Effect of Environmental Regulation on a Firm's Performance

Evidence from a Policy Experiment

PAVEL CHAKRABORTY

Using a policy experiment that involved the imposition of a technical regulation by the Ministry of Environment and Forests on the Indian leather and textile industries in 1997, firm-level data set is used to study trade, adaptation, innovation and survival effects and how they vary by firm size. The study finds that (i) regulation led to significant gains from trade through the use of improved raw materials and technological change, especially for the big firms, (ii) use of high-quality raw materials and productivity level significantly accounts for the exit decision of a firm, and (iii) regulation significantly affects the exit probabilities of all firms across size distribution.

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Pavel Chakraborty (*pavel.chakraborty@gmail.com*) teaches at the Centre for International Trade and Development, Jawaharlal Nehru University, New Delhi.

With production technologies that generate some of the most polluting chemical effluents, both the leather and textile sectors emerged as a battleground for current environmental debates (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 bimodal worldwide; and, second, there have been some dramatic regulatory shifts in the industries, with the processing technologies under greater scrutiny by the governments and consumer advocacy groups in the industrial economies.

1 Regulatory Shift

One such regulatory shift is the circular issued by the Ministry of Environment of Forests (MoEF) in March 1997 on the use of azo dyes. This notification is an extension of a German regulation imposed in July 1994, which banned the import and production of any consumer goods, which is treated with azo dyes. However, though the German regulation is only relevant for the leather and textile exporters, the MoEF regulation caters to the entire set of firms, which belong to these particular industries. I use this policy experiment to study the effect on firm-level trade (export earnings), adaptation (use of new raw materials), innovation (technology transfer) and survival effects using a micro-level data set on Indian leather and textile firms. The main finding of this paper is that the domestic regulation helped the big Indian leather and textile firms to accrue significant gains from exports through the use of high-quality raw materials and upgraded technology, with adverse effects for small firms.

Technical regulations or technical barriers to trade (TBTs) such as product certification requirements, performance standards, testing procedures, conformity assessments, labelling standards, etc, commonly encompass 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. The regulation on azo dyes is one such. The MoEF regulation on azo dyes completely banned the import and consumption of the harmful chemical as it is carcinogenic to the skin. Also, by banning the complete production and import of this harmful chemical, the government not only reduced the cost of enforcement, it also made the industries themselves to be the chief enforcers of the ban (Tewari and Pillai 2005).

One significant event followed the regulation. The Government of India (GoI) along with the upstream sector (chemical firms) and German regulatory authorities unleashed a process of innovation for the new substitutable and direct technical support and started a process of joint collaboration in order to help the leather and textile firms adapt to the new regulations. However, the reactions may well vary due to firm size (financial, technological, human resource capacity, etc). The reason for this immediate and efficient action primarily by the stakeholder associations of these industrial categories is due to the importance of these sectors both in terms of their contribution to the domestic economy and international trade earnings.

India is one of the main exporters of leather and textile products in the global market and both these industries employ a very high proportion of the domestic labour force. The textile industry is one of the largest employers in India, second only to agriculture, accounts for about 16% of India's total exports and 3.04% of the global trade in textiles (Ministry of Textiles 2008). The total leather exports is $2.4 billion, third only to China and Italy, ranks eighth in export earnings within the country and holds a share of around 5.16% of world trade. It is also a major employer, providing employment to about 2.5 million people (CLE 2008).

The fundamental challenge regarding environmental regulations or for any such technical regulation is to resolve the presumed trade-off (between compliance and competitiveness) involving the process of adjustment by the firms. The MoEF ban addresses the issue of compliance in relation to environment related barriers by introducing the role of standards, applicable particularly for the leather and textile industries in India. The environment-related regulations can affect various dimensions of a firm for a number of reasons: (i) standards could directly raise the production costs; (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 markets; and (iii) asymmetric information about standards and inefficiency in the domestic inspection process could also significantly raise further implicit barriers to 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 (Chakraborty 2001; Mehta 2005), neither the empirical nor the theoretical investigations in terms of assessing the effects of environmental regulations or non-tariff barriers (NTBs) at the micro level are very substantive. I use a firm-level panel data set containing direct measures of total sales, exports, imports, assets, expenditure on raw materials, gross value added, research and development (R&D) expenditure, royalty payment on technical know-how, total cost, labour, capital, intermediate goods, etc, to test different conjectures in the context of these particular regulations to test for trade, adaptation, innovation and discontinuity effects of this particular regulation for 1990–2002.

The results are clear. I start by estimating the effect of the 1997 MoEF regulation on three important firm-level attributes—export revenues, expenditure on raw materials and royalty payments for technical know-how (a proxy for technological transfer) and how they vary by firm size.[1] Indirect evidence of a signalling effect is seen. The regulation forced the leather and textile firms to use high quality substitutable inputs and improved technology in their production process, which helped them to earn significant higher revenue from exports. This gain from trade is highest and significant for the big firms, (firms belonging to the fourth quartile of the firm-size distribution), as a result of investments in technology and improved raw materials. In other words, the use of new substitutable input and upgraded technology led to the production of improved, high-quality and cleaner end-products carrying a quality signal and helped the big leather and textile firms reap significant gains from their international trade flows. On the other hand, the regulation negatively hit the small firms in terms of export revenues.

