Does Green Finance Reduce Pollution? Evidence from a Government Pilot Program *

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Abstract

This paper documents the spillover effects of a place-based green finance program. Exploiting the unique setting of the world's first green finance pilot program in China, we adopt difference-in-difference design and find that the launch of pilot zones led to better environmental performances. While the pilot places do improve their environmental performance, we find even greater improvement from other regions. The spillover effect is mainly driven by the environmental tournament effects among local officials when assessing their political achievements. Specifically, non-pilot zone areas with younger local government leaders and higher state ownership improve more. Overall, we find that place-based green finance policies not only create direct positive impacts but also impose positive incentive externalities to other regions.

Keywords: Green finance, Green bonds, Place-based policy, Environmental performances, Environmental violation incidents, China

JEL Codes: G18, G28, R5, Q51, Q53, Q58

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1 Introduction

China's four decades of rapid economic growth has been recognized as a result of the economic tournament among local government officials. (Li and Zhou (2005); Maskin, Qian, and Xu (2000), Xiong (2018)). One remarkable turning point is that President Xi Jinping proposed "lucid waters and lush mountains are invaluable assets" to promote sustainable growth and green development during the 19th National Congress in 2017[1]. Therefore, economic performances and green development performances are treated as equal factors when assessing local government officials political achievements. In this study, we look at a new tournament for local government officials - the government led place-based green finance pilot zones. Instead of incentivizing firms through increasing emission costs, these policies motivate firms to engage in green projects and environmental technological innovations by providing "fast tracks" benefits with regard to accessing the capital market.

To be more specific, we examine the spillover effects of launching five green finance pilot zones in China in June 2017, including Xinjiang, Guizhou, Guangdong, Jiangxi, and Zhejiang. As far as we know, this is world's first place-based green finance program and it provides us with a quasi-natural experiment to study its spillover effects. The country's severe environmental problems and its recent determination in solving them provides a natural laboratory for our research. We first document that after launching the green finance pilot zones, China experiences air quality improvement. However, cities outside the zones improves more than the pilot zone cities. Then, we interpret the unintended spillover effects on peer provinces' environmental performances to be mainly driven by local government competitions.

We first document the spillover effects of this place-based program, which is the major focus of this paper. Specifically, we examine whether green finance leads to real environmental improvements. The environmental performance indicator considered in this paper is air quality, measured by air quality index, which considers the pollution level of six major pollutants (SO_2, NO_2, $PM10$, $PM2.5$, CO, O_3). The reason we focus on air quality is because its visibility

[1]This idea was first proposed by Xi in 2005 when he was the provincial sectary of Zhejiang province. The province later became one of the five green finance pilot zones in our study.

to the general public. People are often concerned about the everyday air quality conditions and there are huge media coverage in China. When a local government is determined to boost their environmental performance, it is likely that they will pay great attention to air quality. We use difference-in-difference (DiD) designs to test the real environmental effects of launching pilot zones and find a significant decline in air quality within the pilot zones compared to the control cities. After excluding Beijing, Tianjin, and Hebei (Jing-Jin-Ji areas) and surrounding areas that are targeted by more aggressive air pollution policies, the relative decline still exists. We argue that the launch of green finance pilot zones is pressing other provinces to catch up and there exist policy externalities. We also conduct matching methods to match the pilot zones with one otherwise similar provinces, and find the environmental improvements are more prominent outside the pilot zones.

Subsequently, we examine how environmental violation incidents are affected by the launch of pilot zones. The violations in our study include air pollution incidents and waste disposal incidents that are penalized or negatively mentioned in government documents. Using a DiD research design, we find relative declines in both air pollution and waste disposal violation incidents following the launch, indicating positive effects of the policy. The change in the firms' environmental violation incidents may be driven by several factors. On the one hand, as the whole environmental campaign in China is government initiated, the local firms may be complying with the increased attention in environmental issues of local governments. On the other hand, there could also be increases in firms' violation incidents as a result of more strict supervision and enforcement of regulations. Problems previously ignored are now exposed. In order to receive favorable policies in the future when the pilot zones expand, regions that are not yet pilot zones have the incentive to tighten their regulations, leading to increased number of violations detected.

The channels through which green finance policies and green projects affect the air quality include: (1) changing the energy consumption pattern by introducing clean energy resources, (2) promoting low-carbon transportation, and (3) promoting the innovation and adoption of

environmental friendly production technologies. Although some other policies and projects are not linked directly to environmental indicators, the active engagement in green finance in a specific city or province can indicate a series of government policies which may include more direct ones. In this paper, the real environmental effects do not purely come from green finance and the underlying projects, but also local government policies and efforts signalled by engaging in green finance as the whole campaign is heavily government promoted. As air quality is influence by (1) direct environmental policies such as limiting emissions and restricting certain activities and (2) green projects from either public or private sectors, our study of green finance captures the effects from both sides.

We believe the relative changes in air quality and environmental violations are driven by both direct effects and spillover effects that lead to opposite results. Being declared as one of the pilot zones is expected to raise the local governments' awareness of environmental issues, and they are also pressed to have environmental accomplishments. We expect there to be better enforcement of regulations and green finance related programs that further promotes such activities. In the meantime, the competition environment among local governments in China give regions outside the pilot zones incentives to enhance their environmental performance. Efforts within the pilot zones lead to relative improvement in air quality, relative decline in violations, and relative increase in green bond issuance. Competing efforts outside the pilot zones result in relative decline in air quality and relative increase in environmental violations for the pilot zones. Moreover, more strict regulation enforcement can also cause increases in violation incidents for the involved areas. Our study provides evidence of which effects dominates in reality.

Next, we discuss the direct benefits of the pilot program. The place-based green finance program directly targets the financial systems and influences local firms' financing behaviors. Because financial institutions will be given incentives to provide credit and specific funds for environmental friendly industries and firms, we study corporate leverage, including loans and bonds, and also specific green financing activities, namely the cumulative number of green

bond issuance within a given city. We find firms increase their leverage after the launching of green finance pilot zones compared with the firms located outside the zones and the effects are concentrated in green-related industries[2]. We also find a relative increase in the cumulative number of green bond issuance in the targeted regions. Our interpretation is the pilot zones have an increased number of green bond issuance because of favorable policies such as the "fast tracks". And the local governments will also propagate to raise firms' awareness of this new financing channel.

Lastly, we further investigate how this unintended environmental spillover is affected by political influences. As we have mentioned, a main driver for this spillover effect is the political motivations behind local government competitions. Local governments compete for central government's resources, policies, as well as promotion opportunities for local officials, with the last one being perhaps the primary factor in the local leaders' maximization problems. Under such circumstances, provincial secretaries whose age will be lower than 65 by 2022 and thus eligible for term renewal or promotion will have more incentive to engage in environmental improvements than those who face compulsory retirement in 2022. Introducing this variation into our baseline analyses, we find that the magnitude of environmental performance enhancements are indeed smaller for provinces with leaders facing mandatory retirement. In terms of the channels through which environmental improvements (air quality amelioration and violation exposure) are achieved, local firms' response to environmental laws and regulations enforcement play a key role. However, due to the political connections of state-owned enterprises, the effectiveness of enforcement may be negatively affected. SOE managers' political connections with local government officials, with high-rank central government officials, and their own political rank could all make these enterprises unresponsive to laws and regulations. Our analyses suggests that provinces with high state ownership concentration have less prominent environmental spillover effects.

[2]We divide the firms into green and non-green industries according to official documents on industry division and green project catalog. In general, green industries are industries with easy access to potential green projects that can be financed with green debt instruments. This also includes traditional pollution industries developing or adopting clean production technologies.

This paper contributes to the literature in the following aspects. First, this paper fits into a body of studies on place-based programs as we study the real effects of green finance pilot zones. Place-based programs are adopted by many countries in the world, mostly focusing on fostering economic development. Examples include the US's enterprise zones, the regional development aid in the EU, and the special economic zones (SEZs) in China. The effectiveness of these programs have been intensively studied both theoretically and empirically, and found heterogeneity in their treatment effects. For instance, Billings (2009) find positive effects of fiscal incentives on job creation but mixed results of tax credits using enterprise zones in Colorado. Becker, Egger, and Von Ehrlich (2010) use the French enterprise zone and find geographical heterogeneity to affect the program's ability to influence employment and wages[3]. Place-based policies in developed countries typically aim at helping disadvantage regions or people, whereas developing countries such as China and India, use place-based policies as experimentation and is often implemented in regions with better economic bases[4]. The place-based program in our study shares many features of the Chinese SEZs and serves as an experiment that will be extended to other regions if successful. Our paper contributes to this topic by studying a place-based program that focuses on the environment rather than economic growth, and provides empirical evidence on its effectiveness.

Second, this study adds to the long-debated question of using government interventions to tackle social externality problems (Coase, 1960; Pigou, 1920). While studies regarding the real impacts of various government policies are nothing innovative, existing studies have typically focused on the traditional environmental policies we have discussed previously that increase the cost of emission. For instance, Bartram, Hou, and Kim (2018) studied the cap and trade system in California and found firms shifting their pollution to other states, which result in a negative spillover. Studies of the 1986 Toxic Release Inventory (TRI) in the United States have found mixed results. Hamilton (2005) found reductions in toxic release, but the causal relationship has been challenged by others (Bui and Mayer, 2003). There are also some

[3]Neumark and Simpson (2015) provides a good review of place-based policies. See Kline (2010), Kline and Moretti (2013), Kline and Moretti (2014) for some theoretical models addressing heterogeneity in effectiveness.

