Green Securities Policy and the Environmental Performance of Firms: Assessing the Impact of China's Pre-IPO Environmental Inspection Policy

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Abstract

China has experimented with a wide range of policies to encourage firms to improve their environmental performance, often with mixed results. This paper investigates the effectiveness of combining two different policies at the same time: (1) a more centralised environmental inspection process and (2) new rules on the public disclosure of policy compliance for firms wanting to undertake an initial public offering (IPO). A theoretical framework predicts that a more centralised inspection and public disclosure should improve both a firm's environmental performance and profitability. The results of instrumental variable estimations for 536 listed Chinese firms for the period 2009 to 2019 confirm the theoretical predictions although the positive effect on profitability only lasts for two years after compliance with the IPO requirements. An investigation into possible mechanisms shows that the joint policy promotes investment in green projects while also increasing demand for the firm's products. The findings highlight greater regulatory complexity may be needed if a country wishes to change the behaviour of firms in a manner that is consistent with overcoming environmental challenges.

Keywords: environmental regulations, centralisation, firm performance, public disclosure, China

JEL codes: D82, Q53, Q58

1. Introduction

Over the last twenty years, the Chinese government has experimented with a wide range of different regulations aimed at tackling the country's environmental challenges. However, the outcome from these different policies has often fallen short of government expectations (Jiang et al., 2014). One explanation for this perceived lack of policy effectiveness is that previous policies, in whatever form, have not been sufficiently enforced. For example, because local government officials have traditionally been incentivised to prioritise economic growth rather than pollution control, it is possible that polluting activities were overlooked (Wang et al., 2003; Zhang et al., 2018). A second explanation is that polluting firms often have little incentive to reduce their emissions because the expected net value of internalising the pollution externality exceeds the regulatory cost (Coase, 1960). Finally, access to finance for projects to improve a firm's environmental performance may be harder to obtain if pollution externalities are correlated with other non-environmental factors such as management ability, technology spillovers, information asymmetry and productivity.

In response to the perceived lack of policy effectiveness and the pressing nature of the environmental challenges facing China, the government adopted a two-pronged approach. First, the government started to enhance the central government's role in enforcing environmental policies, e.g. vertical reform in environmental jurisdictions from 1994 (Han and Tian, 2022) and the National Specially Monitored Firms programme in 2007 (Zhang et al., 2018), to overcome some of the limitations associated with decentralised practices. Second, the government combined environmental regulations with other policies to address non-environmental market failures, such as publishing firms' environmental performance ratings (Wang et al., 2004) and linking environmental performance with access to capital (Yao et al., 2021). This is the first paper to investigate whether combining policies in this way encouraged firms to reduce emissions without impacting their competitiveness.

More specifically, the contribution of this paper is to examine the impact of a recent green securities policy (GSP) that combines a more centralised environmental inspection with public access to information on policy compliance and fundraising in the stock market. It has the goal of simultaneously reducing pollution and helping firms to finance new green investment. The GSP, launched in 2008 by China's Ministry of Ecology and Environment (MEE) and the Securities Regulatory Commission (SRC), is known as the "pre-IPO environmental inspection policy" (hereafter known as the pre-IPO policy). A key contribution of this paper is to develop a quantitative measure of corporate environmental performance (CEP) using information disclosure on pollution-reducing, energy-saving, and environmental management-related activities. This new index captures all green activities that meet the goals of reducing pollution and financing green investment for the pre-IPO policy.

The pre-IPO policy is targeted at firms wishing to apply for an initial public offering (IPO) or refinancing on the Chinese stock market. To comply, firms must disclose their investment intentions, report their environmental performance over the previous three years, receive on-site environmental inspection, and undergo an environmental impact assessment for any project proposed as part of the fund raise. Information on compliance and the outcome of the inspection is published on the websites of central and local environmental authorities. Figure A1 in Appendix A provides a roadmap for the pre-IPO policy. This policy pre-empted more recent policies applied to listed companies in China, such as the need for environmental disclosure in annual reports and is the first green finance initiative that impacts how a firm raises capital and whether it can list on the stock market (or refinance if it is already listed).[1]

A theoretical framework is proposed that explains how this GSP may impact environmental performance and how public access to compliance information may shift the demand for goods and services. The theoretical predictions are tested, and the mechanisms that drive the results in the short-term and long-term are examined. The estimations are based on a sample of 536 publicly listed Chinese firms from 2009 to 2019. An instrumental variable approach is employed to address self-selection bias and the potential endogeneity of policy compliance.

Turning to existing research, this paper is related to four different strands of literature. First, the benefits and drawbacks of centralised and decentralised enforcement have been widely discussed in the literature on environmental regulatory federalism, with empirical evidence coming mainly from developed countries and regions such as the US and the EU (see a survey by Dijkstra and Fredriksson 2010). In recent years, China has started to "bring the centre back" (Kostka and Nahm, 2017), and a small number of studies suggest that a greater degree of centralisation helped improve environmental quality in Chinese provinces and cities (Jia and Chen, 2019; Li et al., 2020; Wang et al., 2021). However, firm-level research is limited, the exceptions being Zhang et al. (2018) and Han and Tian (2022) who examine the impact of some more centralised initiatives prior to 2010.

Second, this paper adds to the literature on how public disclosure affects the environmental and economic performance of firms and the mechanisms by which public disclosure influences firm

[1] The pre-IPO policy shares some similarities with the EU's recent "do no significant harm" principle that aims to prevent environmentally harmful activities and to enable access to finance for sustainable development projects (Klika, 2022). The pre-IPO policy was replaced in 2015 by a more stringent environmental information disclosure policy that targeted certain pollution intensive enterprises regardless listed or not. The new policy was put into effect at the same time as the revised environmental protection law and associated regulations were introduced.

behaviour. Environmental information is disclosed to the public through three routes: (1) eco-labelling or certification by independent agencies, (2) the release of information that shows whether firms are (or are not) in compliance with existing regulations; and (3) firms self-reporting, either voluntarily or mandatorily (Garcia et al., 2007). This paper focuses on (2), the release of information on regulatory compliance.

Previous studies, including Foulon et al. (2002), Garcia et al. (2007) and Wang et al. (2004), show that providing information on regulatory compliance encourages firms to better control pollution. There is also a growing literature that examines the relationship between the disclosure of environmental information and the signals it provides to the capital market (and hence stock prices and market returns) (Dasgupta et al., 2006; Gupta and Goldar, 2005; Lanoie et al., 1998; Wang et al., 2019). However, only Sengupta (2012) theoretically examines how consumers respond to information in the product market and suggests that a firm signals the environmental attributes of its production technology through price which can increase demand and profit margins, although when regulations are weak, price signalling does not necessarily work. This paper extends Sengupta's model to a scenario where environmental regulatory stringency is weak and signalling works through public disclosure of regulatory compliance.

The third strand of the literature this paper contributes to is the recent work that argues that the most effective way to address environmental concerns is to combine environmental regulations with other policies as a way to overcome the multiple externalities and constraints (Bennear and Stavins, 2007; Lehmann, 2012; Rogge and Reichardt, 2016). In particular, Kostka and Nahm (2017) argue that policy centralisation alone is not "a silver bullet" while Foulon et al (2002) suggest that information disclosure strategies are not sufficient by themselves to replace traditional environmental policies but should be considered to be complementary to, or a substitute for, command-and-control and market-based instruments.

The fourth strand of the literature relates to green finance. More specifically, this paper is one of the first to examine a green securities policy and extends the existing research on green finance that tends to concentrate on the impact of green credit (Hu et al., 2021; Jin et al., 2021; Xing et al., 2021; Yao et al., 2021).

To briefly summarise the results, this paper provides theoretical and empirical evidence of how publicly accessible information on policy compliance and a more centralised inspection process combined with a green finance initiative encouraged firms to improve their environmental performance without negatively impacting competitiveness. The empirical results show that the pre-IPO policy increased environmental and short-term economic performance for compliant firms (without loss of competitiveness for at least two years after policy compliance).