Next, I examine the factors which may pose a credible threat on the continuity of a firm's activity as a result of this regulation. The non-linear estimates demonstrate that the use of new raw materials and productivity of a firm significantly explains the exit decision of a firm. Higher expenditure on high-quality new raw material entails low exit probabilities. Also, higher productive firms have lower exit probabilities. Lastly, I check for heterogeneity in firm-survival probabilities as a result of the 1997 MoEF regulation. Significant effect of the regulation on the exit decisions of the leather and textile firms across firm-size distribution is observed.

2 Review of Literature

This paper mainly relates to the literature regarding the impact of regulation especially environmental regulation, on firm competitiveness. The literature on the effect of environmental regulation is concentrated mainly on two different kinds of effects: (i) the signalling or the demand-side effect, and (ii) the cost or the supply-side effect. The demand-side literature argues that a technical standard may act as a label or a quality indicator, thereby giving a signal to the consumers that the product concerned is of higher quality. This may increase the effective demand by relieving consumers' concerns about product quality (Porter and Van der Linde 1995; Thilmany and Barett 1997; Andre et al 2009). On the other hand, the cost-side literature portrays that by raising adaptation costs, higher standards raise overall production costs of the polluting firms, rendering them uncompetitive, and driving them out of the industry (Lahiri and Ono 2007). Given this contradictory theoretical outcome of a single event, the result mainly depends on empirical evidence.

Empirically, the effect of environmental regulations has been explored in the following dimensions: (i) productivity (Gray 1987; Dutta and Narayanan 2005); (ii) plant exit (Biorn et al 1998); (iii) trade volumes (Chen et al 2008); (iv) product choice (Lipscomb 2008); (v) plant or establishment birth and size (List et al 2003); and (vi) innovation activity (Kneller and Manderson 2010). The empirical evidence is mostly mixed, that is, some studies find positive effects, while others the opposite.

In case of India, the empirical literature regarding the effect of environmental regulation can broadly be divided into two different sets of studies: (i) focusing on the technical efficiency of different set of firms belonging to the manufacturing industries, such as: sugar industry (Murthy and Kumar 2003); cement industry (Banerjee 2007); and (ii) exploring the impact of different kinds of trade-related environmental regulations, sanitary and phyto-sanitary (SPS) and TBT, on aggregate export flows from India. Chakraborty (2001) looks at the effect of NTBs on primary exports; Mehta et al (2003) addresses the impact of SPS agreements on selected food products; Mehta (2005) looks at the NTBs faced by Indian exports in the developed countries (United States [US], European Union [EU] and Japan); Mehta (2010) uses gravity analysis to understand the impact of food safety standards from industrialised countries on India's food exports.

Though there is some amount of literature available on the effects of environmental regulation in India, most of it focuses on the effect of such regulations on firm-level efficiency measures or aggregate trade flows or understanding the impact through qualitative case studies approach. This paper adds to the existing literature in identifying an important quasi-natural experiment in terms of trade-related environmental regulation, and estimates its effect using micro-level data on the targeted industries, that is, the Indian leather and textile firms. Tewari and Pillai (2005) surveyed some leather firms in and around Chennai to understand the effect of phencyclidine (PCP) and azo dyes ban by EU on firm competitiveness. However, the paper is of qualitative in nature. To the best of my knowledge, this is the first paper which empirically addresses the effects of the domestic azo dyes ban by the MoEF in 1997 at the micro-level through firm-level exports, expenditure on raw materials, technological change and survival effects.

3 Data Source

The current study uses firm-level data from PROWESS database published by the Centre for Monitoring Indian Economy (CMIE). It contains information primarily from the income statements and the balance sheets of the companies. The database covers large companies, companies listed on the major stock exchanges (this includes all the publicly traded firms) and also many small enterprises. Data for big companies is worked out from the balance sheets while CMIE periodically surveys the smaller companies for their data. The firms in the sample comprises of 60% to 70% of the economic activity in the organised industrial sector in India and encompasses 75% of corporate taxes and 95% of excise duty collected by the GOI (Goldberg et al 2010).

A downside of the database is that it does not cover the unorganised sector, which comprises of a significant proportion of the industrial sectors in India. However, this would not affect the results/findings much, as I look into trade, adaptation, innovation and survival effects of the firms. This is due to two major reasons: (i) most of the firms in the unorganised sector operate in a random fashion and this would pose significant biases in estimating the exit probabilities; (ii) a large part of their trade takes place through the intermediaries and a significant portion of the firms in the unorganised sector are sporadic exporters. This would also pose certain kind of biases in my estimates.

PROWESS has some significant advantages over other data sets documenting India's manufacturing sector: (i) it is a panel of firms, which enables us to see firm performance over time; (ii) the database records detailed product-level information at firm level; and (iii) the data set perfectly suits the period under study, that is, 1990–2002. All the variables are measured in Indian rupees (million). The advantages of this data set allow the examination of the behavioural changes in the leather and textile firms as a result of the imposition of the regulation by MoEF in 1997. An unbalanced panel over the period 1990 to 2002 is used for estimation purposes.