[4]Studies of such programs include Xu (2011), Alder, Shao, and Zilibotti (2016) and Wang (2013).

policies that provide supervision of firms' environmental behaviors and impose significant costs in cases of violations. Chen, Hung, and Wang (2018) found positive environmental effects of China's mandatory CSR disclosure. Duflo, Greenstone, Pande, and Ryan (2013) found pollution auditing system in India to be severely corrupted, but with their experimental treatment, the conditions improve and show positive environmental implications. In general, while these policies have the merit of bringing immediate environmental improvements to the designated areas, they do not, or even negatively affect other areas. The potential costs and reversals also make these policies unfavorable in practice. This study examines an alternative path, the development of green financial market that is part of a national environmental campaign[5]. We believe this path may have longer-term benefits. Using a DiD method, this paper provides evidence of the real effects of promoting the development of green finance.

Third, this study also contributes to the growing body of studies related to green finance and green bonds. As the recognition for the importance of environmental policies and green finance grows, the market for green financial products expands rapidly. Studies have typically focused on the behaviors of these products in the market such as pricing, announcement effects and ownership concentration. For example, Baker, Bergstresser, Serafeim, and Wurgler (2018) find a moderate premium and concentrated ownership for green bonds. Tang and Zhang (2019) documented positive announcement effects of green bonds on the respective firms' stock prices. However, they rarely touched on green bonds' behaviors in what they are meant for - improving environmental conditions. This research can provide some insights regarding the real effects of green finance.

[5]Studies have also found that better market environments and property right protection leads to less pollution. See Jiang, Lin, and Lin (2013).

2 Institutional Background and Hypothesis development

2.1 An overview

The Chinese model of green finance development largely adopts a "top-down" approach. The government has actively engaged in the process and provided substantial regulatory and financial support. The highlight in this field can be seen as part of China's goal of "constructing ecological civilization", which was put forward during the 18th National Congress of the Communist Party of China (CPC) in 2012. The realization of this far-reaching policy objective relies on a well-constructed financial system that finances and supports the transformation process. The government has promoted various aspects of green finance, including green loans, green bonds, green stock index, and green related certification and disclosure. Although green loans have been heavily weighted in the development process so far, green bonds have gradually gained importance[6].

In late 2015, the Political Bureau of the CPC Central Committee issued the *Overall plan of ecological civilization system reform* and the fifth Plenary Session of the 18th CPC Central Committee further addressed the plan of establishing a green finance system. From the first issuance of green bonds in China in mid-2015 to April 2016, the Interbank bond market and the security exchanges in China have promptly built a mechanism for green bond issuance. The *Guiding Opinions on Establishing the Green Financial System* jointly issued by seven ministries in August 2016 marked Beijing's plan of promoting green finance in multiple dimensions including (1) vigorously develop green credit, (2) promote security markets to support green investments, (3) establish green development fund, (4) develop green insurances, (5) perfect the market for environmental rights trading, (6) support local governments' green finance developments and promote international co-operations.

In June 2017, five Provinces Guangdong, Zhejiang, Jiangxi, Guizhou, and Xinjiang were launched as green finance pilot zones. The five provinces cover the southeast coastal areas

[6]See "The green bond trend: Global, mainland China and Hong Kong." (HKEX, 2019)

(more developed regions), the central areas (rapidly developing regions), and the west inland areas (less developed regions but rich in resources). They have different characteristics and are expected to develop their own green finance models. Moreover, these provinces all have accumulated some prior experience in developing green finance. The geographical locations of the five provinces are presented in figure 1.

[Place Figure 1 about here]

Since the announcement of the green finance pilot zones, there have been a body of local policies implemented by the five provinces. The policies are fundamentally consistent but also highlight regional characteristics and advantages. Overall, the policies focus on institutional innovations. Instead of aggressively pursuing pollution mitigation and promoting green financial activities, the pilot zones provide a laboratory to test out new organizational structures, green financial products, and green financial services. It aims at providing a suitable market environment for the development of green finance in China. To some extent, the green finance pilot zones provide a market driven solution to the transition to a green economy. Under a consistent framework, each of the five pilot zones introduced policies with various emphases. Guangdong and Zhejiang are most developed areas in China. Guangdong's policies focus on establishing an international green financial market. Taking advantage of its proximity to Hong Kong and Macao, it has opened up channels for international investor to participate in green private equity, venture capital and other financial institutions. Zhejiang highlights the use of green finance to support the development of small cities and towns through investing in green infrastructure and green industries. In areas rich in environmental resources such as Jiangxi and Guizhou, the goal is to make use of these resources to build a green financial system and discover a sustainable economic model. Xinjiang is largely covered by desert area but is rich in wind and solar energy. Its development in green finance heavily focuses on fight desertification and developing clean energy. Meanwhile, it also takes advantage of its priority in security listing examination to promote green equity. Apart from promoting green finance through relevant policies and amplifying the diversity of green

financial products and services, the green finance pilot zones also attract other provinces to compete for future enrolment of the program. In 2019, Gansu province was chosen among several applicants to be included as a new pilot zone province.

In the 19th National Congress of the Communist Party of China (CPC) in 2017, President Xi put forward the idea of the "three critical battles"[7], representing China's major economic goals in the coming years. The "three critical battles" are (1) "preventing and resolving the major risks", (2) "conducting targeted poverty reduction", and (3) "controlling pollution". It can be seen that the development of green finance directly aligns with (1) "preventing and resolving the major risks" and (3) "controlling pollution", and we believe that the development of green finance will continue to be emphasized in China's economic policies.

Apart from policies related to green finance, China also has a body of policies directly aimed at tackling pollution and other environmental issues. While green finance related policies focus establishing a well-functioning system and fuel the transition to a sustainable economic development model, these pollution policies are stronger and expected to have more significant but short-term effects. Starting from March 1, 2018, a strict limit on air pollutant emission levels is imposed on the "2 + 26" cities in Beijing, Tianjin, and Hebei and surrounding areas[8]. The *Plan of tackling air pollution in autumn and winter in Beijing, Tianjin, and Hebei and surrounding areas* issued by the Ministry of Ecology and Environment (formerly the Ministry of Environmental Protection) for 2017-2018 and 2018-2019 mandates reductions in PM2.5 concentration and the number of severely polluted days in the region. Such goals are achieved through regulating factory productions, heating options, and transportation. Following this policy issued by the central government, some local governments within and outside the specified region also issued similar plans of tackling air pollution.

[7]The report of the 19th Party Congress

[8]Announcement on the special air pollutant emission limit for Beijing, Tianjin, and Hebei air pollution transmission channel cities

2.2 The development of green bonds

While the global green bond market has existed since 2007, green bonds only started to emerge in China in late 2015. Yet, in the 3 year period, China has already grown to be one of most important green bond issuer globally. Its 2018 issuance has reached USD42.8 billion and accounts for 18% of global issuance. Low-carbon transport and energy are the two largest sectors of Chinese green bonds. Other sectors include low-carbon building, water resources, waste, climate change adaption etc. Chinese onshore green bonds account for more than 75% of total issuance and financial corporations are the largest issuer both in terms of number and amount[9].

In July, 2015, the first green bond were issued by Xinjiang Goldwind Science and Technology in Hong Kong. Following the *Overall plan of ecological civilization system reform* and the fifth Plenary Session of the 18th CPC Central Committee mention in section 2.1, in December 2015, both the People's Bank of China (PBoC) and the National Development and Reform Commission (NDRC) issued their guidance for green bond labelling and issuance, the *Green Bonds Endorsed Project Catalogue* and the *Guidance on Green Bond Issuance*. Also in December 2015, the PBoC issued *Announcement on Matters concerning the Issue of Green Financial Bonds in the Interbank Bond Market*. Later in early 2016, the two stock exchanges in China, the Shanghai Stock Exchange (SSE) and the Shenzhen Stock Exchange (SZSE) issued their respective guidance on exchange-traded green bonds. These three places constitute the major markets of Chinese green bonds.

While the two documents are largely identical in terms of standards and regulations, there still remains some inconsistency. Furthermore, unlike the international standards for green bonds that require a 100% usage in green projects, the Chinese labelling system allows part of the funds financed by green bonds to be used for purposes such as paying off existing debts and supplementing working capital. Such inconsistencies of different regulatory bodies within China and across local and international standards have been acknowledged in official

[9]See "China green bond market 2018", (Climate Bonds Initiative, 2018)

documents and the PBoC has issued *The Development Plan for Building the Standardization System for the Finance Sector (2016-2020)* in 2017. "Green financial standardization" is included as a major project in the plan. We are expecting to see an unification of local regulations and a convergence towards to international standards during the period. As a matter of fact, the proportion of Chinese green bonds that are aligned with international standards have seen large increases from 2016 to present.

Figure 2 illustrates the progress of green bond issuance in China. In 2015, there was only 1 issuance in Xinjiang. Gradually, we see more provinces getting involved. By 2018, Only two mainland provinces Ningxia and Jinlin have not issued any green bond. Provinces on the east coast are active issuers and early participants of green bond. Among them, Jiangsu and Zhejiang had the most numbers of issuance. Guangdong had no issuance before 2018, but after being declared as one of the green finance pilot zones, it had 15 issuance in 2018 alone. As for the other pilot provinces, Jiangxi and Xinjiang are pioneer issuers of green bonds. Overall, we observe more green bond issuance in more developed and more economically active areas, such as Beijing, coastal areas and central China provinces with rapid economic growth and policy support. As around one-third of the green bonds are issued by financial institutions, the more established financial system and higher demand driven by economic activities and government policies contribute to this trend.

