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The effect of environmental decentralization on polluting industries in India.

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Abstract

This paper examines the effects of the 2006 reform of the Environmental Impact Assessment (EIA) process in India using firm-level data for the period 1998-2012. The reform favored a decentralization process by delegating the responsibility over environmental clearance of certain activities to state-level authorities. The results show that while the reform has successfully reduced the number of polluting sources, the benefits have accrued only to states with stricter levels of enforcement.

1 Introduction

This paper examines the effects of increased decentralization of environmental decision-making on births of polluting firms in India. A 2006 reform of the Environmental Impact Assessment (EIA) process delegated the responsibility over environmental clearance of certain activities, previously under the

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control of the central government, to newly established state-level authorities. While environmental standards are decided by the central government, most of the environmental compliance monitoring and enforcement in India was already a responsibility of state-level Pollution Control Boards (SPCB). The 2006 EIA reform has expanded this decentralized model by assigning additional tasks to state-level authorities.

While the relationship between environmental regulation and firms' behavior in developed countries, and in particular in the US, has been greatly investigated, there is very little empirical evidence on developing countries. Developing countries differ substantially from more advanced economies. Not only they face greater trade-offs between growth opportunities and environment costs but also institutions are substantially different and political economy factors and market failures greatly affect policy-making (Greenstone and Jack, 2013). This paper contributes to the field by exploiting the quasi-experimental design of the 2006 EIA reform to assess the impact of environmental decentralization in India and examine whether differences in environmental enforcement across states influenced birth rates of polluting firms.

The empirical strategy relies on the fact that the reform affected only certain polluting activities, while for others the assessment remained centralized. The empirical approach is based on a firm-level latent-startup model where the number of births is a function of state and sector level characteristics. The estimations compare pre- and post-reform births, conditional on the strength of environmental enforcement in each state, for treated and unaffected sectors. Environmental enforcement varies notably across states possibly due to variations in socio-economic and political conditions but also due to state-specific technical and financial constraints (Nandimath, 2009). Environmental enforcement is measured using a composite index obtained by aggregating various state-level indicators of institutional quality, civic participation and institutional capacity. The identification strategy relies on the premise that while firm births in sectors affected by the reform should respond to variations in environmental enforcement after the implementation of the reform, no effects are expected on non-polluting firms and on polluting industries not affected by the decentralization process. The estimations are based on the population of registered firms born during the period 1998-2012. Although the formal sector contributes to only a small fraction of total Indian output, large firms are the only ones subject to environmental clearance since smaller informal firms tend to operate outside the control of pollution control authorities.

The reform produced an economically relevant reduction in births of

polluting firms. About 8% less firms were born in affected sectors in the five years following the reform. The effects, however, were not equally distributed across states. In particular, the results show an overall decrease in births in states with higher levels of enforcement while the number of new polluting firms in low enforcing states continued to increase as in the pre-reform period. This effect is consistent with an increase in overall regulatory stringency driven by some states, which tend to be richer and more developed, that exhibit higher levels of enforcement of environmental regulation. Therefore, while the reform has been successful in reducing the number of polluting sources the benefits in terms of environmental quality have not been equally distributed.

The remainder of the paper is organized as follows. Section 2 provides a brief overview of the relevant literature on environmental decentralization and firm location. Section 3 describes the policy background and the reform of the EIA process introduced in 2006. The empirical model is presented in section 4 while the data on firm births and environmental enforcement are described in section 5. Section 6 and 7 discuss the empirical findings and test the validity of the identification strategy. Section 8 provides an economic quantification of the impact of the reform and discusses policy implications. Finally, section 9 concludes.

2 Decentralization, environmental regulation and firm location

The decentralization of environmental regulation is often justified by the intention to form a better understanding of local environmental problems, to promote a more transparent and efficient use of natural resources and to increase local participation due to higher homogeneity of common needs (Cistulli, 2002). There are, however, well recognized constrains on the successfulness of any decentralization process such as weak administrative or technical capacity, lack of financial resources, poor coordination between national and local policies and the risk of local elite capture.

While the theoretical literature has studied extensively the trade-offs involved in the decentralization of the decision making process (Besley and Coate (2003); Oates (2002)) fewer studies have empirically investigated its consequences. Brunnermeier and Levinson (2004) review the empirical literature and find that while earlier cross section studies tend to find no significant effect of environmental regulation on firms' decisions, more recent studies that use panel data estimations find evidence of firms responding to

variations in regulation within a country. Many empirical studies focus on variations in regulation across counties and states of the United States (List et al., 2003). Becker and Henderson (2000), for example, study variations in air quality regulation across counties and find that there has been a significant relocation of polluting firms from more to less polluted areas. Sigman (2005) shows that the decentralization of environmental authorities in the United States has led to a 4% increase in water degradation downstream of states that had the authority to issue and enforce permits for point source polluters.

Very few studies have focused on the impact of environmental decentralization in developing countries. Duvivier and Xiong (2013), for example, studies trans-boundary pollution in China where environmental policy is decentralized. Similarly to India, while the central government sets the standards, local governments are in charge of monitoring and sanctioning. The authors analyze the location choice of polluting firms in one of the most polluted province in China and find that polluting firms tend to locate in counties that share a border with another province. Similarly, Lipscomb and Mobarak (2007) analyze rivers water quality across jurisdictions in Brazil and find a significant strategic polluting behavior around borders.

The first study to analyse firms' location decisions in response to differential environmental regulation across India states was conducted by Mani et al. (1997). The study finds that the number of new plants is not affected by the differences in stringency of environmental regulation at the state level. A positive correlation between a measure of enforcement and the number of new plants, however, suggests that the variable might be capturing the quality of state government rather than environmental enforcement. Moreover, the data date back to 1994 when there was very little enforcement of environmental regulation across all states since prosecution could only occur through the judicial system (Lipscomb, 2008). There is, however, evidence of Indian firms adjusting their behavior in response to changes in environmental regulation over time. Lipscomb (2008), for example, analyses the response of multi-product firms to changes in enforcement at state level[1]. The author finds that firms react to increase stringency by increasing the share of product portfolio allocated to clean products. High productivity firms invest in new and cleaner products and gain from an increase in enforcement. Kathuria (2007) finds that an increase in informal regulation, measured by local news coverage of pollution-related events and the number

[1]Enforcement is measured by the percentage of polluting firms which as been closed by state and year.

of public interest litigations filed, has reduced industrial pollution in the state of Gujarat. On the other hand, however, formal regulation, measured by the number of staff allocated to a region, was found not to affect polluting behavior.

3 Environmental policies in India

Environmental protection rights and duties are incorporated into the Indian Constitution. India has an elaborate set of laws relating to environmental protection that dates back to the Water Act in 1974. The central government, through the Ministry of Environment and Forests (MOEF) and the Central Pollution Control Board (CPCB), is in charge of planning and formulating national policies and standards. Their implementation and enforcement are decentralized and are the responsibility of the State Pollution Control Boards.

In addition, Indian citizens benefit from a unique approach to the enforcement of environmental laws by exercising their constitutional right to a healthy environment in the form of Public Interest Litigations (PILs) before the Court of Justice. PILs have resulted in some environmental improvements on one side, (Kathuria, 2007) but have also contributed to increase the amount of work for state authorities because of court-ordered directives (OECD, 2006).

A compulsory Environmental Impact Assessment (EIA) was first introduced in India with the Environmental Protection Act of 1986, but became effective only in 1994 when the MOEF passed a major legislative measure (Panigrahi and Amirapu, 2012). The main purpose of the EIA is to inform decision makers and the public about the environmental implications of a particular project. The EIA process has been notably modified with the introduction of the 2006 EIA notification. In particular, the reform initiated a process of decentralization of the EIA procedure that had the potential to reduce the burden on the central government and accelerate the approval process. On the other hand, however, the newly created decentralized powers could be misused, if state governments intend to actively pursue industrialisation for their respective state, or be ineffective if state authorities lack technical and financial powers.

The reform classifies polluting projects/firms into two categories based on the potential impacts on human health and natural resources. Projects classified as category A continue to undertake the EIA at the national level (the control group), while category B projects are referred to the State

Environmental Impact Assessment Authority (SEIAA) of the state in which the project is located and form the treatment group.

