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Business groups and environmental violations: Evidence from China
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Business groups and environmental violations: Evidence from China

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Abstract

Although, in the modern era, stakeholders put pressure on firms to engage in environmental friendly practices, yet collaborative arrangements in the shape of business group affiliations may prove a double-edged sword. Accordingly, this study examines the impact of such collaborative arrangements on firm's environmental violations. On one hand, this affiliation can better pursue environmental policies and regulations because of their higher political or social visibility and reduce environmental infractions. Conversely, higher political legitimacy may derive from engaging in environmental violations. Using a unique sample from China comprising 6860 firm-year observations over the 2010 to 2020 time period, we find that business group affiliation increases environmental violations, implying that stronger political legitimacy provides them relaxation in strictly following environmental regulations in comparison to standalone firms. We also find that this nexus is more pronounced when the affiliated firms have poor shareholder and board monitoring. These findings are helpful for policymakers/regulators concerning the initiative's evaluation regarding sustainable development and ecological protection.

Keywords: Business groups; environmental violations; political legitimacy; board monitoring.

"We must not sacrifice the ecological environment for temporary economic growth; we must protect it." Xi Jinping – President of the People's Republic of China

1. Introduction

This study examines whether collaborative arrangements in the form of business groups (henceforth, BGs) preserve or endanger the ecosystem and ensure adherence to or defiance of environmental policies. Specifically, we explore the association between BGs and environmental violations in the world's largest polluter, China. By definition, BG is a collaborative arrangement of legally independent firms that work in different industries but have common ownership and strategic control (Ararat, et al., 2018; Mukherjee et al., 2018; Pattnaik et al., 2013). On the other hand, reducing firm's environmental infractions is a crucial managerial concern in the modern times as such environmental violations point out contravention of environmental laws and regulations by firms, culminating in consequential environmental risk, pollution, and even financial penalties (Manda et al., 2014; Peng et al., 2018; Pham et al., 2020; Shahab et al., 2022; Shevchenko, 2021).

In particular, BGs differ from independent firms and enjoy several advantages; for instance, BGs have the financial flexibility and can shift resources across member firms, reduce the business risk and increase firm value (Choi et al., 2018). BGs are found to affect their member firms' performance (Carney et al., 2009; Guest and Sutherland, 2009), financial constraints (He et al., 2013), risk-sharing (Gopalan et al., 2007; Marisetty and Subrahmanyam, 2010), entrepreneurial orientation (Purkayastha and Gupta, 2022), cash holdings (Nakajima and Sasaki, 2020) and corporate social responsibility (Choi et al., 2018; Cuervo-Cazurra, 2018) in emerging markets. However, it is not clear whether BG affiliations prevent or promote environmental violations, which is the focus of this study.

The motivation behind this study is twofold. First, it is not clear whether BGs firms refrain from committing environmental infractions or engage in them to cause environmental deterioration. The existing evidence highlights two antagonistic views –

political or social visibility and political legitimacy. The visibility standpoint exhibits that BGs perform better in matters pertaining to sustainable ecological protection, e.g., corporate social responsibility (CSR) (Guo et al., 2018; Reverte, 2012). Based on the political legitimacy viewpoint, member firms are less inclined to adopt state initiatives (Choi et al., 2018; Marquis and Qian, 2014), especially environmental policies and regulations. Carney et al. (2011) state that BGs can be either paragons or parasites due to their complex social and economic effects in the context of better sustainable and environmental practices. In short, it is likely that BGs underperform (in terms of environmental orientation) relative to their independent counterparts as BG member firms enjoy political legitimacy. In short, the existing views on BGs have created a paradoxical situation.

Second, an important strand of literature studies pure economic and financial performance (Carney et al., 2009; Guest and Sutherland, 2009), leaving a research void for non-financial outcomes. For instance, BGs affect their member firms' financial constraints (He et al., 2013) and risk-sharing (Gopalan et al., 2007; Marisetty and Subrahmanyam, 2010) in emerging markets, particularly China. He et al. (2013) examine the role of member firms in China as an internal capital market in an environment characterized by an underdeveloped financial market and a weak legal system. They report that BGs assist member firms to overcome constraints through uplifting external capital and that the internal capital market serves as an alternative financing source for state-owned firms than private firms. Drawing on the resource-based view (RBV) in the Indian market, Popli et al. (2017) suggest that BGs leverage their affiliation advantages to reach higher long-term acquisition performance than individual firms. Moreover, Ray and Chaudhuri (2018) emphasize that there is significant progress in understanding the financial outcomes of BGs. However, we are still in nascent stage to know whether BGs contribute to sustainable and ecological development by curbing environmental violations. We aim to address this potential research void in this study.

Contextually, the Chinese market provides an appropriate setting to examine how BGs affect environmental violations. First, China has experienced numerous changes since 1978 after the enactment of the opening policy (Xu et al., 2012), and during the past two decades[1], it has become one of the largest economies in the world (Nguyen et al., 2021; Zeng et al., 2009) with 9.7% Gross Domestic Product (GDP) growth rate (Xu et al., 2012). This rapid economic growth has escorted acute environmental qualms (Diao et al., 2009), and the recurrent environmental violations epidemic include Tai Lake's blue-green algae, Zijin Mining firm's acidic waste water, arsenic contamination in Hunan, among others. Strikingly, BGs contribute approximately 60% to industrial production; 2856 officially conceded BGs were reported in China by 2006 that own 27,950 subsidiaries with employing 30 million workers (He et al., 2013).

Second, shareholder protection laws are weaker in China relative to the rest of the world. Allen et al., (2005) compare investor protection rights in China and other countries using the investor protection rights' index of La Porta et al. (1998). They report that China, Indonesia, and Mexico possess the lowest standards for shareholder protection. In such nations, market monitoring can be costly, and BGs can easily deviate from environmental regulations and norms. Third, China's financial system is state dominated, where the government controls the country's financial resources. The state empowerment in financial resources generally gratifies the businesses groups that have strong ties with them and are deemed an important part of the country's economic reforms – political legitimacy (Choi et al., 2018).

Consequently, our study has clear and distinct contributions in following three ways. First, we contribute to the literature on business ethics and the environment by showing novel evidence that BG member firms violate environment-friendly practices in China by committing environmental infractions. For instance, Choi et al. (2018) and Ray and

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[1] The Chinese government has taken steps to lay out environmental preservation, for instance, State Council Regulation in 2005, Initial Public Offerings (IPOs) notification in 2008 (Chang et al., 2015; Elmagrhi et al., 2018).

Chaudhuri (2018) report the positive effect of BGs on CSR performance in Korea and India. However, in the Chinese market, Guo et al. (2018) find that firms with dual status as state-owned enterprises and BG perform poorly in CSR activities. This conflicting evidence demands further investigation pertaining to the dark side of business groups in emerging economies. Contrary to extant research (e.g., Choi et al., 2018; Guo et al., 2018), we focus on environmental infractions by Chinese listed firms and determine the impact of BGs affiliation on such environmental infractions instead of focusing on CSR performance.

Second, we also add to the debate whether BGs are paragons or parasites (Khanna and Yafeh, 2007), robber barons or red barons (Perotti and Gelfer, 2001). In the Chinese context, our results provide evidence on the association between BGs and non-economic performance, extending the literature on environmental or social performance and various types of ownerships such as institutional ownership (Wang et al., 2011), state ownership (Li and Zhang, 2010), and managerial ownership (Jia and Zhang, 2013). The findings present evidence on the dark side of BGs, showing that member firms act as parasites and do not adhere to environmental regulations and policies and commit environmental violations which lead to environmental deterioration.

In particular, we use a sample of 6860 Chinese firms listed on the Shenzhen Stock Exchange (SZSE) and Shanghai Stock Exchange (SSE) from 2010 to 2020. Our results show that, on average, BGs have a significantly positive impact on environmental violations. The results exist after controlling for firm-level financial variables, ownership structure, and corporate governance. The empirical evidence corroborates the hypothesis that BGs violate environment protected practices and suggest that the political legitimacy view outweighs the political or social visibility view.

