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Environmental Compliance by Firms in the Manufacturing Sector in Mexico

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Abstract

To date, little empirical evidence exists to help regulators understand why some firms comply even when there is little financial incentive to do so and others continually violate environmental regulations. This paper examines data on compliance with environmental regulations within the manufacturing sector in Mexico. The probability of complying depends, among other factors, on the kind of management practices of the firm and the level of environmental training. Some firms in the manufacturing sector over-comply with regulations. Our results show that providing environmental training to employees in the firm increases the probability of over-compliance. Local community has a positive impact on over-compliance however the magnitude of its impact is not as strong as is often suggested in the literature.

JEL Classification: Q20, O10.

Key Words: Environmental regulation, Compliance, Mexico.

1. Introduction

Most environmental regulatory mechanisms are based on the premise that firms would not undertake any environmentally beneficial projects without explicit pressure from the regulatory authority.[1] While this premise is true in a number of cases, there is growing evidence that many firms comply with environmental regulations even when these regulations are weak or non-existent. Despite low penalties, studies assessing overall compliance rates have found that 60 to 80 percent of firms and individuals comply with environmental regulations and many voluntarily exceed the standards (Arora and Cason, 1996, Harrington, 1988, Gangadharan, 2001). Why do firms comply with environmental regulation in the presence of low fines and not very frequent inspection rates? According to one explanation, (Harrington, 1988), the enforcement process can be modelled as a Markov decision problem- i.e., the firms that are caught to be in violation in one period are moved to a separate group in the next period in which they are subject to more frequent inspection and higher fines. Hence firms have an incentive to comply in order to avoid being moved into the frequently inspected group. A second explanation is that firms comply and sometimes even over-comply to guide regulatory authorities to set higher standards for the whole industry, thereby increasing the costs of their rivals (Salop and Scheffman, 1983).

Yet another explanation that is gaining ground recently is that firms comply to gain reputation as an environmentally conscious organisation. Arora & Gangopadhyay, 1995 show that public recognition plays a very important role in the success of voluntary environmental programs. Arora and Cason, 1996 assess the factors that influence a firm's decision to participate in EPA's 33/50 program in the

[1] This is because there is often a cost associated with undertaking environmentally sustainable production, which is borne by the firms alone but the benefits of this sustainable production are usually shared by society.

United States. They find that firms in industries that are closer to final consumers (proxied by normalized advertising expenditures) are more likely to participate in this voluntary programme. In developing countries, environmental regulations could be weak and not very rigorously enforced due to budget constraints, staffing deficiencies and corruption in the judicial system. Hence formal enforcement mechanisms might not work very well in these countries and it is therefore important to focus on other factors that can encourage compliance amongst firms.

In this paper, recent survey evidence from manufacturing industries in Mexico is used, to study the impact of different management practices, vintage of technology, level of environmental training and education of workers and the influence of community pressure on the probability of the firm complying with environmental regulations. Knowledge of the motivation behind a firm's decision to improve environmental performance is of utmost significance. Information on factors that drive firms to voluntarily improve their environmental standing has obvious advantages to policy makers. Particularly in countries where environmental laws are weak, understanding the reasons why firms improve environmental performance can help us in formulating policies to encourage this trend.

Hettige, Huq, Pargal and Wheeler, 1996 find that many countries in South-east Asia including Indonesia, Thailand and the Phillippines suffer from poor environmental standards that are either weak or ineffectively enforced. A common perception is that a lack of enforced regulations in developing countries provides firms with no incentives to improve their environmental performance. If this were the case, then it would be expected that developing countries would become pollution havens for many multi-national companies. However numerous studies have found

that many firms still comply with regulations despite minimal enforcement and monitoring (Hettige et al 1996, Hartment et al).

Recent research has identified a number of informal regulations that may promote environmental compliance. Where does the incentive to comply with regulations come from? One source identified is the capital market (Lanoie, Laplante and Roy, 1998). The capital market, if properly informed can play a significant role in pollution reduction by providing appropriate reputational and financial incentives. This possibility arises because capital markets can react either negatively to announcement of negative environmental incidents or positively to the announcement of positive environmental incidents (Dasgupta, Laplante and Mamingi, 1997). Sen et al (1998) tested the reaction of capital markets in Argentina, Chile, Mexico and Philippines to good environmental news and bad environmental news and found that the capital markets reacted positively to good environmental news and negatively to bad environmental news. This implies that firms in developing countries face a cost of pollution despite weak formal regulations. Firms' incentives to remain "clean" may also be due to pressure from communities and the incentive to uphold their reputations (Hettige et al., 1996, 1997). Pargal and Wheeler, 1996 find that communities penalise dirty factories through informal regulations. In Indonesia the pollution control agency initiated a programme that rates and publicly discloses the environmental performance of Indonesian factories. This easy to interpret colour rating system has been very successful in improving environmental performance at a very low public cost. Following the success of this programme, Phillipines, Mexico and Colombia are also beginning similar programmes (Tietenberg and Wheeler, 2001). Another incentive to comply operates via the credit market. A number of

studies show that banks are less likely to extend credit to firms with poor environmental records (Lanoie, Laplante and Roy, 1998, Laplante and Lanoie, 1994).