The classification of projects into affected (B) and unaffected (A) activities is based on three main criteria that differ across sectors. These criteria do not always allow a clear identification of treated firms. Therefore, for the purpose of the analysis, I have defined 5 different groups of sectors, described in table 1, that are differently affected by the reform. A first criterion defines projects that are of exclusive competence of either state or central authorities. Any project within the petroleum refining industry, for instance, should undertake the EIA at the central level, while projects in the integrated paint industry are the exclusive responsibility of state authorities. This allows me to define the group "Central" composed of firms in sectors unaffected by the reform (control group) and the group "State" formed of firms affected by the reform (treatment group). A second criterion distinguishes projects in terms of capacity. Large coke oven plants (above 150,000 tonnes per year), for example, are under the authority of the central government, small ones are referred to the SEIAA in which the project is located. Because we do not observe firms' capacity, the group "Capacity" includes a mix of treated and untreated firms. Finally, a third criterion categorizes projects on the basis of whether they are located within or outside a notified industrial area. Projects in the leather/skin/hide processing industry, for example, are subject to state level EIA only if located within an industrial district/area. Because the exact firm's location is unknown, the group defined as "Industrial district (ID)" includes both affected and unaffected firms.

Table 1 summarizes the five different groups of activities defined in accordance to the criteria mentioned above. The detailed list of projects and activities, as reported in the official 2006 EIA notification, is provided in table A.1 of the Appendix. SEIAAs were constituted in each state at different points in time and all projects were treated as category A in absence of a notified state authority. Table A.2 of the Appendix reports the date of establishment of each SEIAA.

The EIA process is subdivided into four stages. The first stage (Screening) affects only category B projects and is aimed at determining whether a project requires an EIA report. Projects requiring EIA are categorized as B1 while the others are termed B2 and submit a much shorter application form. Although guidelines for the screening process are provided by the MOEF, there is still lack of clarity on this stage of the process. The second stage (Scoping) involves either the central or state authority in determining the terms of references covering all relevant environmental concerns for

Table 1: Classification of sectors according to EIA status

#	Group	Category	Criteria (Treatment)	Sectors (NID)
1	No EIA	No EIA	Not subject to EIA (untreated)	All sectors not reported below
2	Central	A	Exclusively subject to central-level EIA (untreated)	111, 112, 232, 233, 269, 2412, 2421
3	Capacity	A/B	State-level EIA if of small capacity (mix treated/untreated)	101, 102, 120, 131, 132, 141, 142, 155, 231, 271, 272, 273, 401, 451, 452, 453, 454, 2694
4	ID	A/B	State-level EIA if located within industrial district (mix treated/untreated)	182, 1911, 2411, 2413, 2423, 2424
5	State	B	Exclusively subject to state-level EIA (treated)	1542, 2101[a], 2422, 2430, 2439

Based on NID Classification 2004. [a] Excludes manufacturing of pulp (21011)

the preparation of the EIA. The third stage requires a public consultation through both a public hearing in the proximity of the site and invitations of written responses from the concerned stakeholders. The final stage (Appraisal) involves the scrutiny of the EIA application that can result in either approval or rejection of the project.

Each EIA report contains the environmental management plan that becomes part of the business permit and is binding upon the present and future activities of the company. The final environmental clearance report sets the point of departure for all future supervisions because it determines what pollution control measures should be maintained operative by the firm. The EIA, therefore, affects not only the amount of initial fixed-cost investments required, such as the type of effluent treatment system or scrubber required, but also future marginal costs related, for example, to system maintenance and industrial waste treatment. Initial fixed-costs, however, are likely to be more relevant for the decision of starting a business.

4 Empirical model

This section applies the so called *latent-startup* model (Becker and Henderson, 2000) to model the response of polluting firms to the introduction of the 2006 EIA notification. While environmental clearance is required also for the expansion or modernization of existing polluting firms, this paper considers only the birth of new polluting firms. The model assumes that potential entrepreneurs are spatially immobile and decide whether to set up a firm in a particular sector and location. The alternative model, the *footloose-startup* model, instead, considers the decision about which location to select once investors have already decided to set-up a company. Empirically, the two models are equivalent (Brülhart et al., 2012). At each point in time, an entrepreneur acts as maximizing its net expected present value and compares the sunk cost of entry with the expected profits in a particular sector and location. The expected profits, π_{fijt}, of firm f in sector i state j at time t depends on the characteristics of the sector and location of the firm at the time of establishment, x_{ijt}, and on the expected relative compliance costs, c_j, which refer to expected future monitoring, reporting and punishment costs. Sunk costs are, for simplicity, only represented by the cost of complying with the EIA application, s_{ijt}. Assuming a linear approximation of profits, the expected net present value can be written as follows:

$$npv_{fijt} = \pi_{fijt} - S_{jit} + \epsilon_{fijt} = \boldsymbol{\alpha}_0' \mathbf{x}_{ijt} + \alpha_1 c_j + \beta_1 s_{jt} + \epsilon_{fijt}, \qquad (1)$$

where ϵ_{fijt} is a random disturbance. Expected compliance costs depend on the relative level of enforcement at state level, $c_j = f(E_j)$, and are assumed to be the same before and after the reform, as monitoring and sanctioning have always been competence of state authorities. Set-up costs are instead expected to be different before and after the reform, but only for treated firms (category B, i.e. under state competence). The 2006 EIA reform decentralized the process of environmental clearance for category B firms introducing a new source of variation across states. The model assumes that before 2006, set-up costs were identical across states because the EIA was conducted at the central level for all firms. After 2006, environmental clearance costs depend on E_j only for firms in treated firms.

Set-up costs after the implementation of the reform can, therefore, be re-written as a function of the enforcement capacity in each state:

$$npv_{fijt} = \boldsymbol{\alpha}' \mathbf{x}_{ijt} + \beta_0 f(E_j) + \beta_0 D_T + \beta_1 \left(D_T \times E_j\right)) + \epsilon_{fijt}, \qquad (2)$$

where D_T is a dummy variable indicating the years following the implementation of the EIA notification at time T. After T, set-up costs can be higher

or lower than pre-reform costs. States with low levels of enforcement are expected to impose lower environmental clearance costs. For some firms, start-up costs could drop to zero if the screening process conducted by the SEIAA indicates that the project is exempted from the EIA process.

The expected effect of this decentralization process for treated firms (category B) is twofold. Some states might impose more stringent conditions than those imposed previously by the central government resulting in a reduction of births in high enforcing states (deterrence). On the other hand, some states might conduct a less strict EIA in order to promote industrialization, or due to technical and financial constraints, facilitating the birth of new polluting firms (attraction). Both forces lead to relative lower birth rates in higher-enforcing states compared to lower-enforcing states. Because the relevance of the initial start-up costs vary across sectors, depending on the type and size of the pollution control measures required, the effect of the reform is likely to be more visible in sectors where the influence of such fixed costs is higher. Unfortunately, it is not possible to identify which sectors are likely to incur greater costs, under enforcement, given the lack of systematic information on the types and costs of pollution control requirements by sector. Therefore, the model assumes homogeneous effects across sectors.

Following Becker and Henderson (2000), the model can be represented as a reduced form equation where the total number of new firms in each sector, state and year, n_{ijt}, is a function of the above mentioned variables and a set of state ($\mathbf{g}_j$), sector ($\mathbf{d}_i$), and time ($\mathbf{w}_t$) fixed effects:

$$\begin{aligned} n_{ijt} = \exp(\boldsymbol{\alpha}'\mathbf{x}_{ijt} + \beta_0 D_T + \beta_1 (D_T \times E_j) \\ +\gamma'\mathbf{d}_i + \delta'\mathbf{g}_j + \rho'\mathbf{w}_t). \end{aligned} \tag{3}$$

The above equation can be estimated separately for each group of sectors reported in table 1 (No EIA, Central, Capacity, ID and State). This approach, de facto, compares the average number of new firms born before and after the implementation of the EIA reform, conditioned on the level of enforcement in each state. We expect the coefficient β_1 to be negative only for sectors affected by the reform (group 5: State) while being insignificant for non-polluting firms (group 1: No EIA) and sectors subject to central-level EIA (group 2: Central). For groups 3 (Capacity) and 4 (ID) the effect is ambiguous as they contain a mixture of treated and untreated firms.

In practice, the model is estimated by pooling the five groups of sectors and interacting all variables by group dummies[2]. In doing so the results are equivalent to those obtained by estimating the model separately but have the

[2]The estimated equations is, therefore, the following: $n_{ijt} = \exp(\boldsymbol{\alpha}_0'\mathbf{x}_{ijt} + \boldsymbol{\alpha}_1'(\mathbf{x}_{ijt} \times$

advantage of allowing for a statistical comparison of the coefficients across groups. Moreover, the pooled model can be related to a heterogeneous Difference in Differences model where the treated sectors are those included in group 3, 4 and 5 and the control group includes non-polluting sectors and sectors subject to central-level EIA (group 1 and 2). The treatment effect is allowed to be heterogeneous depending on the level of enforcement in each state prior to the implementation of the 2006 reform. Whether firms tended to prefer low enforcing states also prior to the reform, because of low supervision and monitoring costs, does not affect the results as long as this behavior was uniform across categories.