Third, we further contribute by examining how shareholder and board monitoring affect the association between BGs and environmental violations. To do so, we dichotomize our sample into two groups of stronger versus lower shareholder monitoring and board monitoring in separate regressions. We find that the effect of BGs on

environmental violations is higher and statistically significant in sub-samples of firms with weaker shareholder and board monitoring. The results on sub-samples reveal that loose monitoring enables BGs to avoid good environmental practices.

Furthermore, the potential endogenous relationship arising from self-selection bias between BGs and environmental violations is our major concern. One can raise the question that being environmentally friendly or being a member firm of BGs is a firm's own choice. We address these issues in two ways: first, we divide our sample into firms in a BG (treatment group) and not in a BG (control group). We use Propensity Score Matching (PSM) to determine similar firms from both groups based on observable characteristics used in our baseline models. Second, we employ a two-stage Heckman model using Mandatory CSR disclosure as an exogenous variable. The findings proved to be robust to both analyses.

The remainder of the study is arranged as follows: Section 2 presents the literature review and hypothesis development; Section 3 describes the research design; Section 4 presents the empirical results; Section 5 discusses endogeneity issue; Section 6 concludes the study.

2. Theory, literature review and hypothesis development

In his classic work, Freeman (1984) defines a "stakeholder" as any person or group who may impact the organization's performance or who is influenced by the firm's principles and strategies. Theoretically, the stakeholders' wealth maximization view recognizes their significance to enterprises as well as firms' moral obligation and commitments toward stakeholders. The stakeholder perspective (Donaldson and Preston, 1995; Freeman, 1984) posits that companies owe a moral obligation for their corporate activities not just to owners, but also to all their stakeholders, such as workers, contractors, general public, financiers, among others. The conformity to non-financial norms, such as socially responsible and environmental policies and laws, as well as excellent corporate citizenship, among others, in order to meet the demands of all stakeholders, extends beyond the financial goals of the corporation (Deng et al., 2013; McGee, 1998). Corporations must

preserve the well-being and expectations of its patrons, particularly through making choices that are ethically and ecologically responsible. On the other side, if a business fails to represent the interests of its many stakeholders (in the form of poor environmental pledges or environmental infractions), the repercussions might be severe.

Furthermore, the BGs phenomenon is multifaceted and constitutes a set of independent organizations, contriving in intricate industries, whose economic pursuit is guarded and harmonized via informal ties, interlocking directorship, equity stakes, control rights (Gaur et al., 2019; Khanna and Yafeh, 2007; Nakajima and Sasaki, 2020; Pattnaik et al., 2018), to name a few. The significance of BGs has garnered the attention of management (Ararat et al., 2018; Choi et al., 2018; Cuervo-Cazurra, 2006; Khanna and Palepu, 2000) and finance (He et al., 2013) scholars over the past decades. In several emerging economies, including Indonesia, Brazil, Turkey, and Korea, BGs constitute half of the stock market capitalization (Khanna and Yafeh, 2007; Kim et al., 2004). Among the top 50 firms in Turkey and India, 28 firms and 45 firms are BGs, respectively; almost 80% of GDP comes from BGs in Koreas (Holmes et al., 2018). The nitty-gritty of BGs is not only bound to developing nations but expands over developed countries. For instance, Weston group in Canada, Koch industries in the U.S., Wallenberg group in Sweden, and Agnelli group in Italy are influential players in their concerned industries (Colpan and Hikino, 2018). The BGs literature can be grouped into two broad domains. The first line of inquiry considers pure financial outcomes such as risk-sharing (Chang and Hong, 2000; Friedman et al., 2003; Khanna and Yafeh, 2007), financial constraints (He et al., 2013; Shin and Park, 1999), cash holdings (Nakajima and Sasaki, 2020) and firm performance (Chang and Choi, 1988; Khanna and Rivkin, 2001). These studies emphasize on risk-sharing via resource transfer, reduction in monitoring and agency costs, and funding advantage to member firms. The second body of research shows the role of BGs in terms of the institutional voids paradigm where BGs perform various social and economic roles in less developed countries (Ararat et al., 2018; Choi et al., 2018; Khanna and Yafeh, 2007). The main focus of this strand of literature is on how BGs engage in CSR activities and

conclude that filling the institutional voids member firms perform better in terms of CSR. Until recently, BGs literature highlighted their importance from the lens of functional substitutes in poorly functioning markets (Choi et al., 2018; Leff, 1978). However, this notion was challenged by the popularity of BGs in both developed and developing economies (Jones, 2015). The recent management studies on BGs have started to examine how BGs affect corporate sustainability, responsibility, and citizenship (Ararat et al., 2018; Choi et al., 2018).

In particular, there are two important theoretical views studying the role of BGs on social and environmental issues or environmental footprints. The social or political visibility view (Guo et al., 2018; Reverte, 2012) posits that member firms perform better in terms of CSR due to maintaining their social and political status. On the flip side of the coin, the political legitimacy standpoint (see, for instance, Choi et al., 2018) elaborates that BGs enjoy benefits from their political connections and do not follow government directions for better stakeholder engagements. Conversely, socially and environmentally sustainable initiatives may be expensive, whether they entail direct costs, such as donations or environmental protection expenses, or indirect costs, such as lost efficiency (Claessens & Yurtoglu, 2013). In addition to worsening environmental circumstances, developing markets such as China often experience a lack of effective governance structure, obscure disclosure requirements, and inept judicial systems i.e., institutional voids (Allen et al., 2005), which increase the risk that that companies may participate in immoral and environmentally damaging actions, such as environmental violations.

Contextually, the emergence of the Chinese BGs arises with market-oriented reforms in the country (He et al., 2013). The Chinese government commenced bolstering groups in the mid-1980s as it detained that BGs could achieve international competitiveness, show better financial performance, and adopt new technologies. China's capital market evolved considerably in the early 1990s, and two stock exchanges were settled where group affiliates started to be listed. In contrast to conglomerates in the U.S., member firms in China have distinct legal identities, issue financial statements, have their

own board of directors, and are accountable to their own shareholders. Therefore, it is possible to examine the environmental performance of member firms. As far as the structure of BGs is concerned, it fluctuates across nations in terms of informal social networks and formal ownership roles (i.e., the role of banks, state, and families) (Morck et al., 2005). For instance, Japanese Keiretsus have multiple owners with leading bank involvement, whereas Korean chaebols are featured by family ownership with limited bank roles (Gedajlovic and Shapiro, 2002). In a country like China, firms operate under weaker institutions, inefficient judicial systems, nontransparent disclosure standards i.e., institutional voids (Allen et al., 2005). In such an environment, member firms may have a higher potential to engage in environmental violations because higher environmental and social activities put an extra burden on the firms (Claessens and Yurtoglu, 2013). Based on the above-mentioned theoretical arguments, literature review and Chinese context, we present our hypothesis as follows:

H1: Member firms positively affect environmental violations, ceteris paribus.

3. Research Design

3.1 Data and sample

We collect data from several sources to assemble the panel ready for analysis. We get information on accounting and corporate governance variables for Chinese A-share listed firms from the China Securities Market and the Accounting Research (*CSMAR*) database. For our main outcome variable, we collect data on environmental violations (which represent firms' efforts to protect or degrade the environment) from Corporate Social Responsibilities (*CCSRs*) in China, which are incorporated in the China Research Data Services (*CNRDS*) platform. Our sample period starts in 2010 as the data for environmental violations is available from 2010 onwards. Our initial sample consists of 28,548 firm-years observations, and we remove: (a) special treatment (*ST*) and financial firms (1,764 firm-years observations); (b) firms that do not reveal or reveal insufficient

environmental data [2] on *CCSRs* (19,005 firm-years observations); (c) firm–years observations with missing information for the control variables (668 firm-year observations), and (c) observations with extreme values for leverage (251 firm-year observations). We winsorize all continuous variables at 1% and 99% levels to mitigate the effect of outliers. Our final sample (firm-year observations) totals 6,860.