[Place Figure 2 about here]

2.3 Hypothesis development

The focus of this paper is the real effects of place-based green finance policies. Specifically, we look at the green finance pilot zones launched in June 2017. We study the impacts of this policy on environmental outcomes and investigate the drivers of such results.

The launch of green finance pilot zones can influence the outcome variables through multiple channels. While the development of green finance can have direct positive implications

within the region, studies have also suggested the possibility of policy externalities, especially within the China context[10]. Due to Beijing's determination in fighting environmental issues and active promotion of green finance, local government leaders have the incentive to learn from the pilot zones' practices and compete with other non-pilot regions through boosting their environmental performances. This is especially the case with the launch of the green finance pilot zones. Being declared as one of the pilot zones is not only a commitment to develop green finance, it is also an award that recognizes previous efforts. Hence, other provinces will compete to gain recognition from Beijing and try to become the next generation of pilot zones. The local government leaders might also improve their probability of getting promoted. This competing environment is likely to lead to improvements in environmental conditions in areas outside the pilot zones. As a result of the competing local governments' efforts in boosting their environmental performances, stricter enforcement of regulations might also cause increases in environmental violation incidents detected. Accordingly, we hypothesize that:

Hypothesis 1 (Environmental Performance) *The non-pilot zone areas experience relative improvements in air quality and relative increases in environmental violation incidents subsequent to the launch compared to the control group.*

As the different channels through which the outcomes are affected have results that move in opposite directions, an insignificant change in the dependent variable does not reject the hypotheses. It could be the case that all channels hold and there is a near-parallel improvement for all regions.

By nature of the place-based policy we are concerned with, it is expected to directly affect the financing choices of firms in the pilot provinces, especially those with green projects. With regulatory, organizational and fiscal support of green finance from the central and local governments, firms doing green projects are expected to have better access and more willingness to use green financial instruments. Meanwhile, other firms are also incentivized

[10]See Maskin, Qian, and Xu (2000) and Xu (2011).

to engage in more green-related activities to enjoy policy benefits. As most of the green financial products in the market are debt instruments such as green bonds and green loans, we are likely to see an increase in debt usage in many local firms' capital structure. Green bonds, a major green financial instrument, is also expected to experience booms in issuance. Hence, our hypotheses for the the direct effects are as follows:

Hypothesis 2 (Corporate Leverage) *Local firms in the pilot zones increase their leverage as a result of the launch, and this effect will concentrate in firms more closely related to green projects.*

As we have mentioned that the positive environmental spillover effects could be induced by competitions between local governments, factors that affect this political motivation are likely to cause heterogeneity in the effects. Provinces are motivated to compete not only because of potential policy benefits and resources from the central government that promotes regional development, local government leaders' own career concerns are also crucial. According to Li and Zhou (2005), economic performance is positively correlated with the likelihood of promotion of provincial leaders. In the context of an active environmental campaign, superb environmental performance is also expected to have similar effects. Therefore, provincial leaders who are not facing mandatory retirement in the coming term in 2022 have more incentive to boost environmental performances[11]. Another factor that may influence the spillover effects is political connections between local governments and state-owned enterprises. Local governments impose stricter regulations and enhance their enforcement of environmental laws to press local firms to behave in a more environmental-friendly manner. However, due to political connections and the fact that some SOE managers are higher in political rank than local officials, the enforcements of laws and regulations may be hampered. Following this logic, we expect the spillover effects to be less prominent in regions with higher SOE concentrations. Based on the discussion above, two hypotheses are stated as follows:

[11]China's retirement regulation for provincial leaders requires them to retire if they are 65 or older when they finish their current term. The current term runs from 2017 to 2022.

Hypothesis 3 (Promotion Incentives) *The non-pilot zone provinces whose leaders face compulsory retirement and thus lack promotion incentives have less environmental improvements compared to other non-pilot zone provinces with such incentives.*

Hypothesis 4 (State Ownership Concentration) *The non-pilot zone provinces with higher SOE shares experience less environmental improvements compared to other low SOE-share non-pilot zone provinces.*

3 Sample and Summary Statistics

3.1 The sample

The data employed in this study comes from several separated sources: (1)the green bonds data is from the Xinhua green bond database, (2)data related to firms' capital structure is obtained from their financial statements from the CSMAR database, (3)the air quality and pollutants data is obtained from the Ministry of Ecology and Environment database, and (4)the environmental violation data is from the Institute of Public and Environmental Affairs, a non-profit environmental research organization based in Beijing. As economic activities are expected to influence the dependent variables concerned in this study (Grossman and Krueger, 1995, 1991; Cole and Neumayer, 2004), we obtained monthly data for fiscal income, annually data for provincial population and quarterly data for provincial GDP from the Wind database. The population used for each month is the number of the corresponding year and the monthly GDP is approximated by evenly dividing the corresponding quarter's GDP. All cities within a given province share the same monthly fiscal income, population and GDP.

We first study how local firms' capital structure is affected by the launch of green finance pilot zones. Our sample consists of 3630 companies listed on the Shanghai and Shenzhen stock exchanges from 2013 to 2019. After excluding observations missing necessary information and winsoring 1% in each tail, we obtain a sample of 73,798 observations. A difference-in-difference (DiD) research design is adopted to test the changes in debt financing between pilot zone

provinces and non-pilot zone ones.

We next examine the effects on green bond issuance. We look at the 31 mainland provinces in China within the period from January 2015 to December 2018. After excluding observations with missing information, we obtain a sample of 1246 province-months. We use DiD method to compare the changes in the number of issuance among the treatment and control provinces. We use the cumulative number of issuance as the dependent variable and perform an OLS regression.

The sample for our study of air quality change includes monthly observations from January 2013 to December 2018 of 73 major cities in China. Each mainland province has at least one city in this 73 cities sample. We use January 2013 to May 2017 as the pre-treatment period and June 2017 to December 2018 as the post-period. The environmental violation data has yearly observation of firm-level violation incidents from 2013 to 2019. We include air pollution and waste disposal violations in our study and look at firms that are listed or have connections to listed firms. After aggregating firms' violation incidents to the cities where they are registered, we obtain a sample of 280 cities for air pollution incidents and 215 cities for waste disposal. The green bond dataset consists of green bonds issued from 2015 to the end of 2018. The green bonds are either issued within mainland China (the Interbank Bond Market, SSE, or SZSE) or by mainland Chinese entities in the global market. After excluding bonds that are difficult to identify an issuing city or province, we are left with a sample of 261 bonds identified at the province level and 210 bonds identified at the city level.

In our tests investigating the real effects of launching green finance pilot zones, there are 5 treatment province including a total of 22 treatment cities. After excluding city-months that are missing necessary information for our analysis, the remaining sample has 5256 city-months. We identify 418 treatment city-months and 4838 controlled city-months. We adopt a DiD design that compares the changes in air quality among the treatment group and the changes in air quality among the control group. We use the air quality index to measure air quality. A higher number of the index indicates worse air quality. The raw air quality

index data have strong seasonal trends and are higher in winters. Therefore, we used the Hodrick-Prescott (HP) Filter method (Hodrick and Prescott, 1997) to smooth the data. This HP filtered air quality index (AQI) is used as the dependent variable in our study. We also subsetted the 73 cities according to their geographical location. We first divided China into north and south according to the Qinling-Huai River policy. We believe some government policies concerning this hard cutoff will differently affect the air quality on the two sides (Almond, Chen, Greenstone, and Li, 2009; Chen, Ebenstein, Greenstone, and Li, 2013). A dummy variable *North* indicates whether the city is on the north side of this geographical cutoff. Only Xinjiang is in the north and the other four green finance pilot provinces are on the south side. We also divided China according to the seven geographical divisions: Northeast, Northern China, Central China, Eastern China, Southern China, Northwest, and Southwest. Four of these regions, eastern China, southern China, northwest, and southwest contains at least one of the green finance pilot provinces. A categorical variable *Region* is used to identify these seven divisions and a dummy variable *Pilot* suggests whether the city is in the four divisions that contains pilot zones. As is mentioned in section 2.1, some direct environmental policies are expected to affect Beijing, Tianjin, and Hebei and surrounding areas in Northern China. Therefore, we also created a dummy variable *Jing-Jin-Ji* indicating whether a city is in the affected area.

For the test of launching pilot zones' impact on environmental violation incidents, we aggregate each city's firm level violation data to compute the yearly number of violations in that given city. There are 280 unique cities in our air pollution violation data and 215 cities in the waste disposal violation data. We have 5 treatment provinces which include 58 treatment cities for air pollution and 42 treatment cities for waste disposal. All together we have 1960 (1505) city-years for air pollution (waste disposal) incidents. treatment is set in year 2017[12] and we identify 405(294) treatment city-years and control city-years for air pollution (waste disposal) incidents. A DiD design is adopted to compare the changes in the number of violation incidents among the treatment and control group.

[12]The pilot zones are launched in June 2017.

3.2 Variables and summary statistics

Panel A of table 2 presents descriptive statistics of how corporate leverage is affected by the launch of green finance pilot zones. The mean leverage is 0.406 for the treatment group and 0.440 for the non-pilot zone regions, suggesting the overall leverage level is higher for the non-pilot zone regions in the period concerned. Panel B provides the descriptive statistics of green bond issuance. We can see that the mean cumulative number of green bond issuance is 2.728 for the treatment group and 1.461 for the control group.