The motivation for this paper is multifold. Firstly, the need to understand why firms voluntarily reduce emissions and improve their environmental standing despite ineffective regulatory standards has significant policy implications for regulatory authorities. Research in this area has indicated the presence of informal regulations that provide incentives to minimise pollution, however more research is needed as evidence is still scarce. In addition, the study on Mexico itself is also of importance. Mexico City has notoriously high pollution levels, with air pollution exceeding the legal safe standard 182 days during 1996 (Dasgupta et. al, 2000) and this pollution poses a threat to human health.

This paper is organised as follows: Section 2 summarises the data used in the analysis. Section 3 describes the estimation methodology employed to examine the data on environmental compliance. Section 4 presents the results and Section 5 concludes with a discussion of the results.

2. Data and Descriptive Statistics

In this paper we use data from a survey conducted in 1995 in Mexico, by the World Bank, to examine the incentives that drive pollution improvement programs implemented at the firm level. The survey focused on four sectors: Food, chemicals, non-metallic minerals and metals, that are in total estimated to generate approximately 75 percent to 95 percent of Mexico's total industrial pollution. This includes water pollution, air pollution, toxic residue and non-toxic residue. Detailed interviews were conducted at 236 facilities, which were chosen to represent Mexican industries in a set of categories that were defined by sector, size class and location. The sample is well

balanced with 62 plants in the food sector, 62 in the chemicals sector, 51 in the non-metallic minerals sector and 61 in the metals sector. The plants are also evenly distributed along the size scale, with roughly similar number in the large class and in the medium and small class. Size classes are defined by employment ranges, with small having 16-100 employees, medium about 100-250 employees and large more than 250 employees. In the interview, the respondents were asked questions about compliance with environmental regulation and management. The survey was designed to obtain detailed information about the determinants of the firm's marginal abatement cost curve and the expected marginal penalty schedules. Dasgupta et. al, 2000 provide an excellent summary of all the variables used in the survey.

As the data are self-reported, they rely on the honesty and accuracy of the individual firms surveyed. Hence the data may be subject to upward bias, particularly so for variables like compliance with environmental regulations.[2] Compliance is divided into 5 categories and these are summarised in Table 1. Category 1 is defined in this paper as over-compliance and it represents 10 percent of the firms in the data. The firms in this category have exceeded the environmental requirements and claim to have initiated a world-class environmental program in their firm. Category 2 and 3 are added up to obtain compliance (83 percent of the firms). Category 2 has firms that consistently observe Mexican environmental laws and category 3 has firms that usually observe the environmental laws, though they sometimes fail in specific points. Category 4 and 5 are combined to obtain non-compliance (7 percent of the firms). These categories include firms that usually fail to observe environmental laws and firms that rarely observe the environmental laws, respectively.

[2] Dasgupta et.al, 2000 suggest that the degree of upward bias in the Mexican data on self-assessment of compliance is not large. They compare the compliance rates with those from independent auditing of a large sample of Indonesian firms and find that the reported levels of compliance are reasonable. The analysis in this paper (following Dasgupta et.al, 2000) focuses on relative performance of firms and not on the absolute levels of compliance.

The factors that affect the compliance decision of a firm are the following: the output produced by the firm summarised by the industrial sector that the firm is in (ie, the sectoral composition of the firms). The firms are in the food, chemical, non-metallic minerals and metal sector and each is represented by a dummy, with non-metallic minerals taken as the reference dummy. Some firms reward employees for their contribution towards environmental performance. This is represented by a variable defined as Reward in the paper. Reward is equal to 1 if the firm rewards employees for environmental performance. It is argued that firms that give incentives to employees to improve environmental performance would have a higher probability of compliance. Whether a firm is part of a firm with multiple plants (Multiplant = 1 if firm has multiple plants) is another factor that could determine environmental compliance. Dasgupta et al 2000 found that a firm, which is part of a multiplant organization was related to larger environmental management effort. It is expected that the multiplant status allows the firm to undertake more abatement as it can exploit economies of scale. Ownership status of the plant is another relevant variable in this discussion. If the firm is publicly owned or publicly listed (Ownership2), then it would be subjected to greater public scrutiny and would therefore be faster in adopting better environmental practises. Thus publicly owned firms are anticipated to have a higher probability of complying with environmental regulations.