3.2 Measuring environmental violations

Our main outcome variable is environmental violations. We follow Kong et al. (2020) and measure environmental violations (*ENV*) by two dimensions, environmental punishment (*EP*) and pollutant discharge (*PD*). *EP* and *PD* are both dummy variables. *EP* equals 1 if a firm is punished for environmental reasons and 0 otherwise. *PD* equals 1 if a firm has pollutant discharge and 0 otherwise. Then we calculate environmental violations (*ENV*) as the sum of the two dimensions. We collect data on environmental punishment and pollutant discharges from the China Research Data Services (*CNRDS*) platform[3].

3.3 Measuring business group

We further analyze listed firms in BGs, and for every year using the CSMAR database, we get information on control rights and cash flow rights of the firm's ultimate owner. It is mandatory for Chinese firms to disclose the detailed ownership structure and the ultimate controller in their annual reports. For example, the ownership structure of Desay Battery

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[2] The base data in CCSRs is from firms' CSR disclosure reports and CCSRs further utilize the CSR reports to develop data pertaining to firm's environmental protection and violation. In China, not every firm is required to release a CSR report and mostly firms disclose CSR reports on a voluntary basis. Therefore, the firms that issue CSR reports are only those that have information regarding environmental protection and violations in CCSRs. We have to match the firms' financial and governance data with the data obtained from this CNRDS database to arrive at our final sample. However, to avoid the missing data issues, we have dropped observations where there is missing data or insufficient information about the environmental violations.

[3] In particular, the details for the observations of environmental violations in the form of 2X2 matrix is as follow. (i) 5,588 observations (where EP=0, PD=0); (ii) 1,197 observations (where EP=0, PD=1); (iii) 26 observations (where EP=1, PD=0) and (iv) 49 observations (where EP=1, PD=1). We would like to thank the anonymous reviewer for highlighting this.

in for 2014, is that the SASAC of Hui Zhou City is the ultimate controller of Desay Battery. Following Faccio and Lang (2002), we add the weakest control rights of each control chain as a proxy for the control rights. However, in our example, there is only one control chain; thus, the control rights of SASAC over Desay is the least control right of that control chain, which is, min {100%, 51%, 45.23%} =45.23%. We compute cash flow rights as the sum of each control chain's production equals 23.07% (i.e., 100%*51%*45.23%). Eventually, ownership disparity is the gap between control and cash flow rights and equals 22.16% (i.e., 45.23%-23.07%).

Cross ownership is scarce, and all shareholders have equal voting rights among Chinese public firms; therefore, we can define a member firm if the separation between cash flow rights and control rights differs from zero. It can also be observed that a particular firm is part of a business group with zero separation as the ultimate controller possesses full (100%) control rights through the pyramidal layers. For such firms, we rely on their annual reports for being member firms. Eventually, our key variable of interest is binary, named BG dummy, equal to one if a firm is a member firm of BG, and zero otherwise.

3.4 Empirical model

To examine the relationship between business group and environmental violations empirically, we construct our baseline regression model as follows:

$$ENV_{i,t} = b_0 + \beta_1 BG_{i,t} + \sum \beta_n \text{ } Controls_{i,t} + \varepsilon_{i,t} \qquad (1)$$

Where *BG* is the independent variable and *ENV* is the dependent variable. If our Hypothesis 1 holds true, we predict β_1 to be positive, i.e., business group firms (*BG*) are more likely to commit environmental violations (*ENV*). *Controls* represents a vector of control variables, which may affect firms' environmental behavior. Following previous studies such as Zeng et al. (2012) and Kong et al. (2020), we include the following control variables: (a) *Firm size* is the log value of the book assets of sample firms. (b) *Book-to-market* is the book value of total assets divided by market capitalization. (c) *Book leverage* is total long-term debt plus short-term debt divided by firm assets. (d) *Volatility* is the standard

deviation of daily stock returns on a yearly basis. (e) *Profitability (ROA)* is net income divided by firm assets. (f) *Age* is the number of years since the firm was listed in the Chinese stock exchanges. (g) *Largest ownership* is the ownership fraction by the firm's largest shareholder. (h) *SOE* is a dummy variable, equals 1 if the firm is owned by the state, and 0 otherwise. (i) *Institutional ownership* denotes institutional ownership fraction of the firm. (j) *Herfindal 5* is a firm's herfindal index, which can proxy for ownership concentration. (k) *Cross-listing* indicator is a dummy variable, which takes the value of one if the firm cross-lists at *HKSE, NYSE* or/and *NASDAQ.* (l) *Board size* is the numbers on the firms' board of directors. (m) *Board independence* is a ratio that is calculated as the number of independent directors divided by the total number of board of directors. In addition to these, we also control for industry by China Securities Regulatory Commission (*CSRC*) industry classification codes (2012) and year fixed effects (2010-2018) in all the regression models of this study. All these variables are defined in Appendix A.

4. Empirical Results

4.1 Descriptive statistics

In Table 1, we report the summary statistics for environmental violations, business groups and the control variables used in our study. The mean of environmental violations (ENV) is 0.193. The mean and standard deviation of environmental violations measures are comparable to the descriptive results of Kong et al. (2020). In terms of business group proxies, the mean value of our main predictor of the business group (BG) is 0.479, which indicates that 47.9% of firm-year observations belong to a business group; this is very close to Jiang and Kim (2020)'s statistics. The summary statistics for our control variables are also in line with previous studies.

INSERT TABLE 1 HERE

In Table 2, we report the Pearson pairwise correlation matrix of the variables used in the regression analysis with the significant values at the 5% level in bold. Environmental violations (ENV) are positively correlated to the business group (BG). Correlations between the variables are generally modest, suggesting multicollinearity is not a serious

issue. Moreover, the variance inflation factor (VIF) values are below the standard threshold of 5 which also revalidates that there is no issue of multicollinearity in our data.

INSERT TABLE 2 HERE

4.2 Univariate test

In Table 3, we present the mean difference tests between firms with group affiliation and firms without group affiliation. The t-test of the difference between the means denotes that firms being in the business group have significantly higher environmental violations (*ENV*) on average in comparison to those not in the business group. These univariate results support our main prediction that business group firms are more likely to commit environmental violations. Interesting, we can observe significant differences in means of the two groups in almost every variable, which indicates that group affiliated firms are quite different from non-group affiliated firms in terms of the firms' characteristics, this is in line with the previous literature, e.g., Khanna and Palepu (2000) and Carney et al. (2009).

INSERT TABLE 3 HERE

4.3 Business group and environmental violations

In Table 4, we present the Poisson and OLS regression results of equation (1) for the impact of the business group (BG) on environmental violations (ENV) in the presence of a set of control variables and industry and year fixed effects. Column (1) is the Poisson regression and shows a statistically significant positive impact of BG on ENV, thus supporting our Hypothesis 1. Column (2) is the OLS regression and shows that the coefficient of BG remains positive at the 5% level, providing further support for our H1. In relevance to control variables, we find consistent results as discussed in the pairwise correlations.

Our results provide support to the political legitimacy view (Choi et al., 2018) that BGs refrain from pursuing the environmental rules and regulations and ignore stakeholders' concerns (primarily the environment and society). In China, BGs particularly yield benefits from their political connections as the legal environment is weak and

disclosure standards lack transparency (Allen et al., 2005). The positive nexus between the BGs affiliations and environmental violations show that such collective arrangement structures consider the commitments to environmental cause as an additional burden for the firms (as well as for firms' resources) and try to focus mainly on profits at the expense of the environment (Claessens and Yurtoglu, 2013).

