Environmental and Resource Economics
https://doi.org/10.1007/s10640-021-00539-z

The Short-Run Effect of a Local Fiscal Squeeze on Pollution Abatement Expenditures: Evidence from China's VAT Pilot Program

Fei Peng[1] · Langchuan Peng[2,5] · Jie Mao[3] · Peng Lu[4]

Accepted: 15 January 2021

Abstract
Introduced in 2012, China's value-added tax (VAT) pilot program gradually replaced business tax (BT) with VAT. It has created a large fiscal squeeze for the local government since 75% of VAT revenue goes to the central government. Employing a difference-in-differences estimator with continuous treatment intensity, we find that this fiscal squeeze has a negative effect on pollution abatement expenditures. Moreover, private firms in eastern regions are less responsive to this shock than those in the rest of China due to having better regulated local governments. We also find that this effect is smaller in magnitude if the firm owner is younger, more educated or has industrial and political connections compared to her respective counterparts. This fiscal squeeze reduces pollution abatement expenditures more in regions with higher fiscal stress, looser environmental regulation, and lower pollution abatement costs. Further exploration shows that, in response to this fiscal squeeze, local governments have adopted several tools to compensate for revenue loss, including increasing tax enforcement and loosening environmental regulation.

Keywords VAT pilot program · Pollution abatement expenditure · Tax burden · Environmental regulation

✉ Langchuan Peng
langchuan_peng@126.com

Fei Peng
pengfeihfut@163.com

Jie Mao
maojie@uibe.edu.cn

Peng Lu
rcpe_cass@126.com

1 School of Economics, Hefei University of Technology, Hefei, China

2 Institute of Economics and Finance, Nanjing Audit University, Nanjing, China

3 School of International Trade and Economics, University of International Business and Economics, Beijing, China

4 Institute of Sociology, Chinese Academy of Social Sciences, Beijing, China

5 Present Address: Pukou District, Nanjing, People's Republic of China

Published online: 09 February 2021

JEL Classification H32 · H71

1 Introduction

China has experienced rapid economic growth since the late 1970s (e.g., Chow and Li 2002; Wu 2004; Cheng 2019; Banerjee et al. 2020), along with deteriorating environmental quality (Wu et al. 2014). Many researchers underscore the role of local political leaders in this phenomenon and state that they often choose economic growth over environmental protection to increase their own chances of promotion (e.g., Li and Zhou 2005; Qi and Zhang 2014; Cai et al. 2016). Recently, scholars have estimated the impact of fiscal squeeze on environmental quality (Bai et al. 2019). However, they focus on the behavior of local governments, leaving the behavior of firms largely unexplored. The current study aims to fill in this gap.

The 1994 tax reform established China's modern tax-sharing system. Since 1994, the central government has regularly launched various fiscal reforms to meet ever-changing economic conditions. Many of them create a fiscal squeeze for local government, and their impact has been widely investigated (e.g., Chen 2017; López-Hernández et al. 2018; Xiao 2020). Two indirect taxes have coexisted since 1994. Value-added tax (VAT) applies to the sales of goods, and business tax (BT) applies to the sales of services. To unify tax rates between sectors, the VAT pilot program was launched in 2012 and gradually replaced BT with VAT.

While the local government keeps all revenue collected from BT, 75% of revenue collected from VAT is given to the central government. This program can thus be treated as a natural "fiscal squeeze" experiment on local government, and the degree of this fiscal squeeze varies substantially across different regions due to the different sizes of affected sectors in each region. The variation in revenue loss over time and across regions allows our paper to employ a difference-in-differences (DD) approach with continuous treatment intensity to investigate the effect of this expansion on pollution abatement expenditures. Our empirical results reveal that this fiscal squeeze has a negative effect on pollution abatement expenditures. We also find that this effect is smaller in magnitude if the firm owner is younger, more educated or has industrial and political connections compared to her respective counterparts. Moreover, private firms in eastern regions are less responsive to this shock than those in the rest of China because local governments in eastern regions are better regulated with respect to environmental protection. This fiscal squeeze reduces pollution abatement expenditures more in regions with higher fiscal stress, looser environmental regulation, and lower pollution abatement costs.

When facing fiscal squeeze caused by fiscal policy, local governments are often forced to find ways to compensate for revenue loss. Increasing tax enforcement and loosening environmental regulations have been found to be empirically efficacious and salient in the existing literature on China's tax reform (Qi and Zhang 2014; Chen 2017; Hao et al. 2018; Xiao 2020). Similarly, our novel contribution to the literature is to provide further empirical evidence for these approaches and focus on the impact of China's VAT pilot program on firms' environmental and pollution management. Specifically, higher tax enforcement can increase firms' tax payments and crowd out pollution abatement expenditures. Looser environmental regulation can increase the tax base because it directs firms to invest in their business instead of in pollution abatement activities.

The current study contributes to the literature investigating the consequences of the fiscal squeeze. A similar study is Chen (2017), in which he considers the abolition of agricultural taxes in 2005 as a fiscal squeeze and finds that tax enforcement significantly increases. Several other studies also document this strategy of increasing tax enforcement (e.g., Xiao 2020). Compared to Chen (2017), which documents the impact on local government, the present paper provides a more comprehensive analysis by further analyzing the impact on affected firms. Firms decrease their pollution abatement expenditures because of this impact on local governments. There are also several other studies in this area. Bai et al. (2019) treat regional tax competition as a fiscal squeeze and find that local governments are willing to reduce the standard of environmental quality to broaden the tax base by attracting more external investment. This choice of loosening environmental regulation is quite popular among local governments in China (e.g., Qi and Zhang 2014; Hao et al. 2018). Zhang et al. (2019) consider the financial problems faced by firms and evaluate their impact on environmental activities. They show that when facing financial constraints, firms decrease their efforts to reduce gas waste emissions. Liu (2018) treats the 2002 Chinese Income Tax Reform that cuts local government revenue from income taxes roughly by half as a fiscal squeeze and finds that governments in response resort to informal taxes for compensation.

Our paper also adds to the discussion about the impact of the VAT pilot program. As the keystone of the tax system in many countries, VAT has been extensively analyzed by many scholars (e.g., Zhang et al. 2018; Zou et al. 2019). The transition to VAT attracted many researchers and government officials. Economists have already investigated its effect on firms' tax burden (Fang et al. 2017), and productivity levels (Hoseini and Briand 2020). The current paper complements theirs by providing evidence as to the impact on pollution abatement expenditures. Different from most previous studies, we further explore the mechanisms of our findings and point out two channels through which the expansion causes this decrease in pollution abatement expenditures.

Finally, our paper contributes to the large literature that analyzes pollution abatement expenditures. Conrad and Morrison (1989), Shadbegian and Gray (2005), Huiban et al. (2015), Cao et al. (2016), Dang et al. (2018) investigate the relationship between pollution abatement expenditures and firm productivity or innovation. Stoerk (2019) demonstrates the heterogeneity of pollution abatement costs across different regions in China. Pollution abatement costs also affect foreign investment in the U.S. (Keller and Levinson 2002) and China (Di 2007). Environmental regulations, such as the Clean Air Act Amendments of 1990 in the U.S. (Lee and Alm 2004) and pollution regulations in China (Wang 2002) significantly affect pollution abatement expenditures. He et al. (2020) discuss the impact of regulation from the view of local government incentives. Our study complements theirs by providing causal evidence of the effect of a fiscal squeeze on pollution abatement expenditures.

The rest of the paper is organized as follows. Section 2 introduces the background of the VAT pilot program and the current tax administration system. Section 3 presents the statistical description of our data and the empirical strategy. Section 4 shows the estimation results. Section 5 provides robustness checks and discusses the mechanisms. Section 6 concludes our paper.

2 Background

The services sector has been sluggish in China since 2002 (Fang et al. 2017). In response, a VAT pilot program was implemented in 2012 and expanded nationwide in 2016. It ended the long-lasting coexisting indirect taxes that were established in 1994: a value-added tax (VAT) and a business tax (BT). The aim of this pilot program is to replace all BT with VAT. Unlike BT, the tax base of which is all business revenue, the tax base of VAT is only value-added revenue and thus has no double taxation. Starting on January 1st, 2012, selected modern services sectors and the transportation sector in Shanghai enrolled in this project as a pilot.[1] The program then geographically expanded gradually on these selected modern services sectors and the transportation sector and had different effective dates for different regions. Nine regions were enrolled before the end of 2012, and the rest were enrolled in 2013.[2] Other services sectors have enrolled since 2016. This expansion enables us to implement a solid identification strategy for DD analysis.

The expected impact of this program is as follows. Under China's tax-sharing scheme (TSS) introduced in 1994, while the local government keeps all revenue collected from BT, 75% of revenue collected from VAT is given to the central government. This expansion that replaces BT with VAT thus creates a huge fiscal squeeze for local governments (Bai et al. 2019). The following figure provides supporting evidence. Since 2012, both the growth rates of fiscal revenue and tax revenue have started to decrease (Fig. 1).

In each city in China, there are two bureaus of taxation: the state administration of taxation, which is directly controlled by the central government, and the local tax bureau, which is controlled by the local government.[3] Each administration is in charge of collecting certain types of taxes. It is well known that the effective tax rate is much lower than the statutory rate in China (Chen 2017), which is largely due to agency enforcement.[4] The local government can put pressure on the local tax bureau to increase tax enforcement on the taxes collected, such as corporate income tax, personal income tax, resource tax, real estate tax, and urban and township land use tax. Although VAT is collected by the state administration of taxation, which is directly controlled by the central government, its tax enforcement can also be affected by the local government through various methods, such as land for office buildings, schooling for children, health care, etc. In summary, local governments have various tools to increase tax enforcement (Chen 2017; Xiao 2020).

[1] There are two reasons why the modern services sectors and the transportation sector were chosen to be part of the 3-year VAT pilot program. (1) Their businesses are more connected to manufacturing sectors, thus applying VAT to them is more urgent for the purpose of unifying tax rates between sectors. (2) This program was also initiated in several pilot regions first. Most firms in these pilot sectors are local enterprises without subsidiaries in other regions, and this transition did not cause an unequal tax burden between these subsidiaries.