The environmental decisions made by the firms could also be influenced by the markets in which they sell their products. The survey contains information on whether the firms sell their products in international markets. Variables have been defined for sales within Mexico: Sal_Mexico, sales to Asia: Sal_Asia, sales to the United States and Canada: Sal_Usca, sales to Europe: Sal_eur and sales to other Latin American countries: Sal_laam. Sales in each of these markets are coded as 0 for a 0

percentage of the firm's products being sold in that market and 5 for a percentage between 76-100. We would expect to find that firms that have a large percentage of sales to more developed countries like United States, Canada and Europe would have a higher probability of complying with environmental regulations. This is due to the fact that consumers in developed countries usually have a higher preference for environmental quality and are often more aware of environmental issues. Hence they would have a lower probability of buying products from firms that have a reputation of polluting the environment. This could be linked to the argument that the environment is a luxury good and only when individuals or countries have achieved a certain level of income they turn their attention to environmental issues (Grossman and Krueger, 1995 present evidence that some pollutants follow an inverted U-shaped curve with respect to income, rising at lower levels of income and falling at higher levels).[3] In some cases, there are trade agreements that could prevent or make it very difficult for polluting firms to sell their products internationally. For example, the North American Free Trade Agreement between North America and Mexico has incorporated rules whereby abiding by environmental laws is necessary for firms to avoid sanctions.[4] This would put pressure on firms to improve compliance and encourage them to incorporate pollution prevention into planning and operation decisions within the firm.

To be able to capture the impact of the product market in a more direct manner, we also define a variable for sales to final consumers (Sal_Cons). This

[3] In the early stages of economic development, a country would be unwilling to trade consumption for investment in environmental regulation, hence environmental quality declines. Once the country reaches a threshold level of income, its citizens start to demand improvements in environmental quality and this leads to implementation of policies for environmental protection and eventually to reductions in pollution.

[4] In the early nineties, the North American Free Trade Agreement brought to public attention the question of the impact of trade on environmental protection in countries with different levels of economic development. Critics feared that this trade agreement between North America and Mexico could lead to significant deterioration of the environment, Husted and Logsdon, 1997.

variable is coded from 0 to 5 (0 for 0 percent and 5 for 76-100 percent) depending on the percentage of sales by the firm to final consumers. Variables for sales to industrial consumers (Sal_Ind) and wholesalers or distributors (Sal_Wh) have also been defined with the purpose of comparing with the variable Sal_Cons. These variables reflect the product orientation of the firm. Firms that manufacture mainly for consumers rather than for industrial or wholesale consumption, are in more direct contact with the public. Labatt, 1997 shows that product orientation of the firm has an important role to play in reducing packaging waste, with consumer oriented firms observed to be more proactive in reducing the amount of waste. It is therefore expected that higher the percentage of sales to final consumers, better is the environmental performance of the firm.

Other variables that can influence the compliance decision of the firm are whether the necessary technology required to undertake environmental improvements is available (Tech_avail = 1 if the relevant technology is available) and assessment of the environmental impact of the firm (Cont_eval = 1 if the firm has a procedure for continuous evaluation). The human capital employed by the firm have a very important role to play as well. The education level of employees (represented by the percentage of employees with more than primary education: Empsec) could have an impact on environmental performance of the firm. Training of employees performing tasks in the environmental section of the firm and in the other sections can be vital to the success of a lot of environmental programs. Training could be in areas of environmental management, environmental auditing, environmental law, risk analysis, handling of hazardous residue, industrial risk minimisation or even a Masters in environmental engineering. Some firms are active in providing training within the firm or providing access to training (The variables defined to examine the

effect of training are the following: Train_ne: environmental training available to employees not directly involved in the area of environment, Train_e: Environmental staff received training since 1990, Envman: Have the staff in the environmental area been trained in the field of environmental management) and it is expected that these firms would have a higher probability of being compliant. There are some additional variables in the survey that address the question of management differences between different firms and the number of staff available to work in the environmental section. Variable Env_resp = 1 indicates that in some firms, persons not assigned to the environmental sections have environmental responsibility and variable Oth_resp =1 indicates that employees have other responsibilities in addition to the environmental ones. Env_pers = 1 represents the firms who have hired more employees in the environmental area.