INSERT TABLE 4 HERE

4.4 Sub-sample results based on the ultimate shareholder monitoring

In China, the ultimate controlling shareholders are usually the final decision-makers of the firms they own (Jiang and Kim, 2020). The violation of environmental regulation would generate an outcry in public and harm the reputations of the controlling shareholders. Besides, the family wealth of the controlling shareholders is tied with the firms, so they have a strong motivation to monitor the firm, particularly in its environmental policy. In this regard, we test how the ultimate shareholder monitoring affects the business group (*BG*) and environmental violations (*ENV*) nexus and present the empirical results in Table 5.

In line with Khalil et al. (2020), we partition the sample into those facing strong ultimate shareholder monitoring versus those facing weak ultimate shareholder monitoring[4] and estimate equation (1) separately in these two sub-samples. Columns 1 and 2 present the results based on the sub-sample of firms that are facing strong ultimate shareholder monitoring, while columns 3 and 4 report the findings based on the sub-sample of firms that are facing weak ultimate shareholder monitoring. The coefficient of *BG* is significantly positive in column 3 (0.187, t-value = 2.699) and in column 4 (0.034, t-value = 2.393). However, the coefficient estimates of *BG* are insignificant in the sub-sample of firms facing strong ultimate shareholder monitoring (columns 1 and 2). These findings suggest that the exacerbation effect of business groups on environmental violations can be mitigated by strong ultimate shareholder monitoring.

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[4] A firm is facing strong ultimate shareholder monitoring if its shareholder's ownership is greater than the median of full sample; otherwise, the firm is facing weak ultimate shareholder monitoring.

INSERT TABLE 5 HERE

4.5 Sub-sample results based on the board monitoring

In modern corporate governance literature, boards of directors are established to monitor the management of firms on behalf of the investors (shareholders). Previous studies (Weisbach, 1988; Dahya et al. 2002) show that they are effective monitors. In this section, we explore how board monitoring can affect the impact of the business group (*BG*) on environmental violations (*ENV*), and we report our findings in Table 6. We partition the sample into those facing strong board monitoring versus those facing weak board monitoring[5] and estimate equation (1) separately in these two sub-samples.

Columns 1 and 2 present the results based on the sub-sample of firms that are facing strong board monitoring, while columns 3 and 4 report the findings based on the sub-sample of firms that are facing weak board monitoring. The coefficient of *BG* is significantly positive in column 3 (0.240, t-value = 3.872) and in column 4 (0.048, t-value = 3.692). However, the coefficient estimates of *BG* are insignificant in the sub-sample of firms facing strong board monitoring (columns 1 and 2). These findings suggest that the exacerbation effect of business groups on environmental violations can be mitigated by strong board monitoring as well.

INSERT TABLE 6 HERE

4.6 Additional analysis: Sub-sample results based on the industry monitoring

Table 7 presents the empirical results regarding how industry monitoring affects the impact of business groups (*BG*) on environmental violations (*ENV*). Columns 1 and 2 present the results based on the sub-sample of firms that are facing strong industry monitoring[6], while columns 3 and 4 report the findings based on the sub-sample of firms that are facing weak industry monitoring. The coefficient of *BG* is significantly positive in column 3 (0.303, t-value = 2.007) and in column 4 (0.017, t-value = 2.336). However, the coefficient

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[5] A firm is facing strong board monitoring if its board size is greater than the median of full sample; otherwise, the firm is facing weak board monitoring

[6] As Chines government takes great effort in regulating polluting industry in recent years (Zeng et al., 2012), we define a firm is facing strong industry monitoring if it is from a polluting industry; otherwise, the firm is facing weak industry monitoring.

estimates of *BG* are insignificant in the sub-sample of firms facing strong industry monitoring (columns 1 and 2). These findings suggest that the exacerbation effect of business groups on environmental violations can be mitigated by strong industry monitoring as well.

<div align="center">INSERT TABLE 7 HERE</div>

4.7 Endogeneity Issue

Our baseline and robustness tests indicate that business group and environmental violations have a positive relationship. However, such a positive relationship may be driven by the self-selection bias. To minimize such concerns, we employ the following techniques to tackle endogeneity.

4.7.1 Propensity score matching (PSM)

We employ the propensity score matching (PSM) technique to address the endogeneity; notably, selection bias, as only specific firms with certain attributes adopt environmentally friendly practices. Although firms can also decide to be a part of BGs, this issue is not so serious as Bena and Ortiz-Molina (2013) show that firms become part of groups due to achieving financial advantage. To address selection bias arising from the firm's choice to adopt environmental practices, we used a one-to-one nearest neighbor matching with a 0.01 caliper distance. We identified a sub-sample of firms that are not a member of BGs (control group) that have similar characteristics (firm size, book-to-market, volatility, profitability, age, board size) with our sample of member firms of BGs (treatment group). We show summary statistics comparing the characteristics of the control group to the treatment group in Panel A of Table 8. We then estimate our baseline regressions using the matched sub-sample. The results in Panel B of Table 8 document that after controlling for sample selection bias, we still observe that BG member firms engage in environmental violations.

<div align="center">INSERT TABLE 8 HERE</div>

4.7.2 Heckman Two-stage model

As a firm's decision to disclose CSR reports may be non-random, and this may cause a self-selection bias. Before 2008, disclosing CSR reports was voluntary for listed firms in

China. However, since 2008, some listed firms are required to issue CSR reports[7], from which the environmental violation information is available. Therefore, the environmental violations information cannot be observed if firms choose not to issue CSR reports, and thus our results might be subject to sample selection bias. To address this concern, we employ the two-stage Heckman model to test whether our baseline results are robust to sample selection bias. Table 9 presents the results of the two-stage Heckman model. In the first step, we run a Probit regression that models the likelihood of a firm to disclose its CSR reports and employ the full sample (with observations for which environmental violations data was missing) in the first stage. The dependent variable is *ENV Disclosure*, which equals 1 if a firm discloses its CSR reports and 0 otherwise. The independent variables include "*BG*" and other control variables plus an exogenous variable, i.e., *MANDATORY,* to measure whether a firm mandatorily discloses its CSR report or not. *MANDATORY* is equal to '1' if it is mandatory for a firm to disclose CSR reports, and 0 otherwise. *MANDATORY* is expected to be positively related to *ENV Disclosure*. In the second step, we estimate the main regression, incorporating the "*Inverse Mills Ratio*" estimated from the first stage regression.

In Column (1) most independent variables are significantly related to the possibility of *ENV Disclosure*. In the second stage, as shown in Column (2), the *Inverse Mills Ratio*, Lambda, is positive and significant. However, after controlling for the bias leaves the conclusions unchanged, as *BG* remains highly significant and positively associated with *ENV*, adding support to our contention that business group can exacerbate environmental violations. This investigation further reinforces the robustness of our baseline results and Hypothesis 1.

INSERT TABLE 9 HERE

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[7] On December 30, 2008, the Shanghai Stock Exchange regulated that: (a) firms listed in its "Corporate Governance Sector," (b) firms with shares listed overseas, and (c) financial companies were required to issue a CSR report with their annual report beginning with the 2008 report. On December 31, 2008, the Shenzhen Stock Exchange instructed firms on its "Shenzhen 100 Index" to follow the similar regulations (Chen et al., 2018).

5. Conclusion

The main objective of this study is to provide evidence on whether collaborative arrangements (in the shape of BGs) involve in environmental conservation or eradication by demonstrating a positive or negative effect on environmental violations. Using a sample of Chinese public firms from 2010-2020, we show a positive association between BGs and environmental violations and exhibit the dark side of Chinese BGs. We also find that the reported association is amplified when the member firms have poor shareholder and board monitoring. To deal with the self-selection issue as firms strategically implement environmental responsibilities, we employed the Propensity Score Matching (PSM) technique and two-stage Heckman model, and our results remain consistent.

This study contributes to the literature by analyzing that apart from financial outcomes of BGs, (Guo et al., 2018; He et al., 2013;), their non-financial performance in terms of firms' environmental issues are also affected. This finding is important as it is still unexplored whether BGs have a positive or negative effect on environmental performance. One can expect a positive association between BGs and environmental performance based on the RBV theory, while the legitimacy theory provokes the negative association.