The remainder of the paper is organised as follows. Section 2 presents theoretical frameworks of the policy effect. Section 3 describes the econometric model, data and estimation strategies. Sections 4 and 5 report the empirical results, and section 6 concludes.

2. Theoretical Framework

GSP aims to achieve two different goals. First, to reduce the emissions of compliant firms and second, to encourage capital flows into new “greener” investment projects that, in turn, will have a longer-term impact on emissions. As illustrated in Figure 1, with a single environmental policy, for example an emission tax, the marginal benefit (*MB*) of abatement is constant and represented by τ_1 per unit of abatement. The equilibrium level of abated emissions is Z_1^*, where the marginal abatement cost (*MAC*) equals *MB* at point E_1. The pre-IPO policy enables compliant firms to gain direct benefits by allowing them to raise funds in the capital market, equivalent to increasing *MB* to τ_2 at abatement level Z_1^*. Motivated by the benefit, compliant firms will attract "greener" flows of capital. Green investment then leads to greater abatement until Z_2^* is reached at the new equilibrium point E_2, with a higher marginal abatement cost.

[Figure 1 about here]

On the other hand, the pre-IPO policy increases the demand for the goods (services) of the compliant firm because of the public access to information on policy compliance. Public disclosure sends a direct and distinct signal to uninformed environmental-conscious consumers about the environmental performance of a firm and the effort it has gone to ensure its new investment is "green". Therefore, the pre-IPO policy addresses the problem of asymmetric information about the firm's environmental attributes such that consumers are now happy to pay a higher price for the product of a compliant firm. Previously, consumers could only guess the firm's probability of being clean before deciding their willingness to pay for the firm's products.

For simplicity, for a constant level of emissions abatement, we follow Sengupta (2012) and assume a monopolist produces a good (or service) with an environmental externality. The consumers are risk neutral. In Market A, policy compliance information is available to the public. For a compliant firm operating in an environmentally friendly manner, a consumer has a quasi-linear utility function given by:

$$U^{A1}(q) = d - \frac{1}{2\rho}(a - q)^2 \tag{1}$$

where q is the quantity of the good consumed; $d > 0$ and $a > c > 0$ are constants, where c is the marginal cost of production; $\rho < 1$ is a consumer-specific environmental conscious index and distributed uniformly on the interval $[\underline{\rho},1]$ where $0 < \underline{\rho} < 1$.

The marginal utility of consuming the good, $MU^{A1} = \frac{1}{\rho}(a - q)$, determines the price of the good, p, and the individual demand function is $q^{A1} = a - \rho p$. Hence, the aggregate demand is:

$$Q^{A1} = \frac{1}{1-\underline{\rho}} \int_{\underline{\rho}}^{1} (a - \rho p) \, \mathrm{d}\rho = a - \frac{1+\underline{\rho}}{2} p = a - \frac{p}{\gamma} \tag{2}$$

where $\gamma = \frac{2}{1+\underline{\rho}} > 1$. The more environmentally conscious the distribution of preferences (i.e., the lower the value of $\underline{\rho}$), the higher the value of γ. Assume the marginal cost (c) is constant, and the equilibrium monopoly price and quantity of production are achieved where marginal cost equals marginal revenue:

$$p_{A1}^{*} = \frac{a\gamma + c}{2} \tag{3}$$

$$Q_{A1}^{*} = \frac{a\gamma - c}{2\gamma}. \tag{4}$$

A firm that does not comply with the policy is assumed to have no intention of becoming more environmentally friendly. The individual consumer's utility function becomes:

$$U^{A2}(q) = d - \frac{1}{2}(a - q)^2. \tag{5}$$

The marginal utility of consuming the good is $MU^{A2} = a - q$, which is less than MU^{A1}. Then the individual demand function is $q^{A2} = a - p$ and corresponding aggregate demand is:

$$Q^{A2} = a - p. \tag{6}$$

Next, in Market B, where compliance information is not observable, the consumers guess the environmental attributes of the firm. *Ex ante*, consumers believe that the firm has a probability $\mu \in (0,1)$ of being clean. The aggregate demand for the good then becomes:

$$Q^B = \mu Q^{A1} + (1-\mu)Q^{A2} = a - \left(\frac{\mu}{\gamma} + 1 - \mu\right)p = a - \delta p \quad (7)$$

where $\delta = \left(\frac{\mu}{\gamma} + 1 - \mu\right)$. Since $\mu \in (0,1)$ and $\gamma > 1$, we get $0 < \delta < 1$. In Market B, the firm faces the same market demand as Eq. 7, whether the firm is clean or not.

Similarly, we derive the equilibrium price and quantity demanded in Market B as:

$$p_B^* = \frac{a+\delta c}{2\delta} \quad (8)$$

$$Q_B^* = \frac{a-\delta c}{2}. \quad (9)$$

With Eqs. 3, 4, 8 and 9, we calculate the difference in profits ($\Delta\pi$) under the two market conditions for the policy-compliant firm:

$$\Delta\pi = \pi^{A1} - \pi^B = (p_{A1}^* - c)Q_{A1}^* - (p_B^* - c)Q_B^* = \frac{1}{4\delta\gamma}(\delta\gamma - 1)(\gamma a^2 - \delta c^2) > 0 \quad (10)$$

given $a > c > 0$, $\delta = \left(\frac{\mu}{\gamma} + 1 - \mu\right)$ >0, $\gamma > 1$, and $0 < \mu < 1$, we get $(\delta\gamma - 1) = (\gamma - 1)(1-\mu) > 0$ and $(\gamma a^2 - \delta c^2) > 0$, so $\Delta\pi > 0$.

Therefore, the monopolist earns higher profits if it signals to the market its compliance with the green securities policy. Whether the size of $\Delta\pi$ is significantly different from 0 depends on the values of γ (or $\underline{\rho}$) and μ, suggesting the competitiveness of the compliant firms will be stable or even improved.

The theoretical framework reveals the mechanisms by which the pre-IPO policy improves environmental performance and can simultaneously maintain firm competitiveness. Unlike the US, Europe, and Hong Kong, where IPO and stock listings are based on registration, each IPO in China has to go through an approval process run by CRS on behalf of the central government.

The aim of the approvals process is to screen out poor-quality firms and protect investors (Hoque and Mu, 2019). However, this makes China a global exception as it means the government plays a significant role in determining whether a firm can successfully IPO (Li et al., 2021). In this case, it is argued that government oversight of the pre-IPO policy means that environmental inspections are more effective and therefore ensures that capital flows to legitimate green projects which in turn, increases the potential that these projects will result in "greener" production (services) and improve a firm's environmental performance. Therefore, the first hypothesis can be written as:

H1: *Compliance with the pre-IPO policy improves environmental performance.*

To test the mechanism underpinning H1, we have:

H2: *Firms that comply with the pre-IPO policy invest more in environmentally-friendly projects.*

Given China's historically weak environmental enforcement, the pre-IPO policy provides a more transparent, authoritative, and reliable source of information about the regulatory compliance of firms than price signals or self-reported information. Following legislation in 2007, Chinese government departments (at different levels) are obliged to disclose policy information to the public. However, several studies reveal that government information, especially environmental information, may have been manipulated (Ghanem and Zhang, 2014; Liu and Kong, 2021) although the higher the level of government that discloses the information the more trusted it tends to be (Yu et al. 2021). For this reason, it is believed that a more centralised green securities policy sends a stronger signal to consumers and is a stronger signal to shift consumers' utility functions and willingness to pay, which in turn increases demand and hence firm revenue. The increase in revenue should then offset the increase in abatement costs leading to higher profits in the new equilibrium. Hence, hypotheses 3 and 4 are given by:

H3: *Compliance with the pre-IPO policy maintains firm competitiveness (at the same time it improves environmental performance).*

H4: *Firms that comply with the pre-IPO policy increase their revenues.*

3. Methodology

3.1 Data and Variables

The methodological approach is to use a difference-in-difference specification to test whether compliant firms improve their environmental performance (H1) without losing competitiveness (H3). This approach compares the environmental and economic performance before and after firms have complied with the policy with firms that have not yet complied over the same period.

$$CEP_{it} = \beta_0 + \beta_1 COMPLIANCE_{it} + X_{it}\delta + u_t + v_i + \varepsilon_{it} \tag{11}$$

$$Profit\ Margin_{it} = \beta_0 + \beta_2 COMPLIANCE_{it} + X_{it}\gamma + u_t + v_i + \varepsilon_{it} \tag{12}$$

where CEP_{it} is a measure of the corporate environmental performance of firm *i* in year *t*; $Profit\ Margin_{it}$ is a measure of firm competitiveness using the ratio of pre-tax operating profit to total revenue; the variable of interest, $COMPLIANCE_{it}$, is a dummy variable that equals 1 in the years after the firm complies with the pre-IPO policy; X_{it} is a vector of control variables, including the size (employment), years of being publicly listed, the share of independent directors, education of directors, capital intensity, and leverage rates; u_t is the time fixed effect; v_i is the firm fixed effect; and ε_{it} is the error term.