Firms with newer technology could incur lower abatement costs as new machines might be more energy efficient and might incorporate measures to decrease polluting by-products. Variables Tech 80 (Code for Percentage of plant installed prior to 1980) and Tech 90 (Percentage of plant installed since 1990) have been included in the model to capture this effect. Compliance by firms is often affected by the inspection rates by the environmental agency. This is represented by the variable: Inspect = 1, if the firm has been inspected by the authorities with regard to their environmental performance. Magat and Viscusi, 1990 and Laplante and Rilstone, 1996 show that inspections and the threat of inspections significantly reduce the absolute levels of water pollution emitted by the pulp and paper plants in the United States and Canada. Dasgupta et al, 1999 show that inspections significantly reduce industrial air and water pollution in China. Information barriers about environmental issues (for example, what the law requires and what kind of technology is available to

improve environmental performance) are another reason why firms might not comply. This is included in the variable: Envinfo, which is = 1 if firms find it difficult to obtain environmental information.

Local communities and neighbourhood groups are often argued to influence a firm's environmental record. Firms are concerned about public opinion as bad publicity could have an adverse effect on their product market and share market performance. Communities that are richer, better educated and have more access to information about the consequences of environmental pollution find innovative ways of enforcing environmental norms. These communities would also be able to use available regulatory channels more efficiently. The survey asks questions on the extent of influence of neighbourhood and local communities in the firm's decision making on environmental issues. Information on the influence of industrial chamber and associations and the influence of legislative requirements is also obtained. All the data however is for one time period and some of these variables would start having an impact on the firm's compliance outcome after a lag. For example, we might observe that a firm with a bad environmental performance has stated that the neighbourhood and local community have been very influential in determining their actions regarding environmental issues. So in the data we might in some cases find a negative relationship between the community variable and the firm's compliance record, which might seem counter-intuitive. These variables (the community, business and legal variables) therefore could be endogenous. However to correct for their potential endogeniety bias we need good instruments (for example, variables lagged by a time period), which are difficult to find as all the data are cross-sectional.

3. Estimation Methodology

The decision to comply with environmental regulations is described by the following latent variable model.

$$C_i^* = X_i\beta + \varepsilon_i$$

C_i^* is the net benefit attained by firm *i* by over-complying with environmental regulations. X_i is a vector of firm characteristics that determine C_i^*, and ε_i is a random error, with zero mean and unit variance. However, C_i^* is not observed – what we do observe is the following variable:

$$C_i = \begin{cases} 1, & \text{if the firm over-complies} \\ 0, & \text{otherwise} \end{cases}$$

This can be estimated using a binary logit model.

Now let us assume that C_i can take more values (over-comply, comply and not comply with environmental regulations):

$$C_i = \begin{cases} 0, & \text{if the firm over-complies} \\ 1, & \text{if the firm complies} \\ 2, & \text{if the firm does not comply} \end{cases}$$

In the multinomial logit estimation procedure we can rewrite the above as follows:

(i) $C_i = 0 : C_i^* > \mu_1$ (firm over-complies),

(ii) $C_i = 1 : \mu_1 \geq C_i^* \geq \mu_2$, (firm complies),

(iii) $C_i = 2 : \mu_2 \succ C_i^*$, (firm does not comply)

In the above equations, μ_1 and μ_2 are unknown parameters. The estimated equation is given by:

$$C_i = X_i\beta + \varepsilon_i$$

The reduced form parameters of this equation are estimated using maximum likelihood based on a multinomial logistic distribution of ε. Since the probabilities of being in the 3 states (i) – (iii) must add to unity for each firm, the multinomial logit strategy involves estimating two equations. In this study, we have normalised category (i), i.e. adopted the state of over-compliance as the baseline case in the multinomial logit regressions. The choices mentioned above can also be ranked in a descending order from the viewpoint of social welfare. The welfare based ordering would be as follows: if firm over-complies ($C_i = 0$), if it complies ($C_i = 1$), if it does not comply ($C_i = 2$). The equation is then re-estimated as an ordered logit model that respects this welfare ordering.

In addition to the compliance with environmental laws, we also examine if firms have implemented any improvement programs (with respect to their environmental performance) since 1990 or have plans to undertake improvements. Improve is defined to be binary variable, with 0 representing the choice to not improve and 1 representing the choice to make improvements. This is estimated using a binary logit model. This variable captures the firm's commitment to have better environmental performance in the future.

Heteroscedasticity across observations can often be a concern with cross section analyses, hence the estimates reported in the paper are White-heteroscedasticity consistent. There is some correlation between different groups of variables in the data set, however multicollinearity does not appear to have been a problem for estimation.