Consequently, this study has important implications for management, governments, and regulators, among others. The governments and policymakers are faced with the grim danger of environmental issues and the imperative need to create legislation to prevent and, ideally, reverse the effects of climate change in the current era. Furthermore, corporations experience increased media outrage and scrutiny to improve their green performance and conform to environmental policies and standards; while failure to do so can lead to heavy penalties, financial loss, and even bankruptcy. In particular for policymakers in China, our findings show that business groups are increasing environmental violations and thus increasing the environmental issues and damage in China. Overall, governments and policymakers that are aware of this linkage can formulate plans that account for this factor, while businesses that aspire to minimize the adverse

effects of violating environmental regulations will ideally recognize that transparent corporate governance structure, control on institutional voids and welfare of all stakeholders are crucial to their success. Furthermore, these principles are relevant to both wealthy and developing nations and may serve as the basis for worldwide actions to counteract environmental issues in the form of climate change and global warming.

The study can be expanded in numerous ways. First, like other quantitative research, the proxies for environmental performance and BGs may or may not contemplate practice. Therefore, further qualitative work may provide awareness by administering case studies and interviews with top management teams of affiliated and non-affiliated companies to evaluate the impact of BGs on sustainable environmental performance. Second, our study can be replicated in multiple countries contexts where BGs are customary for establishing whether the study results are generalizable.

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Appendix A: Variable definitions

Variables	Details
Environmental Violations (ENV)	Following Kong et al. (2020), environmental violations (ENV) is measured by two dimensions, environmental punishment (EP) and pollutant discharge (PD). EP and PD are both dummy variables. EP equals to 1 if a firm is punished for environmental reasons, and 0 otherwise. PD equals to 1 if a firm has pollutant discharge, and 0 otherwise. Then we calculate environmental violations (ENV) as the sum of the two dimensions.
Business Group (BG)	= 1 if the firm is in a pyramidal business group, and zero otherwise
Firm size	= the log value of the book assets of sample firms
Book-to-market	= the book value of total assets divided by market capitalization
Book leverage	= total long-term debt plus short-term debt divided by firm assets
Volatility	= the standard deviation of daily stock returns on a yearly basis
Profitability	= net income divided by firm assets
Age	= the number of years since the firm was listed in the Chinese stock exchanges
Largest ownership	= the ownership fraction by the firm's largest shareholder
SOE	= 1 if the firm is owned by the state, and 0 otherwise
Institutional ownership	= institutional ownership fraction of the firm
Herfindal 5	= a firm's herfindal index, which can proxy for ownership concentration
Cross-listing indicator	= 1 if the firm cross-lists at HKSE, NYSE or/and NASDAQ, and 0 otherwise
Board size	= the numbers on the firms' board of directors
Board independence	= the number of independent directors divided by the total number of board of directors.

Table 1: Summary Statistics

This table presents descriptive statistics for all the variables. *ENV* is the environmental violations. *BG* is a dummy variable, which equals to one if the firm is in a pyramidal business group, and zero otherwise. *Firm size* is the log value of the book assets of sample firms. *Book-to-market* is the book value of total assets divided by market capitalization. *Book leverage* is total long-term debt plus short-term debt divided by firm assets. *Volatility* is the standard deviation of daily stock returns on a yearly basis. *Profitability (ROA)* is net income divided by firm assets. *Age* is the number of years since the firm was listed in the Chinese stock exchanges. *Largest ownership* is the ownership fraction by the firm's largest shareholder. *SOE* is a dummy variable, equals to 1 if the firm is owned by the state, and 0 otherwise. *Institutional ownership* denotes institutional ownership fraction of the firm. *Herfindal 5* is a firm's herfindal index, which can proxy for ownership concentration. *Cross-listing* indicator is a dummy variable, which takes the value of one if the firm cross-lists at *HKSE, NYSE* or/and *NASDAQ*. *Board size* is the numbers on the firms' board of directors. *Board independence* is a ratio which is calculated as the number of independent directors divided by the total number of board of directors.

Variables	N	Mean	S.D.	Median	Min	Max
ENV	6,860	0.193	0.412	0.000	0.000	2.000
BG	6,860	0.479	0.500	0.000	0.000	1.000
Firm size	6,860	23.143	1.475	19.586	22.985	30.867
Book-to-market	6,860	1.551	1.738	0.121	0.941	9.982
Book leverage%	6,860	48.636	20.096	1.988	49.445	146.891
Volatility	6,860	0.027	0.009	0.007	0.025	0.087
Profitability (ROA)%	6,860	3.443	6.070	-95.689	2.560	59.815
Age	6,860	12.335	6.855	0.000	12.578	30.000
Largest ownership%	6,860	38.468	16.117	2.950	37.505	89.990
SOE	6,860	0.473	0.499	0.000	0.000	1.000
Institutional ownership%	6,860	0.390	0.268	0.000	0.388	0.949
Herfindal 5	6,860	0.185	0.128	0.003	0.158	1.136
Cross-listing indicator	6,860	0.063	0.243	0.000	0.000	1.000
Board size	6,860	12.310	3.915	4.000	12.000	36.000
Board independence (%)	6,860	36.034	8.942	10.340	35.290	70.000

Table 2: Pearson correlation matrix

This table presents Pearson correlation matrix among all variables. Numbers in bold indicate statistical significance at the 5% level or higher. *ENV* is the environmental violations. *BG* is a dummy variable, which equals to one if the firm is in a pyramidal business group, and zero otherwise. *Firm size* is the log value of the book assets of sample firms. *Book-to-market* is the book value of total assets divided by market capitalization. *Book leverage* is total long-term debt plus short-term debt divided by firm assets. *Volatility* is the standard deviation of daily stock returns on a yearly basis. *Profitability (ROA)* is net income divided by firm assets. *Age* is the number of years since the firm was listed in the Chinese stock exchanges. *Largest ownership* is the ownership fraction by the firm's largest shareholder. *SOE* is a dummy variable, equals to 1 if the firm is owned by the state, and 0 otherwise. *Institutional ownership* denotes institutional ownership fraction of the firm. *Herfindal 5* is a firm's herfindal index, which can proxy for ownership concentration. *Cross-listing* indicator is a dummy variable, which takes the value of one if the firm cross-lists at *HKSE*, *NYSE* or/and *NASDAQ*. *Board size* is the numbers on the firms' board of directors. *Board independence* is a ratio which is calculated as the number of independent directors divided by the total number of board of directors.

Variable names	VIF	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) ENV	-	1													
(2) BG	1.12	**0.042**	1												
(3) Firm size	2.55	**0.029**	0.011	1											
(4) Book-to-market	2.21	**0.048**	-0.019	**0.652**	1										
(5) Book leverage	1.99	-0.004	0.021	**0.554**	**0.6**	1									
(6) Volatility	1.16	0.008	0.017	**-0.274**	**-0.273**	**-0.054**	1								
(7) Profitability (ROA)	1.23	-0.021	**0.032**	-0.025	**-0.216**	**-0.321**	0.003	1							
(8) Age	1.30	0.018	**0.105**	0.267	0.263	0.221	-0.118	-0.106	1						
(9) Largest ownership	1.28	0.008	**0.043**	**-0.136**	**-0.071**	**-0.08**	0.051	0.046	-0.009	1					
(10) SOE	1.27	**0.026**	**-0.247**	0.17	0.115	0.192	-0.065	-0.139	0.131	-0.207	1				
(11) Institutional ownership	1.38	-0.022	**0.145**	**0.363**	**0.183**	**0.08**	**-0.223**	**0.148**	**0.206**	-0.005	-0.002	1			
(12) Herfindal 5	1.51	**-0.029**	**-0.06**	0.264	0.132	0.074	**-0.122**	0.033	**-0.109**	**-0.43**	**0.217**	**0.274**	1		
(13) Cross-listing indicator	1.87	0.012	**-0.055**	**0.351**	**0.23**	**0.136**	**-0.13**	-0.044	**-0.045**	**-0.07**	**0.085**	**0.149**	**0.163**	1	
(14) Board size	1.08	**-0.007**	0.031	**-0.088**	-0.018	**-0.113**	0.005	0.046	**-0.091**	0.002	**-0.199**	0.016	**-0.043**	**-0.032**	1
(15) Board independence	1.09	**-0.031**	-0.01	**-0.075**	**-0.08**	**-0.118**	0.045	0.064	**-0.222**	0.018	**-0.153**	**-0.061**	0.005	**-0.036**	**0.154**