Preliminary Analysis

This section previews the empirical strategy. Table 1 looks at the behaviour of a few important firm-level indicators in the pre- and post-MoEF regulation of 1997. The pre-regulation period is 1990–97 and the post-regulation period is 1998–2002. The average values of expenditures/earnings across all the leather and textile firms is calculated for total sales, export earnings, expenditure on account of raw materials, royalty payments for technical know-how (proxy for technology transfer), investments on account of R&D and expenditure on plant and machinery. Values in Table 1 are corrected for inflation using the sector-specific wholesale price index (WPI).

Table 1: Comparison of Firm-level Characteristics Pre- and Post-1997 Regulation

	All Leather and Textile Firms	
	1997 MoEF Regulation	
	1990–97 Pre-ban	1998–2002 Post-ban
Total sales	59.43	84.43***
Exports	4.39	6.28**
Expenditure on raw material	16.67	25.85***
Expenditure on technology transfer	0.30	0.30
Expenditure on R&D	0.28	0.35**
Expenditure on plant and machinery	0.47	0.77***

Figures are simple averages (deflated by WPI) of all the leather and textile firms. Values are expressed in ₹millions. *, **, *** denotes significance at 10%, 5% and 1% level, respectively.

An average leather and textile firm earns more revenue from selling (both total sales and exports) in the post-regulation period. The increase in sales (total and export earnings) could be either due to an increase in price or quantity or both. Since PROWESS does not provide any information on either price or quantity of exports at the firm level, it is difficult to arrive at the exact reason regarding the increase in the earnings of an average leather and textile firm. Expenditure on account of raw materials saw significant increase in the post-regulation period. Royalty payments towards technical know-how or transfer of technology stayed the same, whereas, R&D expenditure increased marginally. Expenditure on account of plant and machinery also increased significantly. Use of new raw materials may require some changes in the production process, which led to the increase in the investment towards plant and machinery. However, these results are merely suggestive and

not conclusive evidence unless one controls for other simultaneous events and firm-level characteristics (observed and unobserved).

4 Effect of the Regulations

4.1 Empirical Strategy

Following the basic statistical diagnosis, I now evaluate the effect of the 1997 MoEF ban on three of the most important firm-level characteristics by estimating linear regressions of the fixed-effects type specification:

$$\ln(x_{ijt}) = \beta(\text{Post}_t * \text{ltd}_{ij}) + \text{firmcontrols} + \theta_i + \eta_t + \varepsilon_{ijt}$$

The dependent or left-hand side variable x_{ijt}, is either the export earnings or expenditure on raw materials or technology transfer of a leather and textile firm. $Post_t$ is the year dummy variable measuring the environmental regulation. It takes a value 1 for the years following the environmental regulation, that is, it takes the value 1 for the years 1998–2002. Since, the main variable of interest is a year dummy, it will be difficult to distinguish between the "treatment" and the "time" effects unless a control group is used in the estimation. In order to untangle the true effect of the regulation dummy, the entire manufacturing sector less the chemical is used as the control group.[2] This group is exogenous to the shock or the treatment and its behavioural pattern more or less follows the same path as that of the treated one. This may not be the perfect control group that one could use. The best could have been using any sub-sectors within the leather and textile industries, which is exogenous to the regulation. However, given the circumstances, this is the best that I can come up with since all the other manufacturing sectors are also similarly impacted by the macro reforms (for example, by simultaneous tariff and foreign direct investment liberalisation since the 1990s) in the same way as leather and textile sectors. Using any other sector, say services, would definitely be more exogenous to the shock relative to the manufacturing sector, but the behavioural pattern of any services sector is completely different from that of manufacturing (as this is not a tradable sector) and may bias the results.

ltd_{ij} is a dummy variable, which takes a value 1 for a firm if a firm belongs to the leather and textile sector. The main coefficient of interest β measures the effect of the regulation ($ban97 = Post_t * ltd_{ij}$) on firm-level outcomes given that a firm belongs to the leather and textile sector in comparison to those sectors which potentially have the same characteristics as the treated sectors, but are exogenous to the regulation. In other words, it measures the relative effect of the leather and textile firms. *firmcontrols* include size of the firm, age, age squared, and indicator for domestic or foreign ownership. Total assets of a firm is its size indicator. θ_i and η_t are firm and year fixed effects, respectively. The standard errors are clustered at the firm level.

While estimating the above equation, I also control for other simultaneous events or trade policies which could potentially affect the outcomes. Those, if not, may confound the estimates. Four important events took place during the same time frame as the period of analysis which may affect the results: (i) the trade reform process in India, (ii) India becoming a member of World Trade Organization (WTO) in 1995, (iii) partial phasing out of the Agreement on Textiles and Clothing (ATC) as a continuation of the Multi-Fibre Arrangement (MFA) from 1995 onwards, and (iv) in March 1998, the European Commission (EC) requested India to procure export licences in order to export raw hides and skins. Also, as a result of the membership of WTO in 1995, India experienced substantial depreciation in bilateral exchange rate, which could also affect the results. The presence of the year fixed effects (η_t) in the regression equation will categorically control for the effect of all these important and categorical events.

Apart from these simultaneous significant developments, there are also incidences of a number of anti-dumping duties[3] that have been imposed by the EU and US during the same time period on different kinds of textile products from India. The presence of firm fixed effects should absorb any such effect. The presence of firm-level fixed effects (θ_i) will also control for the information received by the firms about the bans, the network effects (with the state-level stakeholder agencies, which are the primary receiver of the information about the regulations) and the assistance the firms got from institutions like the Central Leather Research Institute (CLRI) or the Bombay Textile Research Association (BTRA), which helped them with consultations in the process of upgrading the production process or the use of new raw materials. Controlling for all these other policy effects will help produce better estimates of the regulation.