[2] Shanghai was enrolled in the program on January 1st, 2012. Beijing, Jiangsu, Anhui, Fujian, Guangdong, Tianjin, Zhejiang, and Hubei were enrolled between September and December, 2012. Since August 1st, 2013, the program has been nationwide for these selected modern services sectors and the transportation sector.

[3] These two groups were merged into one institution in 2018.

[4] As Chen (2017) documents, the effective rate of VAT in China is far below the statutory rate. This situation is caused by various issues, such as fake invoices and falsely high expenditures.

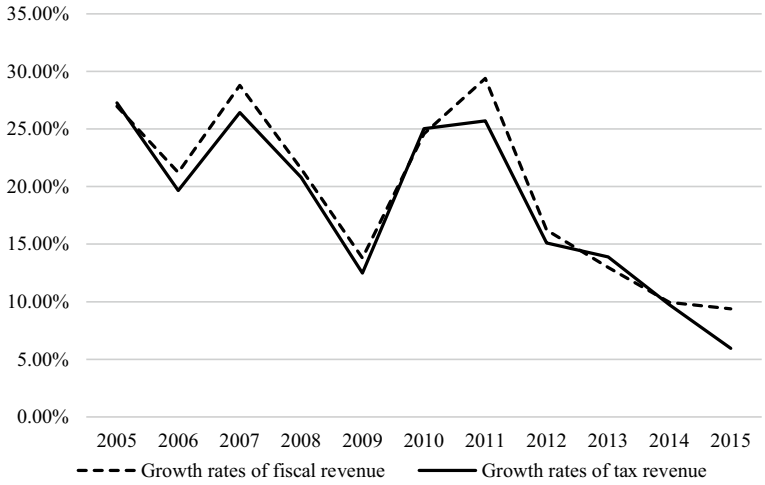

Fig. 1 The growth rates of fiscal revenue and tax revenue

3 Data and Empirical Strategy

3.1 Data

Firm-level data for the current analysis originate from the *Chinese Private Enterprise Survey*. This widely studied dataset provides a representative national sample of private Chinese firms and excludes state-owned enterprises, collective enterprises, and foreign-owned enterprises. Survey questions are designed and biennially carried out by the State Administration for Industry and Commerce of China, the All-China Federation of Industry and Commerce and the Chinese Academy of Social Sciences. Our sample contains information on representative private firms between 2005 and 2015, with detailed firm characteristics.[5] This sample is cross-sectional, not a panel. It is quite large, with 3000–6000 observations each year.

To apply our empirical analysis, we drop observations for (1) firms located in direct-administered municipalities and county-level municipalities since they differ greatly from prefectural-level municipalities in terms of the source of financial revenue, financial management, etc., (2) firms without accurate information with regard to locations and main businesses (the business category that brings the largest share of revenue), and (3) firms that have missing variables used in our estimation or invalid values (such as unverifiable locations). Finally, we trim the data by dropping pollution abatement expenditures above the 99th percentile to remove potential bias due to spurious outliers.[6] After these steps, the total number of observations in our sample is 15268.

[5] The survey years applied in our analysis are 2006, 2008, 2010, 2012, 2014, and 2016. They reflect firms' characteristics in the previous year (2005, 2007, 2009, 2011, 2013, and 2015, respectively).

[6] Instead of trimming the data, we also winsorize it and the results are similar.

3.2 Empirical Strategy

3.2.1 Dependent Variable

The dependent variable in our regression is pollution abatement expenditures per capita. It is widely analyzed in the literature on environmental economics (e.g., Lee and Alm 2004; Shadbegian and Gray 2005; Fowlie 2010; Dang et al. 2018). It measures firms' expenditures to protect the environment. Following previous studies, we adopt firm-level answers in the survey to the following question: "How much does the firm spend on pollution abatement this year?" Pollution abatement expenditures per capita are calculated using the answer divided by the number of employees.[7]

3.2.2 Identification Strategy and Explanatory Variable of Interest

Based on different policy implementation dates, we apply the DD estimation on our repeated cross-sectional dataset to obtain the causal effect of the expansion. Different from a standard DD method, the current study employs continuous treatment intensity. It is reflected using the total output of affected sectors of the city where the firm is located.[8] Before the expansion, all firms in the affected sectors (transport services sector, scientific research and polytechnic services sector, software and information technology services sector, cultural services sector, leasing services sector, postal services sector, and telecommunications sector) paid BT, and 100% of the BT revenue went to the local government. After the expansion, they paid VAT instead, and only 25% of the VAT revenue went to the local government. Therefore, a higher total output for those sectors means larger tax revenue, which means higher revenue loss after the expansion. This fall in fiscal revenue for the local government is widely documented in the literature, and it often happens with reform of the tax sharing system, such as the abolition of the agricultural tax (Chen 2017), the VAT pilot program (Bai et al. 2019), and the 2002 Chinese Income Tax Reform (Liu 2018; Xiao 2020).

Variable $Pilot_{it}$ is a binary indicator showing whether firm i is included in the expansion or not in year t. Recall that our dataset records firms' characteristics in 2005, 2007, 2009, 2011, 2013, and 2015. For all firms in the nine regions (Shanghai, Beijing, Jiangsu, Anhui, Fujian, Guangdong, Tianjin, Zhejiang, and Hubei, hereinafter referred to as "the nine regions") with implementation dates before the end of 2012, the identification variable $Pilot_{it}$ is equal to one for $t > 2012$ and zero otherwise. For all firms in other regions with implementation dates in 2013 (hereinafter referred to as "other regions"), the identification variable $Pilot_{it}$ is equal to one for $t > 2013$ and zero otherwise.[9] This effect is captured by

[7] For the pollution abatement expenditures variable, there are some zero-value observations. This situation could potentially lead to sample selection bias. In response, we conduct several tests in Sect. 5.1.4 below, and the results are robust.

[8] Based on the outline of the gradual expansion, these affected sectors include the transport services sector, scientific research and polytechnic services sector, software and information technology services sector, cultural services sector, leasing services sector, postal services sector, and telecommunications sector.

[9] Except Shanghai, implementation dates of all pilot regions are in the second half of the year. If the policy implementation date is too late in one region, the remaining days of that year are not enough for the program to take effect in that year.

the differences in temporal changes at the firm level in pollution abatement between survey firms in the nine regions and other regions before and after the expansion.

The benchmark estimation function is formulated as follows:

$$Investment_{it} = \beta_0 + \beta_1 Reform_{ct} + \beta_2 Output_{ct} + \gamma X_{it} + \eta_c + \delta_{jt} + \xi_{pt} + \varepsilon_{it} \tag{1}$$

$$Reform_{ct} = Output_{ct} * Pilot_{pt} \tag{2}$$

where j is sector, c is city, p is province, t is year, and i is firm. $Output_{ct}$ is a continuous variable measuring the natural logarithm of the total output of affected sectors of city c where firm i is located in year t.[10] It is noteworthy that the effect of "$Pilot_{it}$" is absorbed by province-year fixed effects in Eq. (1) and thus not included in the regression (including it does not affect regression results). β_1, the parameter of interest, captures the response of the pollution abatement expenditures to the intensity of the revenue loss. X_{it} is a series of other control variables that influence pollution abatement expenditures, and details are given below. They are included to avoid missing variables potentially that are related to $Reform_{ct}$ and influence our dependent variable. η_c and ξ_{pt} represent city fixed effects and interacted fixed effects between provinces and years, respectively. The former absorbs city-specific characteristics, and the latter controls for different time trends within each province. δ_{jt} is the interacted fixed effects between sector and year. It is used to control for time trends in different sectors. ε_{it} is the usual error term.

3.2.3 Other Control Variables

We include a series of determinants of pollution abatement expenditure that is routinely examined in the literature (e.g., Wang 2002; Lee and Alm 2004): (1) firm age, which is equal to the survey year minus the registered year plus one; (2) firm size, which is represented using the natural logarithm of the number of employees; (3) net profit, which is transformed as the natural logarithm in the estimation; (4) R&D indicator, which is an indicator that shows whether this firm has any investment in R&D; (5) supervision indicator, which is an indicator that shows whether this firm sets up a supervisory board to monitor its operations. Moreover, we include three more variables of the firm owner's characteristics: (6) political indicator, which is an indicator that shows whether the firm owner is a member of the National People's Congress (NPC) or Chinese People's Political Consultative Conference (CPPCC); (7) industry indicator, which is an indicator that shows whether the firm owner is a member of the All-China Federation of Industry and Commerce; (8) party indicator, which is an indicator that shows whether the firm owner is a member of the Communist Party of China.

[10] Data on sector output in our study come from the China Economic Census Yearbook 2008, which is the nearest survey to the starting year of our sample. Specifically, for each year before 2014, the total output of affected sectors is constant. In 2014, several additional sectors are included into this pilot program (transport services sector, postal services sector, and telecommunications sector). As such, since 2015, the total output of affected sectors includes these additional sectors and thus increases. As a result, the variable "Output" varies in both city and time, and thus it cannot be absorbed by the city-level fixed effect.

Table 1 Descriptive statistics

	Overall mean	Before the reform		After the reform	
		Nine regions	Other regions	Nine regions	Other regions
Expenditure	0.072	0.056	0.065	0.100	0.074
Firm age	9.244	9.133	8.685	11.676	9.202
Firm size	3.757	4.123	3.804	3.942	3.028
Net profit	3.892	4.093	3.752	4.269	3.415
R&D indicator	0.290	0.425	0.292	0.277	0.161
Supervision indicator	0.266	0.304	0.275	0.246	0.199
Political indicator	0.386	0.444	0.454	0.332	0.248
Industry indicator	0.599	0.689	0.613	0.623	0.431
Party indicator	0.367	0.445	0.399	0.312	0.260

Monetary values are in ten thousand RMB

3.2.4 Descriptive Statistics

Table 1 shows the descriptive statistics of our sample. We first list the overall means of vital variables in our sample. Then, we list conditional means of firms in the nine regions and other regions before and after the reform. The overall average level of pollution abatement expenditures per capita in our sample is 720 RMB. The average expenditure of firms in the nine regions is lower than that of firms in other regions. However, this situation is reversed after the expansion, which is likely because firms in other regions are more sensitive to the fiscal squeeze after expansion. More details are provided in Sect. 5 below.