The firm-level data are from the China Stock Market and Accounting Research Database (CSMAR), which covers all listed firms on the Chinese stock market. *CEP* is an index constructed using environmental information from the "Corporate Social Responsibility (CSR)" report that is part of the CSMAR. CSR reporting is not yet mandatory so each year only around 10-15% of listed firms provide CSR information from which, 60-70% include environmental information (although not in a uniform format). After cleaning, information on 536 firms is available during the pre-IPO policy enforcement period between 2009 and 2014 of which 214 are in pollution-intensive sectors. Information on the same firms is also available up until 2019 means that an assessment of the long-term impact of the pre-IPO policy is possible. The final sample consists of an unbalanced panel of 2,208 observations from 2009 to 2019.

Central to this paper is the construction of a firm-level environmental performance index that captures how well the pre-IPO policy meets the objective of improving environmental performance. With this objective in mind, 17 environmental indicators are identified to capture how a firm performed in terms of (1) pollution abatement (10 indicators), (2) energy saving (3 indicators) and (3) environmental management (4 indicators). Table A1 in Appendix A provides more information on the 17 indicators. The approach taken in this paper is to adopt a two-stage procedure that integrates the 17 indicators into a single *CEP* index and follows the method used to construct the Human Development Index (Klugman et al., 2011). Specifically, all indicators are grouped across the three dimensions and the indicators from each group are aggregated to give a final CEP index. Details on CEP index is constructed are provided in Appendix B.

Information on policy compliance was collected manually from the websites of MEE and provincial environmental authorities. Once a firm applies for pre-IPO inspection in year *t*, the information is published on official websites and is made available to the public. Hence, firms are identified as *compliant firms* and coded as $COMPLIANCE_{it} = 1$ from year *t* onwards and

0 otherwise. Other firms in the sample that do not have application information are considered *non-compliant* and are coded as $COMPLIANCE_{it} = 0$. Of the sampled firms, 68 out of the 536 (12.7%) were identified as compliant.

However, like many other policy instruments in China, enforcement of the pre-IPO policy was not entirely mandatory. The main concern from the start was that implementation might have been hindered due to limited collaboration between central and local environmental authorities, the lack of a unified procedure and technical standards, and no detailed guidance on how to identify which firms were polluting. Such uncertainties may have encouraged some polluting firms to avoid inspection, whereas firms in non-pollution-intensive sectors may have been more likely to voluntarily comply (Clarkson et al., 2008; Wang et al., 2010).[2]

Table 1 presents some descriptive statistics. The final two columns report the results of the two-sample test on the difference in means between compliant and non-compliant firms. The immediate observation is that compliant firms have on average better environmental performance and more independent directors, but fewer managers with higher education, are younger, and considerably less capital-intensive. Average profitability levels are not significantly different from each other.

[Table 1 about here]

3.2 Identification Strategy

The baseline results use a fixed effects estimator. However, it is possible that some unobserved characteristics, such as variation in policy enforcement, management skills, and corporate

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[2] Pollution-intensive sectors, as defined by the MEE, include thermal power generation, iron and steel, cement, electrolytic aluminium, coal, mineral exploitation, metallurgy, chemical materials, petrochemical materials, building materials, paper and pulp, brewery, pharmaceutical products, fermentation, textiles and leather products.

culture, may affect not only compliance but also a firm's environmental and economic performance. Hence, a two-stage residual inclusion (2SRI) method (or control function approach) with instrumental variables (IVs) is adopted to address possible self-selection bias and the potential endogeneity of policy compliance. As *COMPLIANCE* is a binary endogenous variable, 2SRI estimation is more appropriate than two-stage least squares (Terza et al., 2008; Wooldridge, 2015).

To be valid, an IV should be correlated with *COMPLIANCE* but uncorrelated with the residuals of *CEP* and *Profit Margin* in Eqs. 11 and 12. However, finding such an IV at the firm level is a challenge. The recent literature points out that when the endogeneity concern is specific to firms but not to industries or locations, then industry-location averages can be used as instrumental variables (Fisman and Svensson, 2007; Laeven and Levine, 2009; Lin et al., 2010). Hence, two IVs in year *t* are constructed: (1) the sectoral share of cumulative compliant firms (IV1) and (2) the provincial share of cumulative compliant firms (IV2), which proxy the average compliance rates of the sector and the province where the firm is located, respectively. Following Fisman and Svensson (2007), it is assumed that industry-level compliance is determined by industry-specific factors such as underlying technologies, while location-level compliance is related to location-specific factors such as the policy enforcement effectiveness of local bureaucrats. If these assumptions are valid, the two proposed IVs should eliminate the bias resulting from the unobservables correlated with compliance at the firm, but not industry or location, level.

The first stage is a Probit estimation:

$$Pr(\,COMPLIANCE_{it} = 1|X, IV1, IV2) = Pr(\,X_{it}\lambda + \eta_1 IV1_{ijt} + \eta_2 IV2_{ikt} + e_{it} > 0) \qquad (13)$$

where e_{it} is the error term which is linearly related to ε_{it} in Eqs. 11 and 12 but independent of control variables X_{it} and the IVs and follows a standard normal distribution. The generalised residual ($\hat{e}_{it}$) is computed and included as an additional regressor in the second stage estimations of Eqs. 11 and 12 (Wooldridge, 2015). The IVs are exogenous when the covariance between each IV and the baseline residuals, i.e., $Cov(\varepsilon_{it}, IV)$, is close to zero (Wooldridge, 2013).

4. Compliance and Environmental and Economic Performance

4.1 Baseline Results

Table 2 reports the results based on the fixed-effects estimation of Eqs. 11 and 12. Observe a positive and statistically significant coefficient on *COMPLIANCE* for both CEP and profit margin in Columns 1 and 2 in Panel (A). On average, compliance increases a firm's environmental performance by 1.3%, and the switch from non-compliant to compliant leads to a 0.054 increase in the profit margin, everything else equal. Panel (B) which is polluting firms only finds a similar policy effect for the CEP index and a significant but slightly weaker impact on the profit margin. The baseline results support our hypotheses that the pre-IPO policy significantly improves firms' environmental performance (H1) without a loss of competitiveness measured using profit margins (H3) (indeed profit margins are found to increase).

[Table 2 about here]

4.2 Instrumental Variable Analysis

Table 3 presents the results from the 2SRI method. The two IVs are collectively significant in the first-stage regressions (p values of χ^2 test <0.01).[3] The covariances, $Cov\ (\varepsilon, IV1)$ and $Cov\ (\varepsilon, IV2)$, are close to zero in all model specifications, indicating that the IVs are valid (Wooldridge, 2013). The coefficient on $\hat{e}_{it}$ is statistically different from zero across all regressions, implying the policy variable, *COMPLIANCE*, is endogenous.