4.2 Results

Table 2 summarises the effect of the 1997 regulation on firm-level export revenues, expenditure on raw materials and technology transfer. Columns (1) and (2) estimate the effect of the 1997 regulation on export revenues of the leather and textile firms. In a nutshell, the 1997 regulation has significant positive impact on the export revenues of the leather and textile firms. Columns (1) and (2) regress natural logarithm of total exports of a leather and textile firm plus one on the interaction between $Post_t$ and ltd_{ij} controlling for the size, age and the ownership of a firm with firm (which will absorb any unobserved heterogeneity among firms) and year (which will absorb any other policy shock) fixed effects. The coefficient of interest clearly demonstrates that the 1997 MoEF regulation significantly increases

Table 2: Effect of the 1997 Ban on Exports, Raw Materials and Technology Transfer

	1997 MoEF Regulation					
	ln(Exports + 1)		ln(Raw Materials + 1)		ln(Tech Transfer + 1)	
	(1)	(2)	(3)	(4)	(5)	(6)
Ban97	0.126*	0.128*	0.251***	0.256***	0.071	0.061
	(0.073)	(0.073)	(0.086)	(0.085)	(0.241)	(0.243)
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
R-square	0.82	0.83	0.85	0.85	0.76	0.76
N	36769	36769	18483	18483	4932	4932
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	No	Yes	No	Yes

Numbers in the parenthesis are clustered standard errors. Standard errors are clustered at the firm level. *, **, *** denotes 10%, 5% and 1% level of significance. Intercepts are not reported.

the export earnings of a leather and textile firm as opposed to all other manufacturing sectors.

To corroborate the findings of the study, I also check the trend of the total amount of leather and textile exports from India. The value of exports from 1991–92 to 1998–99 went up from ₹30,360 million to ₹64,360 million and ₹1,54,836 million to ₹4,01,715 million for leather and textile goods, respectively—an increase by more than double in each case. My results are strikingly similar to that of Swann et al (1996) and Moenius (2005) even though they use different time periods and different data sets. They use counts of standards to find that British exports are positively correlated with national standards. It also draws support from the central premise of the Porter and Van der Linde (1995) hypothesis that environmental regulations do sometime have a positive effect on the competitiveness of the firms through regulation-induced innovation.

The principal objective of this regulation is to ban a widely used chemical (which is supposedly harmful) in the production process of leather and textile products and substitute it with some improved quality input. This process of substitution entails a firm to adjust its production process either using a different set of inputs (replacing the banned chemical) and/or technical upgradation. Using a different set of inputs (of high-quality) or new upgraded technology may have encouraged this growth in exports in the post-regulation period. This process of substitution may have helped the firms to gain higher export earnings, but they also add to a firm's production cost (Greaker 2006; Andre et al 2009). This brings us to measure the effect of the 1997 regulation on the adaptation expenditure of the firms: use of new raw materials and royalty payment for technical know-how.

Columns (3)–(4), and (5)–(6) estimate the effect of the notification issued by the MoEF in 1997 (*ban97*) on expenditure towards raw materials and royalty payments for technical know-how, respectively. The results show that the 1997 regulation has significant and positive impact on the expenditure towards raw materials by the leather and textile firms with no effect on technology transfer. Based on a field-level survey in Chennai and Kanpur for leather firms and Mumbai and Surat for textile firms, TERI, 2005 also points out that the firms experienced an increase in their adaptation cost (through use of high-quality materials) in the process of substitution of the banned chemical. Moreover, the report also points out that the process of substitution did not hinder export flows significantly.[4] Surveying leather firms in Chennai, Tewari (2001) also documents similar evidence of significant increase in their cost of substituting the newly improved chemical. OECD case studies (2006a, 2006b) on the effect of azo dye ban also reports of similar increase in the adaptation cost for the leather and textile firms. The OECD study (2006a) also points out that one consequence of this change is the improvement in the general environmental performance of India's leather and textile industries.

Effect of the Regulation

Next, I aim to test whether the effect of the regulation is heterogeneous, that is, does the effect vary across size distribution of firms? In order to do so, I divide the entire sample into four quartiles, according to the total assets of a firm. I consider total assets as the size indicator of the firms. The different size categories of firms are indicated by a dummy variable. For example, if the total assets of a particular firm fall below the 25th percentile of the total assets of the industry, then that firm belongs to the first quartile and the variable would indicate 1 for that particular firm, and zero otherwise. Likewise, if a firm's total assets fall between 25th percentile to 50th percentile, 50th percentile to 75th percentile and above 75th percentile, the firm belongs to the categories of second, third and fourth quartile, respectively. I interact different quartile dummies with $ban97 = Post_t * ltd_{ij}$ in order to measure the effect of the MoEF regulation on that particular quartile of firms. I estimate the effect on the different quartiles of the firms using the following equation:

$$\ln(x_{ijt}) = \beta^r \sum_{r=1}^{4} (ban97 * Q_{it}^r) + \psi^r \sum_{r=1}^{4} Q_{it}^r + \gamma(ban97) + firmcontrols + \theta_i + \eta_t + \epsilon_{ijt}$$

where r indexes each of the four different quartiles of the size distribution and Q_{it}^r are dummy variables taking the value of 1 when firm i belongs to quartile r.