Because the model includes state, year and sector fixed effects it is not possible to identify the effects of pure location, time and sector-specific variables. All specifications will control for the average share of firms in each year and location to control for state-level growth patterns and the total number of new firms in a sector. Additional controls will be discussed in the next sections. Although the EIA reform was introduced in September 2006, the decentralization process could not actually take place unless a SEIAA was created. Because most of the SEIAAs were established between 2007 and 2008 (table A.2 in the appendix), the variable D_T will take values one for the post-2007 period.

The model is initially estimated using a simply linear model (OLS) after log-transforming the dependent variable. While the log-transformation does not alter the multiplicative relationship between the explanatory variables and allows for double clustering, it has the disadvantage of dropping all cells with zero births. The model is, therefore, also estimated using a Poisson pseudo-maximum-likelihood estimator with robust standard errors (Wooldridge, 1991), which allows for the discreteness of the dependent variable and the large number of zeros. The estimator produces consistent estimates under relatively weaker assumptions than a standard Poisson model, i.e. only the conditional mean need to be correctly specified.

4.1 Identification issues

At the aggregate level, enforcement capacity can be both the cause and the consequence of firms' location choices. A larger amount of polluting firms may increase the awareness of the public and the media about pollution and lead to increasing pressure to control pollution. On the other hand, however,

$\boldsymbol{C}_i^k) + \beta_0 D_T + \beta_1(D_T \times E_j \times \boldsymbol{C}_i^k) + \beta_2(D_T \times \boldsymbol{C}_i^k) + +\beta_3(D_T \times E_j) + \gamma_0'\mathbf{d}_i + \gamma_1'(\mathbf{d}_i \times \boldsymbol{C}_i^k) + \delta_0'\mathbf{g}_j + \delta_1'(\mathbf{g}_j \times \boldsymbol{C}_i^k) + \rho_0'\mathbf{w}_t + \rho_1'(\mathbf{w}_t \times \boldsymbol{C}_i^k))$, where C_i^k is a vector of binary variables indicating the group a sector belongs to, as reported in table 1.

more polluting firms may put pressure on the capacity of state-level authorities to deal with non-compliance and reduce the ability of the authorities to monitor and punish polluters. By considering only the number of new firms created each year in each state and sector this problem is substantially reduced. Moreover, the measures of enforcement considered in the regressions are time-invariant and, therefore, do not lead to a spurious correlation between changes in enforcement over time and changes in the number of new firms. They also refer to the pre-reform period and are, therefore, not influenced by the effects of the reform. Although all specifications control for the presence of state, location and year-level unobservables, unobserved heterogeneity could still be a concern. Nevertheless, the regressor of central interest is a three-way interaction term, between state-level enforcement, a dummy variable indicating the post-implementation period and a group dummy, and is less subject to endogeneity problems. Moreover, the results are tested for robustness to the inclusion of additional control variables that should capture other sources of unobserved variation over time, such as changes in minimum and average real wages, in electricity prices and in the number of special economic zones.

In cross-section studies it is often argued that failing to control for corruption creates a problem of omitted variable bias (Dean et al., 2009). High corruption often implies lower environmental stringency but may also act as a deterrent for new investments. This is not a concern in this study. Corruption is included as a measure of environmental stringency since it is the best available measure of the quality of state-level institutions and there are no reasons to expect that its deterrence effect should vary before and after the implementation of the EIA notification.

5 Data

This section describes the data used to measure differences in environmental enforcement across states and the firm-level data used to analyze the relationship between the EIA reform and firm births.

5.1 State-level environmental enforcement measures

Although environmental standards for industrial pollution are determined by the central government, evidence suggests that there are large differences across states in terms of enforcement and compliance (OECD (2006); World Bank (2006)). Variations arise from socio-economic differences across states but also from differences in commitment and technical and financial

capacity of state-level environmental authorities. We adopt five measures of environmental enforcement aimed at capturing state-level differences in institutional capacity, civic participation and institutional quality. These measures are reported in table 2.

Table 2: Measures of environmental enforcement by state

State	NGOs	Judgements	Corruption	Articles[a]	Stations[a]	Index
Andhra Pradesh	29	4	4	213	21	2.27
Assam	7	0	15	9	12	-1.54
Bihar	2	3	20	13	2	-1.25
Chandigarh	2	2		4	5	
Chhattisgarh	3	0	6	4	9	-1.38
Delhi	22	2	11	166	11	2.27
Goa	0	0		13	3	
Gujarat	7	4	3	146	20	0.81
Haryana	3	1	13	21	5	-1.31
Himachal Pradesh	4	2	2	3	11	-0.14
Jammu & Kashmir	6	0	19	3	3	-1.85
Jharkhand	2	0	14	5	6	-1.89
Karnataka	17	3	17	247	14	0.73
Kerala	7	0	1	155	16	0.05
Madhya Pradesh	12	4	18	43	26	0.03
Maharashtra	26	4	5	165	42	1.83
Meghalaya	1	0		0	2	
Odisha	17	3	9	8	12	0.42
Puducherry	1	0		2	3	
Punjab	1	1	7	25	15	-1.05
Rajasthan	12	0	16	6	18	-1.31
Tamil Nadu	29	2	12	443	16	1.89
Uttar Pradesh	24	4	10	111	35	1.22
Uttarakhand	4	1		2	2	
West Bengal	15	2	8	120	21	0.20

[a] The indicator is divided by population before constructing the index

The choice of these indicators was constrained by data availability. Institutional capacity is measured by the number of monitoring stations per million people. The data, taken from the IndiaStat database, refer to the year 2007 and reveal a significant variation across states, ranging from 0.02 per million people in Bihar to 2.12 per million people in Himachal Pradesh.

When formal regulation is weak, informal regulation through civic participation can play an important role. This is particularly true in India where a democratic system allows the formation of groups and NGOs, the press is relatively free and people are empowered with the use of public interest liti-

gations to demand interventions of the judiciary system. These features are particularly relevant for this study since citizens are given an active role in the EIA procedure through a public hearing stage. Three measures of civic participation are adopted: the number of environmentally oriented NGOs, the number of newspaper articles mentioning environmental-related news and the number of judgments passed by the supreme and high courts related to environmental disputes. While civic participation can be thought to be higher in states with low environmental compliance as a response to ineffective formal enforcement, Lal and Jha (1999) argue that NGOs and greater judicial effort are more likely found in states with good governance indicating that strong governance is more conducive to building public awareness about the environment. This argument supports the use of these variables as indicators of greater environmental enforcement.

NGOs play an important role in shaping the socio-political discourse in India and there are several examples of how these organizations have successfully promoted environmental disclosure and raised awareness of governments and the general public (UNESCAP, 2000)[3]. The number of environmentally-oriented NGOs was also used in Javorcik and Wei (2003) to measure variation in strength of environmental enforcement across countries. Another measure of public concern over environmental issues is represented by the number of newspaper articles covering topics related to industrial pollution. The number of newspaper articles in each state and year was obtained by conducting a search across all English-language Indian newspapers contained in the database Factiva for the period 1998-2006. Each search included a set of common keywords, such as closure, court, order, fine etc., and the name of the State Pollution Control Board, e.g. Bihar State Pollution Control Board. The variable used to construct the enforcement index was obtained by calculating the cumulative number of articles referring to each State Pollution Control Board for the entire pre-reform period. Finally, it was noted that Indian citizens can benefit from a unique approach to enforce environmental law by exercising a constitutional right before the Supreme Court and the High Courts in the form of Public Interest Litigations (PIL). Unfortunately, it was not possible to obtain the number of PILs filed in each state, but the number of judgments of the Supreme and High courts offers a reasonable proxy. The list of judgments related to environmental issues was obtained from the Judgments information system of the Supreme and High courts of India. Judgments were manually assigned to each state based

[3]The list of Indian NGOs was obtained from an online database: http://ngosindia.com/ accessed in June 2013.

on the location of the firms or the pollution control boards involved in the court case.

To measure institutional quality we used the corruption index at state-level provided in a study by the Centre for Media Studies issued by Transparency International India for the year 2005 (CMS, 2005). While this index is our preferred measure of corruption, it is not available for the Union territories of Chandigarh, Goa, Meghalaya, Puducherry and Uttarakhand that are, therefore excluded from part of the analysis[4].