[Place Table 2 about here]

Table 1 shows the summary statistics of the variables used in our analyses of real environmental effects. Panel A presents our study on the real effects of launching green finance pilot zones. GDP and fiscal income are measured in one hundred million Chinese Yuan, and population is measured in 10,000 persons. We can see that the mean AQI in our sample is 4.028 for the treatment cities and 5.216 for the control cities. Panel B and C reports the descriptive statistics of our tests regarding the effects of launching pilot zones on air and waste violation incidents respectively. In panel A, the mean number of penalized incidents is 2.531 for the treatment group and 5.033 for the control group. The mean number of total violation incidents is 3.730 for the treatment group and 7.397 for the control group. As for waste disposal violations, the mean number of penalized incidents is 1.337 for the treatment group and 1.288 for the control group. The mean number of total violation incidents is 1.918 for the treatment group and 2.296 for the control group.

[Place Table 1 about here]

4 Green Finance Policies Spillover Effects

4.1 The real environmental effect of launching green finance pilot zones

In this section, we present the testing results of our empirical models for the real environmental effects of launching green finance pilot zones. We start with a set of regressions using the whole sample of 73 cities. The AQI is regressed on a dummy variable specifying whether the city belongs to one of the five pilot provinces (*Treat*), a dummy variable *Post* for whether the month belongs to the post-treatment period (from June 2017 and onward), and an interaction term *Treat*Post*. We also controlled for GDP, population, fiscal income and fixed effects of year and region. For classifying city regions, we use the Qinling and Huai river identification of south and north and the seven geographical divisions mentioned in section 3. The regression equation is as follows:

$$AQI_{it} = \alpha + \beta_1 Treat_{it} + \beta_2 Post_{it} + \beta_3 Treat * Post_{it} + \delta X_{it} + \epsilon_{it} \quad (1)$$

In this model, the variable of interest is the interaction term. Its coefficient β_3 captures the difference in changes in air quality between the treatment group and the control group. If β_3 is significantly positive (negative), the act of launching pilot zones improves (worsens) the air quality of the treatment group compared to the control group.

[Place Table 3 about here]

Table 3 presents the regression results. Column (1) shows the impact of launching green finance pilot zones without controlling for macro variables and the two regional fixed effects. We find that instead of having improved air quality after being set as pilot zones, the estimated β_3 coefficient is positive, indicating a rise in air quality index and a decline in air quality relative to the control cities. In columns (2) and (3), we controlled for the regional fixed effects and macro level variables respectively and found similar results as those in (1). When

we included all the controls and fixed effects in column (4), we observed a decline in the significance level of β_3. For all four specifications, the coefficient of *Post* β_2 is always highly significant. When we do not control for regional fixed effects, the coefficient of *Treat* β_1 is also highly significant. It can be concluded that the five pilot zones have better air quality conditions compared to the rest of China before this program was launched. In some ways, this is also one of the reasons why they were chosen as pilot zones in the first place. Also, in the sample period, there is a significant improvement in air quality in the control regions. One possibility of this result is that there is a policy spillover, and the control regions are pressed to improve their environmental conditions. An alternative explanation is that the improvements in air qualities are mainly driven by policies pressing the Beijing, Tianjin, and Hebei and surrounding areas. Since these policies are enforced by the central government, we do not consider them as part of the policy externalities.

[Place Table 4 about here]

To examine the above hypotheses, we performed two sets of regressions excluding areas that may be influenced by the Beijing, Tianjin, and Hebei policies. The results are presented in table 4. In the first column, we excluded the "2 + 26" cities from the sample. These are the cities directly affected by the policies. In the second column, we excluded a larger range of cities close to the Beijing, Tianjin, and Hebei area. Specifically, the three geographical divisions that do not contain any pilot zone provinces were excluded. As for the third specification, we only used sample of cities on the south side of the Qinglin-Huai River line. For all three specifications, our variable of interest *Treat*Post* are positively significant, which is consistent with our results using the full sample. Therefore, the relative improvements in air quality for the control regions are not purely driven by the aggressive policies in the Beijing, Tianjin, and Hebei and surrounding areas. From these evidences, we argue that the launch of green finance pilot zones impose policy externalities to other province and cities in China. The local governments are competing in terms of environmental performance to be selected as green finance pilot zones in the next round.

To further check for robustness and mitigate the concern that the pilot zones are not randomly chosen, we adopt a propensity score matching (PSM) method (Rosenbaum and Rubin, 1984) and match the samples according to provincial macro-level controls and geographical locations. We perform the same analyses in table 3 using the PSM matched sample. The results are presented in table 5. In columns (1) and (2), we match one treatment province with one control province. In (3) and (4), we match one province with two control provinces. The results are in support of our conclusion that while the pilot zone areas experience improvements in air quality, the incentivized control regions boost their environmental performances further more such that there is a relative decline in the air quality of the pilot provinces.

[Place Table 5 about here]

4.2 The effects of launching green finance pilot zones on environmental violation incidents

This section presents the results of how environmental violations are affected by the launch of green finance pilot zones. The dependent variable *Incidents* measures the number of incidents in a given city-year, and is regressed on our variable of interest *Treat*Post*. *Treat*Post* is the interaction term of a dummy variable *Treat* specifying whether the city belongs to one of the five pilot provinces, and a dummy variable *Post* for whether the month belongs to the post-treatment period (from 2017 and onward). We also controlled for GDP, population, fiscal income and fixed effects of year and city. The regression equation is as follows.

$$Incidents_{it} = \alpha + \beta Treat * Post_{it} + \delta X_{it} + \epsilon_{it} \tag{2}$$

In this model, the coefficient β on our variable of interest *Treat*Post* captures the difference in the changes in violation incidents between the treatment group and the control group. If

β_3 is significantly negative (positive), the act of launching pilot zones decreases (increases) the number of incidents in the treatment group compared to the control group.

The results of our test are reported in table 6. Panel A reports the results for air pollution violations and panel B presents the results for waste disposal violations. In the first two columns, we use the number of incidents that received penalties, and in the last two columns, we use the total number of incidents, which includes both penalized ones and ones that are negatively mention in government documents. All standard errors are clustered at the city level for all the specifications in this part. Our results show a significant relative decrease in air pollution violations in the pilot zones, and the estimated decrease is large and robust for all our specifications. The relative decrease in waste disposal violations is less prominent but holds for both penalized incidents and total incidents when the macro controls are included.

[Place Table 6 about here]

The relative decline in violation incidents could be subjected to several channels: (1) the competing environment among other local governments that wish to become the next generation of green finance pilot zones results in more strict enforcement of environmental regulations and hence violations detected, and (2) the firms' increased attention of environmental issues through engaging in green finance. As air pollution is more concerned by the public and the Chinese government, it is not surprising that there is a larger reduction in air pollution violations than waste disposal.

5 Channels of the Policy Spillover Effects

5.1 Benefits of green finance pilot zones: corporate financing

Since the green finance pilot zones mainly provide environment-related projects easier access to financing, we first analyze how local firm's financing decisions are affected by this place-based policy. We use difference-in-difference designs to examine how corporate capital structure

and cumulative city-level green bond issuance respond to the launch.

In analyzing the policy's impact on corporate leverage, we use debt ratio as our measure of leverage and define it to be D/A where D is current liability and A is current asset. It is regressed on a dummy variable specifying whether the firm is located in one of the five pilot provinces (*Treat*), a dummy variable *Post* for whether the month belongs to the post-treatment period (from June 2017 and onward), and an interaction term *Treat*Post*. We follow Garvey and Hanka (1999) to include profitability, firm size, and previous leverage as firm-level controls. We winsorize 1% in each tail to exclude extreme values in leverage. The regression is as follows.

$$leverage_{it} = \alpha + \beta_1 Treat_{it} + \beta_2 Post_{it} + \beta_3 Treat * Post_{it} + \delta X_{it} + \epsilon_{it} \tag{3}$$

The results are reported in table 7. In the first two columns, we control for industry fixed effects, the coefficients on our variable of interest *Treat*Post* are positively significant. The launch of green finance pilot zones led to higher corporate leverage in the pilot provinces. In the latter two columns, we use firm fixed effects and the results are still robust. This outcome is not surprising since debt financing, such as green loans and green bonds are highly supported and is a major target of the place-based green finance policy.

[Place Table 7 about here]

To further investigate the how firms respond to the place-based policy in terms of financing decisions, we examine whether companies whose operations can be more easily related to green projects have more increases in their leverage[13]. To do this, We separate industries into green industries and non-green industries according to "Green Industry Guidance Catalog" by NDRC and other 6 Ministries and "The Guidelines for the Industrial Classification of Listed Companies" by CSRC. We use a dummy variable *GreenInd* that equals to 1 if the company is classified as green industry to separate our data into two subsamples. Then, we perform

[13]Most of these companies belong to industries related to clean energy, transportation and infrastructure, production technologies, and finance.

the regression in equation 3 for the two subsamples of green and non-green industries.

[Place Table 8 about here]

The results are reported in table 8. In the first two columns, we control for industry fixed effect. We can see that the coefficient on *Treat*Post* is positively significant in the first column where $GreenInd = 1$, and it is insignificant in the second column for non-green industries. This suggest that the increase in leverage is concentrated in firms that could take up green projects relatively easily. We also include a set of regressions in the latter two columns where no fixed effects are controlled to address the concern that they may bias our results as we are studying heterogeneity of effects for different industries. The previous conclusion is still valid in this scenario. As for non-green industries, there is no significant change in their capital structure. While the policy has shifted more capital to finance green projects, there is no evidence suggesting this policy is draining resources from other industries.

