currency Expenditure on Technical knowhow or Prowess Firm Payment for Import of Royalty (in Million INRs)*
Environmental Expenses	*Prowess Firm Environmental Expenses = Prowess Firm Expenses on Plant & Machinery + Prowess Firm Expenses on Repairs of Pant & Machinery (in Million INRs)*
Environmental Intensity	*Prowess Firm Environmental Expenses/Prowess Firm Total Sales*
Total Raw Material Expenses	*Prowess Firm Total Raw Material Expenditure (in Million INRs)*
Total Cost	*Prowess Firm Total Cost (in Million INRs)*
Fixed Cost	*Prowess Firm Fixed Cost (in Million INRs)*
Cash Profits	*Prowess Firm Cash Profits (in Million INRs)*
Value of Output	*Prowess Firm Value of Output (in Million INRs)*
Value of Import of Raw Materials	*Prowess Firm Import of Raw Material Expenditure (in Million INRs)*
Value of Import of Capital Goods	*Prowess Firm Import of Capital Goods Expenses (in Million INRs)*
Total Employment	*Prowess Firm Total Employees (in Numbers)*
Foreign Equity	*Prowess Firm Total Foreign Equity (in Million INRs)*
Total Borrowings	*Prowess Firm Total Borrowings (in Million INRs)*
Average Capital Employed	*Prowess Firm Average Capital Employed (in Million INRs)*
Total Investment	*Prowess Firm Total Investment= (in Million INRs)*
Exporter	*Dummy Indicating exporting status of a Prowess Firm*
Yr89	*Dummy equal to 1 for years > 1989*
Yr94	*Dummy equal to 1 for years > 1994*
Yr96	*Dummy equal to 1 for years > 1996*

Table 2 Descriptive Statistics

	All Firms	Exporters	Non-Exporters
Total Sales	64.14	82.14	38.24
	[146.56]	[156.65]	[126.26]
Wages & Salaries	5.79	6.99	4.05
	[15.22]	[16.14]	[13.61]
Power, Fuel and Electricity Charges	4.83	5.59	3.83
	[18.36]	[13.13]	[23.53]
Capital	43.14	59.56	21.21
	[178.92]	[210.54]	[121.35]
Investment	4.18	5.75	2.06
	[26.03]	[32.84]	[11.33]
Exports	14.35	17.15	
	[36.72]	[39.54]	
Domestic Sales	59.00	66.73	
	[126.29]	[136.18]	
Gross Value Added	14.80	17.21	2.44
	[35.29]	[38.05]	[5.14]
Advertising Expenses	0.27	0.37	0.102
	[1.82]	[2.22]	[0.83]
Total Research & Development Expenditure	0.15	0.22	0.05
	[3.28]	[4.23]	[0.53]
Environmental Expenses	39.21	51.40	21.66
	[124.87]	[124.28]	[123.64]
Total Raw Materials Expenses	29.90	38.92	17.84
	[62.95]	[72.56]	[44.35]
Total Cost	64.21	72.91	19.61
	[123.65]	[132.89]	[27.64]
Fixed Cost	8.55	9.86	1.84
	[22.30]	[24.12]	[3.31]
Cash Profits	1.50	2.41	-3.13
	[26.46]	[27.79]	[17.58]
Total Assets	94.04	110.83	18.35
	[280.46]	[307.21]	[28.16]
Value of Output	68.00	77.78	18.20
	[132.63]	[142.56]	[26.92]
Value of Import of Raw Materials	3.31	4.46	1.77
	[14.59]	[17.50]	[9.15]
Value of Import of Capital Goods	1.53	2.12	0.74
	[9.08]	[10.97]	[5.51]
Total Employment	100.12	113.56	81.96
	[1324.55]	[1558.46]	[918.43]
Foreign Equity	22.44	2.24	84.50
	[185.15]	[8.47]	[367.25]
Total Borrowings	41.51	53.77	23.84
	[149.96]	[177.48]	[94.80]
Average Capital Employed	48.61	63.42	25.41
	[186.27]	[210.71]	[136.43]
Total Investment	7.44	9.95	4.07
	[43.55]	[54.13]	[21.95]

Figures in the parenthesis are the Standard Deviations. The values are expressed in INR Millions, except for *Employment*, which is a count variable.