Table 3 produces the required result—heterogeneous estimates of the effect of the 1997 MoEF regulation on export revenues, expenditure on raw materials and technology transfer according to their size distribution. Column (1) regresses the natural logarithm of exports on the interactions of the four different quartile dummies with $Post_t * ltd_{ij}$.

Table 3: Effect of the 1997 Ban on Exports, Raw Materials and Technology Transfer—Quartile Regressions

	1997 MoEF Regulation		
	ln (Exports + 1)	ln (Raw Materials + 1)	ln (Tech Transfer + 1)
	(1)	(2)	(3)
1stQr* *Ban*97	-0.180	-0.121	0.304
	(0.123)	(0.203)	(0.456)
2ndQr* *Ban*97	-0.172*	-0.006	-0.032
	(0.097)	(0.156)	(0.437)
3rdQr* *Ban*97	0.100	0.181	0.605**
	(0.122)	(0.137)	(0.276)
4thQr* *Ban*97	0.463***	0.378***	-0.083
	(0.127)	(0.115)	(0.290)
Firm Controls	Yes	Yes	Yes
R-square	0.83	0.85	0.76
N	36769	18483	4932
Coefficient Equality (p-value)	0.000	0.127	0.063
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Same as Table 2.

The results demonstrate that the effect of the regulations is indeed heterogeneous.[5] The increase in export earnings as a result of the regulation is concentrated only for the big firms, whereas it is opposite for the small firms. Next, in column (2), I use the expenditure on raw materials as the dependent variable. I find that the regulations significantly increases the expenditure on raw materials for the large leather and textile firms, that is, only for firms, which belong to the fourth quartile. The estimate is significant at 1%. Drawing reference from the result in column (1), I argue that the use of the high-quality substitutable raw materials may have possibly helped the firms of the fourth quartile to achieve higher growth in exports in

the post-regulation phase. Lastly, I use natural logarithm of royalty payments on account of technical knowhow as the dependent variable in column (3). As the result demonstrates, the effect of the regulations on the technology transfer is positive and significant for the firms belonging to the upper-middle size cohort of the firm size distribution, that is, the firms of the third quartile. This transfer of technology may have helped the marginally big firms (firms belonging to the third quartile) to negate any negative effects from the regulation, which is the case for the small firms, which could not invest either in high-quality new raw materials or technology transfer.

This result regarding the transfer of technology concentrating on the upper-middle size cohort of firms as a result of some exogenous trade-related shock is outstandingly similar to the benchmark result of Bustos (2011) on Argentine firms (as a result of the MERCOSUR Agreement), even though she uses a completely different context and data set. Tewari and Pillai (2005) also point out that in the adjustment process, there is significant evidence of technical transfer from the standard-imposing country Germany, to India. The Indo–German Export Promotion Project (IGEP) played a significant role in providing the firms with adequate help to adapt to changes in the technical and environmental standard put forward by the regulation. The United Nations Industrial Development Organization (UNIDO) also has been one of the proactive intergovernmental organisations in providing technical assistance to leather industries (OECD 2006b). As a continuation of the significant technical assistance at the firm level, a new, internationally certified testing centre, such as Asia's first ISO-17025 certified testing and certification laboratories was established in 2001. It resulted in important spillover gains for both the industries. These findings recommend that the involvement of the state—both Germany and India—made a crucial difference to the degree and speed of compliance.

So, what is the economic rationale behind the increase in the relative earnings of the leather and textile firms as a result of the regulation? The introduction of the 1997 MoEF regulation allowed for the production of a new and environmental friendly variant using high-quality input. Since, environmental friendly products are more costly to produce, in any unregulated market, many firms would like to avoid the foray from "green" production. But, in the case of a binding regulated market, the firms are bound to adopt the high quality input (the results of this study give an indirect evidence of such practice) as suggested in order to maintain their operations. And, since the regulation came from the demand-side, the firms benefit from the consumers' willingness to pay higher prices for a high-quality good and none would run the risk of being exploited by their competitors. This is called the signalling effect. The adoption of a high-quality input gives a clear signal to the consumers about its quality, which leads to higher earnings from trade. Further, the quick adoption of the newly improved chemical/input due to various local/regional and international agencies, public and private, helped the firms to lower their cost of adjustment, generate ongoing learning and diffuse widely across the value chain. This particular result draws support from the theoretical underpinnings of Greaker (2006) and Andre et al (2009). Both the studies highlight that environmental regulation can positively affect firm performance through investment in high-quality inputs and production process.