Next, we study how green bond issuance is affected by the launch of green finance pilot zones. Compared to the changes in capital structure, green bond issuance is a more direct reflection of this policy. The dependent variable is the cumulative number of issuance. The dependent variable is regressed on the dummy *Treat*, *Post* and the interaction term *Treat*Post* used in our previous analyses. We also controlled for the GDP, population, fiscal income of the provinces and fixed effects of year and month. Below are the regression equations used in our analyses.

$$CumulativeGreenBondIssuance_{it} = \alpha + \beta_1 Treat_{it} + \beta_2 Post_{it} + \beta_3 Treat * Post_{it} + \delta X_{it} + \epsilon_{it} \tag{4}$$

For both regressions, the variable of interest is the interaction term *Treat*Post*. When the coefficient β_3 is positive (negative), the pilot provinces experience a relative increase (decrease) in the number of green bond issuance compared to the remaining regions.

Table 9 presents the results of our tests. It can be observed that the coefficient β_3 is positively significant, indicating that there is a relative increase in the number of green bond

issuance for the pilot provinces. and the launch of green finance pilot zones can encourage the development of green bonds in these areas.

[Place Table 9 about here]

Overall, the green finance pilot zone is indeed able to provide more access to capital for green firms and green projects. With regulatory supports such as fast tracks and newly established specialized financial institutions, we are seeing positive effects on debt usage and green bond issuance in the pilot zone regions.

5.2 The effects of promotion incentives

If the positive spillover effects are driven by competitions between local governments, apart from favorable policies and resources from the central government, promotion potentials for local government leaders are also important reasons why locals are motivated to compete. According to China's retirement provision of local government leaders, the age limit for possible term renewal is 64 years old and has been strictly enforced. In this case, local government leaders who will be 65 or older by the start of next term will lack the promotion incentive to participate in environmental improvements[14]. Intuitively, we would expect the spillover effects to be concentrated in provinces whose leaders have the potentials for term renewal or promotion.

To test this hypothesis, we introduce a dummy variable *Retirement* that equals to one if the province's provincial secretary, who is first in command, will be greater than or equal to 65 by 2022 and forced to retire. There are 31 provinces in our sample, among which 8 of the provinces have provincial secretaries with potential renewal or promotion. None of these 8 provinces are green finance pilot provinces. We perform the analyses using two designs.

[14]The current term started in 2017 and runs for 5 years. Therefore, provincial leaders who will be below 65 have the chance to renew their term or get promoted.

First, we interact *Retirement* with DiD dummies and run the following specification.

$$AQI_{it} = \alpha + \beta_1 Post_{it} + \beta_2 Retirement_{it} + \beta_3 Treat * Retirement_{it} \\ +\beta_4 Post * Retirement_{it} + \beta_3 Treat * Post * Retirement_{it} + \delta X_{it} + \epsilon_{it} \tag{5}$$

Treat and *Treat*Post* are omitted due to collinearity since all five pilot zone provinces have *Retirement* equal to one. The coefficient of interest hear is the triple interaction term *Treat*Post*Retirement*. We report the regression result in the first column of table 10. The fact that it is negatively significant suggests that for peer provinces whose leaders have no promotion incentives, their environmental spillover effects is less prominent.

[Place Table 10 about here]

Then, we run the baseline regression equation 1 in section 4.1 using subsamples for provinces with secretaries who will serve another term (*Next-term*) and secretaries who will retire in 2022 (*Retirement*) separately. The results are presented in the second and third columns of table 10. While the coefficient on *Treat*Post* for both subsamples are positively significant, the magnitude of the coefficient for the *Next-term* subsample is approximately twice as large as that of the *Retirement* subsample. This indicates that the promotion motivations are associated with more prominent environmental improvements.

Generally speaking, both regression designs in this section support our argument that local government leaders' political career motivations drive their willingness to participate in the national environmental campaign and thus result in heterogeneity in the positive spillover effects.

5.3 The effects of state ownership

As many of the findings documented in this paper are results of firm reactions to the policies, state ownership could be a major source of political influences. Therefore, we will focus on state owned enterprises in our study of causes of the heterogeneity in effects. On the

one hand, SOEs are more socially responsible due to government influences and have less incentive to violate environmental regulations. On the other hand, they are also less affected by local regulations as a result of their political connections. In contrast, private firms have more incentive to earn profits through violating environmental regulations, but they are also more affected by stricter enforcement. It remains to empirically investigate which force will dominate and lead to greater improvements in environmental performances. This section presents our result on how the heterogeneity in real environmental impacts is affected by the share of SOEs within the provinces, which is defined by the number of SOEs divided by the total number of firms in the corresponding province.

We use three sets of tests to examine this heterogeneity in real environmental effects. First, we run the baseline regression (equation 1) using two subsamples, share of SOEs below and above the median level. To make the results more straightforward, instead of running the DiD using the *Treat* dummy for the treatment group, we are using a dummy *Peer* that equals to 1 if the city belongs to the control group. The regression equation is changed to:

$$AQI_{it} = \alpha + \beta_1 Peer_{it} + \beta_2 Post_{it} + \beta_3 Peer * Post_{it} + \delta X_{it} + \epsilon_{it} \tag{6}$$

[Place Table 11 about here]

The results are presented in the second and third columns of table 11. We find that the coefficient on *Peer*Post* is negatively significant for the below median subsample and positively significant for the above median subsample. This suggest that control provinces with relatively low shares of SOEs experienced improvements in air quality compared to the pilot zones while those with high shares of SOEs had relative declines.

Second, we add a triple interaction term *Peer*Post*SOE* to our baseline specification in table 3 where *SOE* is the share of SOEs in the provinces. The regression is as follows.

$$AQI_{it} = \alpha + \beta Post_{it} + \gamma Peer * Post_{it} + \sigma Peer * Post * SOE_{it} + \delta X_{it} + \epsilon_{it} \tag{7}$$

The result is presented in column (1) of table 11. While the coefficient on *Peer*Post* is negatively significant, indicating that there is relative improvements in air quality in the control group, the coefficient on *Peer*Post*SOE* is negatively significant. This is consistent with our previous finding that provinces with small shares of SOEs have more prominent environmental performances. Note that the two coefficients add up to be negative, suggesting an overall relative improvement in the control regions as we have found earlier.

Lastly, we interact *Peer*Post* with range dummies. We construct two sets of range dummies. The first is a dummy dividing the sample into two halves. *H1* equals to 1 if the province's SOE share is below median. The second is a set of dummies *Q1, Q2, Q3* for SOE shares from the lowest quantile to the third-lowest quantile. The results are displayed in table 12. In the first column, we interact *Peer*Post* with *H1*. The coefficient is negatively significant, which conforms to our previous results. As for the second column, we include three triple interaction terms *Peer*Post*Q1*, *Peer*Post*Q2* and *Peer*Post*Q3*. This allows us to compare provinces with SOE shares from Q1 to Q3 with those with the highest quantile, Q4, which is left out in the regression. Our result suggest that all three quantiles have better environmental performance than the last quantile. However, since only the coefficient on *Peer*Post*Q1* is greater in absolute value than the coefficient of *Peer*Post*, the relative improvements of air quality in the control provinces seem to be driven by provinces with very low SOE shares.

[Place Table 12 about here]

Corresponding to our study of how environmental violation incidents are affected by the place-based program, we also examine whether political influence affects violations. Since areas outside the pilot zones experience an increase in the number of violation incidents detected as a result of stricter enforcement of regulations, we would expect such effects to be less prominent for SOEs given their power to resist such enforcement to a certain extent. We use the subsample method and the *Peer*Post*SOE* triple interaction method in table 11 to test the heterogeneity in effects of penalized air violations and total air violations.

The results are presented in table 13. In the first column of both panel A and B, we use the triple interaction method and find both coefficients on *Peer*Post*SOE* to be negatively significant. This implies that provinces with higher shares of SOEs have less increases in violations detected. Note that the coefficients on *Peer*Post* is positively significant and have larger absolute values than *Peer*Post*SOE*. Hence, there is still an overall relative increase in violations. In the second and third columns, we compare the subsample with SOE shares above mean level with the subsample with shares below mean. The coefficients on *Peer*Post* are positively significant for both penalized and total violations of the below mean sample and negative but insignificant for the above mean sample. This suggests that the increase in violation incidents is driven by provinces with relatively low SOE shares, further confirming our previous result.

[Place Table 13 about here]

In summary, provinces with low SOE shares seem to drive the spillover mechanism. Due to the political connections of the SOEs, they are less responsive to the local governments' regulatory efforts in improving environmental performances and exposing violation incidents. In more extreme cases, the SOE leaders may be higher in political rank than the local government leaders, giving them the discretion to almost ignore local regulatory policies. In contrast, private firms have less resistance to regulations and stronger enforcement. Thus, places where the private sector accounts for a large proportion can see better effects of local environmental policies.

6 Conclusion

This paper examines the real effects of place-based green finance policies. We find relative increases in corporate leverage and green bond issuance as direct effects of the policies. The increased leverage in concentrated in industries with closer relations to green projects in the targeted areas, indicating that the place-based program can effectively shift capital to the

designated uses. We also find relative declines in air quality in the pilot zones compared with the remaining regions following their launch in 2017. After excluding areas that are likely to be affected by the aggressive air pollution reduction policies in Beijing, Tianjin, Hebei and surrounding areas, we still find the same result. We argue that these results suggest a policy externality imposed by the launch of pilot zones. Local governments in the other regions are pressed to boost their environmental performance to gain recognition from Beijing. Additionally, areas outside the pilot zones also experience relative increases in environmental violation incidents. Provinces that wish to receive environmental recognition from the central government impose stricter supervision and strengthen their enforcement of laws and regulations, which resulted in the increases in the number of violations detected.