The results confirm support for H1 and H3 after controlling for potential endogeneity issues. The positive and significant coefficients on *COMPLIANCE* indicate that policy compliance improves complying firms' environmental and economic performance after correcting the bias caused by endogeneity. To estimate the policy impact, it is necessary to combine both the exogenous and endogenous impacts (the sum of coefficients of *COMPLIANCE* and $\hat{e}_{it}$). *Ceteris paribus*, the environmental performance of compliant firms is, on average, about 1.4% higher than non-compliant firms in the sample of all firms and 1.5% higher for pollution-intensive firms (these are only slightly higher magnitudes than were found in the baseline results). Moreover, as with the baseline results, the pre-IPO policy does not appear to harm firm competitiveness (Columns 2 and 4). For the full sample, compliant firms received 0.056 higher profit margin (pre-tax profit in total revenue) than non-compliant firms on average. For pollution-intensive firms, policy compliance increases 0.044 profit margin, and such effect remains significant. Again, the magnitudes are similar to those found in the baseline regressions.

[Table 3 about here]

[3] Results of the first-stage estimations are available from the authors upon request.

Since our theoretical model implies that the market may take time to respond to the signal of policy compliance information, Table 4 presents the long-term policy impact on profit margins from $t+1$ to $t+3$, where t is the current year. Policy compliance leads to a statistically significant increase in profit margins between 0.023-0.044 in the two years after compliance (Panel A). A similar pattern is found for pollution-intensive firms (Panel B). However, after three years of compliance ($t+3$), the significant impact on the profit margin disappears and the reason could be that disclosure of policy compliance is a one-time action, so the signal effect on the product market is not permanent. These results are consistent with the dynamic analysis of the policy impact based on the baseline model, as shown in Figure A2.

[Table 4 about here]

4.3 Investment in Green Projects and the Shift in Demand

The next stage is to assess whether the pre-IPO policy encourages compliant firms to invest more in green investment projects. As stated in H2, it is argued that compliant firms are more likely to use their capital to finance environmentally friendly projects. Using the project data from CSR reports, the number of projects that benefit any of the 17 indicators used to construct the CEP index is counted (Table A1). Table 5 reports the findings using OLS and two different count models, Poisson regression and Negative Binomial regression. It is found that policy compliance shifts investment to environmentally friendly projects confirming H2. The coefficient on *COMPLIANCE* is positive and statistically significant in all three specifications. For the average firm, compliance led to a 10% increase in investment in green projects.[4] For

[4] The coefficient on *COMPLIANCE* in Poisson and Negative Binomial regressions explains the percentage change of the number of green projects. For example, in column 2, the coefficient of *COMPLINACE* means the compliant firms increase $e^{1.740} = 5.697$ green projects, consistent with the OLS estimation (5.916) in column 1. In each specification, the coefficients of COMPLIANCE and $\hat{e}_{it}$ jointly explains the policy compliance effect.

pollution-intensive firms, the policy also promotes investment in green projects but on a smaller scale (Columns 4-6), which also explains the smaller policy effect on CEP in these firms compared to the average (Table 3).

[Table 5 about here]

It is also of interest to know whether the public disclosure on policy compliance increases profit margins driven by increased revenue from shifting aggregate demand (H4). Table 6 reports the results from regressing firms' operating revenue on policy compliance, controlling for total operating costs (COST). The coefficient on *COMPLIANCE* is positive and statistically significant in Column 1, indicating that policy compliance increases revenues, holding costs and other variables constant. The positive effect on revenue lasts for two years (Columns 2 and 3) and explains the two-year policy effect found on profit margin in Table 4.

[Table 6 about here]

5. Robustness Checks

Two alternative measures for corporate environmental performance are constructed using the same 17 indicators. One is a factor score obtained from the exploratory factor analysis (EFA) (Gorsuch, 1983), and the second is a factor score from the confirmatory factor analysis (CFA) that allows a *priori* hypothesis and is predicted using a structural equation modelling (SEM) approach. Table 7 reports results on EFA and CFA factor scores. The coefficient on

COMPLIANCE is positive and significant in all specifications and is in line with the main results in Table 3 and confirms support for H1. [5]

As an alternative measure of economic performance, the ratio of net income to total assets (ROA) is calculated. The results are presented in Table 8. The competitiveness of compliant firms remains positive and significant for the two years after policy compliance.[6]

[Tables 7 and 8 about here]

For a final robustness check, a propensity score matching (PSM) approach is taken that allows a counterfactual to be constructed to help understand how a firm's CEP or profit margin would have evolved if it had not complied with the policy. One-year lagged CEP, profit margin and control variables are used to estimate the propensity scores. Using 1-to-1 nearest neighbour matching methods and De Loecker's (2007) algorithm, we obtain an unbalanced panel of 389 firms matched and then regress CEP, profit margin and ROA on policy compliance with a fixed-effects estimator.[7] Table 9 shows that the main results generally hold. The pre-IPO policy does not reduce firm competitiveness (positive and significant on profit margin and insignificant for ROA) while the environmental performance is still found to improve. The magnitudes of the effects are broadly similar with a somewhat smaller impact on environmental performance but a large profit margin effect.

[Table 9 about here]

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[5] We also constructed a third instrument (IV3) which is the ratio of provincial government expenditure on financial regulations to the total budget and captures the provincial-level enforcement effort of financial regulations. The results are generally robust for all three CEP measures (in the main results and in the robustness checks) and available upon request.

[6] A limitation of using *ROA* is that it is hard to compare firms across industries, as some sectors spend more on assets to generate income (e.g., manufacturing vs. services).

[7] Other matching methods including kernel matching and radius matching are also applied but generate similar results. The balancing tests suggest the matching is unbiased (Table A2). With unbalance panel data, we use parametric matching estimators to obtain the average treatment effect on the treated (Blundell and Dias, 2009).

6. Conclusions

To improve the effectiveness of environmental regulatory enforcement in China there are calls for a more centralised policy and for agencies to use different, often interlinked, policies to offset the transaction costs associated with policy compliance and to reduce the associated externalities. In this study, the effects on both environmental and economic benefits of a unique green securities policy that combines IPO approval with a central environmental inspection and the disclosure of policy compliance are examined.

The theoretical framework outlined in this paper suggests that the enhanced role given to central government before and after a firm's IPOs improves the environmental performance of compliant firms. Furthermore, allowing public access to policy compliance information should correct for asymmetric information issues between firms and consumers which leads to a shift in individual utility, drives up aggregate demand and has a positive impact on profits in equilibrium. The theoretical predictions are tested using a unique dataset of listed firms in China from 2009 to 2019. The findings support the hypotheses that firms complying with the pre-IPO policy improved their environmental performance without negatively impacting competitiveness. However, the positive impact on competitiveness lasts for only two years after compliance. In other results, it is found that compliant firms tend to invest more in green projects, and increased profit margins are a result of increased revenue from greater demand.

This is one of the first studies to evaluate the effectiveness of a policy approach that involves combining two policies at the same time (a more centralised environmental inspection and public disclosure of regulatory compliance as part of the IPO process). This research contributes to the literature on environmental regulation centralisation and how linking environmental policy with information disclosure can improve environmental performance without a loss of competitiveness through increasing demand for a firm's products as a result of public disclosure of a firm's green credentials. This paper also adds to the literature of green finance by shedding light on China's pre-IPO policy, the success of which may encourage similar policies to be rolled out elsewhere.

One result is clear. There is considerable regulatory complexity associated with attempts to finance environmentally sustainable economic activities. Maintaining economic growth while promoting environmental protection is a challenge due to the costs associated with stringent environmental regulations. The results of this paper show that a more centralised environmental inspection process and thus avoiding issues related to regulatory capture at the local level can improve environmental performance, but that policy centralisation alone is not a silver bullet. Complementing a stricter inspection regime with information disclosure and access to finance is one way of offsetting the cost of regulatory compliance and facilitates a greater flow of capital into greener investment projects.

In this paper it is shown that the pre-IPO policy is an example of a policy linked to the stock market. Findings support the argument that incorporating environmental policy and information disclosure regimes into financial mechanisms (e.g. IPO approval) can address multiple issues (e.g. transaction costs and information asymmetry) related to environmental protection. Possible extensions of the policy design might include continuous information disclosure regimes, such as mandatory self-reporting, ESG (environmental, social and governance) rating, and regularly published list of violators. Such an approach should incentivise firms to continue to pay close attention to environmental protection.