Table 3 Production Function Estimates

	Capital			Labour		
	OLS	Fixed Effects	Levinshon-Petrin	OLS	Fixed Effects	Levinshon-Petrin
All Firms	0.457	0.301	0.728	0.530	0.533	0.463
Leather	0.478	0.375	1.116	0.576	0.473	0.456
Textile	0.452	0.296	0.688	0.528	0.537	0.468
Exporters	0.463	0.315	0.769	0.517	0.518	0.463

We follow the steps outlined by the Levinshon-Petrin (2003) paper. The details of the Levinshon-Petrin Methodology have been outlined in the main text.

Table 4 Comparison of Pre & Post-Bans Scenario

1989-1996: Pre Ban Scenario	
Mean Sales	52.68
	[112.57]
Mean Export Earning	8.28
	[21.66]
Mean Environmental Expenses	1.64
	[13.16]
Mean Imports	6.14
	[22.00]
Mean R&D Spending	0.11
	[1.12]
Mean Foreign Royalty Spending	0.07
	[0.49]
Mean Productivity (Levinshon-Petrin)	0.82
	[0.75]
Mean Total Raw Material Expenses	25.05
	[46.30]
Mean Import of Raw Materials	2.56
	[11.29]
Mean Investment	2.60
	[19.35]
Mean Average Capital Employed	35.83
	[106.08]
Mean Cash Profits	3.34
	[14.07]
% of firm undertaking R&D	
% of firm undertaking Environmental Expenses	
1997-2003: Post Ban Scenario	
Mean Sales	73.27
	[168.26]
Mean Export Earning	18.97
	[44.35]
Mean Environmental Expenses	1.67
	[7.79]
Mean Imports	8.30
	[28.40]
Mean R&D Spending	0.18
	[4.30]
Mean Foreign Royalty Spending	0.07
	[0.83]
Mean Productivity (Levinshon-Petrin)	0.58
	[0.71]
Mean Total Raw Material Expenses	33.91
	[73.69]
Mean Import of Raw Materials	3.93
	[16.80]
Mean Investment	5.50
	[30.43]
Mean Average Capital Employed	57.68
	[226.13]
Mean Cash Profits	0.09
	[32.88]
% of firm undertaking R&D	
% of firm undertaking Environmental Expenses	

Figures in the parenthesis are the Standard Deviations. The values are expressed in INR Millions

Table 5 Comparison between High & Low *Environmental Intensity* Firms- Before & After 1996

	High Environmental Intensity		**Low Environmental Intensity**	
	1989-1996: Pre Ban Scenario	**1997-2003: Post Ban Scenario**	**1989-1996: Pre Ban Scenario**	**1997-2003: Post Ban Scenario**
Mean Sales	58.20	75.92	48.45	69.44
	[131.46]	[194.35]	[93.92]	[115.26]
Mean Export Earning	2.557	9.00	1.74	5.77
	[13.43]	[34.30]	[8.80]	[21.62]
Mean Environmental Expenses	35.27	65.86	11.49	22.10
	[94.52]	[187.47]	[19.27]	[50.22]
Mean Imports	7.50	9.89	3.69	5.87
	[25.72]	[33.35]	[10.08]	[14.77]
Mean R&D Spending	0.16	0.25	0.03	0.06
	[1.39]	[5.43]	[0.22]	[0.54]
Mean Productivity (Levinshon-Petrin)	0.73	0.49	1.00	0.72
	[0.65]	[0.65]	[0.87]	[0.78]
Mean Total Raw Material Expenses	26.61	33.31	22.93	32.15
	[53.41]	[80.40]	[37.66]	[57.80]
Mean Import of Raw Materials	3.17	4.62	1.67	2.51
	[13.62]	[19.97]	[6.45]	[8.42]
Mean Investment	7.20	9.32	4.26	7.52
	[42.07]	[56.68]	[22.25]	[29.99]
Mean Average Capital Employed	44.96	68.30	21.93	37.52
	[127.44]	[273.63]	[59.03]	[83.52]
Mean Cash Profits	3.42	-1.52	3.70	4.06
	[16.26]	[38.89]	[8.03]	[14.90]

High and Low Environmental Intensity is defined as follows: *if a firm's Mean Environmental Intensity is greater (lower) than the median of the Environmental Intensity of the Industry, then we define it as a High (Low) Environmental Intensity Firm*

Figures in the parenthesis are the Standard Deviations. The values are expressed in Rs Millions.