With regard to firm characteristics, the average age of firms in our sample is 9.244 years, and the average number of employees is 42.820. On average, the net profit is 490,088 RMB for each firm in each year. In our sample, 29% of firms invest in R&D, and 27% of firms in our sample set up a supervision board.

With regard to firm owners' characteristics, 60% of firm owners are members of the All-China Federation of Industry and Commerce, 39% of firm owners in our dataset are members of the NPC or CPPCC, and 37% of firm owners are members of the Communist Party of China.[11]

[11] The Pearson's correlation coefficient between the political indicator and the party indicator is 0.2208, indicating that they are not highly correlated. Based on our statistical summary, 38.6% of firm owners are members of the NPC or CPPCC, 36.7% of them are members of the Communist Party of China, and 19.4% of them are both. The former status can help build political connections with local government. This status can potentially bring indirect benefits for the firm and influence pollution abatement expenditures (Min et al. 2016). The latter status may increase the firm's corporate social responsibility (CSR) and increase expenditures (Zhou et al. 2020).

4 Empirical Results

4.1 Main Results

Table 2 presents the results of our benchmark estimation. It presents evidence as to how this expansion affects pollution abatement expenditures per capita. Robust standard errors are applied and clustered at the provincial level.

Column (1) of Table 2 only controls province-year fixed effects. They control for the unobserved difference in time trends within each province. The results show that the fiscal squeeze has a significantly negative effect on pollution abatement expenditures per capita. In columns (2) and (3), we further control for city fixed effects and sector-year fixed effects. They, respectively, control for the unobserved differences in environmental regulation intensities across cities and in time trends within each sector. The coefficient of our identification variable remains significant, although it moderately increases.

In column (4), we further control for a series of firm characteristics. We include firm age, firm size, net profit, R&D indicator, and supervision indicator. The results are similar to before. This fiscal squeeze still significantly lowers pollution abatement expenditures per capita. For other control variables, firm age has no effect on pollution abatement expenditures, whereas firm size has a significantly negative effect due to economies of scale. In contrast, net profit positively affects expenditures on pollution abatement, and firms that invest in R&D, on average, invest more in pollution abatement per capita. Many studies in the literature document that pollution abatement can contribute to upgrades in technology and increases in productivity (e.g., Conrad and Morrison 1989).

In that last column, we include firm owners' characteristics. The signs and significance levels of the factors explained above do not vary, and we further show that firms with owners who are members of the All-China Federation of Industry and Commerce invest more in pollution abatement. The Federation has various requirements, including environmental regulations. The other two indicators are concerned with political attributes and thus have no correlation with the environment. Our estimation results indicate that average pollution abatement expenditures decrease more in cities with higher affected sector output and larger fiscal squeeze. The coefficient for "Reform" indicates that for a 1% increase in the output of affected sectors in the city, firms' pollution abatement expenditures decrease by 1.7%. On average, pollution abatement expenditures decrease by 29.31% after the expansion.[12]

4.2 Heterogeneity

In this subsection, we explore the heterogeneity of our empirical finding. (1) We first investigate the heterogeneity of this effect across firms' and firm owners' characteristics. In Panel A of Table 3, private firms in our sample are categorized into three groups based

[12] 0.2931 = 0.017/0.058, where the nominator is the coefficient of our estimate, and the denominator is the average pollution abatement expenditure before the expansion in our sample.

Table 2 Reform impacts on pollution abatement expenditure: benchmark results

	(1)	(2)	(3)	(4)	(5)
Reform	− 0.018***	− 0.018***	− 0.016***	− 0.015***	− 0.017***
	(0.004)	(0.003)	(0.003)	(0.005)	(0.005)
Output	− 0.004	0.010	− 0.002	− 0.002	− 0.013
	(0.003)	(0.037)	(0.039)	(0.025)	(0.027)
Firm age				− 0.000	− 0.000
				(0.000)	(0.001)
Firm size				− 0.003*	− 0.004**
				(0.002)	(0.002)
Net profit				0.014***	0.014***
				(0.002)	(0.002)
R&D indicator				0.015***	0.014***
				(0.005)	(0.005)
Supervision indicator				0.024***	0.024***
				(0.007)	(0.007)
Political indicator					0.001
					(0.008)
Industry indicator					0.015**
					(0.006)
Party indicator					0.006
					(0.004)
Constant	0.067***	0.021	0.061	− 0.031	0.023
	(0.012)	(0.119)	(0.126)	(0.082)	(0.088)
City FE	No	Yes	Yes	Yes	Yes
Province-year FE	No	Yes	Yes	Yes	Yes
Sector-year FE	No	No	Yes	Yes	Yes
adj. R^2	0.030	0.053	0.084	0.100	0.102
N	18,637	18,637	18,637	15,635	15,268

Standard errors are reported in parentheses; *Significant at the 10%, **Significant at the 5%, ***Significant at the 1%

on their location.[13] The regression results for each group are presented separately. Compared to the eastern regions, the negative effect is much larger in magnitude for private firms in middle and western regions, possibly because with more developed economies, local governments in the eastern regions are better regulated with respect to environmental protection. For example, later in this subsection, we introduce an environmental policy announced in September 2013 stating that the PM10 concentration level needs to decrease by 15–25% in certain provinces of eastern regions.

Next, private firms are categorized into seven different groups based on their belonging sectors. The results are presented in Panel B. The effect is similar to that in the benchmark regression for private firms in the agriculture, mineral extraction, and manufacturing

[13] Eastern regions include Liaoning, Beijing, Tianjin, Hebei, Shandong, Jiangsu, Shanghai, Zhejiang, Fujian, Guangdong, and Hainan. Middle regions include Heilongjiang, Jilin, Shanxi, Henan, Anhui, Hunan, Hubei, and Jiangxi. Western regions include Inner Mongolia, Guangxi, Yunnan, Guizhou, Tibet, Xinjiang, Shaanxi, Ningxia, Qinghai, Sichuan, Chongqing, and Gansu.

Table 3 Heterogeneity: firms' and firm owners' characteristics

Panel A: Region	(1) Eastern region	(2) Middle region	(3) Western region
Reform	− 0.013**	− 0.024***	− 0.028**
	(0.005)	(0.003)	(0.012)
Output	− 0.020	0.038	− 0.043
	(0.051)	(0.048)	(0.042)
Controls	Yes	Yes	Yes
City FE	Yes	Yes	Yes
Province-year FE	Yes	Yes	Yes
Sector-year FE	Yes	Yes	Yes
adj. R^2	0.104	0.126	0.066
N	8798	3603	2867

Panel B: Sector	(1) Agriculture	(2) Mineral extraction	(3) Manufacturing	(4) Utilities	(5) Construction	(6) Transport services	(7) Other services[a]
Reform	− 0.098**	− 1.098***	− 0.014*	0.089	0.004	− 0.033	− 0.013
	(0.037)	(0.212)	(0.007)	(0.176)	(0.014)	(0.062)	(0.010)
Output	− 0.009	− 3.496**	− 0.021	0.418	− 0.106	− 0.436	− 0.022
	(0.154)	(1.305)	(0.088)	(2.411)	(0.096)	(0.500)	(0.033)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
adj. R^2	0.073	0.188	0.105	0.307	0.132	− 0.330	0.058
N	1259	311	6289	197	927	359	5926

Panel C: Firm Owners' Characteristics	(1) Industry and political indicator = 0	(2) Industry and political indicator = 1	(3) Age ≥ 46	(4) Age < 46	(5) Junior college and above	(6) Below Junior college
Reform	− 0.020**	− 0.018*	− 0.019***	− 0.010	− 0.013*	− 0.022***
	(0.008)	(0.010)	(0.006)	(0.008)	(0.007)	(0.005)
Output	− 0.121*	0.011	− 0.020	− 0.021	0.004	− 0.041
	(0.060)	(0.087)	(0.039)	(0.039)	(0.040)	(0.044)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes	Yes	Yes
Province-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector-year FE	Yes	Yes	Yes	Yes	Yes	Yes
adj. R^2	0.100	0.083	0.100	0.113	0.098	0.129
N	5312	5411	7842	7426	9087	6181

Standard errors are reported in parentheses; *Significant at the 10%, **Significant at the 5%, ***Significant at the 1%

[a]Other services include information services, wholesale and retail trades, accommodation and catering, finance, real estate, leasing and commercial services, scientific research and polytechnic services, public

Table 3 (continued)

facilities, resident services, education, health care, and culture and sports

sectors. Among the three, the effect is much larger in magnitude for firms in the mineral extraction sector than the other two. The other four sectors left are not significantly affected by this expansion. This finding indicates that, compared to clean industries, this negative effect is larger in magnitude for private firms in polluting industries.

Finally, firms are categorized based on the characteristics of the firm owner. In columns (1) to (6) of Panel C, we explore the heterogeneity of this effect across different firm owner attributes, including the industry indicator and the political indicator as defined above, and the firm owner's age and educational attainment. For the latter two variables, we use the median (forty-six years old and junior college, respectively) as the cutoffs. The expansion has a consistently significant effect across all different groups. In columns (1) and (2), we document that compared to firms with owners whose indicator does not equal 0, firms with owners whose political and industry indicators are both equal to 1 experience a smaller impact on pollution abatement expenditures. This finding shows that having industrial and political connections reduces the impact caused by the program. Firms with owners who are younger and have higher educational attainment also experience a smaller impact than their respective counterparts.

Second, we explore heterogeneity from the perspective of fiscal squeeze. Following Stoerk (2019), we rank all cities in our sample based on the variable "Output". It measures the natural logarithm of the total output of affected sectors in the city. In this way, we can rank cities based on the revenue loss caused by this program. The estimation results for all four quartiles are presented below. We find that this fiscal squeeze crowds out pollution abatement expenditures in regions with high fiscal stress: for cities in the fourth quartile (in which revenue loss is highest), fiscal squeeze significantly decreases pollution abatement expenditures (the coefficient of estimate for the third quartile is negative and significant at 10.9%) (Table 4).