We also find that political influence can result in heterogeneity in the environmental spillover effects. Promotion incentives of provincial leaders play a significant role inmotivating them to engage in environmental improvements. Also, political powers of state owned enterprises make them less responsive to local governments' policies and supervisions and thus distort the effects of environmental efforts. In non-pilot provinces where there are higher shares of SOEs, both the improvements of air quality and increases in environmental violations detected are significantly less prominent.

In general, the results of our study are consistent with the hypothesis that green finance and government interventions have positive environmental implications. As an alternative to existing environmental policies that increases the emission cost, the development of green finance is proven to be effective. This does not mean a replacement of existing policies. The two sets of policies can be implemented simultaneously and our results do suggest that the aggressive emission policies have more pronounced pollution reduction effects. However, we expect green finance to have long term benefits and less negative spillovers. Moreover, environmental projects and local government efforts involved in the development of green finance is not the only channel through which green finance can benefit the environment. In a setting of competing local governments, we also find policy spillover effects that stimulates the

environmental efforts of regions not directly targeted by the policies. In order to compete for resources from the central government, the local governments are incentivized to boost their performances in areas the central government values. This argument is further enhanced by the finding that provinces whose leaders have term renewal or promotion potentials experience greater environmental boosts. However, the political influence of state ownership generates a force of distortion to the spillover effects that came from firm level reactions, which could potentially hamper environmental improvements.

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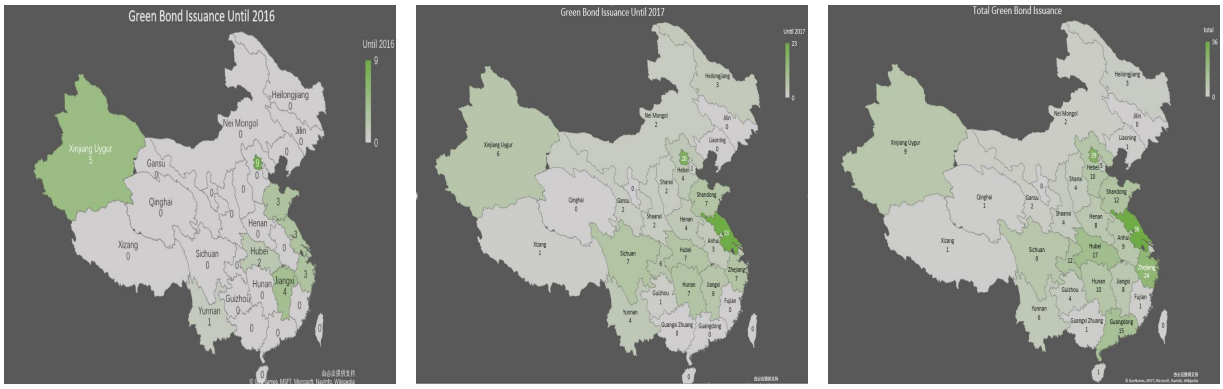
Figures

Figure 1: **Map of pilot zones**
This figure depicts the location of the five pilot zones in China. Xinjiang is located in the north side of the Qinglin-Huai River line and the other four provinces are located south to the line. As for the seven geographical divisions of China, Xinjiang is in the Northwest, Guizhou is in the Southwest, Guangdong is in Southern China, and both Jiangxi and Zhejiang are in Eastern China.

Figure 2: **Green bond issuance map**
This figure shows the aggregate number of green bond issuance of the 31 mainland provinces in China for year 2016 to 2018. The darker green of a province means a greater number of green bond issuance.



(a) Issuance until 2016 year end (b) Issuance until 2017 year end (c) Issuance until 2018 year end

Table 1: **Summary statistics for environmental performances**
Panel A reports the summary statistics for our analysis on the environmental effects of launching pilot zones. Panel B and C reports the summary statistics of the effect of launching pilot zones on environmental violation incidents. *AQI* is the HP-filtered air quality index. *Penalized* is the number of violation incidents that received penalties. *Total* is the total number of incidents, including both penalized ones and ones that are negatively mention in government documents. *lnGDP* is the natural logarithm of the GDP of the province to which a given city belongs. *Population* is the provincial population, and *Fiscal Income* is the provincial fiscal income.

Panel A: Summary statistics (Launching pilot zones)

	Treatment group				Control group			
	N	Mean	Median	std. dev.	N	Mean	Median	std. dev.
AQI	418	4.028	4.155	0.592	4,838	5.216	5.080	1.408
lnGDP	418	10.085	10.112	0.594	4,745	9.576	9.738	1.045
Population	286	6663.652	5737	2503.141	4,502	6238.64	7332.61	2840.601
Fiscal income	416	654.214	632.480	339.942	4,806	367.083	281.95	256.191

Panel B: Summary statistics(Air pollution violations)

	Treatment group				Control group			
	N	Mean	Median	std. dev.	N	Mean	Median	std. dev.
Penalized	405	2.531	0	6.832	1,555	5.033	1	11.220
Total	405	3.730	0	8.497	1555	7.397	1	14.599
lnGDP	348	9.787	9.781	0.535	1,200	9.999	10.103	0.769
Population	307	5932.240	4592	3364.923	1,169	5645.069	5816	2640.562
Fiscal income	348	4652.457	2246.9	3770.98	1,316	2789.568	2390.2	1767.233

Panel C: Summary statistics (Waste disposal violations)

	Treatment group				Control group			
	N	Mean	Median	std. dev.	N	Mean	Median	std. dev.
Penalized	294	1.337	0	3.743	1,211	1.288	0	3.776
Total	294	1.918	0	4.795	1,211	2.296	0	6.593
lnGDP	252	9.941	9.911	0.548	960	10.067	10.111	0.735
Population	225	6511.529	5539	3259.371	931	5744.140	5902	2638.218
Fiscal income	252	5342.846	4810	3719.469	1028	2967.848	2454	1887.248

Table 2: **Summary statistics for corporate financing activities**
Panel A contains the summary statistics for the effects of launching pilot zones on corporate leverage. *Leverage* debt ratio defined by total liabilities divided by total asset. *ROA* is prior year's operating cash flow divided by assets. Δ *ROA* is the change in ROA from the previous year. Panel B reports the summary statistics for our analysis of the effect of launching pilot zones on green bond issuance. *CI* is the cumulative number of green bond issuance.*Issuance* is a dummy for whether any green bonds are issued in a given month. *lnGDP* is the natural logarithm of the GDP of the province to which a given city belongs. *Population* is the provincial population, and *Fiscal Income* is the provincial fiscal income.

Panel A: Summary statistics (Capital Structure)

	Treatment group				Control group			
	N	Mean	Median	std. dev.	N	Mean	Median	std. dev.
Leverage	22,007	0.406	0.393	0.208	52,348	0.440	0.423	0.225
ROA	22,007	0.012	0.011	0.296	52,348	0.009	0.008	0.105
Δ ROA	21,841	0.007	0.002	0.089	51,964	0.006	0.001	0.070
Lagged Leverage	51,959	0.350	0.322	0.359	51,959	0.330	0.500	16.034
Lagged Log Asset	21,841	7.972	7.858	1.236	51,966	8.154	7.944	1.457
Lagged Asset $\times 10^{-5}$	21,841	1.742	0.259	19.697	51,966	8.781	0.282	537.805

Panel B: Summary statistics (Green bond issuance)

	Treatment group				Control group			
	N	Mean	Median	std. dev.	N	Mean	Median	std. dev.
CI	195	2.728	1	4.174	1,051	1.461	0	3.632
Issuance	195	0.149	0	0.357	1,051	0.080	0	0.271
lnGDP	195	8.468	8.234	0.707	1,051	8.316	8.563	0.980
Population	195	5079	4592	2629	1,051	4125	3788.7	2679
Fiscal income	195	325	187	287	1,051	219	179.9	180

Table 3: **The spillover effect of launching pilot zones on peer air quality**
This table reports the results of the real environmental effects of launching green finance pilot zones using the full sample of the 73 cities. The dependent variable AQI is the HP-filtered air quality index. *Treat* is a dummy variable specifying whether the city belongs to one of the five pilot provinces. *Post* is a dummy that equals to one if the year-month belongs to the post treatment period (from June 2017 and onward). *Treat*Post* is the interaction term. *lnGDP* is the natural logarithm of the GDP of the province to which a given city belongs. *Population* is the provincial population, and *Fiscal Income* is the provincial fiscal income. We controlled for year, north, and region fixed effects. North is a dummy for northern and southern China according to the Qinglin-Huai river line. Region is a categorical variable for the seven geographical divisions in China. Standard errors are clustered at the city level and reported in the parentheses. *, ** and *** denote significance at the 10% , 5% and 1% level respectively.