4. Results

Of particular interest in the compliance literature is the issue of over-compliance. Why do some firms comply more than required by law? To focus on the over-compliance decision of the firm, we examine the factors that determine whether firms comply more than required by legislation. Out of 235 firms in the data set, 23 firms over-comply with environmental regulations. Table 2 presents the logit estimates of the factors that determine the firm's decision to over-comply with environmental regulations. Firms in the food and the chemical industry have a lower probability of over-complying as compared to the non-metallic minerals. Firms that give a reward to their employees, financially or otherwise, for their contribution to the environmental performance of the firm exhibit a significantly higher probability of over-compliance. Similarly firms with multiple plants have a higher probability of over-compliance. This is expected as firms that have a multiplant status have the ability to undertake more abatement by perhaps buying cleaner machines and also by initiating a progressive environmental management strategy in their firm.

An increase in the firm's domestic sales reduces the probability of over-compliance. An increase in sales to the United Sates and Europe also decrease the probability of over-compliance. An increase in sales to Latin America increases the probability of over-compliance. An increase in sales to final consumers and to industries decreases the probability of over-complying. When the percentage of employees with more than primary education is higher in firms, then the probability of over-compliance increases. When the staff not directly involved in the area of the environment are given environmental training, then the probability of over-compliance increases. Similarly, when staff not assigned to environmental sections

are given environmental responsibilities then again the probability of over-compliance is high. These management policies increase awareness of environmental issues in the whole firm and also motivate people to do better than what the law requires. The vintage of the technology used by the firms matters: when the percentage of plant installed prior to 1980 is higher then probability of over-compliance is lower. Installation of newer technology seems to increase the probability of over-compliance. This could also be an indicator of indivisibilities in the abatement technology. Newer technology could be so efficient that it leads to more pollution reduction than required or planned by the firm. Inspection by environmental authorities reduces the probability of over-compliance. It is possible that inspection is targeted towards firms that have a record of non-compliance, hence inspection could be an endogenous variable. Pargal et.al, 1997 estimate a simultaneous equation model taking into account the endogeniety of the inspections variable and use data on industrial water pollution from India to find that the frequency of inspections have no impact on the level of emissions of firms. Local community has a positive influence on environmental over-compliance, whereas industrial associations and business have a negative impact on over-compliance. Providing training in environmental management to staff who work in the environment section, seems to reduce the probability of over-compliance.

4.1. Multinomial Compliance Choice

Table 3 presents the multinomial logit regression estimates for a) the case where the firm complies and b) where the firm does not comply. The choice category of over-compliance has been adopted as the baseline category for normalisation. The corresponding marginal probabilities are presented in Table 4.

The results from the multinomial estimation procedure indicate that the firms in the food and chemical industry have a higher probability of compliance and firms in the metal industry have a lower probability of compliance. The policy of giving a reward for environmental performance seems to increase the probability of non-compliance compared to the over-compliance baseline. Similarly if the firm has a multi-plant status it has a higher probability of being non-compliant as compared to the baseline category. A higher percentage of sales to Asia and to other Latin American countries leads to a higher probability of not complying with environmental regulations. It is possible that consumers in Asia and Latin America are less environmentally conscious than the consumers in the United States, Canada and Europe hence firms that sell their products in the Asian and Latin American markets are less concerned about their environmental performance. An increase in the sales to final consumers decreases the probability of not complying and increases in sales to industrial consumers also decreases the probability of non-compliance. This makes intuitive sense as firms that sell directly to final consumers are more responsive to environmental concerns (as compared to firms that sell to wholesalers or distributors) and are interested in projecting a green image as this might help increase their market share. Availability of appropriate technology seems to lead to a higher probability of non-compliance and so does the continuous assessment of the environmental impact of the plant.

A higher percentage of employees in a firm with more than primary education leads to a higher probability of that firm not complying. Dasgupta et al (2000) confirm that employee education does not significantly raise compliance. When environmental training is available to employees not directly involved in the area of environmental management, then it leads to a higher probability of the firm not

complying, relative to the baseline category of over-compliance. Employees in non-environmental sections of the firm might not be concerned about or aware about the environmental implications of their actions. Hence the management could be targeting training towards these groups and this could start having an impact on environmental performance, however this could be observed only with a time lag. To be able to examine this issue, we need to follow the firm's environmental performance over a number of years and use panel data estimation techniques. Inspection by environmental authorities increases the probability of over compliance. The vintage of the technology in the firm seems to have a perverse effect, as when percentage of plant installed before 1980 increases, there is a decrease in the non-compliance probability of a firm. So having old technology in the plant leads to higher compliance levels. Industrial chambers and associations are influential in significantly increasing the probability of over compliance amongst firms. Neighbourhood and local communities seem to have no impact on compliance probabilities of firms. Finally, the compliance choices that a firm faces can also be ranked with respect to social welfare. To estimate this ordered choice model we use an ordered logit model. The estimates from this model are very similar to the multinomial logit results. They are not presented in the paper but are available on request.