Table 6 Effect of the Bans

	Environmental Expenses						*Exports*						*Productivity*					
Yr89	1.7851	1.364					2.413	2.371					-1.288	-1.026				
	(0.089)^{c}	(0.195)^{c}					(0.346)^{c}	(0.360)^{c}					(0.107)^{c}	(0.226)^{c}				
Yr94			1.785	1.538					2.171	2.039					-1.288	-1.216		
			(0.089)^{c}	(0.137)^{c}					(0.337)^{c}	(0.333)^{c}					(0.107)^{c}	(0.147)^{c}		
Yr96					1.649	1.476					2.171	1.996					-1.369	-1.367
					(0.083)^{c}	(0.111)^{c}					(0.337)^{c}	(0.336)^{c}					(0.103)^{c}	(0.124)^{c}
Yr89*Exporter		0.447												-0.278				
		(0.189)^{b}												(0.208)				
Yr94*Exporter				0.260												-0.076		
				(0.114)^{b}												(0.109)		
Yr96*Exporter						0.180												-0.002
						(0.085)^{b}												(0.079)
Yr89*Assets								-0.002										
								(0.003)										
Yr94*Assets										-0.003								
										(0.001)^{c}								
Yr96*Assets												-0.001						
												(0.000)^{c}						
Log (TFP) and																		
	-0.106	-0.106	-0.106	-0.106	-0.106	-0.106	0.322	0.340	0.322	0.349	0.322	0.339						
	(0.025)^{c}	(0.025)^{c}	(0.025)^{c}	(0.025)^{c}	(0.025)^{c}	(0.025)^{c}	(0.059)^{c}	(0.057)^{c}	(0.059	(0.057)^{c}	(0.059)^{c}	(0.057)^{c}						
Log (GVA)													0.447	0.447	0.447	0.448	0.447	0.447
													(0.026)^{c}	(0.026)^{c}	(0.026)^{c}	(0.026)^{c}	(0.026)^{c}	(0.026)^{c}
R-square	0.5747	0.5754	0.5747	0.5770	0.5747	0.5763	0.2982	0.3072	0.2982	0.3213	0.2982	0.3146	0.4649	0.4652	0.4649	0.4651	0.4649	0.4649
N	4777	4777	4777	4777	4777	4777	3278	3278	3278	3278	3278	3278	4842	4842	4842	4842	4842	4842
F-Statistics	54.35	51.71	54.35	51.60	54.35	51.39	16.58	16.44	16.58	17.36	16.58	16.75	49.28	46.10	49.28	46.04	49.28	46.33
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Productivity is measured with Levinshon-Petrin (LP) Methodology.
Numbers in the parenthesis are clustered standard-errors. The standard-errors are clustered at the firm level. ^{a},^{b},^{c}: Significant at 10%, 5% and 1% level of Significance. Intercepts are not reported

Table 7 Discontinuation from the Markets (Export and Domestic) due to the Bans

	Exit Decision										
	Exports							*Domestic*			
Environmental	-0.005	0.0002	-0.005	-0.005	-0.005	-0.005	-0.005	-0.516	-0.959	-0.496	-0.636
Expenses	(0.001)[c]	(0.000)	(0.002)[c]	(0.001)[c]	(0.002)[c]	(0.002)[c]	(0.001)[c]	(2.647)[a]	(0.557)[a]	(2.510)[a]	(3.965)[a]
Total Factor	-0.003		-0.003	-0.002	-0.003	-0.003	-0.002	-1.378	0.627	-0.415	-2.691
Productivity	(0.003)		(0.001)[a]	(0.001)	(0.003)	(0.001)[a]	(0.001)[a]	(0.560)[b]	(0.650)	(0.441)	(1.364)[b]
R&D		-0.267		-0.061			-0.117				
		(0.135)[b]		(0.085)			(0.153)				
Gross Value Added			-0.00004						-0.052		
			(0.000)						(0.018)[c]		
Total Assets		-9.33e-06									
		(0.000)									
Cash Profits				-0.0001						-0.099	
				(0.000)[b]						(0.021)[c]	
Total Cost						-0.00001					-0.150
						(0.000)					(0.063)[b]
Raw Material Expenses					-5.45e-06						
					(0.000)						
Pseudo R-square	0.0703	0.0527	0.0796	0.0919	0.0706	0.0789	0.0769	0.6239	0.8460	0.6999	0.6994
N	2278	2504	2278	2272	2278	2278	2272	574	495	574	574
Log Pseudo Likelihood	-127.99	-166.39	-126.71	-124.96	-127.94	-126.81	-127.01	-7.053	-2.82	-5.63	-5.64
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Since, the decision is either to stay or exit from the market, our dependant variable is a binary variable with value either 0 or 1. We analyze our hypothesis using Probit Regressions. Marginal Effects are reported. Standard Errors are clustered at the firm-level. We control for all firm level, industry level and year dummies. Productivity is measured with Levinshon-Petrin (LP) Methodology.

