Less financial constraints, more clean production? New evidence from China

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HIGHLIGHTS

- Financial constraints significantly restrict gas exhaust expense in China.
- State-owned firms can better alleviate financial constraints and finance gas exhaust expense than private and foreign firms.
- State-owned firms use external financial resources, but private and foreign firms rely on internal financial resources to invest gas exhaust expense.

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ABSTRACT

This paper explores the effects of financial constraints on pollution abatement at firm level in China. By using a novel matched data contains rich financing information and air pollution protection variables, we find financial constraints hinder air pollution abatement significantly, whereas state-owned factor can alleviate financial constraints through external financial resources and better support pollution expense than privately and foreign owned firms.

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1. Introduction

Production pollution has been a rising challenge of sustainable economic growth in China (Zhang and Liu, 2017; Zhang et al., 2018), the high-quality growth target requires substantial reduction of pollution level in short-run, and how to reduce the pollution of production has been an urgent issue for academics and policy makers. Pollution reduction is heavily determined by the financial resource, thus financial constraint may be an important channel of pollution control (Andersen, 2017). However, the role of financial constraint in pollution reduction is far from a clear answer, we try to answer this question by providing a firm-level evidence with a novel data in China.

Our basic findings show that financial constraints significantly restrict gas exhaust expense, and state-owned firms can better alleviate financial constraints and finance gas exhaust expense than

private and foreign firms. This paper contributes to the literature in three strands. The first is the determinants of pollution of production. Most of previous literature shed light on international trade, environmental regulation, technology (Andersen, 2017; Wu et al., 2017; Cherniwchan et al., 2017; Zhang et al., 2018; Forslid et al., 2018; Gutiérrez and Teshima, 2018). However, the role of financial constraint is less studied, the closet related paper is Andersen (2017), which provides a framework to evaluate the effect of financial constraints on pollution emission in both theory and empirics. The second is the heterogeneity of pollution performance. A growing literature have mentioned the ownership discrimination between state-owned and non-state firms, which in terms of productivity, export, investment, financial resource (e.g., Zhang et al., 2001; Bai et al., 2006; Ge and Qiu, 2007). However, the discrimination of financial constraints on gas exhaust expense has not well discussed. In addition, the soft budget constraint has been verified for state-owned firms, while the heavy burden caused by financial constraints also can be widely proved among private firms in China (e.g., Bai et al., 2006; Zhang and Liu, 2017). Those different ownerships among Chinese firms would like to make heterogeneous effects in face to financial constraints. Third, this paper

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Table 1
The relationship between financial constraint and exhaust gas expense.

| | Expense dummy | Exhaust gas expense/Assets | | |
| | Probit | Tobit | OLS | |
	(1)	(2)	(3)	(4)
FC	−0.480**	−0.187***	−0.745***	−0.392***
	(0.204)	(0.022)	(0.102)	(0.098)
Export	−0.022	−0.026***	−0.094***	−0.041***
	(0.022)	(0.002)	(0.011)	(0.010)
Size	−0.009	0.075***	0.221***	0.160***
	(0.095)	(0.010)	(0.041)	(0.038)
Size^2	0.006	−0.008***	−0.021***	−0.016***
	(0.008)	(0.001)	(0.003)	(0.003)
Age	−0.027*	−0.017***	−0.041***	−0.005
	(0.016)	(0.002)	(0.008)	(0.007)
Observations	34,235	34,235	34,235	34,235
R-squared			0.009	0.161
Log pseudolikelihood	−3725.8	−3032.7		
Fixed effects	Yes	Yes	No	Yes

Note: Robust standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Fixed effects include industry-level, province-level, and firm-level fixed effects. We do not report the results of constant term, it can be obtained when request. FC is the abbreviation of Financial Constraints.

also contributes to the financial constraints' measurement on FHP theory (investment–cash flow sensitivity by Fazzari et al., 2000), and we provide a new evidence on the environmental investment. We show that environmental investment of financially constrained firms is significantly financed by cash flow in China.

To our best knowledge, we are the first to investigate the effect of financial constraint on pollution abatement at firm-level. The majority of previous literature shed light on the impact of trade, competition or regulation on pollution emission/pollution abatement, only a few papers turn to the effect of financial constraint on pollution emission (Andersen, 2017). Moreover, most of existing studies focus on the evidence of developed countries, but this study provides a novel evidence from the perspective of pollution abatement, and use a newly data of Chinese manufacturing firms.

The rest of this paper is organized as follows. Section 2 discusses the empirical strategy and data source, Section 3 describes the results, Section 4 concludes this paper.