Table 3: Environmental enforcement index (E_j): principal component analysis

Component	Eigenvalue	Proportion of Variance	Cumulative
Comp1	1.876	0.375	0.375
Comp2	1.492	0.298	0.674
Comp3	0.883	0.177	0.850
Comp4	0.479	0.096	0.946
Comp5	0.270	0.054	1.000
Variable	First component		
NGOs	0.638		
Judgments	0.519		
Corruption Index	-0.299		
Total articles/Population	0.481		
Stations/Population	0.060		

All enforcement measures are time-invariant and, when possible, refer to the pre-reform period. They are aggregated into one unique index of state-level enforcement through principal component analysis. The use of principal component analysis is appealing because the variables are correlated and environmental enforcement is a multifaceted concept that none of the indicators can fully capture. The index coveys the common dimension of the data and should, therefore, provide a better proxy of environmental enforcement than each indicator individually. Table 3 shows that, as expected, all measures but the corruption index are positively related to the latent environmental enforcement measure. The first principal component explains about 37% of the total variance in the data. The eigenvalue of the first principal component is close to two, thus we retain only the first com-

[4]We also tested an alternative measure of institutional quality constructed as the number of cases of persons arrested under the prevention of corruption act and related sections that have obtained charges. The information was obtain from the India Bureau of Crime and was available for all states. We also tested the robustness of the results to the exclusion of corruption from the enforcement index.

ponent which will be referred to as enforcement index. The index ranges between -1.9 and 2.2 and takes higher values in states where environmental enforcement is stronger.

5.2 Firm-level data

The firm-level data used to compute the number of births in each sector and year are collected in the Orbis database by Bureau Van Dijk and are originally provided by the Centre for Monitoring Indian Economy (CMIE). The database covers the universe of registered companies, i.e. all companies, public or private, that are registered under the Companies Act, 1956 at the Registrar of Companies (RoCs). It records about 140,000 companies created between 1998 and the end of 2012. Although registered companies account for only 20% of all firms in India, which tend to be very small and operate under informality, they are the most likely to be subject to pollution controls as only large and medium-sized facilities have the required environmental clearance permits. Most small-scale industries operate without any consent (OECD, 2006).

The analysis considers only companies belonging to the manufacturing and energy sectors. While the database provides very little information on companies characteristics, such as assets, employment etc., it was possible to obtain important information using the corporate identification number (CIN) that the Ministry of Corporation assigns to each registered company and that combines information on the year of establishment, state, 5 digit industry code (National Industrial Classification, NID), ownership type and a registrar code. In 1998 the Indian Statistical office adopted a substantially different sector classification which also affected the sector definition contained in the CIN code. To avoid problems of misclassification of some firms, the analysis only considers firms established after 1998. This does not constitute a major drawback since prior to 1997 there was very little enforcement of environmental regulation across all states (Lipscomb, 2008).

A birth is defined as the registration of a new company in the Registrar of Companies of the Ministry of Corporation. Companies are assigned to the five groups reported in table 1 based on the sector they operate in. Unfortunately, it is not always possible to assign a particular activity or project listed in the 2006 EIA notification to a specific sector. Projects/activities descriptions are sometimes too broad or too narrow to perfectly match a sector as defined in standard industrial classifications. It was, however, possible to recover some useful information from a previous draft of the EIA notification, which was circulated before the official approval of the reform,

that provides a concordance table between sectors classification and activities using the National Industrial Classification (NID). The concordance table was later removed from the official EIA notification. The list provided in the draft notification was supplemented by manually matching activities that did not report a corresponding sector code. The matching of sectors to activities was conducted at the 5 digit level and, when possible, sectors were aggregated at the highest level that allowed a one-to-one matching between activities and sectors. The entire list of sector-activity concordance used in the analysis is reported in table A.1 in the Appendix while a summary is provided in table 1. Some sub-sectors were dropped because of ambiguous matching with listed activities and are reported in table A.3 of the appendix. Similar results are, however, obtained when these sectors are included and matched to the most plausible activity.

Table 4: Number of new firms by category and year of incorporation

Year Year	1 Without EIA	2 Central-level	3 Capacity	4 ID	5 State-level	Total
1998	2346	160	1045	399	116	4066
1999	2438	208	1273	483	141	4543
2000	1780	154	1038	422	99	3493
2001	1497	115	1128	343	106	3189
2002	1747	154	1400	458	101	3860
2003	2284	207	2200	590	128	5409
2004	3133	225	3660	706	193	7917
2005	4097	335	5799	952	231	11414
2006	3966	351	6556	877	255	12005
2007	4944	337	7084	1020	250	13635
2008	4802	397	7984	833	230	14246
2009	5058	350	4653	699	194	10954
2010	6792	437	7297	980	311	15817
2011	7405	477	7045	1226	328	16481
2012	6534	404	5232	1007	209	13386
Total	58823	4311	63394	10995	2892	140415

The information contained in the Orbis database does not allow for the identification of production capacity or of company's location within or outside an established industrial district. Therefore, it was not possible to distinguish whether a company belonging to group 3 and 4 (defined as Capacity and ID) had undertaken the EIA at the central or state level. One attempt to distinguish large from small companies will, however, be made in the next sections. The number of births in each group and year is reported in table 4. The same information is reported by state and year in table A.4

in the Appendix. We excluded the states and union territories of Andaman and Nicoba, Lakshadweep, Manipur, Mizoram, Nagaland, Tripura, Daman and Diu, Dadra and Nagar Haveli and Arunachal Pradesh because of insufficient firm level data and the lack of information on most enforcement measures. These states, however, represent only about 1% of the Indian population.

6 Firm births and environmental enforcement

This section begins presenting the results of estimating equation 3 using the simplest linear model. The results are reported in table 5. Columns 2 to 6 show the effects of each of the five individual enforcement measures forming the environmental enforcement index used in column 1 and 7. All specifications include state, year and sector fixed effects capturing state, time and sector level shocks and trends. The dependent variable is the log of new firms in each sector. A set of group dummies indicates whether the sectors are non-polluting (No EIA, the omitted baseline) or subject to different EIA criteria (Central, Capacity, ID and State). These dummies are interacted with the post-reform dummy (D_T) and the enforcement index at state level (E_j) to estimate how firm births have been affected by the reform depending on the level of enforcement.

The results show that the decentralization of the EIA process has lead to a relative decrease in firm births in states with higher environmental enforcement for those sectors subject to state-level environmental clearance. This conclusion is reinforced when considering the possibility that states applying a more stringent environmental clearance process may attempt to mitigate its negative effects by offering fiscal incentives to new plants. Considering the results reported in column 7, while no effect is found for non-polluting firms and for new firms subject to central-level EIA (No EIA and Central), the strength of environmental enforcement is shown to have a larger negative effect after the reform for firms in sectors of exclusive competence of the SEEIA authority (State, category B). In particular, the reform leads to an increase in births in low enforcing states and a decrease in births in high-enforcing states[5]. A similar effect if found for firms subject

[5]The overall effect of the reform for the State category, for example, can be computed considering the coefficient of the interaction term "$D_T \times ID$" (column 7 of table 5), which is not significant, and of the triple interaction term "$D_T \times E_j \times ID$". The overall effects depends on the level of enforcement according to the following relationship: $\frac{\delta n_{ijt}}{\delta D_T} = 0.019 - 0.166 \times E_j$. Given that the enforcement index ranges between - 1.85 and 2.21, the reform leads to an increase in births in low enforcing states and a decrease in births in

Table 5: Base results: log-linear model. Impact of the EIA reform by groups

Dependent variable: log of new firms by sector							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Index	NGOs	Judgments	Corruption	News	Monitor	Index[a]
D_T x Central (A)	-0.109***	-0.097	-0.150*	0.051	-0.086	-0.162**	-0.109**
	(0.036)	(0.119)	(0.079)	(0.057)	(0.190)	(0.078)	(0.045)
D_T x Capacity (A/B)	0.007	0.016	0.037	0.080	-0.103	-0.022	0.007
	(0.045)	(0.097)	(0.072)	(0.115)	(0.152)	(0.109)	(0.037)
D_T x ID (A/B)	0.166***	0.299***	0.329***	-0.150	0.547***	0.284***	0.166***
	(0.038)	(0.079)	(0.084)	(0.114)	(0.164)	(0.067)	(0.027)
D_T x State (B)	0.019	0.321***	0.258***	-0.209***	0.156	0.254***	0.019
	(0.047)	(0.121)	(0.083)	(0.065)	(0.306)	(0.094)	(0.056)
D_T x Ej	0.058**	0.010***	0.063***	0.002	0.037*	0.008***	0.058
	(0.023)	(0.003)	(0.015)	(0.005)	(0.021)	(0.002)	(0.041)
D_T x Ej x Central (A)	0.023	-0.000	0.019	-0.015***	-0.001	0.003	0.023
	(0.045)	(0.008)	(0.033)	(0.005)	(0.039)	(0.004)	(0.050)
D_T x Ej x Capacity (A/B)	-0.016	-0.001	-0.020	-0.009	0.022	0.001	-0.016
	(0.067)	(0.008)	(0.041)	(0.011)	(0.033)	(0.007)	(0.062)
D_T x Ej x ID (A/B)	-0.132**	-0.013**	-0.095**	0.027**	-0.090***	-0.009**	-0.132**
	(0.057)	(0.006)	(0.036)	(0.012)	(0.033)	(0.004)	(0.057)
D_T x Ej x State (B)	-0.166**	-0.025***	-0.137***	0.012*	-0.046	-0.017***	-0.166**
	(0.079)	(0.009)	(0.040)	(0.006)	(0.063)	(0.005)	(0.074)
State	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	11561	12590	12590	11561	12590	12590	11561

Standard errors clustered at sector level in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ [a]Double clustering at sector and state level. This table reports only the relevant interactions terms. All specifications are, however, estimated including all interaction terms as reported in footnote 2. They also include the average share of new firms in each state-year and the total number of new firms in each sector-year, which have been omitted from the table. D_T is a dummy indicating the post-reform period and Ej is enforcement at state-level. These are interacted with category dummies: Central, Capacity, ID and State. The omitted category is "No EIA" (non polluting firms). The enforcement measure used in each specification is indicated in the column header.

to state-level EIA if located within an industrial district (ID). This group contains a mix of category A (treated) and B (untreated) projects since the exact location of the firm is unknown. The effects are not statistically different between the State and ID groups.