Finally, it is acknowledged that this research has some limitations. First, our sample size is fairly small. Green securities policies more broadly are relatively new, with many in the pilot stage. In addition, the Chinese stock market is relatively young compared to other developed markets. More broadly, the rate of policy compliance tends to be relatively low in China. These limitations restrict further analyses of heterogeneous effects. Second, this paper only evaluates one specific green securities policy in China. Given that evidence on policies incorporating different functions to tackle environmental problems is still limited at the firm level, future studies may take an in-depth analysis of other policies (e.g. self-reporting and ESG rating).

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Table 1. Descriptive Statistics by Compliant and Non-compliant Firms

	All firms		Compliant firms		Non-compliant firms		Difference	
	Mean	s.d.	Mean	s.d.	Mean	s.d.	t	p-value
CEP Index	0.131	0.235	0.179	0.270	0.121	0.226	3.810***	0.00
Profit Margin	0.130	0.275	0.136	0.180	0.129	0.283	0.354	0.72
ROA	0.039	0.052	0.043	0.050	0.039	0.052	0.994	0.32
Employment	2.343	5.930	1.922	4.751	2.384	6.030	-1.028	0.30
Director	0.372	0.058	0.382	0.066	0.371	0.057	2.436**	0.01
Education	0.359	0.262	0.314	0.265	0.363	0.261	-2.497**	0.01
Age	11.464	6.143	10.628	6.208	11.544	6.133	-1.970**	0.03
Capital intensity	0.497	0.702	0.320	0.333	0.514	0.726	-3.647***	0.00
Leverage	0.091	0.101	0.099	0.103	0.090	0.101	1.177	0.24
Obs.	2208		197		2011			

Notes: s.d. refers to standard deviation. The *CEP index* is calculated for the period of enforcement using the method as described in Appendix B. *Profit Margin* is the ratio of pre-tax operating profit to total revenue; *Employment* refers to the number of full-time equivalent employees (10,000 persons); *Director* captures the share of independent directors on the board; *Education* represents the share of executive managers with a master degree or above; *Age* is the number of years the company listed in the stock market; *Capital intensity* is the ratio of total fixed assets to total revenue; and *Leverage* is the rate of leverage. t-statistics are reported for a two-sided two-sample test of means.

Source: Constructed by authors using CSMAR.

Table 2. Baseline Regression Results: CEP and Profit Margin

	(A) All firms		(B) Pollution-intensive firms	
	(1)	(2)	(3)	(4)
	CEP	Profit Margin	CEP	Profit Margin
COMPLIANCE	0.013**	0.054***	0.014**	0.044**
	(0.007)	(0.020)	(0.006)	(0.021)
Employment	0.005**	0.006	-0.006	0.015
	(0.002)	(0.004)	(0.005)	(0.011)
Director	0.021	-0.093	0.015	-0.030
	(0.039)	(0.135)	(0.057)	(0.076)
Education	-0.007	0.101***	-0.036	0.079**
	(0.017)	(0.021)	(0.023)	(0.032)
Age	-0.003***	-0.005**	-0.001	-0.004
	(0.001)	(0.002)	(0.002)	(0.003)
Capital intensity	0.000	-0.023***	0.000***	-0.024***
	(0.000)	(0.001)	(0.000)	(0.001)
Debt-equity ratio	0.057***	-0.043	-0.004	-0.264
	(0.019)	(0.131)	(0.028)	(0.179)
Constant	0.052**	0.208***	0.073***	0.147**
	(0.025)	(0.061)	(0.021)	(0.057)
Firm fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Within R^2	0.03	0.08	0.03	0.17
F-test statistics	4487.3***	896.8***	332.0***	146869.9***
N	2208	2208	991	991

Notes: The fixed-effect estimator is used for regression. *CEP index* is logged. COMPLIANCE=1 if the firm complies with the pre-IPO environmental inspection from year t onwards; and 0 otherwise. *** p<0.01, ** p<0.05, *p<0.1. Driscoll-Kraay standard errors in parentheses.

Table 3. Second-stage Results of 2SRI Estimations with IVs: CEP and Profit Margin

	(A) All firms		(B) Pollution-intensive firms	
	(1)	(2)	(3)	(4)
	CEP	Profit Margin	CEP	Profit Margin
COMPLIANCE	0.171***	0.520**	0.144***	0.349**
	(0.058)	(0.210)	(0.077)	(0.155)
$\hat{e}_{it}$	-0.157***	-0.464**	-0.129***	-0.305*
	(0.055)	(0.215)	(0.074)	(0.161)
Firm controls	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Cov (ε, IV1)	0.000	0.000	0.000	0.001
Cov (ε, IV2)	0.000	0.002	0.001	0.001
Joint Sig. of IVs χ^2(p-value)	8.54 (0.01)	11.98 (0.00)	22.75 (0.00)	25.70 (0.00)
Within R^2	0.03	0.07	0.03	0.14
F-test statistics	113.8***	2918.1***	790.4***	2774.4***
N	2208	2208	991	991

Notes: The first stage is estimated using Eq. 13, with IVs. $\hat{\boldsymbol{e}}_{\boldsymbol{it}}$ is the residual estimated from the first stage. *IV*1 measures the sectoral share of cumulative compliant firms in year *t*; *IV*2 measures the provincial share of cumulative compliant firms in year *t*; *Cov*(ε, IV1) and *Cov*(ε, IV2) are the covariances between the residuals estimated from the baseline model and the IVs. CEP index is logged. *** p<0.01, ** p<0.05, *p<0.1. Driscoll-Kraay standard errors in parentheses.

Table 4 Long-term Effects on Profit Margin, 2SRI Estimations with IVs

Profit Margin	(1) *t*	(2) *t+1*	(3) *t+2*	(4) *t+3*
(A) All firms				
COMPLIANCE	0.520**	0.597***	0.617**	0.449
	(0.210)	(0.117)	(0.248)	(0.326)
$\hat{e}_{it}$	-0.464**	-0.574***	-0.573**	-0.465
	(0.215)	(0.122)	(0.247)	(0.322)
Cov(ε, IV1)	0.000	0.000	0.000	0.000
Cov(ε, IV2)	0.002	0.002	0.003	0.003
Within R^2	0.07	0.04	0.03	0.03
F-test statistics	2918.1***	56392.5***	420559.7***	189070.4***
N	2208	1476	1198	999
(B) Pollution-intensive firms				
COMPLIANCE	0.349**	0.574**	0.824***	0.203
	(0.155)	(0.251)	(0.261)	(0.291)
$\hat{e}_{it}$	-0.305*	-0.581**	-0.805***	-0.199
	(0.161)	(0.258)	(0.253)	(0.283)
Cov(ε, IV1)	0.001	0.000	0.000	0.000
Cov(ε, IV2)	0.001	0.004	0.004	0.003
Within R2	0.14	0.08	0.07	0.04
F-test statistics	2774.4***	365956.5***	1125.0***	483.3***
N	991	693	587	497
Firm controls	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes

Notes: Dependent variables are the profit margin at time t, t+1, … t+3. $\hat{\boldsymbol{e}}_{it}$ is the residual estimated from the first stage. *Cov*(ε, IV1) and *Cov*(ε, IV2) are the covariances between the residuals estimated from the baseline model and the instrumental variable. *** p<0.01, ** p<0.05, *p<0.1. Driscoll-Kraay standard errors in parentheses.

Table 5. Mechanism Effect through Investment in Environment-friendly Projects

	(A) All firms			(B) Pollution-intensive firms		
	(1)	(2)	(3)	(4)	(5)	(6)
No. of Env-friendly investment projects	OLS	Poisson	Negative binomial	OLS	Poisson	Negative binomial
COMPLIANCE	5.916***	1.740***	1.739***	4.087***	1.375***	1.378***
	(0.596)	(0.300)	(0.304)	(0.562)	(0.252)	(0.258)
$\hat{e}_{it}$	-5.721***	-1.647***	-1.653***	-3.986***	-1.327***	-1.343***
	(0.602)	(0.304)	(0.308)	(0.538)	(0.244)	(0.253)
Cov (ε, IV1)	-0.001	0.000	0.000	-0.001	-0.001	-0.001
Cov (ε, IV2)	0.001	0.001	0.000	0.001	0.000	0.000
F or wald χ^2 *statistics*	176.2***	627.4***	602.4***	87.2***	423.1***	388.3***
N	2208	2208	2208	991	991	991
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	No	No	No	No	No	No
Year fixed effects	No	No	No	No	No	No

Note: $\hat{\boldsymbol{e}}_{\boldsymbol{it}}$ is the residual estimated from the first stage. *Cov*(ε, IV1) and *Cov*(ε, IV2) are the covariances between the residuals estimated from the baseline model and the instrumental variable. *** p<0.01, ** p<0.05, *p<0.1. Driscoll-Kraay standard errors in parentheses.