4.2. Improvements in Environmental Performance

Another variable of interest is whether the firm has any plans to improve environmental performance or has carried out improvement programs since 1990. Examining this variable helps us in understanding the firm's interest in making dynamic changes to its management strategy and whether it has a sustained interest in environmental practises. Decision to improve is a binary variable: with 0, representing

the choice to not improve and 1 representing the choice to make improvements. Results from this binary logit model are presented in Table 5. The results show that technology being available and continuous assessment of the performance of the plant leads to a higher probability of improvements being carried out by the firm. The marginal results indicate that these factors can increase the probability of improvements by 5 percent. Providing environmental training and responsibility to all employees, even those who do not work in the environmental management area increases the probability of improvements being carried out by the firm by about 11 percent. Rewarding employees for environmental performance strangely, decreases the probability of improvements being carried out by the firm. A possible reason for obtaining this counter-intuitive result is that the firms that have instituted this reward policy might be the ones who have bad environmental records and are now trying to motivate their employees to take environmental implications into consideration. Hence this negative relationship in the data between reward and environmental improvements could be due to endogeniety issues, which could be corrected for if we had access to long term data or had other relevant variables that could be used as instruments. The community and business variables do not play a significant role in influencing the probability of improvements.

5. Discussion

Firms' decision regarding compliance can be explained in various ways. Some firms comply due to the fear of inspections and fines, others comply as they want to project an environmentally responsible image to their consumers and shareholders. This paper examines data on compliance by Mexican manufacturing sector firms. Over-compliance by firms in this sample, is observed to be influenced by positive

factors (for example, rewards and training) more than negative factors (like inspections). Rewarding environmental performance increases the probability of over-compliance. These rewards are given to employees based on environmental performance measures, on suggestions for environmental improvements or for observance of internal auditing. They can take financial forms or they could also be in the form of recognition within the firm. Providing environmental training similarly leads to an increase in the firm's probability of over-compliance with environmental regulations. Community variables are influential in increasing the likelihood of over-compliance. These variables are statistically significant in increasing the probability of over-compliance, though their magnitudes are not very big. The data that we examine in this paper deals with air pollution, water pollution, toxic and non-toxic residue and some of this pollution is perhaps not easy to identify. Communities usually pay particular attention to firms whose pollution activities are more visible. Researchers who have found that community pressure can have an enormous impact on the firm's incentive to reduce emissions have often focused on one kind of pollution being emitted by firms (for example: Pargal and Wheeler, 1996 examine the extent of water pollution generated by industries). As the data are aggregated for different kinds of pollution indicators in this paper, it is difficult to capture the impact of collective action by communities. We therefore find that the community variables though significant, do not have big coefficients.

As the data are cross-sectional, it is difficult to examine the dynamic nature of environmental performance of firms. A few of the variables used in the paper are endogenous and this could lead to some bias in the estimated coefficients. To be able to determine the exact causal relationship between compliance and some of these

potentially endogenous variables, we need access to panel data, which is not available at this point of time.

Notwithstanding the limitations of the data, the results show that some factors are very robust in explaining the compliance decisions of firms. The environmental training provided to employees working in the firm is observed to be very important in improving environmental performance. The implication of this is that environmental policy makers should put more emphasis on providing and in some cases subsidising environmental training to employees in developing countries. Training would increase the stock of human capital by improving information flows and increasing morale. It would also have the ability to create positive externalities and spillovers and would therefore be expected to lead to better economic and environmental outcomes for the firm and for society. These kind of informal and voluntary schemes can be initiated with modest public funds and are a valuable addition to the policy toolkit of regulators.