The results are consistent across all different individual measures of enforcement, although, in few instances, some coefficients are not significant[6].

high-enforcing states.

[6]Similar results are obtained for all enforcement measures when excluding the Union

The coefficient related to the third group of sectors (Capacity) is also negative but much smaller and not statistically significant. This group is formed of a mix of untreated and treated firms that are subject to state-level EIA only if of small capacity. The results suggest that many of the companies included in this group are of large capacity and, therefore, unaffected by the reform. This issue will be further explored below. In order to interpret the magnitude of the effects we can consider that the average gap between states in terms of environmental index score is 0.25. Therefore, an increase in enforcement that would, on average, allow a state to catch up with the next higher ranked state would lead to a relative decrease in the share of new polluting firms of about 4% every year. This is a relevant effect considering that the overall average annual change in births is about 9-10%.

In table 6 we test the robustness of the above results to the inclusion of additional control variables. The table reports the results pertaining the average effect of the control variables. Very similar results were, however, obtained when interacting all the control variables with group dummies. The first column control for the number of new special economic zones (SEZs) in polluting sectors by sector-state and year. Data were obtained from the Department of Commerce of the Ministry of Commerce and Industry. SEZs offer notable advantages, such as tax exemptions, to new firms. India is one the first country to recognize the importance of SEZs and the first zone was created in 1965. The Indian government passed the SEZ act in 2005 in order to increase investors' confidence. The bill was implemented in 2006 and brought about a simplification of the bureaucratic procedures. While most of the SEZs involve only the information technology sectors (55%) it is still important to consider those that affected polluting sectors (about 20% including general multi-product SEZs) as they could induce possible confounding effects if omitted. The creation of a SEZ has a positive but not significant impact on the number of new firms and the results pertaining the reform remain almost unchanged.

Results reported in column 2 and 3 of table 6 are obtained after controlling for the average wage in each state and year and changes in minimum wages in polluting sectors (source: IndiaStat). The data on average wages are provided by the Ministry of Statistics and Programme Implementation (Government of India, 2012) and are calculated from the Annual Survey of Industries that collects information on medium and large firms in India. Wages are deflated using state-level price indexes (source: IndiaStat). The inclusion of these variables does not significantly affect the results. Changes

territories for which corruption data are not available.

Table 6: Log-linear model: additional control variables

Dependent variable: log of new firms by sector					
	(1)	(2)	(3)	(4)	(5)
D_T x Central (A)	-0.105**	-0.105**	-0.115**	-0.115**	-0.113***
	(0.045)	(0.044)	(0.046)	(0.046)	(0.043)
D_T x Capacity (A/B)	0.015	0.014	-0.017	-0.017	-0.013
	(0.037)	(0.036)	(0.053)	(0.053)	(0.052)
D_T x ID (A/B)	0.164***	0.165***	0.120**	0.120**	0.122**
	(0.030)	(0.030)	(0.058)	(0.058)	(0.060)
D_T x State (B)	0.026	0.027	0.015	0.015	0.013
	(0.053)	(0.054)	(0.052)	(0.052)	(0.052)
D_T x Ej	0.042	0.045	0.044	0.045	0.025
	(0.043)	(0.043)	(0.043)	(0.042)	(0.042)
D_T x Ej x Central (A)	0.027	0.027	0.029	0.029	0.032
	(0.052)	(0.052)	(0.053)	(0.053)	(0.052)
D_T x Ej x Capacity (A/B)	-0.013	-0.012	-0.014	-0.014	-0.014
	(0.062)	(0.062)	(0.062)	(0.062)	(0.062)
D_T x Ej x ID (A/B)	-0.136**	-0.135**	-0.135**	-0.135**	-0.134**
	(0.058)	(0.058)	(0.060)	(0.061)	(0.062)
D_T x Ej x State (B)	-0.163**	-0.164**	-0.163**	-0.163**	-0.160**
	(0.075)	(0.075)	(0.076)	(0.076)	(0.077)
SEZ	0.042	0.044	0.044	0.044	0.051
	(0.033)	(0.033)	(0.033)	(0.033)	(0.036)
Average wages		-66.631	-58.350	-61.308	-28.129
		(72.486)	(73.647)	(73.931)	(70.887)
Minimum wage			0.001	0.001	0.001
			(0.001)	(0.001)	(0.001)
Electricity price				-0.069	-0.051
				(0.179)	(0.200)
Observations	11561	11561	11561	11561	11561
State time-trend	No	No	No	No	Yes
State	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes
Sector	Yes	Yes	Yes	Yes	Yes

Standard errors clustered at sector and state level in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. This table reports only the relevant interactions terms. All specifications are, however, estimated including all interaction terms as reported in footnote 2. They also include the average share of new firms in each state-year and the total number of new firms in each sector-year, which have been omitted from the table. D_T is a dummy indicating the post-reform period and Ej is the enforcement index at state-level. These are interacted with category dummies: Central, Capacity, ID and State. The omitted category is "No EIA" (non polluting firms).

in average wages show a negative but not significant effect on firm births. While wages are usually found to be an important determinant of firms'

location decisions, their poor performance in these specifications could be attributed to the limited variation in real wages over time.

The specification reported in column 4 controls for changes in electricity prices (source: IndiaStat), that could also affect a firm location choice and be potentially correlated with environmental enforcement. Differences in electricity prices, however, are likely to weakly reflect the commitment toward the environment of Indian states. Energy prices are instead a powerful political tool. Higher prices for the commercial and industrial sectors are often imposed to subside the agricultural sector and the rural poor, in particular in the proximity of state elections (Badiani et al., 2012). The results are robust to the inclusion of electricity prices that are found to have a negative but not significant effect on firm births. Again this is likely to be due to the limited variation of electricity prices over time.

The results obtained so far have helped to deal with the concern that variations in environmental enforcement across states could proxy for differences in other state level unobservable characteristics. It is, however, possible that some differences in the policy environment remain unmeasured. The results reported in column 5 include state-specific time trends and identify the effect of a change in the EIA process deviating from the pre-existing state-specific trends. The effect of the 2006 EIA reform is still apparent and mostly unchanged. Similar results are also obtained using the ranking of states by level of enforcement rather than the actual index (results are reported in table A.5 of the Appendix).

Table 7 reports the results obtained using the Poisson model. Also these results support the central hypothesis: firm births in sector affected by the decentralization process are negatively affected by the strength of environmental enforcement after the implementation of the reform, while no changes are observed for non-polluting sectors and sectors under the competence of central authorities. The results are robust to the inclusion of the additional control variables considered previously in table 6 and reported in column 2 to 6. The creation of SEZs has now a positive and significant effect on firm births, although significance drops when controlling for state-level time trends. An increase in average wages at sector-state level also show a negative and significant effect on firm births.