Table 6. Mechanism Effect through Revenue, Controlling for Cost

	(1)	(2)	(3)	(4)
Revenue	*t*	*t+1*	*t+2*	*t+3*
(A) All firms				
COMPLIANCE	1.120***	1.147***	1.201***	0.265
	(0.199)	(0.195)	(0.244)	(0.372)
$\hat{e}_{it}$	-1.131***	-1.074***	-1.158***	-0.263
	(0.198)	(0.211)	(0.249)	(0.367)
COST	0.978***	0.564***	0.147**	-0.005
	(0.022)	(0.056)	(0.066)	(0.051)
Cov(ε, IV1)	0.000	0.002	0.003	0.002
Cov(ε, IV2)	0.001	-0.002	-0.001	0.004
Within R^2	0.87	0.34	0.08	0.07
F-test statistics	7319.5***	5084.6***	640.1***	1265.3***
N	2208	1476	1198	999
(B) Pollution-intensive firms				
COMPLIANCE	0.686***	1.187***	1.021**	-0.350
	(0.095)	(0.355)	(0.505)	(0.340)
$\hat{e}_{it}$	-0.708***	-1.147***	-0.991*	0.366
	(0.098)	(0.358)	(0.507)	(0.340)
COST	0.910***	0.446***	0.094*	0.020
	(0.053)	(0.061)	(0.050)	(0.068)
Cov(ε, IV1)	0.001	0.002	0.003	0.003
Cov(ε, IV2)	-0.0003	-0.001	0.0009	-0.002
Within R2	0.89	0.33	0.09	0.10
F-test statistics	10047.7***	1617.3***	3520.6***	347.3***
N	991	693	587	497
Firm controls	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes

Note: Sale revenue and cost are both logged. Dependent variables are at year t, t+1, t+2 and t+3. $\hat{\boldsymbol{e}}_{\boldsymbol{it}}$ is the residual estimated from the first stage. *Cov*(ε, IV1) and *Cov*(ε, IV2) are the covariances between the residuals estimated from the baseline model and the instrumental variable. *** p<0.01, ** p<0.05, *p<0.1. Driscoll-Kraay standard errors in parentheses.

Table 7. Robustness Tests Using Factor Scores for Environmental Performance, 2SRI Estimations

	(A) All firms		(B) Pollution-intensive firms	
	(1)	(2)	(3)	(4)
CEP: Factor Scores	EFA Scores	CFA Scores	EFA Scores	CFA Scores
COMPLIANCE	0.010***	0.034***	0.009**	0.053***
	(0.004)	(0.012)	(0.004)	(0.014)
$\hat{e}_{it}$	-0.009***	-0.029**	-0.007*	-0.044***
	(0.003)	(0.012)	(0.004)	(0.014)
Firm controls	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Cov(ε, IV1)	0.000	0.000	0.000	0.000
Cov(ε, IV2)	0.000	0.000	0.000	0.000
Within R^2	0.01	0.04	0.05	0.04
F-test statistics	2239.6***	83991.2***	7614.9***	39051.6***
N	2208	2208	991	991

Notes: CEP (corporate environmental performance) is measured by factor scores estimated from the exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). $\hat{\boldsymbol{e}}_{\boldsymbol{it}}$ is the residual estimated from the first stage. *Cov*(ε, IV1) and *Cov*(ε, IV2) are the covariances between the residuals estimated from the baseline model and the instrumental variable. *** p<0.01, ** p<0.05, *p<0.1. Driscoll-Kraay standard errors in parentheses.

Table 8. Robustness Tests on Current and Long-term ROA, 2SRI Estimations

	(1)	(2)	(3)	(4)
ROA	*t*	*t+1*	*t+2*	*t+3*
(A) All firms				
COMPLIANCE	0.281***	0.148***	0.160**	0.049
	(0.036)	(0.024)	(0.062)	(0.060)
$\hat{e}_{it}$	-0.278***	-0.148***	-0.145**	-0.059
	(0.036)	(0.028)	(0.061)	(0.058)
Cov(ε, IV1)	0.000	0.000	0.000	0.000
Cov(ε, IV2)	0.000	0.000	0.000	0.000
Within R^2	0.10	0.07	0.03	0.03
F-test statistics	8662.7***	12169.8***	606.8***	1492.6***
N	2208	1477	1199	1001
(B) Pollution-intensive firms				
COMPLIANCE	0.246***	0.194***	0.175**	0.088
	(0.031)	(0.026)	(0.069)	(0.060)
$\hat{e}_{it}$	-0.243***	-0.194***	-0.164**	-0.100*
	(0.028)	(0.033)	(0.068)	(0.059)
Cov(ε, IV1)	0.000	0.000	0.000	0.000
Cov(ε, IV2)	0.000	0.001	0.001	0.001
Within R2	0.15	0.11	0.08	0.08
F-test statistics	771672.1***	6950.0***	940571.0***	501.4***
N	991	694	588	499
Firm controls	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes

Notes: ROA refers to the return to assets. $\hat{\boldsymbol{e}}_{\boldsymbol{it}}$ is the residual estimated from the first stage. *Cov*(ε, IV3) and *Cov*(ε, IV3_sq) are the covariances between the residuals estimated from the baseline model and the instrumental variable. *** p<0.01, ** p<0.05, *p<0.1. Driscoll-Kraay standard errors in parentheses.

Table 9. Fixed-Effects Results Using PSM Matched Samples

	(A) All firms			(B) Pollution-intensive firms		
	(1)	(2)	(3)	(4)	(5)	(6)
	CEP	Profit Margin	ROA	CEP	Profit Margin	ROA
COMPLIANCE	0.018**	0.017**	0.003	0.018*	0.022**	0.007
	(0.008)	(0.007)	(0.007)	(0.010)	(0.009)	(0.009)
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Within R^2	0.03	0.04	0.09	0.04	0.06	0.10
F-test statistics	22.5***	1977.5***	19821.3***	205.9***	58315.9***	3095.5***
N	1447	1447	1447	677	677	677

Notes: The fixed-effect estimator is used for regression. CEP index is logged. *** p<0.01, ** p<0.05, *p<0.1. Driscoll-Kraay standard errors in parentheses.

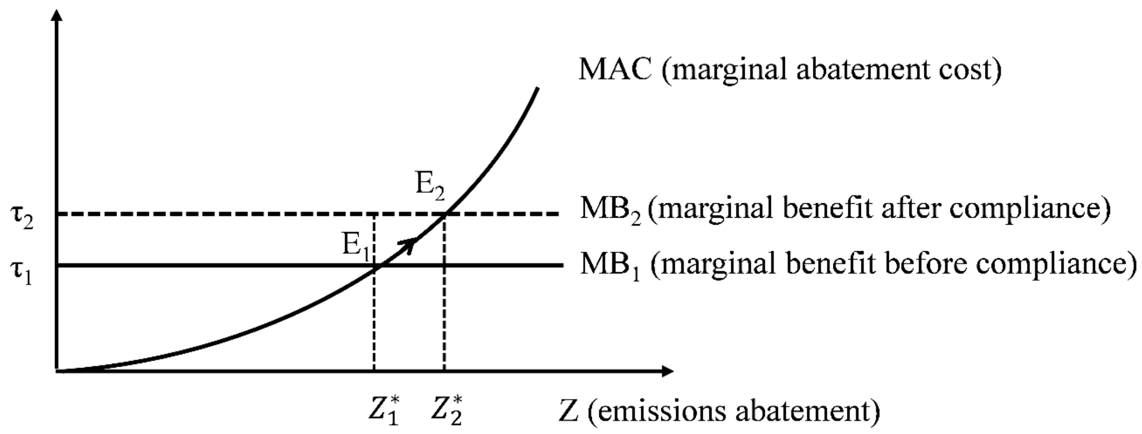


Figure 1. The Impact of Policy Compliance on Firms' Emission Abatement

Source: constructed by the authors.