Finally, we explore heterogeneity from the perspective of pollution abatement costs and environmental regulation. Two relevant policies are discussed. In the 11th Five Year Plan (announced in 2015), the Ministry of Ecology and Environment of the People's Republic of China lays down the plan to reduce total emissions by 10%. To accomplish this goal, the State Council decided to double the pollution discharge fees for SO2 and allowed each province to pick the start date, which was no later than 2015. We divide our sample into two subsamples, i.e., observations (firms) when fees (abatement costs) have been increased in their regions and observations (firms) when fees have not yet been increased in their regions. The results are reported in columns (1) and (2) of Table 5. It is found that this negative effect of fiscal squeeze on pollution abatement expenditure is smaller in magnitude (i.e., 0.015) in regions with increased pollution abatement costs than the impact in other regions (i.e., 0.024). These results suggest that lower pollution abatement costs can strengthen the negative influence of fiscal squeeze on pollution abatement expenditure.

The State Council of China made an announcement in September 2013 stating that by 2017, the PM10 concentration needs to decrease by 15–25% in Beijing, Tianjin, Hebei, Jiangsu, Shanghai, Zhejiang, and Guangdong. Based on this announcement, we divide our

Table 4 Heterogeneity: fiscal squeeze

	First Quartile (1)	Second Quartile (2)	Third Quartile (3)	Fourth Quartile (4)
Reform	0.006	0.083	− 0.234	− 0.041*
	(0.074)	(0.061)	(0.140)	(0.024)
Output	− 0.011	0.202	0.039	0.074
	(0.082)	(0.166)	(0.154)	(0.192)
Controls	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes
Province-Year FE	Yes	Yes	Yes	Yes
Sector-Year FE	Yes	Yes	Yes	Yes
adj. R^2	0.087	0.138	0.123	0.081
N	3762	3823	3906	3777

Standard errors are reported in parentheses; *Significant at the 10%, **Significant at the 5%, ***Significant at the 1%

sample into two groups based on whether the firm is located in these areas. Environmental regulation in these pilot regions is, in general, more stringent than regulation in other areas. The results in both groups are presented in columns (3) and (4) of Table 5 below. The impact of a fiscal squeeze on pollution abatement expenditures is smaller (insignificant) in these regions than in the other regions (i.e., 0.028). These results suggest that, again, environmental regulation is a vital mechanism through which fiscal squeeze affects pollution abatement expenditures. Moreover, more stringent environmental regulation can weaken the negative impact of the fiscal squeeze on pollution abatement expenditures, whereas loose environmental regulation amplifies it.

Table 5 Heterogeneity: pollution abatement costs and environmental regulation

	Regions where the fees have been increased (1)	Regions where the fees have not been increased yet (2)	PM10 pilot regions (3)	PM10 non-pilot regions (4)
Reform	− 0.015**	− 0.024***	− 0.014	− 0.028***
	(0.006)	(0.004)	(0.009)	(0.006)
Output	− 0.029	− 0.005	− 0.012	− 0.032
	(0.049)	(0.028)	(0.054)	(0.032)
Controls	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes
Province-Year FE	Yes	Yes	Yes	Yes
Sector-Year FE	Yes	Yes	Yes	Yes
adj. R^2	0.101	0.106	0.073	0.112
N	9218	6050	4731	10,537

Standard errors are reported in parentheses; *Significant at the 10%, **Significant at the 5%, ***Significant at the 1%

5 Robustness Checks and Mechanisms

5.1 Robustness Checks

5.1.1 Common Trend Assumption

The parallel trend assumption is the most important assumption of DD analysis. It requires that in the absence of treatment, the difference between firms in the nine regions and firms in other regions is constant over time. We provide evidence using four different approaches.

(1) Figure 2 below provides preliminary graphical evidence. It depicts the average pollution abatement expenditures of firms in the nine regions and other regions over time. The solid line represents firms in the nine regions. Its increment is significantly lower from 2011 to 2013. This shift is probably because the program intensifies fiscal stress for local governments in the nine regions starting in 2012. Local government, in response, increases tax enforcement and loosens environmental regulation. Both actions contribute to the (relative) decrease in pollution abatement expenditures, which is the main finding of our DD specification. This causes a slower increase in pollution abatement expenditures from 2011 to 2013 for firms in the nine regions.

The expenditures of firms in the nine regions increased in 2015. This is because this impact documented in our paper is a short-run effect, and we focus on evaluating it before 2015. Since 2015, the results have been mixed due to other environmental policies. For example, the State Council made an announcement in September 2013 stating that by 2017, the PM10 concentration level needs to decrease by 15–25% in Beijing, Tianjin, Hebei, Jiangsu, Shanghai, Zhejiang, and Guangdong.[14] These regions also belong to the nine regions. In general, the central government sets different targets on developed and undeveloped regions, and regulations are more stringent for the former. These policies could contribute to the increasing efforts around environmental protection, including pollution abatement expenditures.

Finally, the expenditures of firms in other regions starts to fall in 2015. This change is because the program has expanded to firms in other regions starting in 2015. Similarly, in response to the fiscal squeeze, local governments may increase tax enforcement and loosen environmental regulation. Both lead to a decrease in firms' pollution abatement expenditures. As shown in Part A of Table 3, the impact is more substantial in the middle and western regions. Local governments in less developed areas (non-eastern areas, where most firms in other regions are located) are more sensitive to a decrease in fiscal revenue. The trade-off between economic development and environmental protection implies that, compared with developed regions (where most firms in the nine regions are located), undeveloped regions can tolerate more pollution, and firms in those regions can further decrease their pollution abatement expenditures (Wang et al. 2015).

(2) We use an event study design that regresses firms' pollution abatement expenditures on a series of year-wise dummies from 6 years before the implementation of the VAT expansion program to 4 years after it (Liu and Mao 2019). In Fig. 3, the solid line

[14] http://www.gov.cn/zwgk/2013-09/12/content_2486773.htm (in Chinese), accessed on August 9th, 2020.

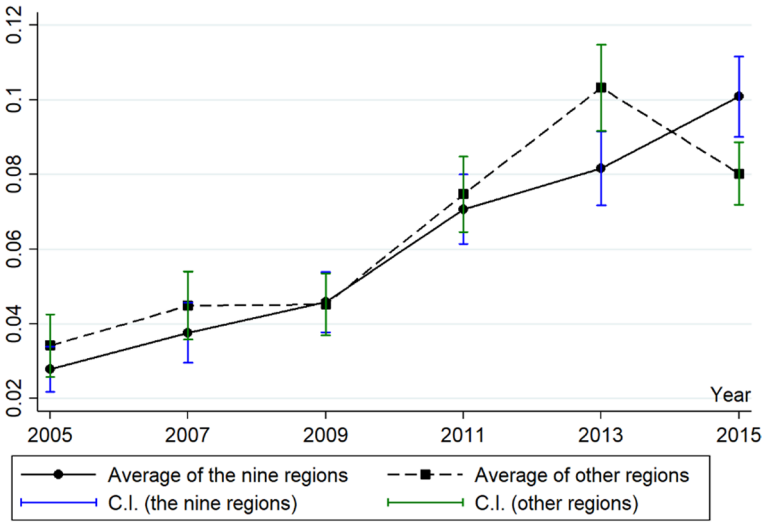

Fig. 2 The average pollution abatement expenditures of the two groups (unit: thousand RMB)

represents the value of the coefficient, and the two dotted lines together constitute the estimates' confidence intervals.

The table below shows that the effect is weakened 4 years later compared to 2 years later. This finding is consistent with Fig. 2, which shows that the difference between firms in the nine regions and firms in other regions decreased in 2015. In 2015, the central government of China made a series of announcements that all aimed to strengthen environmental regulation and supervision, such as the founding of the Environmental

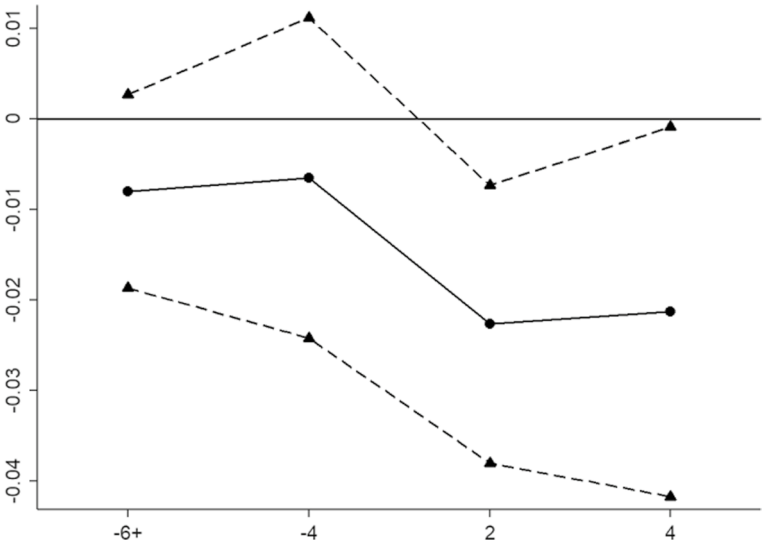

Fig. 3 Event study estimates

Table 6 Dynamic effects and common trend

	(1)	(2)
6 years before		− 0.008
		(0.005)
4 years before		− 0.007
		(0.009)
2 years after	− 0.018***	− 0.023***
	(0.005)	(0.007)
4 years after	− 0.017*	− 0.021**
	(0.009)	(0.010)
Output	− 0.012	− 0.006
	(0.031)	(0.033)
Controls	Yes	Yes
City FE	Yes	Yes
Province-year FE	Yes	Yes
Sector-year FE	Yes	Yes
adj. R^2	0.102	0.102
N	15,268	15,268

Standard errors are reported in parentheses; *Significant at the 10%, **Significant at the 5%, ***Significant at the 1%. The year presented in the table indicates the distance to the actual year of reform for each group. For example, "2 years after (the reform)" indicates 2013 for firms in the nine regions, and 2015 for firms in other regions. 2 years before is omitted to avoid collinearity

Table 7 Common Trend

	City–year trend	Province – sector – year trend
	(1)	(2)
Reform	− 0.023**	− 0.018***
	(0.009)	(0.005)
Output	0.018	− 0.010
	(0.037)	(0.029)
Controls	Yes	Yes
City*Year trend	Yes	–
Province*Sector*Year Trend	–	Yes
City FE	Yes	Yes
Province-Year FE	Yes	Yes
Sector-Year FE	Yes	Yes
adj. R^2	0.105	0.107
N	15,268	15,268

Standard errors are reported in parentheses; *Significant at the 10%, **Significant at the 5%, ***Significant at the 1%

Table 8 Preexisting and polynomial time trends

	(1)	(2)	(3)
Reform	− 0.020***	− 0.016***	− 0.016***
	(0.006)	(0.005)	(0.005)
Output	− 0.023	− 0.020	− 0.021
	(0.037)	(0.028)	(0.028)
Controls	Yes	Yes	Yes
City FE	Yes	Yes	Yes
Province-Year FE	Yes	Yes	Yes
Sector-Year FE	Yes	Yes	Yes
Treatment trend	Yes	Yes	Yes
Pre-trend city characteristics × Year dummy	Yes		
Controls × T		Yes	
Controls × T^2		Yes	
Controls × T^3		Yes	
Controls × Year dummy			Yes
adj. R^2	0.102	0.102	0.103
N	15,268	15,268	15,268

Standard errors are reported in parentheses; *Significant at the 10%, **Significant at the 5%, ***Significant at the 1%

Supervision System and the Environmental Protection Law of the People's Republic of China. It is possible that they partially counter the decline in pollution abatement expenditures. The results illustrated in the figure and table below show that there is no decrease in pollution abatement expenditures before the year in which the expansion took place, whereas the expenditures significantly decrease immediately after the expansion started (Table 6).