Table 3: Univariate test: Group affiliation firms vs non group affiliation firms
This table presents the mean difference tests between firms with group affiliation and firms without group affiliation. *, **, and *** show significance at the 10%, 5%, and 1% levels, respectively. *ENV* is the environmental violations. *Firm size* is the log value of the book assets of sample firms. *Book-to-market* is the book value of total assets divided by market capitalization. *Book leverage* is total long-term debt plus short-term debt divided by firm assets. *Volatility* is the standard deviation of daily stock returns on a yearly basis. *Profitability (ROA)* is net income divided by firm assets. *Age* is the number of years since the firm was listed in the Chinese stock exchanges. *Largest ownership* is the ownership fraction by the firm's largest shareholder. *SOE* is a dummy variable, equals to 1 if the firm is owned by the state, and 0 otherwise. *Institutional ownership* denotes institutional ownership fraction of the firm. *Herfindal 5* is a firm's herfindal index, which can proxy for ownership concentration. *Cross-listing* indicator is a dummy variable, which takes the value of one if the firm cross-lists at *HKSE, NYSE* or/and *NASDAQ*. *Board size* is the numbers on the firms' board of directors. *Board independence* is a ratio which is calculated as the number of independent directors divided by the total number of board of directors.

	Firms with group affiliation	Firms without group affiliation	Mean difference	t-statistics
Observation	3,288	3,572	NA	NA
ENV	0.211	0.176	0.035	3.513***
Firm size	23.160	23.128	0.032	0.898
Book-to-market	1.515	1.583	-0.068	-1.610
Book leverage	49.067	48.240	0.827	1.702*
Volatility	0.027	0.027	0.0003	1.387
Profitability (ROA)	3.647	3.256	0.390	2.660***
Age	13.082	11.647	1.435	8.709***
Largest ownership	39.195	37.799	1.396	3.586***
SOE	0.345	0.592	-0.247	-21.115***
Institutional ownership	0.430	0.353	0.078	12.127***
Herfindal 5	0.177	0.192	-0.015	-4.953***
Cross-listing indicator	0.049	0.076	-0.027	-4.546***
Board size	12.252	12.363	-0.110	-1.164
Board independence	35.943	36.117	-0.174	-0.805

Table 4: Baseline regression results

This table presents the Poisson and OLS regression results of equation (1) for the impact of business group (BG) on environmental violations (ENV). Column (1) is the Poisson regression and Column (2) is the OLS regression. All continuous variables are winsorized at the 1st and 99th percentiles. Numbers in parentheses are t-statistics. ***, **, and * indicate significance (two-tailed) at the 1%, 5%, and 10% levels, respectively. *ENV* is the environmental violations. *BG* is a dummy variable, which equals to one if the firm is in a pyramidal business group, and zero otherwise. *Firm size* is the log value of the book assets of sample firms. *Book-to-market* is the book value of total assets divided by market capitalization. *Book leverage* is total long-term debt plus short-term debt divided by firm assets. *Volatility* is the standard deviation of daily stock returns on a yearly basis. *Profitability (ROA)* is net income divided by firm assets. *Age* is the number of years since the firm was listed in the Chinese stock exchanges. *Largest ownership* is the ownership fraction by the firm's largest shareholder. *SOE* is a dummy variable, equals to 1 if the firm is owned by the state, and 0 otherwise. *Institutional ownership* denotes institutional ownership fraction of the firm. *Herfindal 5* is a firm's herfindal index, which can proxy for ownership concentration. *Cross-listing* indicator is a dummy variable, which takes the value of one if the firm cross-lists at *HKSE, NYSE* or/and *NASDAQ*. *Board size* is the numbers on the firms' board of directors. *Board independence* is a ratio which is calculated as the number of independent directors divided by the total number of board of directors.

	(1) Poisson	(2) OLS
BG	0.121**	0.021**
	(2.460)	(2.177)
Firm size	0.054**	0.006
	(2.071)	(1.200)
Book-to-market	0.193***	0.029***
	(10.994)	(7.401)
Book leverage	-0.002	0.000
	(-0.921)	(0.996)
Volatility	14.622***	2.898***
	(3.922)	(3.636)
Profitability (ROA)	0.003	0.001
	(0.659)	(0.658)
Age	-0.012***	-0.001
	(-2.740)	(-1.448)
Largest ownership	0.001	0.000
	(0.725)	(1.179)
SOE	0.202***	0.038***
	(3.355)	(3.355)
Institutional ownership	-0.556***	-0.110***
	(-4.234)	(-4.612)
Herfindal 5	-0.115	0.014
	(-0.465)	(0.330)
Cross-listing indicator	0.155	0.019
	(1.397)	(0.809)
Board size	-0.001	-0.002
	(-0.007)	(-0.139)
Board independence	-0.010***	-0.002***
	(-3.814)	(-3.479)
Constant	-3.170***	-0.048
	(-4.492)	(-0.357)

Industry fixed effects	Y	Y
Year fixed effects	Y	Y
Observations	6,860	6,860
(Pseudo) R-squared	0.210	0.189

Table 5: Strong ultimate shareholder monitoring vs weak ultimate shareholder monitoring
This table presents the empirical results regarding how ultimate shareholder monitoring affects the impact of business group (*BG*) on environmental violations (*ENV*). Columns 1 and 2 present the results based on the sub-sample of firms that are facing strong ultimate shareholder monitoring, while columns 3 and 4 report the findings based on the sub-sample of firms that are facing weak ultimate shareholder monitoring. All continuous variables are winsorized at the 1st and 99th percentiles. Numbers in parentheses are t-statistics. ***, **, and * indicate significance (two-tailed) at the 1%, 5%, and 10% levels, respectively. E *ENV* is the environmental violations. *BG* is a dummy variable, which equals to one if the firm is in a pyramidal business group, and zero otherwise. *Firm size* is the log value of the book assets of sample firms. *Book-to-market* is the book value of total assets divided by market capitalization. *Book leverage* is total long-term debt plus short-term debt divided by firm assets. *Volatility* is the standard deviation of daily stock returns on a yearly basis. *Profitability (ROA)* is net income divided by firm assets. *Age* is the number of years since the firm was listed in the Chinese stock exchanges. *Largest ownership* is the ownership fraction by the firm's largest shareholder. *SOE* is a dummy variable, equals to 1 if the firm is owned by the state, and 0 otherwise. *Institutional ownership* denotes institutional ownership fraction of the firm. *Herfindal 5* is a firm's herfindal index, which can proxy for ownership concentration. *Cross-listing* indicator is a dummy variable, which takes the value of one if the firm cross-lists at *HKSE*, *NYSE* or/and *NASDAQ*. *Board size* is the numbers on the firms' board of directors. *Board independence* is a ratio which is calculated as the number of independent directors divided by the total number of board of directors.