Although the analysis considers only registered firms, the presence of a large informal economy in some sectors more than others might affect the impact of the reform. Firms in high enforcing states, for example, could easily opt to operate informally in face of high compliance costs in sectors where informality is widespread. On the other hand, this might prevent firms from seeking to establish officially in a state with lower enforcement. The

Table 7: Poisson Pseudo-maximum likelihood model: base specification and additional control variables. Impact of the EIA reform by groups

Dependent variable: Number of new firms by sector						
	(1)	(2)	(3)	(4)	(5)	(6)
D_T x Central (A)	0.012	0.012	0.012	0.011	0.010	0.020
	(0.074)	(0.073)	(0.072)	(0.073)	(0.073)	(0.075)
D_T x Capacity (A/B)	0.095	0.129	0.128	0.126	0.124	0.051
	(0.085)	(0.091)	(0.091)	(0.091)	(0.094)	(0.070)
D_T x ID (A/B)	0.172***	0.126**	0.126**	0.121*	0.120*	0.085
	(0.057)	(0.061)	(0.061)	(0.064)	(0.064)	(0.071)
D_T x State (B)	0.179*	0.197*	0.197*	0.194*	0.194*	0.160
	(0.101)	(0.105)	(0.105)	(0.106)	(0.106)	(0.099)
D_T x Ej	0.002	-0.003	-0.004	-0.004	-0.003	-0.014
	(0.038)	(0.037)	(0.037)	(0.037)	(0.037)	(0.040)
D_T x Ej x Central (A)	-0.007	-0.007	-0.007	-0.006	-0.005	-0.013
	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)
D_T x Ej x Capacity (A/B)	-0.103	-0.111	-0.111	-0.111	-0.109	-0.070
	(0.079)	(0.078)	(0.078)	(0.078)	(0.080)	(0.063)
D_T x Ej x ID (A/B)	-0.119***	-0.154***	-0.154***	-0.153***	-0.152***	-0.128***
	(0.041)	(0.048)	(0.048)	(0.048)	(0.048)	(0.047)
D_T x Ej x State (B)	-0.114*	-0.121**	-0.120**	-0.119**	-0.118**	-0.107*
	(0.059)	(0.057)	(0.057)	(0.058)	(0.058)	(0.062)
SEZ		0.064*	0.064*	0.064*	0.065*	0.061
		(0.034)	(0.034)	(0.033)	(0.033)	(0.041)
Average wages			0.031	0.036	0.018	-0.416***
			(0.107)	(0.109)	(0.093)	(0.118)
Minimum wage				0.002	0.002	0.001
				(0.005)	(0.005)	(0.005)
Electricity price					-0.068	0.016
					(0.201)	(0.180)
State time-trend	No	No	No	No	No	Yes
State	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Sector	Yes	Yes	Yes	Yes	Yes	Yes
Observations	24900	24900	24900	24900	24900	24900

Standard errors clustered at sector level in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. This table reports only the relevant interactions terms. All specifications are, however, estimated including all interaction terms as reported in footnote 2. They also include the average share of new firms in each state-year and the total number of new firms in each sector-year, which have been omitted from the table. D_T is a dummy indicating the post-reform period and Ej is the enforcement index at state-level. These are interacted with category dummies: Central, Capacity, ID and State. The omitted category is "No EIA" (non polluting firms).

role of informality is, therefore, ambiguous. In an attempt to empirically test the role of informality I estimated the model separating the sample into low and high informal sectors. Unfortunately, the results were inconclusive. This leaves scope for future research since more could be learned on the effects of the reform by analyzing its impact on the informal sector using data on unregistered firms.

6.1 Small versus large capacity firms

The Capacity group includes a mix of treated and untreated firms since whether a new firm in this group is subject to state-level EIA depends on its capacity, which is not observed. In this section, I attempt to separate these two types of firm by considering the classification of companies provided by the Orbis database. This classification allows the distinction between small, medium and large firms based on annual turnover, total assets or total number of employees. Although this classification is not intended to measure capacity it can provide a reasonable approximation. The results reported in table 8 show that the effect is indeed much larger for small firms, i.e. those more likely to be subject to state-level EIA. In column 2 of table 8 the results are obtained using the Poisson estimator and show that the negative effect previously attributed to the category "Capacity" is entirely capture by small firms. This confirms once again that the observed negative effects are attributable to the decentralization process that has affected only some polluting activities (Category B).

6.2 Sectors not affected by the reform

As noted earlier, no changes are observed for firms belonging to non-polluting sectors. While this finding supports the underlying hypothesis, this control group includes a large number of sectors and, although on average the effect is close to zero, it could conceal significant individual sector responses. To provide further evidence in support to our hypothesis, the effect is estimated separately for each of the 18 non-polluting sectors at two-digit level. The extended model was estimated using both the linear and Poisson estimators. A negative and significant coefficient was found only for the tobacco (-0.211) and the office, accounting and computing machinery (-0.368) sectors. It is reasonable to expect these two sectors to not be indirectly affected by the reform as their appear to be quite disconnected from polluting sectors. The negative effects could, instead, be associated to pre-existing trajectories in birth rates that will be analyzed in the next section.

Table 8: Small versus large companies in the "Capacity" group

	(1) FE	(2) Poisson
D_T x Ej	0.050	-0.034
	(0.043)	(0.041)
D_T x Ej x Central (A)	-0.029	-0.034
	(0.055)	(0.059)
D_T x Ej x Large (Capacity) (A)	-0.011	0.022
	(0.049)	(0.046)
D_T x Ej x Small (Capacity) (B)	-0.073	-0.259*
	(0.090)	(0.158)
D_T x Ej x ID (A/B)	-0.146***	-0.111**
	(0.055)	(0.051)
D_T x Ej x State (B)	-0.221***	-0.127***
	(0.052)	(0.044)
SEZ	Yes	Yes
Average wage	Yes	Yes
Minimum wage	Yes	Yes
Electricity price	Yes	Yes
Time trend	Yes	Yes
State	Yes	Yes
Year	Yes	Yes
Sector	Yes	Yes
Observations	12596	30000

Standard errors are clustered at sector and state level in the FE estimation and at sector level in the Poisson model. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. This table reports only the relevant interactions terms. All specifications are, however, estimated including all interaction terms as reported in footnote 2. They also include the average share of new firms in each state-year and the total number of new firms in each sector-year, which have been omitted from the table. D_T is a dummy indicating the post-reform period and Ej is the enforcement index at state-level. These are interacted with category dummies: Central, Capacity, ID and State. The omitted category is "No EIA" (non polluting firms).

Among the 18 sectors mentioned above we consider also the automobile industry. This sector was initially included in the draft EIA reform, officially circulated in September 2005, but later removed from the final version of the notification. Because all projects in the automobile sector were assigned to state-level authorities, the fact that we do not find any effect of the intervention suggests that there were no anticipatory effects of 2006 EIA reform.

7 Robustness checks

In this section I test the robustness of the common trends assumption underlying the above estimations. I first compare trends in firm births in the pre- and post- reform period for treated and untreated sectors. Figure 1 reports 3-year moving averages of the number of firm births by groups of sectors as defined above. The graph shows no evident violation of the common trends assumption as the curves are almost parallel during the pre-reform period. Moreover, while sectors completely unaffected by the reform (NoEIA and Central) show a steady upward trend throughout the entire period, those affected by the reform, in particular the State group, which comprises only treated firms, show a decrease in births after the reform (vertical line).

Figure 1: Number of new firms by groups and year

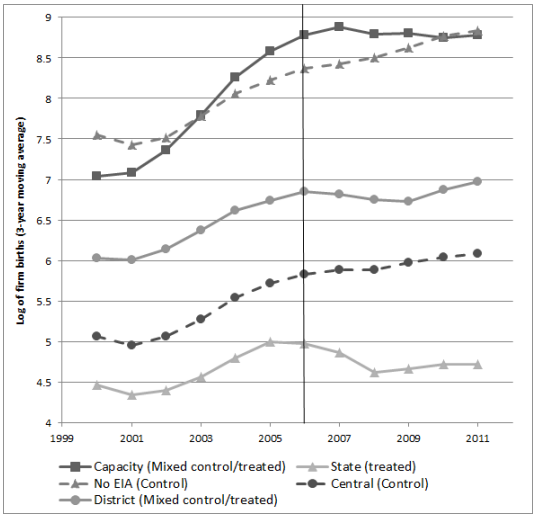


Figure 2 compares trends in births of polluting firms by level of enforcement. In particular, states are classified into low and high enforcing

states (bottom and top 6 states respectively). Considering the State group, which comprises only treated firms, the first panel of figure 2 shows similar trends in the pre-reform period between high and low enforcing state. On the other hand, the two groups of states experience opposite shocks after the implementation of the reform. In particular, as suggested by the results discussed above, while low enforcing states experience a relative increase in firm births after 2006, we observe a relative decrease in the number of new firms in high enforcing states. A similar pattern can be observed for firms in the Industrial District (ID) and Capacity group. These two groups include a mix of treated and control firms as the treatment for these two groups depends on the location or capacity of the firm that are not observable. When considering these two latter groups, the plots suggest that the positive pre-reform trend has been altered by the reform in high enforcing states while remained unaffected in low enforcing states. Finally, when considering firms in the Central category, formed entirely by control firms, we do not observe any significant sudden diversion in trends in the years following the reform in both high and low enforcing states.

The second robustness check involves a placebo difference in difference exercise considering firm births in pre-treatment period. Table 9 reports the estimates of three specifications that consider 2003, 2004 and 2005 as fake treatment events. The estimates of the interaction terms from the placebo tests are not statistically different from zero in all specifications.