5 Survival Probabilities

5.1 Empirical Strategy

As trade cost goes down, the chance of survival of a firm increases, thereby enabling new firms to enter the market. I test the opposite. The regulation could impose an additional cost on the operation on the firms (in terms of complying with the regulation). This could lower their survival chances thereby forcing them to exit the market (Melitz 2003). In particular, the factors which could be responsible in lowering the chances of survival of a leather and textile firm as a result of the regulation or help them to survive are examined. Since, the decision to exit is a discrete variable, which by definition equals 0 or 1, the conditional probit model with a discrete binary endogenous dependent variable is appropriate. Hence the discontinuing probability of a firm i operating in industry j at time t is:

$$\Pr\left(X_{ijt}=0 \middle| X_{ijt-1}>0\right) = 1 \text{if} \left(\text{ban97}*Z_{ijt}\right)+\mu_j+\eta_t+\epsilon_{ijt}=0$$
$$= 0 \text{ otherwise}$$

where, Z_{ijt} is a vector of control variables, which includes expenditure on raw materials, technology adoption, productivity of a firm, expenditure on plant and machinery and capital employed. All the firm-level attributes are used in their natural logarithmic form. The dependent variable is the discontinuing decision of a firm, which is denoted as 1 if the domestic sales of a firm equals zero for the years 1998 or 1999, conditional on the fact that the domestic sales is positive on or before the year of the ban. Since, the exit decision is taken at the firm-level, a full set of industry (μ_j) dummies is used. A battery of year fixed effects (η_t) is included. The standard errors are clustered at firm level. The coefficients are estimated by maximum likelihood procedure. Marginal effects are reported. The entire manufacturing sector less the chemical as the control group is used in the estimation. All the estimations include the double interaction and the individual terms. To check if the dependent variable is capturing the right effect and not any just general trend, another estimation is additionally performed (the results are not reported). Any random year is taken as the potential year of exit and the same set of regressions are run to see if the factors, which significantly affect the operation decision of a firm as result of the regulation, stay the same. No such evidence is found.

5.2 Results

A regulation can affect an establishment or a firm for a variety of reasons: choice of technology, production scale, investment behaviour, changes in revenues and costs (due to acquisition of more capital), choice of inputs, etc. These changes in a firm's structure due to compliance with a regulation could act as potential barriers, thereby decreasing their chance of survival. Biorn et al (1998) studies the correlation between

environmental regulations and plant exit for three manufacturing sectors in Norway to find that firm characteristics play an important role in the exit probability of a firm. Therefore, following the imposition of this binding environmental regulation (acting as a trigger) significantly impact the exit decision of the firms, through different choice variables?

Table 4 discusses the results from the conditional probit estimation. Columns (1)–(5) estimate the survival probabilities of a firm as a result of MoEF regulation in 1997. Column (1) regresses the exit decision of a firm on the interaction of the natural logarithm of expenditure of raw materials and $Post_t * ltd_{ij}$. The result shows that higher expenditure towards raw materials entails low exit probability. In other words, the estimates indicate that at the mean, a surviving leather and textile firm spent 0.2%–0.7% more in comparison to a non-survivor on account of raw materials. Column (2) examines whether productivity of a firm has any effect on the exit decision. Productivity is estimated using Levinshon and Petrin (2003) methodology. Higher productive firms have lower probabilities of exit. Columns (3) and (4) introduce expenditure on account of plant and machinery and capital employed (another size indicator). No significant evidence of any other factor except for the expenditure on the raw materials and productivity level is found on the exit decision of the firms. Column (5) additionally introduces the amount of technology adopted by a new firm. Technology adoption is defined as the sum of expenditure on R&D and royalty payments for technical know-how. No significant effect of the technology adoption by a leather and textile firm is seen on its exit decision. The primary result continues to hold. The components of technology adoption are separated and separate regressions are also run (the results are not reported). No significant effect of either of the components affecting the exit decision is seen.

Table 4: Effect of the 1997 Ban on Survival Probabilities

	1997 MoEF Regulation				
	Exit Decision				
	(1)	(2)	(3)	(4)	(5)
*Ban*97*RM	-0.002***	-0.0003	0.002	-0.007*	-0.001***
	(0.001)	(0.000)	(0.001)	(0.004)	(0.000)
*Ban*97*TA					0.001***
					(0.001)
*Ban*97*TFP		-0.002***	-0.002***	-0.001	-0.002**
		(0.000)	(0.001)	(0.003)	(0.002)
*Ban*97*PM			-0.001	-0.0004	
			(0.001)	(0.001)	
*Ban*97*Cap				0.006	
				(0.004)	
R-square	0.178	0.153	0.112	0.158	0.277
N	1554	1254	688	197	560
Industry FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes

"RM" is the amount of expenditure on raw materials by a firm. "TA" is the amount of technology adoption of a firm. Technology adoption is the sum of R&D expenditure of a firm and technology transfer. "TFP" is the total factor productivity of a firm. "PM" is the amount of expenditure on the repairs of plant and machinery by a firm. "Cap" is the amount of capital employed by a firm in its production process. All the firm characteristics are used in their natural logarithm form. All the regressions include the individual terms of the double interactions and double interaction terms of the triple interactions. Numbers in the parenthesis are clustered standard errors (at the firm-level).
*, **, *** denotes significance at 10%, 5% and 1% level, respectively.

Next, the direct impact of the regulation on the discontinuing decisions of the firms across different quartiles is estimated:

$$\Pr\left(X_{ijt}=0 \middle| X_{ijt-1}>0\right) = 1 \text{ if } \beta^r \sum_{r=1}^{4} (ban97*Q_{it}^r) + \psi^r \sum_{r=1}^{4} Q_{it}^r + \gamma(ban97) + \mu_j + \eta_t + \epsilon_{ijt} = 0$$

=0 otherwise

The dependent variable used in the equation is the same as before. It takes a value 1 if the domestic sales of a leather and textile firm is zero in either of the years following the regulation conditional on the fact that it is positive on the year or before the year of the ban. Again, the entire manufacturing sector minus the chemical is used as the control group. The standard errors are clustered at the firm level.