	Dependent variable: Air Quality Index			
	(1)	(2)	(3)	(4)
Treat	-1.429***	-0.345	-1.385***	-0.425**
	(0.256)	(0.235)	(0.246)	(0.182)
Post	-0.163***	-0.163***	-0.388***	-0.201***
	(0.036)	(0.036)	(0.125)	(0.057)
Treat*Post	**0.242****	**0.241****	**0.349****	**0.205***
	(0.091)	**(0.091)**	**(0.150)**	**(0.112)**
lnGDP			0.078	0.044
			(0.113)	(0.052)
Population			0.199***	0.189***
			(.072)	(.051)
Fiscal income			-0.022***	-0.001
			(0.006)	(0.004)
Year fixed effect?	Yes	Yes	Yes	Yes
North fixed effect?	No	Yes	No	Yes
Region fixed effect?	No	Yes	No	Yes
N	5256	5256	4762	4762
$Adj.R^2$	0.2161	0.5683	0.3230	0.6452

Table 4: **Robustness check: The spillover effect of launching pilot zones on peer air quality**

This table reports the results of the real environmental effects of launching green finance pilot zones for three subsets of the 73 cities. The dependent variable AQI is the HP-filtered air quality index. The dependent varaibles are defined in the same way as table 3. We excluded the "2+26" cities in Beijing, Tianjin, Hebei and surrounding areas in the first column. Three geographical divisions that do not contain any of the five pilot zones were excluded in the second column, and cities north to the Qinglin-Huai river line were excluded in the third. We controlled for year and region fixed effects in all three specifications. Robust standard errors are reported in the parentheses. *, ** and *** denote significance at the 10% , 5% and 1% level respectively.

	Dependent variable: Air Quality Index		
	(Jing-Jin-Ji=0)	(Pilot=1)	(North=0)
Treat	-0.500***	-0.499***	-0.712**
	(0.031)	(0.030)	(0.029)
Post	-0.272***	-0.326***	-0.485***
	(0.062)	(0.068)	(0.064)
Treat*Post	**0.117****	**0.111***	**0.280*****
	(0.057)	**(0.063)**	**(0.065)**
lnGDP	0.200***	0.257***	0.348***
	(0.016)	(0.015)	(0.016)
Population	-0.027***	0.021**	0.058***
	(0.007)	(0.008)	(0.008)
Fiscal income	0.250***	-0.135*	-0.266***
	(0.066)	(0.080)	(0.070)
Year fixed effect?	Yes	Yes	Yes
North fixed effect?	Yes	Yes	No
N	3,863	3,263	2,778
$Adj.R^2$	0.3619	0.4848	0.3646

Table 5: **The spillover effect of launching pilot zones on peer air quality (Matching sample)**

This table reports the results of the real environmental effects of launching green finance pilot zones using the propensity score matched samples. In the first two columns, we match one treatment province with one control province. In the latter two columns, we match one province with two control provinces. The dependent variable AQI is the HP-filtered air quality index. *Treat* is a dummy variable specifying whether the city belongs to one of the five pilot provinces. *Post* is a dummy that equals to one if the year-month belongs to the post treatment period (from June 2017 and onward). *Treat*Post* is the interaction term. *lnGDP* is the natural logarithm of the GDP of the province to which a given city belongs. *Population* is the provincial population, and *Fiscal Income* is the provincial fiscal income. We controlled for year, north, and region fixed effects. Standard errors are reported in the parentheses. *, ** and *** denote significance at the 10% , 5% and 1% level respectively.

	Dependent variable: Air Quality Index			
	(1:1)	(1:1)	(1:2)	(1:2)
Treat	-0.606***	-0.606	-0.465***	-0.465*
	(0.058)	(0.542)	(0.031)	(0.243)
Post	-0.644***	-0.644***	-0.387***	-0.387***
	(0.117)	(0.226)	(0.072)	(0.107)
Treat*Post	**0.373***	**0.373***	**0.206***	**0.206***
	(0.107)	**(0.210)**	**(0.070)**	**(0.114)**
lnGDP	0.372***	0.372*	0.288***	0.288***
	(0.025)	(0.184)	(0.016)	(0.097)
Population	0.001	0.001	0.001	0.001
	(0.001)	(0.007)	(0.001)	(0.006)
Fiscal income	-0.031***	-0.031	0.002	0.002
	(0.010)	(0.050)	(0.009)	(0.050)
Year fixed effect?	Yes	Yes	Yes	Yes
North fixed effect?	Yes	Yes	Yes	Yes
Region fixed effect?	Yes	Yes	Yes	Yes
Cluster at city-level?	No	Yes	No	Yes
N	1774	1774	2821	2821
$Adj.R^2$	0.3665	0.3665	0.4084	0.4084

Table 6: **The spillover effect of launching pilot zones on environmental violation incidents**

This table reports the results of the effects of launching pilot zones on environmental violation incidents. The dependent variable is the number of such incidents. In the first two columns, we use the number of incidents that are penalized. In the last two, we use the total number of incidents, including both penalized ones and ones that are negatively mention in government documents. *Treat*Post* is an interaction term of a *Treat* dummy that specifies whether the city belongs to one of the five pilot provinces and a *Post* dummy that equals to one if the year-month belongs to the post treatment period (from 2017 and onward). *Treat* and *Post* are omitted due to collinearity with the fixed effects. *lnGDP* is the natural logarithm of the GDP of the province to which a given city belongs. *Population* is the provincial population and *Fiscal Income* is the provincial fiscal income. We control for city and year fixed effects for all specifications. Standard errors are clustered at the city level and reported in the parentheses. *, **, *** denote significance level of 10%, 5%, and 1% respectively.

Panel A: Air Pollution

	Dependent variable: Number of Incidents			
	(Penalized)	(Penalized)	(Total)	(Total)
Treat*Post	**-3.340*****	**-5.908*****	**-4.080*****	**-8.188*****
	(0.989)	**(1.164)**	**(1.158)**	**(1.600)**
lnGDP		5.565		6.599
		(3.388)		(4.413)
Population		-0.011		-0.010
		(0.014)		(0.019)
Fiscal income		0.0030*		0.0034*
		(0.0016)		(0.0021)
Year fixed effect?	Yes	Yes	Yes	Yes
City fixed effect?	Yes	Yes	Yes	Yes
N	1960	1438	1,960	1,438
$Adj.R^2$	0.3562	0.4079	0.4169	0.4520

Panel B: Solid Waste and Hazardous Waste

	Dependent variable: Number of Incidents			
	(Penalized)	(Penalized)	(Total)	(Total)
Treat*Post	**0.608**	**-0.999***	**0.661**	**-2.115****
	(0.555)	**(0.524)**	**(0.700)**	**(0.909)**
lnGDP		1.823		3.802**
		(1.185)		(1.931)
Population		-0.008		-0.011
		(0.006)		(0.008)
Fiscal income		0.0014**		0.0022**
		(0.0007)		(0.0009)
Year fixed effect?	Yes	Yes	Yes	Yes
City fixed effect?	Yes	Yes	Yes	Yes
N	1505	1131	1505	1131
$Adj.R^2$	0.2954	0.4099	0.2756	0.3054

Table 7: **The benefits of launching pilot zones: corporate capital structure**
This table shows the effects of launching green finance pilot zones on firms' debt usage. We use debt ratio defined by total liabilities divided by total asset as our measure of leverage. ROA is prior year's operating cash flow divided by assets. Δ ROA is the change in ROA from the previous year. All standard errors are clustered at the industry level and reported in the parentheses. *, ** and *** denote significance at the 10% , 5% and 1% level respectively.

	Dependent variable: leverage			
	(1)	(2)	(3)	(4)
Treat	-0.027**	-0.027**		
	(0.010)	(0.010)		
Post	-0.027**	0.003	0.002	0.007**
	(0.007)	(0.003)	(0.004)	(0.002)
Treat*Post	**0.016****	**0.015****	**0.016****	**0.016****
	(0.005)	**(0.005)**	**(0.006)**	**(0.006)**
ROA	-0.058***	-0.058***	0.009***	0.008***
	(0.009)	(0.009)	(0.002)	(0.002)
Δ ROA	-0.041**	-0.040**	-0.041***	-0.039***
	(0.012)	(0.012)	(0.005)	(0.005)
Lagged leverage	0.0006*	0.0007*	0.0004***	0.0005***
	(0.0003)	(0.0003)	(0.0004)	(0.0001)
Log of lagged asset	0.066***	0.066***	0.022***	0.024***
	(0.005)	(0.005)	(0.002)	(0.002)
Lagged asset $\times 10^{10}$	-5.260***	-5.360***	-1.390***	-1.560***
	(0.910)	(0.928)	(0.129)	(0.137)
Year fixed effect?	No	Yes	No	Yes
Industry fixed effect?	Yes	Yes	No	No
Firm fixed effect?	No	No	Yes	Yes
N	73,798	73,798	73,776	73,776
$Adj.R^2$	0.2584	0.2615	0.8265	0.8272

Table 8: **Effects on corporate capital structure for green industries**
This table shows the effects of launching green finance pilot zones on firms' debt usage using subsample divided by *GreenInd*, a dummy variable for whether the company belongs to an industry closely related to green projects. We use debt ratio defined by lagged total liabilities divided by lagged total asset as our measure of leverage. ROA is prior year's operating cash flow divided by assets. Δ ROA is the change in ROA from the previous year. All standard errors are clustered at the industry level and reported in the parentheses. *, ** and *** denote significance at the 10% , 5% and 1% level respectively.