Appendix A

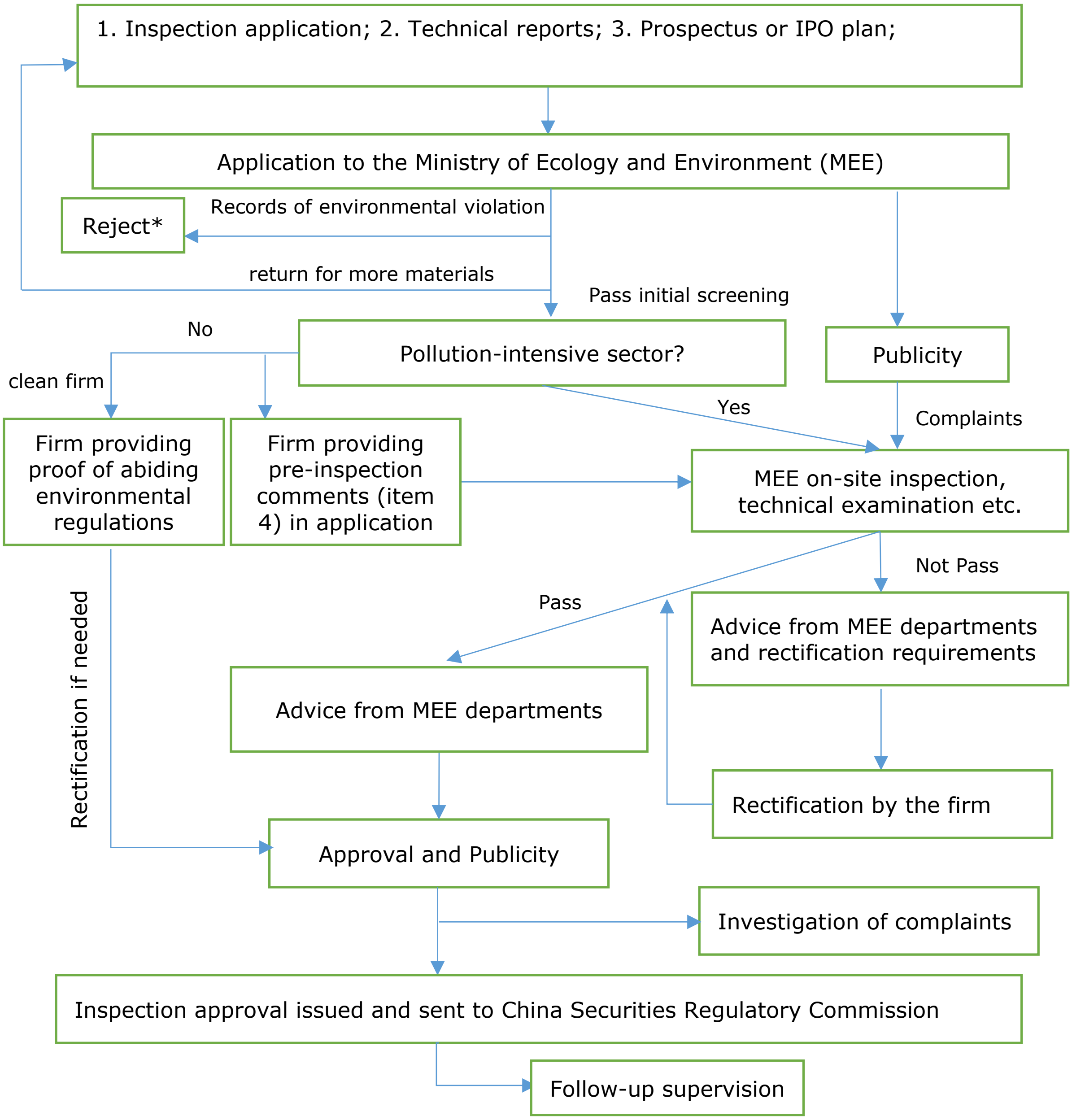
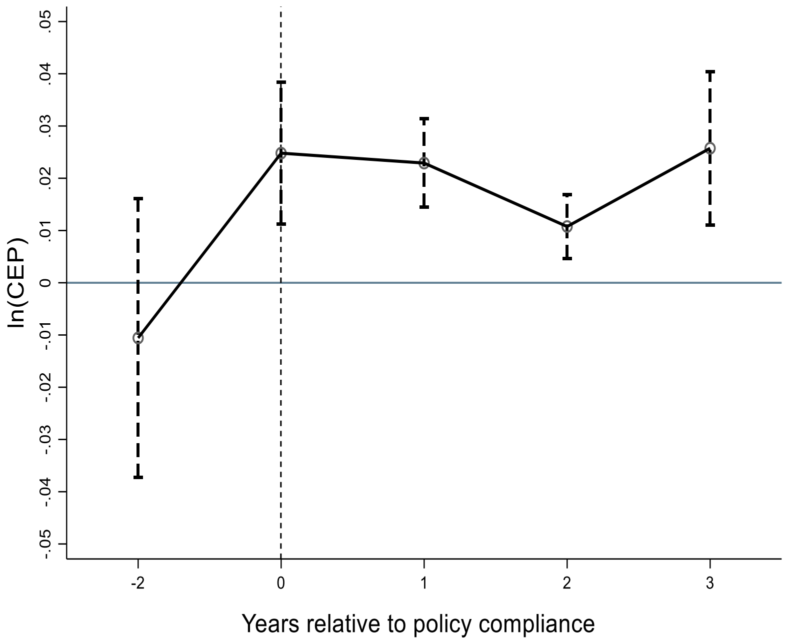


Figure A1. Pre-IPO Environmental Inspection Procedure

Notes: The inspection is free of charge. The inspection length varied depending on the firm's size, location, industry, pollution intensity, issues identified and length of rectification. *For firms with a record of environmental violations over the past 12 months, the inspection application would be directly rejected and cannot be resubmitted within 6 months.

Sources: Constructed by the authors based on various documents of environmental authorities in China.



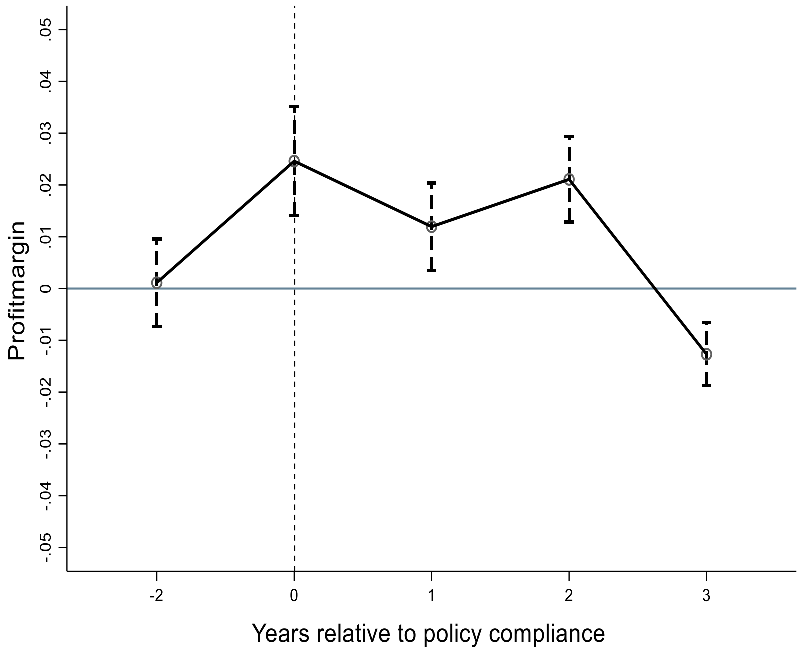


Figure A2. The Dynamic Impacts of Policy Compliance on Firms' CEP and Profit

Notes: The figures plot the dynamic impacts of the policy on firms' CEP and profit, spanning from 2 years before policy compliance until 3 years after policy compliance, based on the baseline regression. We use one year before policy compliance as the base group. We only consider a 5-year window because the number of observations for compliant firms beyond the plotted window is very small (only 1.5%). The dashed lines represent 95% confidence intervals of the estimated coefficients of the year dummy variables.