Table 5 displays the direct effect of the 1997 domestic regulation on the survival probabilities of the leather and textile firms of different sizes. This is done to examine the heterogeneity in the survival probabilities of the firms. In other words, how the firm exit effects vary by size. The required effect is investigated by using a conditional probit regression with a full set of industry and year fixed effects. The variables of interest are the interaction terms of four different quartile dummies with $Post_t * ltd_{ij}$. The coefficients of these interaction terms measure the variance in the effect of the regulations on different sizes of the leather and textile firms. Significant negative effects of the regulation are seen across size distribution of the leather and textile firms, that is, all size quartiles are significantly affected. But, this does not say whether the firms actually exit the market or stop producing the product. Lipscomb (2008) reports evidence of product-switching by the Indian manufacturing firms as a result of state-level environmental enforcement in India. The big firms are usually the exporters who may have already adjusted themselves in response to the foreign regulation in 1994. Therefore, the firms of the third or the fourth quartile which are affected as a result of the domestic regulation are more likely to be the medium-sized enterprises in absolute terms rather than the usual big ones.

Table 5: Effect of the 1997 Ban on Survival Probabilities—Quartile Regressions

	1997 MoEF Regulation
	Exit Decision
1stQr**Ban*97	-0.012*
	(0.006)
2ndQr**Ban*97	-0.017***
	(0.005)
3rdQr**Ban*97	-0.036***
	(0.004)
4thQr**Ban*97	-0.029***
	(0.004)
R-square	0.060
N	3906
Coefficient Equality (p-value)	0.004
Industry FE	Yes
Year FE	Yes

Numbers in the parenthesis are the clustered standard errors. Standard errors are clustered at the firm level.
*, **, *** denotes significance at 10%, 5% and 1% level, respectively.

6 Conclusions

This paper investigates the effects of the imposition of a technical standard or trade-related environmental regulation by a domestic regulatory authority in response to a foreign regulation on trade, adaptation, innovation and firm exit for the Indian leather and textile firms. It exploits firm-level data from leather and textile manufacturing sector to present evidence, which is at odds with the prevalent view of environmental

compliance and trade competitiveness of firms from developing countries. In particular, the study finds that the regulation leads to significant increase in gains from international trade for both the leather and textile firms. The gains from trade are realised on the basis of a signalling effect through the use of high-quality raw materials and high-technology production process. This gain is concentrated only in the big firms, fourth quartile of the size distribution.

Regulation, on average, acts as a barrier and can be termed as an implicit cost, which can impact firm survival. The impact of the regulations on the exit probabilities of an average leather and textile firm shows that higher use of high-quality raw materials entails low exit probabilities. The high-productive firms survive the domestic regulation. Lastly, the study shows that the domestic regulation significantly affects the exit probabilities across firms of all sizes.

There is considerable debate about whether regulations or standards do help or hurt the competitiveness of firms. This paper is an empirical contribution to this continuously growing literature. Though this paper does not test Porter's hypothesis (1995) directly, it explores somewhat similar issues. The results go beyond the assumed trade-off between the compliance and the competitiveness of the firms and prove that firms from developing countries can also comply with stringent global standards that are increasingly being associated with trade, without necessarily undermining their competitiveness.

In the context of these reforms, India not only promoted the quality of production for the domestic market but also for exports in order to obtain the necessary foreign revenue for development and investments. And, in the process, the leather and textile industry played an important role. According to an interview conducted by Tewari and Pillai (2005) in IGEP in 2003, there is a general agreement that India had taken care of its azo dye problem and emerged as a model in the international circles, especially among its competitor countries, such as China and Pakistan.

NOTES

1 The reason to look at the technology transfer and not R&D expenditure is because the literature on azo dyes points out that the investments in R&D expenditure or the innovation of the new substitutable product has mainly occurred with the upstream (chemical) sector.

2 The chemical sector is eliminated from the control group as the azo dyes ban on leather and textile goods is also a de facto ban on the chemical sector.

3 Temporary Trade Barriers Database, World Bank (http://econ.worldbank.org/ttbd/); Global Antidumping Database, World Bank (http://econ.worldbank.org/ttbd/gad/).

4 Surveying 30 firms (mostly small and medium-sized, and some large) each from the leather and textile sector, the report highlights that sufficient amount of time was given by the importers to modernise (which had obvious cost implications), but the cost has not been prohibitive for further export opportunities.

5 The probability that the coefficient for four different quartiles being equal is zero.

REFERENCES

Andre, F J, P Gonzalez and N Porteiro (2009): "Strategic Quality Competition and the Porter Hypothesis," *Journal of Environmental Economics and Management*, Vol 57, Issue 2, pp 182–94.

Banerjee, S (2007): "Environmental Regulation and Technical Efficiency: A Data Envelopment Analysis for Indian Cement Industry," ERU Discussion Paper ERU/2007-01, Indian Statistical Institute, Kolkata.

Biorn, E, R Golombek and A Rakneurd (1998): "Environmental Regulations and Plant Exit," *Environmental and Resource Economics*, Vol 11, No 1, pp 35–59.