(3) Following Angrist and Pischke (2014), we control for the city-year trend and present the results in column (1) of Table 7. In this setting, the effect of this expansion on pollution abatement expenditures remains significantly negative. This finding implies that even if we relax the assumption of the common trend and control the heterogeneity of trends across different cities, the impact is still significant. Second, in column (2), we control for the province-sector-year trend. This finding implies that our results still hold even if we relax the assumption of the common trend and control the heterogeneity of the trend across provinces and sectors.

(4) Following Moser and Voena (2012), Li et al. (2016), we further control preexisting time trends. One potential problem with the DD estimate is that it may confound the effects of the pilot program with preexisting differences in time trends across treated and untreated firms. In other words, firms that are affected by this program may have experienced a decrease in pollution abatement expenditures after the expansion due to differences in time trends that preceded the pilot program. Although Fig. 2 does not yield any evidence for such a difference, we included additional tests here that incorporate a linear time trend for all treated firms for the preprogram period. We also include interactions of pre-trend city characteristics with a year dummy. These

Table 9 Exogenous shock: Firm-level

	(1)
Reform	− 0.017***
	(0.005)
Output	− 0.013
	(0.027)
Output*Area*D2011	0.001
	(0.007)
Controls	Yes
City FE	Yes
Province-Year FE	Yes
Sector-Year FE	Yes
adj. R^2	0.102
N	15,268

Standard errors are reported in parentheses; *Significant at the 10%, **Significant at the 5%, ***Significant at the 1%

characteristics include GDP, the growth rate of GDP, business tax revenue, and total budgetary revenue. These indicators reflect the economic status of the city, and they are also highly related to treated firms. Data come from the China Statistical Yearbook for Regional Economy. The results are presented in column (1) of Table 8 below.

Moreover, interactions between the controls and a third-order polynomial function of time are included in column (2). Interactions between the controls and year dummies are included in the estimation presented in column (3). These two specifications are implemented to ensure that the fluctuations of controls do not impact our estimation findings. The results are as expected.

5.1.2 The Exogeneous Shock Assumption

The exogeneous shock assumption is also important for the credibility of our empirical findings. It asks us to explore how likely firms may relocate following the VAT program roll-out. The DD analysis requires that firms cannot anticipate this program, and thus, cannot prepare anything for it. Otherwise, firms can move to their preferred locations before the program, and the estimation is biased. Ideally, we could count how many firms relocate. However, our dataset does not contain this information. In response, we explore this concern from two perspectives.

First, we add an interaction term "Output*Area*D2011" to indicate whether the firm relocates in advance to a region with smaller fiscal stress where the expansion is introduced in 2012, where Area is a binary variable indicating if the region is included in the expansion in 2012 (equal to 1 if located in the nine regions; equal to 0 in other regions). D2011 is a binary variable and equals 1 if year equals 2011. Results are presented in Table 9 below. The coefficient of this newly added interaction term is insignificant. In 2011 (one year before the program was initiated), the pollution abatement expenditures of firms in the nine regions were not significantly different from those of firms in other regions. Thus, before the program starts, the firm's choice of location should

Table 10 Exogenous shock: City-level

	(1)	(2)
Fiscal stress 1	− 1.128	
	(2.147)	
Fiscal stress 2		− 0.021
		(0.029)
Government expenditure	− 0.075	− 0.563
	(2.107)	(0.799)
Scientific research expenditure	12.247***	13.169**
	(4.279)	(4.794)
International trade	0.337***	0.329***
	(0.081)	(0.086)
Fixed investment	− 0.070	− 0.081
	(0.186)	(0.199)
Secondary sector	− 0.011*	− 0.012**
	(0.006)	(0.006)
Tertiary sector	− 0.006	− 0.007
	(0.006)	(0.006)
Year FE	Yes	Yes
R^2	0.244	0.254
N	2266	2011

Standard errors are reported in parentheses; *Significant at the 10%, **Significant at the 5%, ***Significant at the 1%

not be affected by the expected weakening effect of fiscal stress on pollution abatement expenditures.

Second, it also requires that the choice of regions is random. In other words, it cannot correlate with regions' fiscal stress before the expansion. To answer this question, we create a binary variable indicating whether the city was included in the expansion in 2012. We separately regress this binary indicator on two measures of fiscal stress with a series of city characteristics and year fixed effects as controls. These city characteristics include government expenditures (the ratio of municipal general public budget expenditures to GDP), scientific expenditures (the ratio of the sum of R&D funds and those for training, teaching, maintenance and diffusion of knowledge to GDP), international trade (the ratio of the sum of imports and exports to GDP), fixed investment (the ratio of fixed investment to GDP), secondary sector (the ratio of the value added for the secondary sector to GDP), and tertiary sector (the ratio of the value added for the tertiary sector to GDP). Fiscal stress 1 is defined as (municipal general public budget expenditure—municipal general public budget revenue)/municipal GDP, and fiscal stress 2 is defined as (provincial general public budget expenditure—provincial general public budget revenue in the last year)/provincial general public budget revenue in the last year. Estimation results are presented in Table 10 below. In both columns, the coefficients of fiscal stress remain insignificant, indicating that the level of fiscal stress cannot affect the probability of being selected into the pilot program in 2012.

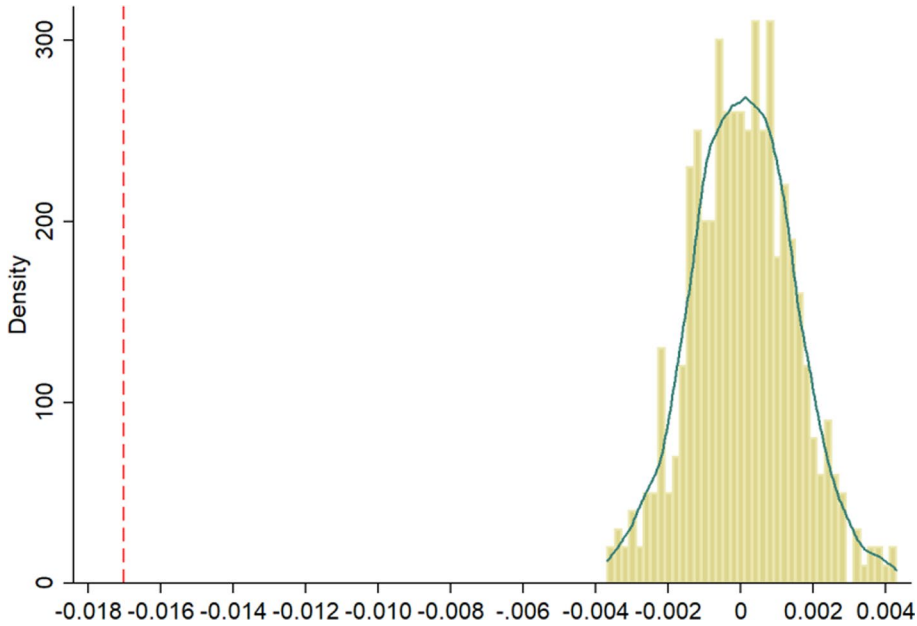

Fig. 4 Placebo tests

Table 11 Testing sample selection bias

	(1) Dummy_ expenditure	(2) Expenditure	(3) PSM_DD
Reform	− 0.012	− 0.017***	− 0.014***
	(0.016)	(0.005)	(0.004)
Output	− 0.016	− 0.013	− 0.044
	0.050	(0.027)	(0.038)
Expenditure_dum_est		0.031***	
		(0.008)	
Controls	Yes	Yes	Yes
City FE	Yes	Yes	Yes
Province-Year FE	Yes	Yes	Yes
Sector-Year FE	Yes	Yes	Yes
Pseudo R^2	0.250		
adj. R^2		0.102	0.082
N	15,121	15,138	9076

Standard errors are reported in parentheses; *Significant at the 10%, **Significant at the 5%, ***Significant at the 1%. In column (4), we do not include city fixed effects and province-year fixed effects because the dependent variable is correlated with the firm's location

5.1.3 Placebo Tests

Our empirical specification includes the time trends in the region and the time trends in the sector. These variables can help with the issue of missing variables. However, there may be unobservable factors that vary with time, sector and region. For example, local governments of different regions may implement different policies about environmental protection and revise them regularly. This process could affect pollution abatement expenditures and lead to biased estimates. To address this issue, we follow Ferrara et al. (2012) and Liu and Lu (2015) and conduct a series of placebo regressions. We randomly generate a year of the VAT pilot reform and randomly select cities to be the treated regions. Based on these random draws, we then construct a false VAT pilot program and replace the original variable "Reform" with the new one. We repeat this exercise 500 times. If our original specification is correct, we should find that most of these 500 coefficients are not systematically different from zero. The results are presented below in Fig. 4, and they are as expected. The distribution of the estimated coefficients is centered around zero, which is far higher than the true estimate (− 0.017), which is represented as the vertical dotted line. They show that these unobserved factors do not affect our estimates.

5.1.4 Sample Selection

There are some zero-value observations for one key variable of interest in our paper: pollution abatement expenditures. This situation could potentially cause concerns about sample selection and lead to biased estimates. In response, we test sample selection bias using three different approaches.