	(1) Poisson	(2) OLS	(3) Poisson	(4) OLS
	Strong	Strong	Weak	Weak
BG	0.057	0.008	0.187***	0.034**
	(0.800)	(0.579)	(2.699)	(2.393)
Firm size	-0.002	-0.002	0.124***	0.015**
	(-0.050)	(-0.319)	(3.437)	(2.148)
Book-to-market	0.214***	0.029***	0.167***	0.029***
	(7.909)	(5.073)	(6.370)	(5.262)
Book leverage	-0.000	0.001	-0.004	-0.000
	(-0.041)	(1.368)	(-1.395)	(-0.032)
Volatility	12.558***	2.360**	16.744***	3.389***
	(2.588)	(2.135)	(2.824)	(2.988)
Profitability (ROA)	0.011*	0.002	-0.006	-0.001
	(1.701)	(1.442)	(-1.097)	(-0.588)
Age	-0.015**	-0.002*	-0.011*	-0.001
	(-2.455)	(-1.698)	(-1.810)	(-0.541)
Largest ownership	-0.002	-0.001	0.032***	0.006***
	(-0.660)	(-0.847)	(4.682)	(4.929)
SOE	0.081	0.013	0.351***	0.066***
	(1.019)	(0.851)	(3.863)	(3.890)
Institutional ownership	-0.079	-0.008	-1.209***	-0.216***
	(-0.375)	(-0.187)	(-6.048)	(-6.777)
Herfindal 5	-0.247	-0.016	1.686***	0.360***
	(-0.465)	(-0.173)	(3.020)	(3.841)
Cross-listing indicator	-0.027	-0.013	0.159	0.027
	(-0.144)	(-0.370)	(1.108)	(0.852)
Board size	-0.041	0.001	-0.055	-0.020
	(-0.367)	(0.064)	(-0.442)	(-0.874)
Board independence	-0.018***	-0.003***	-0.003	-0.000
	(-4.467)	(-4.329)	(-0.881)	(-0.546)

Constant	-1.494	0.227	-5.556***	-0.370
	(-1.481)	(1.178)	(-5.296)	(-1.569)
Industry fixed effects	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y
Observations	3,430	3,430	3,430	3,430
Regression model	Poisson	OLS	Poisson	OLS
(Pseudo) R-squared	0.217	0.198	0.224	0.205

Table 6: Strong board monitoring vs weak board monitoring
This table presents the empirical results regarding how board monitoring affects the impact of business group (BG) on environmental violations (ENV). Columns 1 and 2 present the results based on the sub-sample of firms that are facing strong board monitoring, while columns 3 and 4 report the findings based on the sub-sample of firms that are facing weak board monitoring. All continuous variables are winsorized at the 1st and 99th percentiles. Numbers in parentheses are t-statistics. ***, **, and * indicate significance (two-tailed) at the 1%, 5%, and 10% levels, respectively. *ENV* is the environmental violations. *BG* is a dummy variable, which equals to one if the firm is in a pyramidal business group, and zero otherwise. *Firm size* is the log value of the book assets of sample firms. *Book-to-market* is the book value of total assets divided by market capitalization. *Book leverage* is total long-term debt plus short-term debt divided by firm assets. *Volatility* is the standard deviation of daily stock returns on a yearly basis. *Profitability (ROA)* is net income divided by firm assets. *Age* is the number of years since the firm was listed in the Chinese stock exchanges. *Largest ownership* is the ownership fraction by the firm's largest shareholder. *SOE* is a dummy variable, equals to 1 if the firm is owned by the state, and 0 otherwise. *Institutional ownership* denotes institutional ownership fraction of the firm. *Herfindal 5* is a firm's herfindal index, which can proxy for ownership concentration. *Cross-listing* indicator is a dummy variable, which takes the value of one if the firm cross-lists at *HKSE, NYSE* or/and *NASDAQ*. *Board size* is the numbers on the firms' board of directors. *Board independence* is a ratio which is calculated as the number of independent directors divided by the total number of board of directors.

	(1) Poisson	(2) OLS	(3) Poisson	(4) OLS
	Strong	Strong	Weak	Weak
BG	-0.088	-0.020	0.240***	0.048***
	(-1.123)	(-1.353)	(3.872)	(3.692)
Firm size	0.048	0.004	0.052	0.006
	(1.064)	(0.462)	(1.618)	(0.926)
Book-to-market	0.173***	0.021***	0.195***	0.033***
	(5.980)	(3.553)	(8.618)	(6.347)
Book leverage	-0.001	0.001	-0.003	-0.000
	(-0.452)	(1.335)	(-1.171)	(-0.033)
Volatility	10.325*	2.445**	15.459***	2.938***
	(1.764)	(2.080)	(3.126)	(2.688)
Profitability (ROA)	0.001	0.001	0.005	0.001
	(0.148)	(0.773)	(0.939)	(0.500)
Age	-0.019***	-0.003**	-0.013**	-0.001
	(-2.580)	(-2.309)	(-2.322)	(-1.229)
Largest ownership	0.002	0.001	-0.001	-0.000
	(0.902)	(1.379)	(-0.371)	(-0.092)
SOE	0.279***	0.041**	0.156**	0.032**
	(2.967)	(2.427)	(2.006)	(2.086)
Institutional ownership	-0.666***	-0.130***	-0.479***	-0.094***
	(-3.176)	(-3.489)	(-2.760)	(-2.963)
Herfindal 5	0.379	0.101	-0.446	-0.039
	(0.975)	(1.512)	(-1.372)	(-0.684)
Cross-listing indicator	-0.042	-0.016	0.276**	0.038
	(-0.218)	(-0.443)	(1.987)	(1.219)
Board size	0.706***	0.137***	-0.117	-0.026
	(3.332)	(3.592)	(-0.802)	(-0.825)
Board independence	-0.016***	-0.002***	-0.007**	-0.001*
	(-3.596)	(-3.073)	(-1.976)	(-1.892)

Constant	-4.319***	-0.274	-3.086***	-0.031
	(-3.580)	(-1.187)	(-3.266)	(-0.170)
Industry fixed effects	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y
Observations	2,765	2,765	4,095	4,095
Regression model	Poisson	OLS	Poisson	OLS
(Pseudo) R-squared	0.236	0.219	0.206	0.185

Table 7: Additional analysis: Polluting industries vs nonpolluting industries

This table presents the empirical results regarding how industry monitoring affects the impact of business group (BG) on environmental violations (ENV). Columns 1 and 2 present the results based on the sub-sample of firms that are facing strong industry monitoring, while columns 3 and 4 report the findings based on the sub-sample of firms that are facing weak industry monitoring. All continuous variables are winsorized at the 1st and 99th percentiles. Numbers in parentheses are t-statistics. ***, **, and * indicate significance (two-tailed) at the 1%, 5%, and 10% levels, respectively. *ENV* is the environmental violations. *BG* is a dummy variable, which equals to one if the firm is in a pyramidal business group, and zero otherwise. *Firm size* is the log value of the book assets of sample firms. *Book-to-market* is the book value of total assets divided by market capitalization. *Book leverage* is total long-term debt plus short-term debt divided by firm assets. *Volatility* is the standard deviation of daily stock returns on a yearly basis. *Profitability (ROA)* is net income divided by firm assets. *Age* is the number of years since the firm was listed in the Chinese stock exchanges. *Largest ownership* is the ownership fraction by the firm's largest shareholder. *SOE* is a dummy variable, equals to 1 if the firm is owned by the state, and 0 otherwise. *Institutional ownership* denotes institutional ownership fraction of the firm. *Herfindal 5* is a firm's herfindal index, which can proxy for ownership concentration. *Cross-listing* indicator is a dummy variable, which takes the value of one if the firm cross-lists at *HKSE, NYSE* or/and *NASDAQ. Board size* is the numbers on the firms' board of directors. *Board independence* is a ratio which is calculated as the number of independent directors divided by the total number of board of directors.