Numbers in the parenthesis are clustered standard-errors. The standard-errors are clustered at the firm level. [a],[b],[c]: Significant at 10%, 5% and 1% level of Significance. Intercepts are not reported

Table 8 Quartile Regressions-With the Reform Dummies

	Environmental Expenses			Exports			Productivity		
1st Quartile*Yr89	0.139			1.083			-0.421		
	(0.063)[b]			(0.532)[b]			(0.170)[b]		
2nd Quartile*Yr89	0.100			1.922			-0.470		
	(0.055)[a]			(0.380)[c]			(0.154)[c]		
3rd Quartile*Yr89	0.067			1.441			-0.488		
	(0.050)			(0.426)[c]			(0.159)[c]		
4th Quartile*Yr89	0.078			1.967			-0.577		
	(0.053)			(0.582)[c]			(0.155)[c]		
1st Quartile*Yr94		0.110			1.287			-0.574	
		(0.055)[b]			(0.406)[c]			(0.157)[c]	
2nd Quartile*Yr94		0.134			1.560			-0.356	
		(0.053)[b]			(0.353)[c]			(0.157)[b]	
3rd Quartile*Yr94		0.064			1.653			-0.403	
		(0.054)			(0.368)[c]			(0.155)[b]	
4th Quartile*Yr94		0.089			1.863			-0.545	
		(0.054)[a]			(0.385)[c]			(0.151)[c]	
1st Quartile*Yr96			0.093			1.550			-0.554
			(0.056)[a]			(0.392)[c]			(0.160)[c]
2nd Quartile*Yr96			0.092			1.596			-0.382
			(0.053)[a]			(0.353)[c]			(0.152)[b]
3rd Quartile*Yr96			0.074			1.760			-0.417
			(0.052)			(0.368)[c]			(0.151)[c]
4th Quartile*Yr96			0.122			1.700			-0.520
			(0.051)[b]			(0.367)[c]			(0.150)[c]
Log (Total Factor Productivity)	-0.157	-0.157	-0.156	0.375	0.384	0.375			
	(0.023)[c]	(0.023)[c]	(0.023)[c]	(0.057)[c]	(0.056)[c]	(0.057)[c]			
Log (Environmental Expenses)							-0.113	-0.1055	-0.105
							(0.033)[c]	(0.033)[c]	(0.034)[c]
R-square	0.1113	0.1135	0.1121	0.3351	0.3362	0.3343	0.2112	0.2146	0.2136
N	4777	4777	4777	3278	3278	3278	4777	4777	4777
F-Statistics	6.48	6.49	6.91	21.75	20.26	19.78	30.32	31.64	30.72
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Productivity is measured with Levinshon-Petrin (LP) Methodology.
Numbers in the parenthesis are clustered standard-errors. The standard-errors are clustered at the firm level. [a],[b],[c]: Significant at 10%, 5% and 1% level of Significance.
Intercepts are not reported

Table 9 Quartile Regressions: Determinants of the Exit Decisions

	Exit Decision					
	Exports			*Domestic*		
1stQr*Environmental Expenses	-0.006					
	(0.005)					
2ndQr*Environmental Expenses	-0.004					
	(0.003)					
3rdQr*Environmental Expenses	-0.016					
	(0.008)[b]					
4thQr*Environmental Expenses	-0.022					
	(0.007)[c]					
1stQr*Total Factor Productivity	0.002			-0.0001		
	(0.002)			(0.000)		
2ndQr* Total Factor Productivity	-0.002			0.0001		
	(0.003)			(0.000)		
3rdQr*Total Factor Productivity	-0.006			0.0002		
	(0.003)[a]			(0.000)		
4thQr*Total Factor Productivity	-0.008			-0.0002		
	(0.002)[c]			(0.000)		
1stQr*Investment		-0.018			-0.025	
		(0.001)[a]			(0.005)[c]	
2ndQr* Investment		-0.004			-0.003	
		(0.001)[c]			(0.005)	
3rdQr* Investment		0.003			-0.002	
		(0.003)			(0.441)	
4thQr* Investment		0.0004			0.0002	
		(0.001)			(0.109)	
1stQr*Total Cost			0.001			-0.360
			(0.002)			(0.096)[c]
2ndQr*Total Cost			0.002			-4.670
			(0.002)			(0.943)[c]
3rdQr*Total Cost			0.001			-0.548
			(0.002)			(0.109)[c]
4thQr*Total Cost			-0.001			-0.169
			(0.001)			(0.028)[c]
Pseudo R-square	0.1011	0.0507	0.0621	0.3951	0.1387	0.4255
N	2278	3645	2645	576	1770	783
Log Pesudo Likelihood	-123.75	-187.42	-174.59	-11.35	-66.17	-17.38
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Controls	Yes	Yes	Yes	Yes	Yes	Yes