(1) We create a binary variable of whether a firm's pollution abatement expenditure is positive and apply it as the alternative dependent variable. The Probit estimation results presented below in Table 11 shows that fiscal stress does not affect this decision.
(2) The second approach consists of two steps. First, we apply the Probit model and regress the decision to have any positive expenditure on a series of controls, including firm characteristics, city-level fixed effects, sector-year fixed effects, and province-year fixed effects. Next, the predicted value of the dependent variable estimated in the first step is included as one control variable in column (2), where we rerun the benchmark regression. The results in column (2) show that the coefficient of Reform is similar to before.
(3) Finally, we employ a standard propensity score matching (PSM)—DD method. The results are presented in Table 11 below. We first use the logit model and regress the indicator of whether a firm is in the nine regions on a series of covariates (characteristics of firms and firm owners and numerous fixed effects explained above). This process gives us a propensity score for each private firm in our sample. Then, based on those observations that satisfy the common matching conditions, we use the DD method to run our benchmark regression again. The results in column (3) show that the estimation results are similar to those in the benchmark regression. In addition, PSM can help alleviate the potential bias originating from unobserved omitted variables in our repeated cross-sectional sample. In sum, all three approaches indicate that our results should not be affected by the issue of sample selection bias.

Table 12 Testing possible interfering policies

	(1)	(2)	(3)
Reform	− 0.020**	− 0.024***	− 0.021***
	(0.010)	(0.004)	(0.006)
Output	− 0.003	− 0.005	− 0.012
	(0.032)	(0.028)	(0.030)
Controls	Yes	Yes	Yes
City FE	Yes	Yes	Yes
Province-Year FE	Yes	Yes	Yes
Sector-Year FE	Yes	Yes	Yes
Pseudo R^2	0.101	0.106	0.100
N	9377	6050	11,649

Standard errors are reported in parentheses; *Significant at the 10%, **Significant at the 5%, ***Significant at the 1%

5.1.5 Possible Interfering Policies

The identification in our study also requires the absence of a shock or policy or trend change that would affect firms' decisions about pollution abatement expenditures. As a result, we consider three possible shocks at the same time that could potentially interfere with our results. The first one is the pollutant control policy. The 11th Five-Year Plan (2006–2010) included emissions control targets for air pollution (SO2) and water pollution (chemical oxygen demand, or COD) and a target for energy efficiency (Stoerk 2019). In the current study, as we control for the differences in time trends among different regions, our results should not be affected by this shock.

The second is the adjustment for pollution discharge fees for SO2. Between 2007 and 2014, 15 regions successively adjusted the standards for pollution discharge fees for SO2. Similarly, in our estimation function (Eq. 1), we control for the differences in time trends among different regions. Our results should not be affected by this shock either.

The last one is the investment tax credit (ITC). In 2008, the State Council announced that 10% of firms' expenditures on eco-friendly equipment can be deducted from the taxable income. Since this policy is nationwide, it can be absorbed by our year fixed effects.

To ensure that the results of our paper are not affected by the overlap of those three policies above, we implement several additional regression specifications by only keeping observations within a period, and this subsample is only affected by one policy at one time. In columns (1)–(3) of Table 12 below, we separately keep the observations between 2011 and 2015 (to exclude any potential influence caused by the 11th Five-Year Plan) in the control regions (to exclude any potential influence caused by the adjustments of pollution discharge fees for SO2) and between 2009 and 2015 (to exclude any potential influence caused by the ITC preferential policy). All results are still robust.

5.1.6 Additional Controls and Alternative Measurements

In the current subsection, we first include a series of additional control variables to address the issue of the omitted variables. The results are illustrated in Table 13 below. The cross-sectional sample employed in the current study cannot control for firm fixed effects. In

Table 13 Robustness checks

	Firm-type FE	Province-Sector FE	Clustered at the city level	Municipal ratio	Provincial ratio	Municipal – provincial ratio	Productivity	Fiscal stress 1	Fiscal stress 2
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Reform	− 0.017***	− 0.018***	− 0.017***	− 7.780**	− 6.547**	− 0.130***	− 0.017***		
	(0.005)	(0.005)	(0.006)	(3.388)	(3.067)	(0.044)	(0.005)		
Output	− 0.015	− 0.011	− 0.013	− 3.022**	2.309***	− 0.106	− 0.013		
	(0.026)	(0.029)	(0.031)	(1.113)	(0.631)	(0.132)	(0.026)		
Productivity							0.012***		
							(0.001)		
Fiscal stress								− 0.428**	− 0.011***
								(0.208)	(0.002)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
adj. R^2	0.103	0.101	0.102	0.102	0.101	0.102	0.106	0.109	0.101
N	15,047	15,268	15,268	15,268	14,123	15,268	15,260	12,771	15,899

Standard errors are reported in parentheses; *Significant at the 10%, **Significant at the 5%, ***Significant at the 1%

column (1), we attempt to mitigate the potential bias by controlling the firm-type fixed effects in the sample (sole proprietorship; partnership firm; limited liability company; single-member limited liability company; joint stock limited company). In column (2), we control for the interacted fixed effects between provinces and sectors (province-sector fixed effects) to control for the differences in policies with regard to pollution across different regions. Politicians often face a trade-off between economic development and environmental protection. Developed regions cannot tolerate high pollution levels, whereas undeveloped regions can (Wang et al. 2015). In the benchmark regression shown in Table 2, standard errors are clustered at the provincial level. In column (3), we replace them with standard errors clustered at the city level. The results in columns (1)–(3) show that the coefficient of the variable of interest remains significantly negative.

Next, in columns (4)–(6), we design and implement several additional regressions using alternative measures of the municipal total output of affected sectors. In our benchmark regression, we use the natural logarithm of the affected sectors' total outputs in that city in 2008. In column (4), we instead apply the city-level ratio of the affected sectors' total output to total GDP. In column (5), we apply the provincial-level ratio of the affected sectors' total output to the total services sectors' output. In column (6), we apply the ratio of the city-level total output of the affected sectors to the provincial-level total output of the affected sectors.

There may exist some unobservable factors that could affect expenditure decisions, such as productivity. It varies between firms and thus cannot be controlled by fixed effects. Firms with different levels of productivity could make different decisions about pollution abatement expenditures, and the productivity level may also be related to the expansion. As a result, in column (7), we construct a simple measure of firm productivity (the natural logarithm of the ratio of revenue to the number of employees) and include it in our regression.[15] The results are consistent as before.

In columns (8) and (9), employing a standard pooled OLS, we separately replace "Reform" with the two measures of fiscal stress adopted in Table 10 and rerun the regression. This process can provide us with a general picture of the correlation between pollution abatement expenditures and fiscal stress. The estimated results in all these columns remain significantly negative, but the magnitude varies substantially.

5.1.7 Unobservable Factors

Since our dataset is not a panel, firm-level fixed effects cannot be included in the regression to control for unobservable factors. In response, we implement an IV approach to control for unobservable firm-level heterogeneity.[16] We choose three different instrumental variables: the city-level average business tax revenue between 2000 and 2004, the city-level average revenue of the wholesale and retail trades sector between 2000 and 2004, and the city-level average number of large enterprises between 2000 and 2004.[17] Below is the statistical summary of these three IVs. There are 187 cities in our sample. The data come from China City Statistical Yearbook (Table 14).

[15] The common measure of total factor productivity cannot be deducted in our sample due to missing fixed investments.

[16] We thank the anonymous referee for this suggestion.

[17] To be classified as a large enterprise, a firm needs to satisfy several criteria that are updated regularly: business revenue, the number of employees, and total capital.

Table 14 Statistical summary of three IVs

Variable	Obs	Mean	S. D	Min	Max
Average business tax revenue (in million RMB)	187	782.6	2261.2	34.6	27,431
Average revenue of the wholesale and retail trades sector (in million RMB)	187	14,335.6	18,696.6	538.8	174,730.7
Average number of large enterprises	187	2411.3	40.576	1.0	461.8

We use the average across five years (2000–2004) to avoid being influenced by occasional shocks. Consistent with other variables of interest, they are all transformed to the natural logarithm in the estimation. In our opinion, these three indicators are correlated with fiscal stress but not with pollution abatement expenditures during our sample period. Before the expansion, cities with more tax revenue from the services sector are more likely to experience a higher level of fiscal stress. The average revenue of the wholesale and retail trades sectors in a city can indirectly reflect the city's tax revenue from the services sector since it is positively related to the tax base. Finally, large enterprises can contribute sustainable tax revenue, and a city with more large enterprises should face lower fiscal stress. The results are shown below.

The table below shows the results for IVs. A standard 2SLS method is applied. The results of the first stage are presented in column (1). The F-value is larger than 10, and the coefficients of our three IVs are all statistically significant. This finding means that all of them are indeed correlated with fiscal stress. The positive coefficients of the average business tax revenue and the average revenue of the wholesale and retail trade sectors and the negative coefficient of the average number of large enterprises all confirm our speculations above. The test of overidentifying restrictions using robust errors shows that all IVs are exogenous. The coefficient of our IV estimate is statistically significant. In addition, our three IVs all draw data from 2000 to 2004, and they are constant between 2005 and 2015. As such, they cannot control for city-level fixed effects (Table 15).

5.2 Mechanism

Theoretically, switching from BT to VAT decreases the fiscal revenue of local governments. However, the actual tax revenue of local governments depends not only on the tax sharing system but also on the effective tax rate and the tax base. Local governments may respond in several ways to compensate for revenue loss.

In this subsection, we explore two potential mechanisms through which expansion affects pollution abatement expenditures. These two mechanisms are examined by replacing our dependent variables with potential mechanisms. The first one is tax enforcement. As explained in Sect. 2, local governments have several methods to affect tax enforcement (Chen 2017; Xiao 2020). The second method is environmental regulation (Qi and Zhang 2014; Bai et al. 2019; Hao et al. 2018). Local governments may loosen environmental regulations to encourage firms to invest in their business instead of pollution abatement expenditures. In this way, local governments try to increase the tax base so they can collect more revenue. In

Table 15 Results of 2SLS

	Reform (1)	Expenditure (2)
Reform		− 0.128**
		(0.058)
Average business tax revenue	0.061***	
	(0.017)	
Average revenue of the wholesale and retail trades sector	0.065***	
	(0.020)	
Average number of large enterprises	− 0.030***	
	(0.010)	
Output	0.312***	0.049**
	(0.011)	(0.023)
F-value	25.306[0.000]	
Test of Overidentifying Restrictions	0.217[0.897]	
Controls	Yes	Yes
Province-Year FE	Yes	Yes
Sector-Year FE	Yes	Yes
R^2	0.954	0.056
N	12,619	12,619

Standard errors are reported in parentheses; *Significant at the 10% **Significant at the 5% ***Significant at the 1%

appendix B, we provide additional graphical evidence showing that environmental regulation was loosened during our sample period.