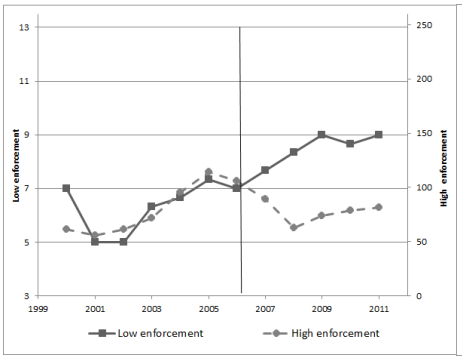
8 Discussion and policy implications

Various explanations could in principle support the above findings that show that the decentralization of the EIA process has induced a relative change in firm births across states. Some states, for example, could have used lax environmental standards as a competitive instrument to attract polluting firms. On the other hand, institutional, technical and financial constraints could also play an important role in limiting the effectiveness of environmental enforcement in certain locations. None of these explanations, however, seem to underly the observed patterns of firm births.

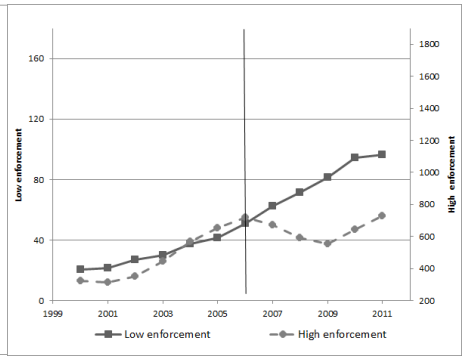
The plot in Figure 1 shows that the number of new polluting firms has experienced a negative shock, or at least a slowdown, in sectors affected by the decentralization. Figure 2 reveals that this is due to a reduction in the number of new firms in high enforcing states while firm births have continued on the positive pre-reform trend in low-enforcing states. The decrease in the number of polluting firms in high-enforcing states has been

Figure 2: Number of new polluting firms by groups and enforcement level

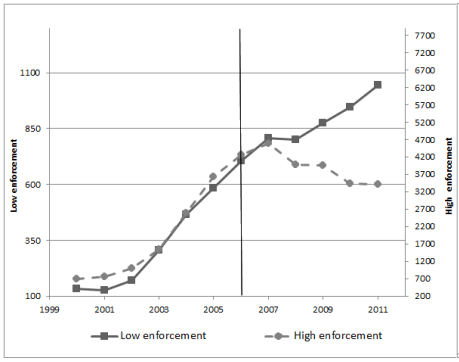
(a) State (treated)



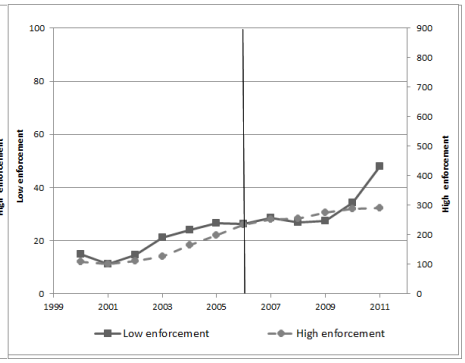
(b) ID (mixed treated/control)



(c) Capacity (mixed treated/control)



(d) Central (control)



Author's calculation based on the Orbis database. The plots are based on 3-year moving averages.

substantially larger than the increase experienced by low enforcing states given the smaller size of the their economies.

Overall the relative change in firm births between states seems to be driven by projects facing stricter environmental assessments in high enforcing states. The pre-reform EIA was considered to be relatively lax and characterized by very little involvement of the public and civil society (Jha-Thakur (2011)) as opposed to the new EIA procedure that puts greater emphasis on public consultation. The findings, therefore, indicate that the decentralization process has led to an overall increase in the average regulatory stringency by decentralizing EIA duties to state-level authorities. In doing so, the reform has been successful in limiting polluting activities. Be-

Table 9: Placebo difference in differences test on pre-reform period

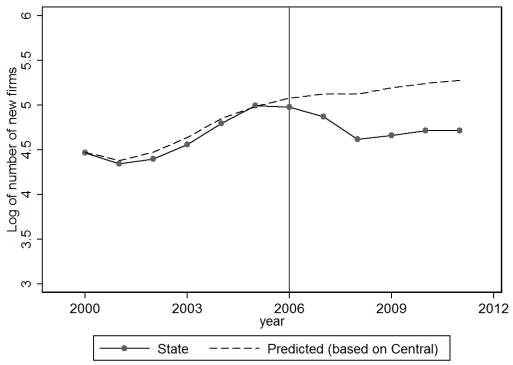
	(1)	(2)	(3)	(4)
D_T =	2002	2003	2004	2005
D_T x Central (A)	0.026	0.058	0.057	-0.023
	(0.702)	(0.488)	(0.567)	(0.775)
D_T x Capacity (A/B)	0.077	0.097*	0.094	0.032
	(0.147)	(0.070)	(0.202)	(0.660)
D_T x ID (A/B)	0.014	-0.007	-0.034	0.008
	(0.657)	(0.898)	(0.541)	(0.942)
D_T x State (B)	-0.048	-0.109	-0.149*	-0.173
	(0.465)	(0.256)	(0.100)	(0.227)
Baseline: No EIA	0.070***	0.072***	0.096***	0.091***
	(0.003)	(0.003)	(0.000)	(0.001)
D_T x Ej x Central (A)	-0.055	-0.087	-0.084	-0.039
	(0.255)	(0.155)	(0.106)	(0.345)
D_T x Ej x Capacity (A/B)	-0.060	-0.044	-0.062	0.004
	(0.141)	(0.291)	(0.108)	(0.938)
D_T x Ej x ID (A/B)	-0.004	0.012	0.023	-0.056
	(0.933)	(0.747)	(0.586)	(0.331)
D_T x Ej x State (B)	0.035	0.104	0.139	0.132
	(0.633)	(0.141)	(0.143)	(0.293)
State	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Sector	Yes	Yes	Yes	Yes
Observations	5290	5290	5290	5290

Standard errors clustered at sector level in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. This table reports only the relevant interactions terms. All specifications are, however, estimated including all interaction terms as reported in footnote 2. They also include the average share of new firms in each state-year and the total number of new firms in each sector-year, which have been omitted from the table. D_T is a dummy indicating the period following the year reported on the column header and Ej is the enforcement index at state-level. These are interacted with category dummies: Central, Capacity, ID and State. The omitted category is "No EIA" (non polluting firms).

cause, the data cover the entire population of registered firms it is possible to quantify the effect of the reform by comparing the actual decrease in firm births and the predicted trend in the absence of the reform based on the observed trend in the control group (Central). Figure 3 show the actual and predicted trend for the group State, as an example. The prediction is obtain by overlapping the trend observed for the Stage group with that for the Central (control) group.

The impact is economically relevant. About 560 new firms were es-

Figure 3: Actual number of new firms in the State group and predicted trend



tablished in sectors belonging to the State group across all India in the post-reform period (from 2007 to 2011); about 110 every year. The counterfactual indicates that as many as 370 (66%) additional firms would have been established in the absence of the reform. The impact becomes significantly larger, in absolute terms, when considering the District and Capacity groups. The reform has induced about 1,200 (25%) and 1,500 (4%) less new firms in sectors belonging to the District and Capacity groups, respectively, in the five years following the reform.

The benefits of the reform, however, have not been equally distributed. While high enforcing states have experienced a decrease in the number of polluting sources, no effect is observed on low enforcing states who continued on their upward pre-reform trajectory. Some simple correlations suggest that lower enforcing states tend to be poorer and with lower levels of education. If differences in the stringency of the EIA process were to trigger a strategic response from polluting firms intending to enjoy less strict assessments, these states could benefit from the increased comparative advantages in polluting sectors (Kahn and Mansur, 2013). Nevertheless, the negative consequences of pollution on health and related socio-economic outcomes, as described in Graff Zivin and Neidell (2013), can be substantial and could significantly offset the benefits.

9 Conclusions

The decentralization of environmental regulation and enforcement has the potential to lead to a more efficient and transparent system of pollution control and management. On the other hand it carries the risk of inducing a race-to-the bottom competition among local authorities and to suffer from the consequences of heterogeneous financial and technical constraints across states. The 2006 reform of the EIA process in India has provided a useful setting for testing these hypotheses in a context where environmental enforcement varies notably across states.

This paper has investigated whether the decentralization of the EIA process in India, initiated in 2006, has effected firms' behavior across the country. By considering all registered companies, the findings allow for a quantification of the overall impact of the reform. The results show that the reform has produced a significant change in the number of firm births in polluting sectors and has led to a relative decrease in birth rates in states with higher enforcement levels. The results are robust to different specifications and are not driven by pre- or post- reform shocks or trends.