| | (1) Poisson | (2) OLS | (3) Poisson | (4) OLS |
	Polluting	Polluting	Nonpolluting	Nonpolluting
BG	0.084	0.024	0.303**	0.017**
	(1.350)	(1.164)	(2.007)	(2.336)
Firm size	0.151***	0.069***	-0.214***	-0.008**
	(5.714)	(5.649)	(-2.802)	(-2.403)
Book-to-market	0.067***	0.039***	0.121	-0.000
	(3.672)	(3.791)	(1.549)	(-0.062)
Book leverage	0.004**	0.002**	0.005	0.000*
	(2.322)	(2.092)	(1.121)	(1.873)
Volatility	24.169***	13.111***	18.051*	0.587
	(6.192)	(5.977)	(1.661)	(1.055)
Profitability (ROA)	-0.003	-0.002	0.015	0.000
	(-0.972)	(-1.000)	(1.046)	(0.719)
Age	-0.017***	-0.006***	-0.019	-0.001**
	(-3.542)	(-2.659)	(-1.467)	(-2.168)
Largest ownership	0.001	0.000	0.016***	0.001***
	(0.495)	(0.536)	(2.774)	(2.727)
SOE	0.195***	0.087***	-0.013	0.008
	(3.333)	(3.205)	(-0.067)	(0.857)
Institutional ownership	-0.629***	-0.268***	0.834*	0.014
	(-4.914)	(-5.065)	(1.858)	(0.715)
Herfindal 5	-0.517**	-0.220**	-0.444	0.006
	(-2.172)	(-2.237)	(-0.477)	(0.179)
Cross-listing indicator	0.019	0.143	-16.265***	-0.043***
	(0.113)	(1.625)	(-20.420)	(-2.911)
Board size	0.169**	0.077**	-0.415	-0.013
	(2.240)	(2.222)	(-1.443)	(-0.951)
Board independence	-0.010***	-0.003***	-0.012	-0.000
	(-3.669)	(-2.842)	(-1.169)	(-0.549)

Constant	-5.317***	-1.765***	2.055	0.307***
	(-5.345)	(-3.618)	(1.057)	(2.844)
Industry fixed effects	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y
Observations	2,142	2,142	3,801	3,801
Regression model	Poisson	OLS	Poisson	OLS
(Pseudo) R-squared	0.120	0.257	0.269	0.117

Table 8: Propensity score matching

This table presents the results for the relationship between business group and environmental violations on a matched sample using *PSM* technique. Panel B shows the Probit regression on the matched sample. All continuous variables are winsorized at the 1st and 99th percentiles. Numbers in parentheses are t-statistics. T-statistics are based on robust standard errors clustered by firm. ***, **, and * indicate significance (two-tailed) at the 1%, 5%, and 10% levels, respectively. *ENV* is the environmental violations. *BG* is a dummy variable, which equals to one if the firm is in a pyramidal business group, and zero otherwise. *Firm size* is the log value of the book assets of sample firms. *Book-to-market* is the book value of total assets divided by market capitalization. *Book leverage* is total long-term debt plus short-term debt divided by firm assets. *Volatility* is the standard deviation of daily stock returns on a yearly basis. *Profitability (ROA)* is net income divided by firm assets. *Age* is the number of years since the firm was listed in the Chinese stock exchanges. *Largest ownership* is the ownership fraction by the firm's largest shareholder. *SOE* is a dummy variable, equals to 1 if the firm is owned by the state, and 0 otherwise. *Institutional ownership* denotes institutional ownership fraction of the firm. *Herfindal 5* is a firm's herfindal index, which can proxy for ownership concentration. *Cross-listing* indicator is a dummy variable, which takes the value of one if the firm cross-lists at *HKSE, NYSE* or/and *NASDAQ*. *Board size* is the numbers on the firms' board of directors. *Board independence* is a ratio which is calculated as the number of independent directors divided by the total number of board of directors.

Panel A: Univariate test: treated group vs control group

	Treatment group (firms with group affiliation)	control group (firms without group affiliation)	Mean difference	t-statistics
Observation	3,288	3,572		
Firm size	23.16	23.159	0.001	0.03
Book-to-market	1.515	1.551	-0.036	-0.85
Book leverage%	49.067	49.531	-0.464	-0.95
Volatility	0.027	0.027	0.0002	-0.70
Profitability (ROA)%	3.647	3.372	0.274	1.64
Age	13.082	13.382	-0.3	-1.72*
Largest ownership%	39.195	38.968	0.227	0.57
SOE	0.345	0.339	0.005	0.47
Institutional ownership%	43.034	41.435	1.599	2.5**
Herfindal 5	0.177	0.179	-0.002	-0.59
Cross-listing indicator	0.049	0.047	0.002	0.46
Board size	2.473	2.471	0.001	0.19
Board independence (%)	35.943	35.746	0.197	0.91

Panel B: PSM second step regressions

	(1) Poisson	(2) OLS
BG	0.135***	0.025***
	(2.675)	(2.638)
Firm size	0.065**	0.009*
	(2.407)	(1.896)
Book-to-market	0.212***	0.031***
	(11.137)	(8.402)
Book leverage	-0.002	-0.000
	(-1.357)	(-0.036)
Volatility	18.536***	3.755***
	(4.902)	(4.910)
Profitability (ROA)	0.013***	0.002***
	(3.129)	(3.611)
Age	-0.017***	-0.001**
	(-4.040)	(-2.125)
Largest ownership	0.002	0.001**
	(1.247)	(1.973)
SOE	0.209***	0.041***
	(3.368)	(3.505)
Institutional ownership	-0.454***	-0.101***
	(-3.307)	(-3.995)
Herfindal 5	-0.465*	-0.035
	(-1.827)	(-0.875)
Cross-listing indicator	0.184	0.025
	(1.559)	(1.009)
Board size	-0.019	-0.007
	(-0.217)	(-0.458)
Board independence	-0.015***	-0.003***
	(-4.863)	(-5.052)
Constant	-3.621***	-0.151
	(-4.775)	(-1.159)
Industry fixed effects	Y	Y
Year fixed effects	Y	Y
Observations	6,576	6,576
(Pseudo) R-squared	0.215	0.191

Table 9: Heckman two step model

This table presents the results of two-stage Heckman model. In the first step, we run a Probit regression that models the likelihood of a firm to disclose its CSR reports and employ the full sample (with observations for which environmental violations data was missing) in first stage. The dependent variable is ENV Disclosure, which equals 1 if a firm discloses its CSR reports and 0 otherwise. The independent variables include "BG" and other control variables plus an exogenous variable i.e., MANDATORY to measure whether a firm mandatorily discloses its CSR report or not. MANDATORY is equal to '1' if it is mandatory for a firm to disclose CSR report, and 0 otherwise. MANDATORY is expected to be positively related to ENV Disclosure. In the second step, we estimate the main regression, incorporating the "Inverse Mills Ratio" estimated from the first stage regression. All continuous variables are winsorized at the 1st and 99th percentiles. Numbers in parentheses are t-statistics. ***, **, and * indicate significance (two-tailed) at the 1%, 5%, and 10% levels, respectively.

	First step	Second step
Dependent variable	ENV Disclosure	ENV
BG	-0.120***	0.019*
	(-5.202)	(1.954)
Mandatory	2.550***	-
	(53.855)	-
Firm size	0.336***	0.021***
	(25.445)	(3.772)
Book-to-market	-0.017***	0.001
	(-5.386)	(0.995)
Book leverage	-0.004***	0.001***
	(-6.244)	(2.647)
Volatility	-9.925***	2.491***
	(-5.935)	(3.013)
Profitability (ROA)	0.003*	0.000
	(1.687)	(0.163)
Age	0.014***	-0.001
	(7.181)	(-1.442)
Largest ownership	-0.005***	0.001
	(-3.037)	(0.906)
SOE	0.050*	0.038***
	(1.746)	(3.147)
Institutional ownership	0.240***	-0.126***
	(4.342)	(-5.066)
Herfindal 5	0.554**	-0.084
	(2.352)	(-0.819)
Cross-listing indicator	-0.699***	0.028
	(-6.115)	(1.278)
Board size	0.014	0.053***
	(0.346)	(3.083)
Board independence	-0.120***	0.019*
	(-5.202)	(1.954)
Lambda		0.031***
		(2.378)
Constant	-0.510***	-8.601***
	(-3.471)	(-25.268)
Industry fixed effects	Y	Y

Year fixed effects	Y	Y
Observations	25,865	25,865
Wald-chi2	-	1535.01