In Table 16, we investigate the mechanisms by replacing the dependent variable. We control for city-level fixed effects and provincial-year fixed effects. Following our benchmark regression, standard errors here are clustered at the provincial level. We first examine the mechanism of tax enforcement. Column (1) shows that tax enforcement indeed increases after the expansion.[18]

Next, columns (2) and (3) present the results of environmental regulation. We confirm that environmental regulation is loosened after the expansion. Two measures of environmental regulation are constructed, and details are provided in the appendix. The first concerns the weighted average of three representative regulated emissions: wastewater, sulfur dioxide, and dust (Zhao and Sun 2016; Ren et al. 2018). The second concerns the rates of abatement of sulfur dioxide and dust particles (Maisseu and Voss 1995). They both concentrate on pollutants. To make our results robust, in columns (3) and (4) of Table 5 above, we explore heterogeneity from the perspective of environmental regulation. Applying a policy shock, we estimate the consequences of more stringent environmental regulation.

[18] To measure city-level tax enforcement, we follow the methodology in Mertens (2003), Xu et al. (2011). Tax enforcement equal to the actual tax ratio divided by the estimated tax ratio. The actual tax ratio is measured using the percentage of tax revenue to GDP. The estimated tax ratio is predicted using a multi-regression model where we regress the tax ratio on the first industry ratio (the first industry's proportion to GDP), the second industry ratio (the second industry's proportion to GDP), and municipal openness (the proportion of the sum of import and export to GDP). More details are available upon request.

Table 16 Mechanism

	(1) Tax enforcement	(2) Environmental regulation 1	(3) Environmental regulation 2	(4) Turnover tax revenue	(5) Corporate income tax revenue	(6) Informal tax revenue	(7) Total tax payments per capita	(8) Fees per capita
Reform	0.051**	− 0.054***	− 0.084**	0.058**	0.072*	− 0.003	5.244**	− 0.252
	(0.023)	(0.018)	(0.039)	(0.024)	(0.037)	(0.028)	(2.455)	(0.203)
Output	0.088	− 0.044	0.154	0.010	0.217**	− 0.098	− 30.059*	0.086
	(0.125)	(0.044)	(0.113)	(0.059)	(0.096)	(0.066)	(16.914)	(1.202)
Constant	0.766*	1.126***	2.222*	2.346***	0.114	2.420***	123.458**	4.179
	(0.432)	(0.251)	(1.228)	(0.167)	(0.282)	(0.206)	(54.152)	(3.777)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Within-R^2	0.263	0.310	0.197	0.944	0.893	0.885	− 0.008	0.038
N	2565	2794	2802	2762	2737	2663	15,268	15,268

Standard errors are reported in parentheses; *Significant at the 10%, **Significant at the 5%, ***Significant at the 1%. The control variables in columns (7) and (8) are the same as the benchmark scenario. In columns (1) to (6), we additionally include additional regional control variables adopted in Table 10

The results show that stringent environmental regulation can weaken the negative influence of a fiscal squeeze on pollution abatement expenditures, whereas loose environmental regulation can amplify this influence.

As discussed above, these two mechanisms both serve to compensate for revenue loss: increasing tax enforcement increases the effective tax rate, and loosening environmental regulation can expand the tax base. As expected, columns (4) and (5) show that the program actually increases local governments' tax revenue.[19] In column (6), we examine the impact on informal tax revenue, and the coefficient is insignificant which is because extrabudgetary revenue is limited and has been under the supervision of the central government since 2011.[20] For robustness, in columns (7) and (8), we separately estimate the impact on firms' total tax payments per capita and fees per capita. The result confirms that this expansion increases firms' tax payments but not informal tax payments. The data on these two outcome variables come from the Chinese Private Enterprise Survey.

6 Conclusion

This current study contributes to the literature that quantitatively estimates the impact of fiscal squeeze. Different from most studies that focus on the role of local government, we not only quantitively estimate local government's response to this fiscal squeeze but also make a novel contribution by further evaluating the impact on firms' pollution abatement expenditures. Treating a recent tax reform in China as a fiscal squeeze for local government, we apply a DD estimation with continuous treatment intensity. Using a representative biennial sample of China's private firms between 2005 and 2015, our empirical results show that this fiscal squeeze substantially decreases pollution abatement expenditures. We also find that this effect is smaller in magnitude if the firm owner is younger, more educated or has industrial and political connections than their respective counterparts. Moreover, private firms in the eastern regions are less responsive to this shock than those in the rest of China because local governments in the eastern regions are better regulated with respect to environmental protection. The fiscal squeeze crowds out more pollution abatement expenditures in regions with higher fiscal stress, looser environmental regulation, and lower pollution abatement costs. We further explore the mechanisms behind our results. On the one hand, when facing fiscal squeeze, local governments apply various tools to increase tax enforcement to compensate for revenue loss. On the other hand, local governments also loosen environmental regulations to encourage firms to invest in their business instead of

[19] In column (4), the dependent variable is turnover tax revenue (the natural logarithm of revenue from VAT and consumption tax). In column (5), the dependent variable is corporate income tax revenue (natural logarithm). Data from these two variables and all macroeconomic control variables come from China Statistical Yearbook for Regional Economy and China City Statistical Yearbook.

[20] Similar as these categories of extrabudgetary revenue, the impact on fines is also small and insignificant. The reason for all insignificant impacts is because, in recent decades, the central government of China has made several official announcements to restrict the usage of extrabudgetary revenue. These announcements all aim to move extrabudgetary revenue into the budget and restrict the scope of administrative and institutional fees pertaining to firms:
(http://gz.mof.gov.cn/zt/banshizhinan/zhengcefagui/201012/t20101222_383174.htm; http://www.gov.cn/zhengce/content/2014-06/26/content_8910.htm'; http://ln.mof.gov.cn/lanmudaohang/zhengcefagui/201609/t20160921_2423543.htm; all accessed on July 28, 2020).

in pollution abatement activities. In this way, local governments increase the tax base and collect more revenue. Both contribute to the significant decrease in firms' pollution abatement expenditures.

The results of the current study shed some light on China's fiscal system, such as the current tax-sharing scheme. Our analysis explores the reason that local governments look for more revenue and highlights the necessity of developing and reshaping the current main types of taxes, especially those whose revenue is collected by local governments. Moreover, our results reveal that the current environmental regulation should be further strengthened to mitigate the negative impact on pollution abatement expenditures. Finally, it is noteworthy that our estimates capture only the short-run effect of this fiscal squeeze on pollution abatement. As revealed in our empirical results, since 2015, this negative impact on pollution abatement expenditures has started to decrease due to more stringent environmental regulations, which are caused by several environmental policies (such as the founding of the Environmental Supervision System and the Environmental Protection Law of the People's Republic of China, doubling the pollution discharge fees for SO2, and decreasing the PM10 concentration levels).

Appendices

Appendix A

The current study adopts two distinct measures of environmental regulation (*ER*). They are separately evaluated in columns (2) and (3) in Table 16. The first measure concerns three representative indicators of regulation: wastewater, sulfur dioxide, and dust (Zhao and Sun 2016; Ren et al. 2018). We standardize the original data on all three indicators since the raw data are not comparable. Then, the value of each single indicator is mapped into the interval [0, 1]. In this way, we remove the restriction of different units. The min–max normalization method is applied. We evaluate the ratio of each city's level to the average level. If the ratio is larger than 1, then this city's weighted average emissions of these three representative indicators are higher than the average of all cities, and the regulation in that city is also looser than average. Finally, this measure is adopted as its inverse value. Therefore, if fiscal squeeze indeed loosens environmental regulation as expected, we should see a negative coefficient for this measure. It is calculated as follows:

$$ER_{1i} = \frac{1}{\frac{1}{3}\sum_{j=1}^{3} W_j UE_{ij}^{n}} \tag{3}$$

where $UE_{ij}^{n} = \frac{UE_{ij} - \min\left(UE_j\right)}{\max\left(UE_j\right) - \min\left(UE_j\right)}$, and $W_j = UE_{ij}/UE_j^{avg}$. UE_{ij}^{n} is the rescaled (min–max normalized) emission of pollutant j in city i during our sample period. $\min\left(UE_j\right)$ and $\max\left(UE_j\right)$, respectively, denote the minimum and maximum emissions of pollutant j of all cities in our sample. UE_j^{avg} denotes the average emissions of pollutant j in all cities. W_j represents the weight for each pollutant j.

The second measure of environmental regulation in our study focuses on the rates of abatement of sulfur dioxide and dust particles (Maisseu and Voss 1995). A higher rate of abatement indicates more stringent regulation in the city. We add the weight of each city, which is represented by the amount of emissions for each pollutant. This weighting is necessary because the amount of emissions varies greatly across cities, and the amount of emissions within each city also varies across different pollutants. If this measure of a city is higher, then we can conclude

that firms in this city have, on average, a higher rate of abatement for the two representative indicators compared to other cities and are subject to a more stringent level of environmental regulation. If the fiscal squeeze indeed loosens environmental regulation as expected, we should also see a negative coefficient of this measure. It is calculated as follows:

$$ER_{2i} = \frac{1}{2}\sum_{j=1}^{2} P_j R_{ij}^n \tag{4}$$

where $R_{ij}^n = \frac{R_{ij} - \min(R_j)}{\max(R_j) - \min(R_j)}$. R_{ij}^n is the rescaled (min–max normalized) rate of abatement of pollutant j (sulfur dioxide or dust particle) in city i during our sample period. $\min(R_j)$ and $\max(R_j)$, respectively, denote the minimum and maximum rates of abatement of pollutant j of all cities in our sample. P_j represents the weight for each pollutant j. Specifically, $P_j = \frac{D_{ij}}{\sum_i D_{ij}} / \frac{GDP_{ij}}{\sum_i GDP_{ij}}$, where D_{ij} denotes the amount of emissions of pollutant j for city i. This weighting is necessary because the amount of emissions varies greatly across cities, and the amount of emissions within each city also varies across different pollutants.