A stricter EIA process implies that fewer firms are given permission to operate. The findings indicate that the decentralization process has led to an increase in the average regulatory stringency and has been successful in reducing the number of polluting activities. The benefits, however, have not been equally distributed and have only accrued to high-enforcing states. If the regulatory gap between low and high enforcing states is maintained, in the long run it could lead to a redistribution of polluting sources towards low enforcing states who tend to be richer and with higher levels of education. This has important implications for future amendments of the EIA regulation that should not ignore the great disparities in environmental enforcement across states. Assistance in the form of training programs or funding, for example, could be provided to states that face technical or financial constraints.

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Appendix

Table A.1: Activities listed in the EIA notification, their categorization and the corresponding NID classification

Project or Activity	NID 3 digit	A	B	Group
Mining, extraction of natural resources and power generation				
Mining of minerals	101, 102, 120, 131, 132, 141, 142	$\geq$ 50 ha. of mining lease area; Asbestos mining irrespective of mining area	<50 ha; 5 ha of mining lease area.	Capacity
Offshore and onshore oil and gas exploration, development and production	111, 112	All projects		Central
River Valley projects	401, 452	(i) > 50 MW hydroelectric power generation; (ii) > 10,000 ha. of culturable command area	(i) < 50 MW > 25 MW hydroelectric power generation; (ii) < 10,000 ha. of culturable command area	Capacity
Thermal Power Plants	401	500 MW (coal/ lignite/ naphta and gas based); 50 MW (Pet coke diesel and all other fuels)	< 500 MW (coal/ lignite/ naptha and gas based); <50 MW; $\geq$5MW (Pet coke ,diesel and all other fuels)	Capacity
Nuclear power projects and processing of nuclear fuel	401,452, 233	All projects		Central
Primary Processing				
Coal washeries	101, 102	$\geq$ 1 million ton/ annum throughput of coal	<1 million ton/ annum throughput of coal	Capacity
Mineral beneficiation	-	$\geq$ 0.1 million ton/ annum mineral throughput	< 0.1million ton/ annum mineral throughput	Capacity
Materials Production				
Metallurgical industries (ferrous and non ferrous)	271, 272	a)Primary metallurgical industry: All projects; b) Sponge iron manufacturing: $\geq$ 200TPD; c) Secondary metallurgical processing industry: All toxic and heavy $\geq$ 20,000 tonnes / annummetal producing units	Sponge iron manufacturing: < 200 TPD; Secondary metallurgical processing industry: i) All toxic and heavy metal producing units: < 20,000 tonnes /annum; ii) All other non-toxic secondary metallurgical processing industries > 5000 tonnes/annum	Capacity

Cement plants	269	1.0 million tonnes/ annum production capacity	<1.0 million tonnes/ annum production capacity. All Stand alone grinding units	Capacity
Materials Processing				
Petroleum refining industry	232	All projects		Central
Coke oven plants	231	≥ 2,50,000 tonnes/ annum	< 2,50,000 and ≥ 25,000 tonnes/ annum	Capacity
Asbestos milling and asbestos based products	269, 142	All projects		Central
Chlor-alkali industry	2411	>300 TPD production capacityor a unit located out side the notified Industrial district/ district	<300 TPD production capacity and located within a notified Industrial district/ district	Capacity
Soda ash Industry	-	All projects		Central
Leather/skin/hide processing industry	1911, 182	New projects outside the Industrial district or expansion of existing units out side the Industrial district	All new or expansion of projects located within a notified Industrial district/ district	Industrial district
Manufacturing/Fabrication				
Chemical fertilizers	2412	All projects		Central
Pesticides industry	2421	All units producing technical grade pesticides		Central
Petrochemical complexes (industries based on processing of petroleum fractions and natural gas and/or reforming to aromatics)	-	All projects		Central
Manmade fibres manufacturing	2430	Rayon	Others	State
Petrochemical based processing (processes other than cracking and reformat not covered under complexes)	-	Located out side the notified Industrial district/ district	Located in a notified Industrial district/ district	Industrial district
Synthetic organic chemicals industry (dyes and dye; intermediates; bulk drugs and intermediates; synthetic rubbers; basic organic chemicals, other synthetic organic chemicals and chemical intermediates including pesticides intermediates)	2411, 2413, 2423	Located out side the notified Industrial district/ district	Located in a notified Industrial district/ district	Industrial district
Distilleries	155	(i) All Molasses based distilleries; (ii) All Cane juice/ non-molasses based distilleries ≥ 30 KLD	All Cane juice/non-molasses based distilleries <30 KLD	Capacity

Integrated paint industry	2422	All projects		State
Pulb and paper industry excluding manufacturing of paper waste from paper and manufacture of paper from ready pulp with out bleaching	210	Pulp manufacturing	Paper manufacturing without pulp	State
Sugar Industry	1542		$\geq$ 5000 tcd cane crushing capacity	State

Table A.2: Date of constitution of State EIA Authority

State	Date of constitution of SEIAA
Andhra Pradesh	4th July 2007
Arunachal Pradesh	27th March 2008
Bihar	7th February 2011
Chandigarh	21st August 2009
Chhattisgarh	9th January 2008
Dadra and Nagar Haveli	11th October 2007
Daman & Diu	11th October 2007
Delhi	30th July 2008
Goa	15th April 2010
Gujarat	12th June 2007
Haryana	21st April 2008
Himachal Pradesh	11th October 2007
Jammu and Kashmir	8th January 2008
Jharkhand	20th December 2012
Karnataka	11th June 2007
Kerala	3rd November 2011
Madhya Pradesh	8th January 2008
Maharashtra	21st April 2008
Meghalaya	23rd July 2007
Nagaland	15th April 2010
Orissa	17th November 2008
Puducherry	13th December 2007
Punjab	19th November 2007
REjasthan	30th July 2008
Sikkim	8th July 2008
Tamil Nadu	3rd March 2008
Uttar Pradesh	12th July 2007
Uttarakhand	22nd September 2008
West Bengal	13th April 2007

Table A.3: Sectors excluded from the analysis because of ambiguities in their classification

NIC code	Description
103	Extraction and agglomeration of peat [incl. digging of peat]
181	Manufacture of wearing apparel, except fur apparel
192	Manufacture of footwear.
261	Manufacture of glass and glass products
281	Manufacture of structural metal products, tanks, reservoirs and steam generators
289	Manufacture of other fabricated metal products; metal working service activities
2410	Manufacture of basic chemicals
2420	Manufacture of other chemical products
2424	Manufacture of soap and detergents
2429	Manufacture of other chemical product n.e.c.
2102	Manufacture of corrugated paper
2109	Manufacture of other articles of paper

Table A.4: Number of new firms by category and state

State	Without EIA	Large	Central-level	ID	State-level	Total
Andhra Pradesh	3281	326	4909	1406	259	10181
Assam	301	52	488	27	18	886
Bihar	454	30	1733	124	17	2358
Chandigarh	326	16	325	180	22	869
Chhattisgarh	265	56	1041	49	13	1424
Delhi	11984	512	12018	1823	605	26942
Goa	207	14	258	28	12	519
Gujarat	6200	803	4110	1346	215	12674
Haryana	1349	61	743	200	59	2412
Himachal Pradesh	134	10	514	83	14	755
Jammu & Kashmir	123	12	177	24	5	341
Jharkhand	242	29	1053	39	7	1370
Karnataka	3474	169	3291	407	161	7502
Kerala	1179	96	1639	274	55	3243
Madhya Pradesh	1075	164	2065	387	73	3764
Maharashtra	12822	875	11306	2061	651	27715
Meghalaya	48	13	170	7	4	242
Odisha	531	78	2165	91	27	2892
Puducherry	89	6	86	33	9	223
Punjab	1202	78	858	197	61	2396
REjasthan	1919	186	4711	435	75	7326
Tamil Nadu	5185	266	3898	652	269	10270
Uttar Pradesh	2121	135	1776	668	92	4792
Uttarakhand	217	19	163	50	13	462
West Bengal	4095	305	3897	404	156	8857
Total	58823	4311	63394	10995	2892	140415

Table A.5: Results obtained using the ranking of states by enforcement level

	(1)	(2)
	OLS	Poisson
D_T x Ej	0.008	0.002
	(0.010)	(0.009)
D_T x Ej x Central	-0.004	-0.006
	(0.016)	(0.013)
D_T x Ej x Capacity	-0.006	-0.024
	(0.017)	(0.015)
D_T x Ej x ID	-0.029*	-0.022*
	(0.016)	(0.013)
D_T x Ej x State	-0.036*	-0.024**
	(0.019)	(0.011)
Average wage	Yes	Yes
Minimum wage	Yes	Yes
SEZ	Yes	Yes
State	Yes	Yes
Year	Yes	Yes
Sector	Yes	Yes
Time-trend	Yes	Yes
Observations	11561	24900