Bustos, P (2011): "Trade Liberalization, Exports and Technology Upgrading: Evidence on the Impact of MERCOSUR on Argentinian Firms," *American Economic Review*, Vol 101, No 1, pp 304–40.

Chakraborty, D (2001): "Non-tariff Barriers on Indian Primary Exports," RGICS Working Paper No 27, Rajiv Gandhi Institute of Contemporary Studies, New Delhi.

Chen, M X, T Otsuki and J S Wilson (2006): "Do Standards Matter for Export Success," World Bank Policy Research Working Paper 3809, World Bank, Washington DC.

— (2008): "Standards and Export Decisions: Firm-level Evidence from Developing Countries," *Journal of International Trade and Economic Development*, Vol 17, Issue 4, pp 501–23.

CLE (2008): *Annual Reports*, Council of Leather Exports, Chennai.

Dutta, N and K Narayanan (2005): "Impact of Environmental Regulation on Technical Efficiency: A Study of Chemical Industry in and Around Mumbai," mimeograph, Department of Humanities & Social Sciences, Indian Institute of Technology, Bombay.

Goldberg, P, A Khandelwal, N Pavcnik and P Topalova (2010): "Multi-product Firms and Product Turnover in the Developing World: Evidence from India," *The Review of Economics and Statistics*, Vol 92, No 4, pp 1042–49.

Gray, W B (1987): "The Cost of Regulation: OSHA, EPA and the Productivity Slowdown," *American Economic Review*, Vol 77, No 5, pp 998–1006.

Greaker, M (2006): "Spillovers in the Development of New, Pollution Abatement Technology: A New Look at the Porter Hypothesis," *Journal of Environmental Economics and Management*, Vol 52, No 1, pp 411–20.

Kneller, R and E Manderson (2010): "Environmental Compliance Costs and Innovation Activity in UK Manufacturing Industries," Discussion Paper No 10/08, University of Nottingham, United Kingdom.

Lahiri, S and Y Ono (2007): "Relative Emission Standard Versus Tax Under Oligopoly: The Role of Free Entry," *Journal of Economics*, Vol 91, No 2, pp 107–28.

Levinshon, J and A Petrin (2003): "Estimating Production Functions Using Inputs to Control for Unobservables," *Review of Economic Studies*, Vol 70, No 2, pp 317–42.

Lipscomb, M J (2008): "The Effect of Environmental Enforcement on Product Choice and Competition: Theory and Evidence from India," mimeograph, University of Notre Dame, the US.

List, J A, D L Millimet, P G Fredriksson and W W McHone (2003): "Effects of Environmental Regulations on Manufacturing Plant Births: Evidence from a Propensity Score Matching Estimator," *Review of Economics and Statistics*, Vol 85, No 4, pp 944–52.

Mehta, R, M Saqib and S Geroge (2003): "Addressing Sanitary and Phyto-Sanitary Agreement: A Case Study of Select Processed Food Products in India," RIS Discussion Papers No 39, Research and Information System, New Delhi.

Mehta, R (2005): "Non-Tariff Barriers Affecting India's Exports," RIS Discussion Papers No 97, Research and Information System, New Delhi.

— (2010): "International Food Safety Standards and India's Food Exports: An Analysis Based on Gravity Model Using Three-Dimensional Data," RIS Discussion Papers No 169, Research and Information System, New Delhi.

Melitz, M (2003): "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity," *Econometrica*, Vol 71, No 6, pp 1695–725.

Ministry of Textiles (2008): *Annual Report*, Government of India.

Moenius, J (2005): "Information versus Product Adaptation: The Role of Standards in Trade," Mimeograph, University of Redlands, USA.

Murthy, M N and S Kumar (2003): "Win-Win Opportunities and Environmental Regulation: Testing of Porter Hypothesis for Indian Manufacturing Industries," *Journal of Environmental Management*, Vol 67, pp 139–44.

OECD (2006a): "Limits on Aromatic Amies in Textiles Coloured with Azo Dyes," Organisation for Economic Co-operation and Development, Paris.

— (2006b): "Limits on Chemical Residues in Leather Goods," Organisation for Economic Co-operation and Development, Paris.

Porter, M E and C Van der Linde (1995): "Towards a New Conception of the Environment-Competitiveness Relationship," *Journal of Economic Perspectives*, Vol 4, No 4, pp 97–118.

Swann, P, P Temple and M Shurmer (1996): "Standards and Trade Performance: The UK Experience," *The Economic Journal*, Vol 106, No 438, pp 1297–1313.

TERI (2005): "Trade Liberalization—Impacts and Opportunities for the Indian Leather, Textile and Marine Products," The Energy and Resources Institute, New Delhi.

Tewari, M (2001): "Trade Liberalization and the Restructuring of Tamil Nadu's Leather Sector: Coping with Liberalization's New Environmental Challenges and Lessons from Prior Episodes of Adjustment," mimeograph, paper prepared for the Center for International Development, Harvard University and Government of Tamil Nadu, India.

Tewari, M and P Pillai (2005): "Global Standards and the Dynamics of Environmental Compliance in India's Leather Industry," *Oxford Development Studies*, Vol 33, No 2, pp 245–67.

Thilmany, D D and C B Barrett (1997): "Regulatory Barriers in an Integrating World Food Market," *Review of Agricultural Economics*, Vol 19, No 1, pp 91–107.