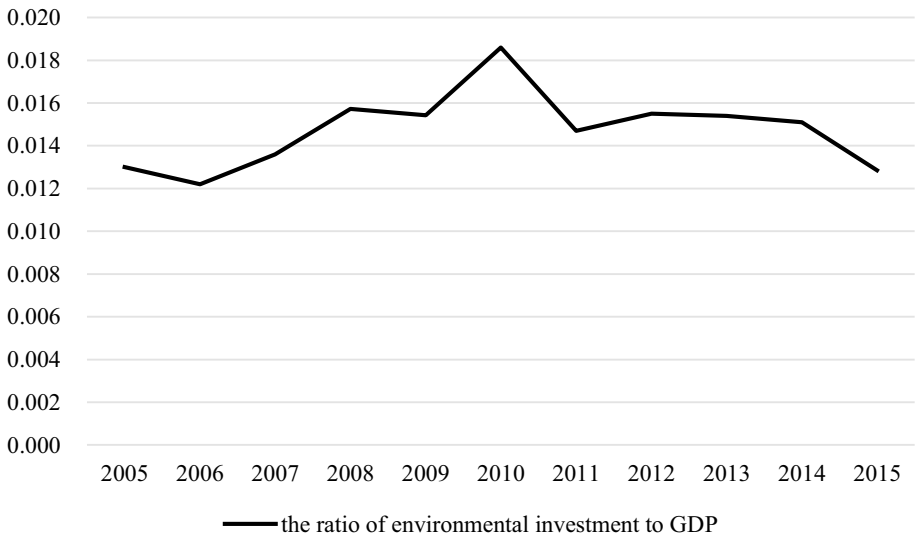

Fig. 5 The ratio of environmental expenditure to GDP

Appendix B

In this section, we provide graphical evidence showing that environmental regulation was loosened during our sample period. The following figure depicts that the ratio of environmental expenditures to total GDP has gradually decreased since 2012, indicating that environmental regulation has loosened in response to the fiscal squeeze (Qi and Zhang 2014; Bai et al. 2019; Hao et al. 2018) (Fig. 5).

Appendix C

In this section, we provide present descriptive statistics on several variables that are analyzed later in our paper (Table 17).

Table 17 Statistical summary

	Before Reform		After Reform	
	Nine regions	Other regions	Nine regions	Other regions
Tax enforcement	1.126	1.086	1.263	1.095
Turnover tax revenue	3.132	2.598	3.979	3.326
Corporate income tax revenue	1.446	0.854	2.283	1.748
Informal tax revenue	2.431	2.363	3.556	3.281
Environmental regulation 1	0.039	0.155	0.028	0.220
Environmental regulation 2	1.060	1.497	1.184	1.601
Total tax payments	3.363	6.010	13.264	6.707
Fees	1.076	0.455	1.402	0.451

Acknowledgements We acknowledge the financial support from the National Natural Science Foundation of China (Grant No. 71803035; No. 71974051) and the key project of the National Social Science Foundation of China (Grant No. 18ZDA064; No. 18ZDA097). We would like to thank the editor and three anonymous referees for their very helpful comments and suggestions. We also benefit from discussion with Huanxiu Guo and Lanlan Liu.

References

Angrist JD, Pischke J-S (2014) Mastering'metrics: the path from cause to effect. Princeton University Press, Princeton

Bai J, Lu J, Li S (2019) Fiscal pressure, tax competition and environmental pollution. Environ Resource Econ 73(2):431–447

Banerjee A, Duflo E, Qian N (2020) On the road: access to transportation infrastructure and economic growth in China. J Dev Econ 145:102442

Cai H, Yuyu C, Qing G (2016) Polluting the neighbor: unintended consequences of china's pollution reduction mandates. J Environ Econ Manag 76:86–104

Cao J, Qiu LD, Zhou M (2016) Who invests more in advanced abatement technology? Theory and evidence. Can J Econ Revue CanadienneD'ÉConomique 49(2):637–662

Chen SX (2017) The effect of a fiscal squeeze on tax enforcement: evidence from a natural experiment in China. J Public Econ 147:62–76

Cheng C-Y (2019) China's economic development: growth and structural change. Routledge, Abingdon
Chow GC, Li K-W (2002) China's economic growth: 1952–2010. Econ Dev Cult Change 51(1):247–256
Conrad K, Morrison CJ (1989) The impact of pollution abatement investment on productivity change: an empirical comparison of the US, Germany And Canada. Southern Econ J 55(3):684–698
Dang TV, Wang Y, Wang Z (2018) The Effects of Mandatory Pollution Abatement on Corporate Investment and Performance: Theory and Evidence from A US Regulation. Available at *SSRN* 3257675 (2018).
Di W (2007) Pollution abatement cost savings and FDI inflows to polluting sectors in China. Environ Dev Econ 12(6):775–798
Fang H, Bao Y, Zhang J (2017) Asymmetric reform bonus: the impact of VAT pilot expansion on China's corporate total tax burden. China Econ Rev 46:S17–S34
Fowlie M (2010) Emissions trading, electricity restructuring, and investment in pollution abatement. Am Econ Rev 100(3):837–869
Hao Y, Deng Y, Lu Z-N, Chen H (2018) Is Environmental regulation effective in China? Evidence from city-level panel data. J Cleaner Prod 188:966–976
He G, Wang S, Zhang B (2020) Watering down environmental regulation in China. Q J Econ 135(4):2135–2185
Hoseini M, Briand O (2020) Production efficiency and self-enforcement in value-added tax: evidence from state-level reform in India. J Dev Econ 144:102462
Huiban JP, Mastromarco C, Musolesi A, Simioni M (2015) The impact of pollution abatement investments on technology: Porter hypothesis revisited. *SEEDS Working Paper Series* 8 (2015)
Keller W, Levinson A (2002) Pollution abatement costs and foreign direct investment inflows to US States. Rev Econ Stat 84(4):691–703
La F, Alberto Chong E, Duryea S (2012) Soap operas and fertility: evidence from Brazil. Am Econ J Appl Econ 4(4):1–31
Lee AI, Alm J (2004) The clean air act amendments and pollution abatement expenditure equipment. Land Econ 80(3):433–447
Li H, Zhou L-A (2005) Political turnover and economic performance: the incentive role of personnel control in China. J Public Econ 89(9–10):1743–1762
Li P, Lu Y, Wang J (2016) Does flattening government improve economic performance? Evidence from China. J Dev Econ 123:18–37
Liu Q, Lu Y (2015) Firm investment and exporting: evidence from China's value-added tax reform. J Int Econ 97(2):392–403
Liu Y, Mao J (2019) How do tax incentives affect investment and productivity? Firm-level evidence from China. Am Econ J Econ Policy 11(3):261–291
Liu Y (2018) Government extraction and firm size: local officials' responses to fiscal distress in China. J Comp Econ 46(4):1310–1331
López-Hernández AM, Zafra-Gómez JL, Plata-Díaz AM, de la Higuera-Molina EJ (2018) Modeling fiscal stress and contracting out in local government: the influence of time, financial condition, and the great recession. Am Rev Public Adm 48(6):565–583
Maisseu A, Voss A (1995) Energy, entropy and sustainable development. Int J Global Energy Issues 8(1–3):201–220
Mertens JB (2003) Measuring tax effort in central and Eastern Europe. Public Finance Manag 3(4):530
Maung M, Wilson C, Tang X (2016) Political connections and industrial pollution: evidence based on state ownership and environmental levies in China. J Bus Ethics 138(4):649–659
Moser P, Voena A (2012) Compulsory licensing: evidence from the trading with the enemy act. Am Econ Rev 102(1):396–427
Qi Y, Zhang L (2014) Local environmental enforcement constrained by central-local relations in China. Environ Policy Gov 24(3):216–232
Ren S, Li X, Yuan B, Li D, Chen X (2018) The effects of three types of environmental regulation on eco-efficiency: a cross-region analysis in China. J Clean Prod 173:245–255
Shadbegian RJ, Gray WB (2005) Pollution abatement expenditures and plant-level productivity: a production function approach. Ecol Econ 54(2–3):196–208
Stoerk T (2019) Effectiveness and Cost of Air Pollution Control in China. Grantham Research Institute on Climate Change and The Environment
Wang H (2002) Pollution regulation and abatement efforts: evidence from China. Ecol Econ 41(1):85–94
Wang Q, Zhao Z, Shen N, Liu T (2015) Have Chinese cities achieved the win–win between environmental protection and economic development? From the perspective of environmental efficiency. EcolInd 51:151–158
Wu Y (2004) China's economic growth: a miracle with Chinese characteristics, vol 6. Routledge, Abingdon

Wu J, Deng Y, Huang J, Morck R, Yeung B (2014) Incentives and outcomes: China's environmental policy. Capital Soc 9(1):1–41

Xiao C (2020) Intergovernmental revenue relations, tax enforcement and tax shifting: evidence from China. Int Tax Public Finance 27(1):128–152

Xu W, Zeng Y, Zhang J (2011) Tax enforcement as a corporate governance mechanism: empirical evidence from China. Corp GovInt Rev 19(1):25–40

Zhang L, Chen Y, He Z (2018) The effect of investment tax incentives: evidence from China's value-added tax reform. Int Tax Public Finance 25(4):913–945

Zhang D, Du W, Zhuge L, Tong Z, Freeman RB (2019) Do financial constraints curb firms' efforts to control pollution? Evidence from Chinese manufacturing firms. J Clean Prod 215:1052–1058

Zhao X, Sun B (2016) The influence of Chinese environmental regulation on corporation innovation and competitiveness. J Clean Prod 112:1528–1536

Zhou P, Arndt F, Jiang K, Dai W (2020) Looking backward and forward: political links and environmental corporate social responsibility in China. J Bus Ethics 1–19

Zou J, Shen G, Gong Y (2019) The effect of value-added tax on leverage: evidence from China's value-added tax reform. China Econ Rev 54:135–146