	Dependent variable: leverage			
	(Green Ind)	(Non Green)	(Green Ind)	(Non Green)
Treat	-0.021**	-0.029	-0.016	-0.036
	(0.007)	(0.018)	(0.012)	(0.021)
Post	-0.030***	-0.013	-0.031***	-0.021*
	(0.003)	(0.012)	(0.004)	(0.010)
Treat*Post	**0.015*****	**0.014**	**0.013****	**0.015**
	(0.002)	**(0.013)**	**(0.004)**	**(0.013)**
ROA	-0.407***	0.005	-0.469***	0.006
	(0.027)	(0.005)	(0.056)	(0.008)
Δ ROA	0.114***	0.073**	0.129***	0.081**
	(0.022)	(0.020)	(0.011)	(0.022)
Lagged leverage	0.0006**	0.342**	0.0007**	0.367**
	(0.0002)	(0.111)	(0.0002)	(0.125)
Log of lagged asset	0.069***	0.043***	0.074***	0.052***
	(0.008)	(0.007)	(0.006)	(0.006)
Lagged asset $\times$ 10^{10}	-5.550***	-207	-5.620**	-151
	(0.972)	(133)	(1.730)	(317)
Industry fixed effect?	Yes	Yes	No	No
N	51,686	22,112	51,686	22,112
$Adj.R^2$	0.2743	0.4667	0.2441	0.4243

Table 9: **The effect of launching pilot zones on green bond issuance**
This table reports the results of our analysis of the effect of launching pilot zones on green bond issuance. The dependent variable is the cumulative number of green bond issuance. *Post* is a dummy that equals to one if the year-month belongs to the post treatment period (from June 2017 and onward). *Treat*Post* is the interaction term of *Treat* and *Post*, where *Treat* is a dummy variable specifying whether the city belongs to one of the five pilot provinces. *Treat* is omitted in the regression because we controlled for province fixed effects. *lnGDP* is the natural logarithm of the GDP of the province to which a given city belongs. *Population* is the provincial population and *Fiscal Income* is the provincial fiscal income. We also controlled for province, year, and month fixed effects. Robust standard errors are reported in the parentheses. *, **, *** denote significance level of 10%, 5%, and 1% respectively.

	Dependent variable: green bond issuance	
	(1)	(2)
Post	0.535	1.005***
	(0.379)	(0.304)
Treat*Post	**2.638*****	**1.302*****
	(0.442)	**(0.495)**
lnGDP		-0.231
		(0.152)
Population		0.015***
		(0.003)
Fiscal income		0.005
		(0.016)
Province fixed effect?	Yes	Yes
Year fixed effect?	Yes	Yes
Month fixed effect?	Yes	Yes
N	1,488	1,246
$Adj.R^2$	0.5899	0.5929

Table 10: **Promotion incentive and environmental spillover effects**
This table reports the results of how the real environmental effects of launching pilot zones is affected by local government leaders' promotion incentives. Provincial secretaries who are below 65 years old by 2022 will have the chance to serve another term or get promoted in the Provincial People's Congress in 2022. *Retirement* is a dummy variable for provinces whose leaders will be greater than or equal to 65 years old and will thus retire. *lnGDP* is the natural logarithm of the GDP of the province to which a given city belongs. *Population* is the provincial population, and *Fiscal Income* is the provincial fiscal income. We control for city and year fixed effects in both models. Standard errors are reported in the parentheses. *, **, *** denote significance level of 10%, 5%, and 1% respectively.

	Dependent variable: Air Quality Index		
	(1)	(Next-term)	(Retirement)
Treat		-0.709***	-0.445***
		(0.014)	(0.027)
Post	-0.746***	-0.243**	-0.166***
	(0.179)	(0.107)	(0.058)
Treat*Post		**0.283***	**0.151***
		(0.092)	**(0.056)**
Retirement	-0.278*		
	(0.160)		
Treat*Retirement	-0.373**		
	(0.156)		
Post*Retirement	-0.338**		
	(0.159)		
Treat*Post*Retirement	**-0.746***		
	(0.164)		
lnGDP	0.030	0.010	-0.002
	(0.049)	(0.032)	(0.018)
Population	0.021***	0.012***	0.027***
	(0.004)	(0.002)	(0.001)
Fiscal income	-0.007	0.015	0.046***
	(0.034)	(0.015)	(0.007)
Year fixed effect?	Yes	Yes	Yes
Region fixed effect?	Yes	Yes	Yes
N	4,762	2,720	3,494
$Adj.R^2$	0.6395	0.6488	0.6582

Table 11: **Political influence on the environmental spillover effects**
This table reports the results of how the real environmental effects of launching pilot zones is affected by Political influence. The dependent variable AQI is the HP-filtered air quality index. *Post* is a dummy that equals to one if the year-month belongs to the post treatment period (from June 2017 and onward). *Peer*Post* is the interaction term of *Post* and a dummy *Peer* specifying whether the city belongs to the non-pilot provinces. *SOE* is the share of SOEs in the province. *Peer*Post*SOE* is the interaction term of *Peer*Post* and *SOE*. *lnGDP* is the natural logarithm of the GDP of the province to which a given city belongs. *Population* is the provincial population, and *Fiscal Income* is the provincial fiscal income. We control for city and year fixed effects in both models. Standard errors are reported in the parentheses. *, **, *** denote significance level of 10%, 5%, and 1% respectively.

	Dependent variable: Air Quality Index		
	(1)	(Below Median)	(Above Median)
Post	0.064**	0.016	-0.120***
	(0.025)	(0.014)	(0.021)
Peer*Post	-0.339***	-0.130***	0.180***
	(0.026)	(0.014)	(0.021)
Peer*Post*SOE	**0.179*** **		
	(0.015)		
lnGDP	-0.016***	-0.034***	-0.026***
	(0.007)	(0.005)	(0.006)
Population	-0.011	0.032***	0.083***
	(0.008)	(0.005)	(0.007)
Fiscal income	0.014***	0.007***	0.002
	(0.004)	(0.002)	(0.003)
SOE	-0.004		
	(0.008)		
Year fixed effect?	Yes	Yes	Yes
City fixed effect?	Yes	Yes	Yes
N	4,762	2,909	3,305
$Adj.R^2$	0.9648	0.9847	0.9840

Table 12: **(Continued) Political influence on the environmental spillover effects**
This table presents additional tests on how the real environmental effects of launching pilot zones is affected by Political influence. The dependent variable AQI is the HP-filtered air quality index. *Post* and *Peer* are defined in the same way as 11. *H1* is a dummy for provinces with SOE shares below the median level. *Q1, Q2* and *Q3* are three dummies for provinces with SOE shares in the first (lowest), second and third quantile, ranked from low shares to high shares. We also include province-level controls and control for city and year fixed effects. Standard errors are reported in the parentheses. *, **, *** denote significance level of 10%, 5%, and 1% respectively.

	Dependent variable: Air Quality Index	
	(1)	(2)
Post	-0.019	-0.033
	(0.024)	(0.024)
Peer*Post	0.096***	0.287***
	(0.027)	(0.039)
Peer*Post*H1	**-0.252*** **	
	(0.025)	
Peer*Post*Q1		**-0.477*** **
		(0.042)
Peer*Post*Q2		**-0.214*** **
		(0.045)
Peer*Post*Q3		**-0.231*** **
		(0.040)
H1	-0.383***	
	(0.019)	
Q1		-0.484***
		(0.031)
Q2		-0.447***
		(0.023)
Q3		-0.074***
		(0.018)
Controls?	Yes	Yes
Year fixed effect?	Yes	Yes
City fixed effect?	Yes	Yes
N	4,762	4,762
$Adj.R^2$	0.9688	0.9697

Table 13: **Political influence on environmental violation incidents**
This table reports the results of how political influence affects violation incidents. The dependent variable is the penalized air violation incidents. *Post* is a dummy that equals to one if the year-month belongs to the post treatment period (from June 2017 and onward). *Peer*Post* is the interaction term of *Post* and a dummy *Peer* specifying whether the city belongs to the non-pilot provinces. *SOE* is the share of SOEs in the province. *Peer*Post*SOE* is the interaction term of *Peer*Post* and *SOE*. Standard errors are reported in the parentheses. *, **, *** denote significance level of 10%, 5%, and 1% respectively.

Panel A: Dependent variable: Penalized Air Violation Incidents

	(1)	(Below Median)	(Above Median)
Peer*Post	10.273***	8.342***	-0.769
	(1.624)	(2.676)	(2.205)
Peer*Post*SOE	**-4.963*** **		
	(1.205)		
lnGDP	4.111	72.498***	-3.024
	(3.671)	(18.497)	(5.197)
Population	-0.020***	-0.048***	-0.006
	(0.007)	(0.014)	(0.012)
Fiscal Income	0.340***	0.009***	-0.0003
	(0.083)	(0.002)	(0.0014)
SOE	-0.166		
	(0.651)		
Year fixed effect?	Yes	Yes	Yes
City fixed effect?	Yes	Yes	Yes
N	1,438	647	722
$Adj.R^2$	0.4160	0.5484	0.1991

Panel B: Dependent variable: Total Air Violation Incidents

	(1)	(Below Median)	(Above Median)
Peer*Post	14.513***	11.847***	-1.002
	(2.159)	(3.487)	(2.912)
Peer*Post*SOE	**-7.188*** **		
	(-1.602)		
lnGDP	4.490	-108.714***	-3.772
	(4.881)	(24.102)	(6.866)
Population	-0.023**	-0.068***	-0.008
	(0.009)	(0.018)	(0.015)
Fiscal Income	0.004***	0.014***	0.0005
	(0.001)	(0.003)	(0.0019)
SOE	-0.243		
	(0.866)		
Year fixed effect?	Yes	Yes	Yes
City fixed effect?	Yes	Yes	Yes
N	1,438	647	722
$Adj.R^2$	0.4609	0.5934	0.2690