Table A1. Corporate Environmental Performance Index Indicators

Dimensions	No.	Indicators	Unit of Measurement	Mean	Std. Dev.
Energy-saving activities	1	Savings on water consumption	10,000 tons	447.148	9793.042
	2	Savings on electricity consumption	10,000 kWh	812.782	19706.650
	3	Savings on other energy (coal, gas, etc.)	10,000 tons	12.485	391.345
Pollution abatement activities	4	Industrial wastewater treatment	ton	1.770e+07	5.890e+08
	5	City sewage treatment	ton	89077.710	2715870.000
	6	Chemical oxygen demand (COD) treatment	ton	1644.306	27080.380
	7	NH_3 removal	ton	24.103	454.950
	8	SO_2 removal	ton	12666.980	388731.000
	9	NO_2 removal	ton	2356.778	101549.900
	10	Carbon removal	ton	476.762	15052.470
	11	Soot (dust) removal	1000 tons	1135.632	24972.300
	12	Waste gas removal	10,000 m^3	714.238	16794.660
	13	Industrial solid waste treatment	10,000 tons	25.489	223.617
Other management-related activities	14	Investment in environment-related projects	10,000 yuan	6558.116	71799.710
	15	ISO14000/1 Certificate	Count	0.368	0.482
	16	No. of environmental education activities	Count	1.156	14.788
	17	No. of trees planted	10,000 trees	0.554	13.403

Notes: Since there are no standard criteria for environmental information disclosure in the CSR report, firms present their environmental information differently in terms of the activities, the items included in each activity, the format of data and the quality of data. To solve these problems, we keep only the activities that are included in the statistical bulletin of the Ministry of Ecology and Environment of China, as these activities make an effective contribution to environmental improvement. We then group the thousands of data items into 17 identified indicators for the CEP index. To solve the differences in data quality, we assume that if a firm decides to disclose and has improved environmental performance, it would be more likely to include such information in its CSR report; whereas those with limited environmental improvement are more likely to limit their disclosure. This assumption follows the findings of Meng et al. (2014) that although both good and poor performers disclosed environmental information, good performers disclosed more solid information while poor performers avoided disclosing negative information. Therefore, our CEP index focuses on environmental improvement indicators rather than pollution emissions only. To construct a CEP index, we started from the most complicated 2014 data (with near 6000 data items). After discussing the method with peers working in this area, we set up a cleansing and calculation method for each activity, which are used for other years.

Table A2. Matching Propensity Average Balancing Test for All the Companies

	Mean		*Bias*	*Equality of Means*	
Variable	*Treated*	*Control*	*reduced %*	t	$p > \|t\|$
CEP_{t-1}	0.045	0.045	-0.0	-0.00	1.000
$Profit\ margin_{t-1}$	0.107	0.112	-1.9	-0.16	0.876
$Employment_{t-1}$	1.432	1.236	3.6	0.61	0.539
$Director_{t-1}$	0.373	0.372	0.9	0.07	0.943
$Education_{t-1}$	0.315	0.266	18.7	1.52	0.131
Age_{t-1}	10.828	11.615	-13.0	-1.03	0.305
$Capital\ intensity_{t-1}$	0.298	0.271	3.7	0.77	0.444
$Debt\text{-}equity_{t-1}$	0.098	0.089	8.8	0.70	0.487
CEP^2_{t-1}	0.004	0.004	0.3	0.20	0.843
$Profit\ margin^2_{t-1}$	0.065	0.051	6.9	0.64	0.521
$Employment^2_{t-1}$	11.369	4.522	3.0	1.02	0.309
$Director^2_{t-1}$	0.143	0.142	2.1	0.17	0.864
$Education^2_{t-1}$	0.168	0.128	19.8	1.72	0.087
Age^2_{t-1}	153.27	169.9	-11.8	-0.93	0.352
$Capital\ intensity^2_{t-1}$	0.165	0.144	0.2	0.50	0.614
$Debt\text{-}equity^2_{t-1}$	0.021	0.018	10.9	0.92	0.357

Note: *Mean* represents the mean value of each control variable for companies in the treated and control groups. *Bias* refers to the mean standardised percentage bias across all the covariates between treated and control included in the probit estimation for the matching; and *bias reduced %* is the percentage of bias reduction after the matching procedure. t-statistic refers to the test statistic for the equality of the means of companies in the matched sample compared to those in the unmatched sample.

Appendix B: Construction of the Corporate Environment Performance (CEP) Index

Assume there are I firms ($i = 1, 2, \ldots, I$) with P dimensions of CEP ($p = 1, 2, \ldots, P$) for each firm. Each of the P dimensions contains J ($j = 1, 2, \ldots, J$) measurable indicators. To construct a CEP_{it}, we firstly aggregate all indicators in the same dimension to a dimensional index and then aggregate all dimensional indices to the CEP_{it}.

We compute the dimensional index (DI_{ipt}) for firm *i* at time *t* using the Euclidean distance synthesis method:

$$DI_{ipt} = \frac{1}{2} \times \left[\frac{\sqrt{\sum_{j=1}^{q} \hat{x}_{ipjt}^2}}{\sqrt{\sum_{j=1}^{q} w_{pj}^2}} + \left(1 - \frac{\sqrt{\sum_{j=1}^{q} (w_{pj} - \hat{x}_{ipjt})^2}}{\sqrt{\sum_{j=1}^{q} w_{pj}^2}} \right) \right] \tag{A1}$$

where $\hat{x}_{ipjt} \equiv w_{pj} \cdot \tilde{x}_{ipjt}$, the weighted adjusted indicator, firm *i* would have a higher value of $\hat{x}_{ipjt}$ if it performs better in indicator *j* of dimension p at time *t*; and $\tilde{x}_{ipjt} = \frac{x_{ipjt} - x_{pj}^{min}}{x_{pj}^{max} - x_{pj}^{min}}$, the original normalised value of indicator *j*; and $w_{pj} = \frac{V_{pj}}{\sum_j V_{pj}}$, the weight computed on the coefficient of variation, and a larger weight means an indicator has a wider variation across all observations.

Let $O_p \equiv (0, 0, \cdots, 0)$ be the point representing the worst situation (no performance) and $W_p \equiv (w_{p1}, w_{p2}, \cdots, w_{pq})$ be the point representing the ideal situation with the highest achievement in the *q*-dimensional space. The first component in the brackets of Eq. (A1) is the normalised Euclidean distance between X_{ipt} and O_p. The second component is the normalised inverse Euclidean distance between X_{ipt} and W_p. If two firms stand at the same distance from the ideal point, the one farther away from no performance has a higher dimension index.

Then the CEP_{it} for each firm is:

$$CEP_{it} = \frac{1}{2} \times \left[\frac{\sqrt{\sum_{p=1}^{P} y_{ipt}^2}}{\sqrt{\sum_{p=1}^{P} w_p^2}} + \left(1 - \frac{\sqrt{\sum_{p=1}^{P} (w_p - y_{ipt})^2}}{\sqrt{\sum_{p=1}^{P} w_p^2}} \right) \right] \times 100 \tag{A2}$$

where $y_{ipt} \equiv w_p \cdot DI_{ipt}$, the weighted value of the dimensional index; and the weight is calculated by $w_p = \frac{V_p}{\sum_p V_p}$ and the coefficient of variation is calculated by $V_p = \frac{\sigma_p}{a_p}$, where σ_p is the standard deviation and a_p is the sample average of DI_{ipt} across firms and time. A firm with better environmental performance has CEP_{it} that is further away from the zero achievement $O \equiv (0,0,\cdots,0)$.