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Tables:

Table 1: Compliance (Self-Assessed Measure)

Environmental Performance	Number of Plants	% of Total
Excellent: far more than necessary for compliance	23	10
Good: almost always in compliance	96	41
Fair: occassionally compliant	99	42
Poor: never in compliance	10	4
Very poor: far below compliance; very damaging	8	3

Table 2: Maximum Likelihood Estimates for Binary Logit Model
Dependent Variable: Over-compliance (=1 if firm over-complies and 0 otherwise)

Variable	Coefficient	Std Error	Marginal
Constant	0.15	3.77	0.99E-05
Food	-3.26**	1.54	-0.21E-03
Metal	0.45	1.15	0.29E-04
Chemical	-2.10*	1.25	-0.14E-03
Reward	2.90**	0.97	0.19E-03
Multiplant	5.41**	1.10	0.35E-03
Ownership1	-0.18	1.31	-0.12E-04
Ownership2	0.46	1.23	0.30E-04
Sal_Mexico	-0.80**	0.33	-0.51E-04
Sal_Asia	2.08**	0.79	0.13E-03
Sal_Usca	-1.60**	0.53	-0.10E-03
Sal_Eur	-1.66**	0.57	-0.11E-03
Sal_Laam	0.57*	0.36	0.37E-04
Sal_Cons	-2.30**	0.63	-0.15E-03
Sal_Wh	-0.15	0.30	-0.98E-05
Sal_Ind	-0.88**	0.36	-0.57E-04
Tech_avail	1.44	1.57	0.92E-04
Cont_eval	1.63	1.09	0.10E-03
Empsec	0.04**	0.02	0.28E-05
Train_ne	2.46**	0.97	0.16E-03
Train_e	0.15	0.86	0.97E-05
Env_resp	3.51**	0.89	0.23E-03
Oth_resp	-0.10	1.47	-0.64E-04
Env_pers	0.66	0.94	0.43E-04
Tech80	-1.44**	0.43	-0.93E-04
Tech90	0.14	0.28	0.88E-05
Inspect	-4.94**	1.67	-0.32E-03
Envinfo	-1.18	0.96	-0.76E-04
Community	3.38**	1.30	0.22E-03
Business	-4.22**	1.06	-0.27E-03
Legal	-0.30	1.06	-0.19E-04
Envman	-2.61**	0.86	-0.17E-03
Number of Observations	235		
Log Likelihood function	-31.40		
Chi-squared	87.78		
Degrees of freedom	31		

Notes:
Robust Standard Errors: Corrected for heteroscedasticity.
Significance: *: denotes a coefficient that is significantly different from zero at 5-percent.
**: denotes a coefficient that is significantly different from zero at 1-percent.

Table 3: Maximum Likelihood Estimates for Multinomial Logit Model
Dependent Variable: Compliance (can take values: 0:over-comply, 1: comply and 2: not comply)

	Prob(Y=1)		**Prob(Y=2)**	
Variable	**Coefficient**	**Standard Error**	**Coefficient**	**Standard Error**
Constant	-1.94	2.01	-5.33	3.34
Food	-0.60	0.71	-2.60*	1.40
Metal	-2.55**	1.11	-2.06	1.49
Chemical	-1.07	0.73	-2.21*	1.14
Reward	2.52	1.53	4.70**	1.76
Multiplant	-1.04	0.78	3.32**	1.31
Sal_Mexico	0.10	0.21	-0.21	0.38
Sal_Asia	1.20	1.03	2.39*	1.33
Sal_Usca	0.47	0.63	-0.78	0.76
Sal_Laam	1.92**	0.77	2.17**	0.82
Sal_Cons	-0.12	0.20	-1.74**	0.47
Sal_Wh	-0.34	0.24	-0.44	0.33
Sal_Ind	-0.33	0.24	-0.87**	0.35
Tech_avail	1.25*	0.75	1.99	1.41
Cont_eval	2.96**	0.82	4.73**	1.34
Empsec	0.001	0.01	0.04*	0.03
Train_ne	0.94	1.27	2.51*	1.48
Train_e	0.67	0.79	1.51	1.03
Env_resp	-1.00	0.80	1.78	1.33
Oth_resp	2.29*	1.21	1.75	1.67
Env_pers	0.22	0.76	0.51	1.09
Tech80	-0.15	0.21	-1.26**	0.39
Tech90	-0.12	0.21	-0.08	0.32
Inspect	1.16	0.78	-2.22	1.40
Envinfo	0.25	0.68	-0.74	1.08
Community	-0.13	0.66	1.78	1.15
Business	0.79	0.63	-2.11*	1.18
Legal	1.07	0.76	0.85	1.30
Envman	-0.02	1.71	-2.13	1.86
Number of Observations	235			
Log Likelihood function	-79.59			
Chi-squared	160.62			
Degrees of freedom	56			

Notes:
Robust Standard Errors: Corrected for heteroscedasticity.
Significance: *: denotes a coefficient that is significantly different from zero at 5-percent.
**: denotes a coefficient that is significantly different from zero at 1-percent.