Since, the decision is either to stay or exit from the market, our dependant variable is a binary variable with value either 0 or 1. We analyze our hypothesis using Probit Regressions. Marginal Effects are reported. Standard Errors are clustered at the firm-level. We control for all firm level, industry level and year dummies. Productivity is measured with Levinshon-Petrin (LP) Methodology. Numbers in the parenthesis are clustered standard-errors. The standard-errors are clustered at the firm level. [a],[b],[c]: Significant at 10%, 5% and 1% level of Significance. Intercepts are not reported

Table 10 Quartile Regressions: With the Reform Dummies on Exit Decisions

	Exit Decision		
	Exports		*Domestic*
1st Quartile*Yr89	0.511		
	(0.102)[c]		
2nd Quartile*Yr89	0.455		
	(0.093)[c]		
3rd Quartile*Yr89	0.392		
	(0.088)[c]		
4th Quartile*Yr89	0.425		
	(0.089)[c]		
1st Quartile*Yr94		0.528	
		(0.137)[c]	
2nd Quartile*Yr94		0.543	
		(0.117)[c]	
3rd Quartile*Yr94		0.355	
		(0.116)[c]	
4th Quartile*Yr94		0.993	
		(0.006)[c]	
1st Quartile*Yr96			0.995
			(0.009)[c]
2nd Quartile*Yr96			0.605
			(0.142)[c]
3rd Quartile*Yr96			0.579
			(0.148)[c]
4th Quartile*Yr96			0.024
			(0.020)
Log (Total Factor Productivity)	-0.002	-0.001	-0.0001
	(0.002)	(0.001)	(0.000)
Pseudo R-square	0.0568	0.0664	0.3299
N	2295	2295	281
Log Pesudo Likelihood	-130.03	-128.70	-11.13
Firm Fixed Effects	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes
Year Controls	Yes	Yes	Yes

Since, the decision is either to stay or exit from the market, our dependent variable is a binary variable with value either 0 or 1. We analyze our hypothesis using Probit Regressions. Marginal Effects are computed. Standard Errors are clustered at the firm-level. We control for all firm level, industry level and year dummies.

Total Factor Productivity is measured using Levinshon-Petrin (LP) Methodology. Numbers in the parenthesis are the clustered Standard Errors. [a],[b],[c]: Significant at 10%, 5% and 1% level of Significance. Intercepts are not reported

Table 11 Effect of the Bans – Chemical Firms

	Domestic Sales			*R&D*			*Investment*		
Yr89	-0.070 (0.084)			0.196 (0.218)			1.604 (0.194)[c]		
Yr94		-0.301 (0.063)[c]			0.661 (0.287)[b]			1.582 (0.160)[c]	
Yr96			-0.313 (0.075)[c]			0.682 (0.283)[b]			1.536 (0.176)[c]
R-square	0.3540	0.3540	0.3540	0.1582	0.1582	0.1582	0.3206	0.3206	0.3206
N	9583	9583	9583	3115	3115	3115	5998	5998	5998
F-Statistics	123.66	123.66	123.66	11.13	11.13	11.13	36.61	36.61	36.61
Wald Chi-Square									
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Since, the purpose of the bans is to change the production structure of the Textile and Leather Industries, which includes the banning of certain chemicals from their production process, there could be an indirect effect on the chemical firms as well, which used to produce the textile and leather dyes. There should be a negative effect on the domestic sales due to fall in the demand for certain chemicals, with an positive effect both on R&D and Investment, in order to produce their substitutes.
Productivity is measured with Levinshon-Petrin (LP) Methodology.
Numbers in the parenthesis are clustered standard-errors. The standard-errors are clustered at the firm level. [a],[b],[c]: Significant at 10%, 5% and 1% level of Significance. Intercepts are not reported