Table 4: Maximum Likelihood Estimates for Multinomial Logit Model: Marginal Effects

Dependent Variable: Compliance (can take values: 0:over-comply, 1: comply and 2: not comply)

Variable	Prob(Y=0)	Prob(Y=1)	Prob(Y=2)
Constant	-0.10E-05	-0.32E-04	0.33E-04
Food	0.40E-07	0.24E-03	-0.24E-03
Metal	0.15E-06	-0.36E-04	0.36E-04
Chemical	0.31E-07	0.15E-03	-0.15E-03
Reward	-0.11E-06	-0.21E-03	0.21E-03
Multiplant	0.40E-07	-0.40E-03	0.40E-03
Ownership1	0.13E-05	0.97E-05	-0.11E-04
Ownership2	0.14E-05	-0.37E-04	0.36E-04
Sal_Mexico	-0.28E-07	0.58E-04	-0.58E-04
Sal_Asia	-0.16E-08	-0.16E-03	0.16E-03
Sal_Usca	-0.20E-07	0.12E-03	-0.11E-03
Sal_Eur	-0.11E-05	0.12E-03	-0.12E-03
Sal_Laam	-0.13E-06	-0.40E-04	0.40E-04
Sal_Cons	0.21E-08	0.17E-03	-0.17E-03
Sal_Wh	0.17E-07	0.11E-04	-0.11E-04
Sal_Ind	0.11E-07	0.64E-04	-0.64E-04
Tech_avail	-0.66E-07	-0.97E-04	0.97E-04
Cont_eval	-0.18E-06	-0.12E-03	0.12E-03
Empsec	0.43E-09	-0.33E-05	0.33E-05
Train_ne	-0.63E-07	-0.18E-03	0.18E-03
Train_e	-0.37E-07	-0.81E-05	0.82E-05
Env_resp	0.35E-07	-0.25E-03	0.25E-03
Oth_resp	-0.17E-06	0.80E-04	-0.80E-04
Env_pers	-0.28E-07	-0.48E-04	0.48E-04
Tech80	0.28E-08	0.11E-03	-0.11E-03
Tech90	-0.18E-08	-0.10E-04	0.10E-04
Inspect	-0.53E-07	0.37E-03	-0.37E-03
Envinfo	-0.14E-07	0.88E-04	-0.88E-04
Community	0.57E-08	-0.25E-03	0.25E-03
Business	-0.17E-07	0.31E-03	-0.31E-03
Legal	-0.62E-07	0.25E-04	-0.25E-04
Envman	-0.57E-07	0.19E-03	-0.19E-03

Table 5 :Maximum Likelihood Estimates for Logit Model

Dependent Variable: Improve

Variable	**Coefficient**	**Standard Error**	**Marginal Effects**
Constant	-4.73**	2.18	-0.15
Food	0.55	0.77	0.02
Metal	-1.24	1.13	-0.04
Chemical	0.10	0.62	0.003
Reward	-1.87**	0.69	-0.06
Multiplant	-0.12	0.52	-0.004
Ownership1	0.56	0.83	0.02
Ownership2	-0.08	0.91	-0.003
Sal_Mexico	0.24	0.22	0.008
Sal_Asia	2.44	1.60	0.08
Sal_Usca	0.36	0.32	0.01
Sal_Eur	-0.04	0.38	-0.001
Sal_Laam	0.48*	0.29	0.02
Sal_Cons	-0.25	0.24	-0.008
Sal_Wh	-0.01	0.21	-0.003
Sal_Ind	-0.06	0.25	-0.002
Tech_avail	1.60**	0.59	0.05
Cont_eval	1.56**	0.63	0.05
Empsec	-0.02*	0.01	-0.0006
Train_ne	3.29**	1.16	0.11
Train_e	0.66	0.68	0.02
Env_resp	1.41**	0.69	0.05
Oth_resp	1.55**	0.66	0.05
Env_pers	0.74	0.66	0.02
Tech80	0.18	0.16	0.006
Tech90	0.28	0.20	0.009
Inspect	0.30	0.81	0.01
Envinfo	-0.12	0.60	-0.004
Community	0.67	0.56	0.02
Business	-0.70	0.56	-0.02
Legal	0.82	0.78	0.03
Envman	0.32	1.14	0.01
Number of Observations	235		
Log Likelihood function	-57.98		
Chi-squared	107.71		
Degrees of freedom	31		

Notes:

Robust Standard Errors: Corrected for heteroscedasticity.

Significance: *: denotes a coefficient that is significantly different from zero at 5-percent.

**: denotes a coefficient that is significantly different from zero at 1-percent.