Appendix III

Productivity

To begin our analysis, we construct consistent measures of firm-level TFP. Previous studies estimated productivity by ordinary least squares (OLS), taking as TFP the difference between actual and predicted output. This technique is subject to omitted variables bias, as the firm's choice of inputs is likely to be correlated with any unobserved firm-specific productivity shocks. If productivity is assumed time-invariant, the simultaneity problem may be solved by including firm fixed effects (Harrison (1994) and Balakrishnan et al. (2000)); however, this strategy may not be appropriate when we are interested in changes in firm-level productivity. We construct a consistent firm-level measure of TFP following the methodology of LP (2003). Building on Olley and Pakes (1996), LP (2003) use firm's raw material inputs to correct for the simultaneity in the firm's production function. The inclusion of a proxy in the estimation equation that controls for the part of the error correlated with inputs ensures that the variation in inputs related to the productivity term will be eliminated. LP (2003) show that if the demand function for intermediate inputs is monotonic in the firm's productivity for all relevant levels of capital, then raw materials can serve as a valid proxy. Assuming a Cobb-Douglas production function, the equation estimated for company i in industry j at time t in the first step can be written as follows:

$$Y_{ijt} = \widehat{A}_{ijt} L_{ijt}^{\theta_l} K_{ijt}^{\theta_k} Q_{ijt}^{\theta_q}$$

or

$$y_{ijt} = \theta_l l_{ijt} + \theta_k k_{ijt} + \theta_q q_{ijt} + \omega_{ijt} + \epsilon_{ijt}$$

where, lower caps symbolize the variables in natural logarithm. Y_{ijt} represents output of firm i in industry j at time t; L_{ijt}, K_{ijt}, and Q_{ijt} denotes labour, capital and power, fuel and electricity expenditures respectively. $\widehat{A}_{ijt} = A^{\theta_q}$ is the productivity. We can write the above equation as follows:

$$va_{ijt} = \theta_l l_{ijt} + \theta_k k_{ijt} + \omega_{ijt} + \epsilon_{ijt}$$

where, $va_{ijt} = y_{ijt} - \theta_q q_{ijt}$ signifies the natural logarithm of value added. ω_{ijt} is the firm-level Total Factor Productivity (TFP) and is unobservable to the econometrician, while ϵ_{ijt} is the classical error term. Using OLS to estimate the above equation will lead to biased coefficients since the input choice for each firm will be correlated with its productivity level. For example, if more productive firms are also the ones that are more capital intensive, then OLS on the above equation will lead to a downward bias on θ_k and an upward bias on the remaining co-efficients. On the other hand, a standard fixed-effects estimator will ignore time-varying shocks to productivity. As a result, to obtain consistent estimates of the input coefficients in the above equation, I will use the LP methodology.

The highlight of this approach is its ability to account for the simultaneity between input choices and productivity. The LP method is a semi-parametric technique based on a dynamic profit maximization problem in which the firm, if it decides to remain in the market, must choose the level of labor and intermediate inputs to employ at time t. The intermediate input demand function can be written as $q_{ijt} = q_t(k_{ijt}, \omega_{ijt})$. Assuming intermediate input use to be positive and monotonically increasing in productivity, we can invert the input demand function to obtain the following expression $\omega_{ijt} = \omega_t(k_{ijt}, q_{ijt})$. This allows us to proxy for the unobservable productivity variable in the value-added equation, with a function of capital and proxy for intermediate inputs. Following LP (2003), we have used power, fuel and electricity expenditures at the firm level as our choice for the intermediate inputs. This yields an estimate of the coefficient for labour. In the second stage, the coefficient for capital is obtained using the assumption that productivity follows a first-order Markov process. We use the procedure to consistently estimate productivity separately for both the textile and leather industry. The production function estimates obtained from the LP (2003) methodology are then used to calculate the log of TFP for each firm using the following:

$$tfp_{ijt} = va_{ijt} - \theta_l l_{ijt} - \theta_k k_{ijt}$$

θ_l and θ_k are actual estimated coefficients of labour and capital respectively. Table **3** compares OLS, Fixed Effects and LP's capital and labour estimates of production function. As expected, both OLS and FE overestimate the coefficients for labor and underestimate the coefficient for capital. The underestimation of capital is especially acute in the case of fixed effects estimation.