2. Empirical strategy and data

Following the estimation strategy of Andersen (2017), we design the following estimation equation:

$$y_{ijk} = \alpha + \beta \cdot \text{constraint}_{ijk} + X'\Gamma + \mu_j + \mu_k + \varepsilon_{ijk} \qquad (1)$$

where y_{ijk} represents the pollution abatement expense for firm i, in industry j, at province k. We use the decision of exhaust gas expense and the intensity of exhaust gas expense (calculated by the ratio of exhaust gas expense to total asset), to indicate the pollution abatement of manufacturing production, respectively. And constraint$_{ijk}$ indicates firm-level financial constraint, which proxied by investment–cash flow sensitivity, according to Hovakimian and Hovakimian (2009), Zhang and Liu (2017), and this proxy is calculated by the ratio of cash flow to investment. And X contains firm-level characteristics, such as export status, age, size, and the square term of size. Furthermore, we also control industry-level fixed effect μ_j and province-level fixed effect μ_k, ε_{ijk} is the random error term.

The main data sources used in this paper are twofold. The first is Environmental Survey (ES hereafter), maintained by the Ministry of Environmental Protection of China, which contains detailed information on pollution and pollution reduction. Due to the limited access, we only obtain the sample of year 2013. The second is Chinese Industrial Annual Survey (CIAS hereafter), which maintained by National Bureau of Statistics of China. It contains rich financial information for all state-owned firms and above-scale non-state manufacturing firms. We then match them by using the firm-level identifier, and the final observation of the merged data is 56,075, which accounts for 44.68% and 17.46% of whole sample in ES and CIAS, respectively. The statistics of main variables can be found in Table A.1.

3. Results

Table 1 shows the primary results of the effect of financial constraint on pollution abatement. First, we use a Probit model to investigate the role of financial constraints on the decision of investing in exhaust gas. We reveal that financial constraints hinder the increase of gas exhaust expense, either using Probit model for decision of expense, or OLS model with/without fixed effects and Tobit model for the intensity of gas exhaust expense. For

Table 2
Heterogeneous effect of financial constraint on the intensity of exhaust gas expense.

| | OLS | | | Tobit | | |
| | Exhaust gas expense/Assets | | | Exhaust gas expense/Assets | | |
	(1)	(2)	(3)	(4)	(5)	(6)
FC	−0.598***	−0.002	−0.363***	−0.240***	−0.118***	−0.161***
	(0.101)	(0.137)	(0.103)	(0.023)	(0.035)	(0.023)
FC*State	2.289***			0.623***		
	(0.291)			(0.065)		
FC*Nonstate		−0.507***			−0.090**	
		(0.138)			(0.035)	
FC*Foreign			−0.223*			−0.185***
			(0.134)			(0.039)
Export	−0.041***	−0.042***	−0.040***	−0.026***	−0.026***	−0.025***
	(0.010)	(0.010)	(0.010)	(0.002)	(0.002)	(0.002)
Size	0.176***	0.168***	0.158***	0.080***	0.077***	0.073***
	(0.038)	(0.038)	(0.038)	(0.010)	(0.010)	(0.010)
Size^2	−0.017***	−0.016***	−0.016***	−0.008***	−0.008***	−0.007***
	(0.003)	(0.003)	(0.003)	(0.001)	(0.001)	(0.001)
Age	−0.007	−0.006	−0.005	−0.018***	−0.017***	−0.017***
	(0.007)	(0.007)	(0.007)	(0.002)	(0.002)	(0.002)
Observations	34,235	34,235	34,235	34,235	34,235	34,235
R-squared	0.163	0.161	0.161			
Log pseudolikelihood				−2976.0	−3029.5	−3023.0
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Note: See above.

Table 3
Heterogeneous effects of financial constraint on exhaust gas expense.

	OLS			Tobit		
	Exhaust gas expense/Assets					
	(1)	(2)	(3)	(4)	(5)	(6)
FC	−0.596***	−0.041	−0.371***	−0.241***	−0.056	−0.188***
	(0.101)	(0.137)	(0.104)	(0.023)	(0.123)	(0.027)
FC*State	−0.233			0.120		
	(1.003)			(0.220)		
FC*State*Leverage	2.447***			0.542***		
	(0.722)			(0.157)		
FC*Nonstate		−0.961***			−0.956***	
		(0.202)			(0.178)	
FC*Nonstate*Leverage		0.770***			0.823***	
		(0.270)			(0.237)	
FC*Foreign			−0.612**			−0.423***
			(0.259)			(0.090)
FC*Foreign*Leverage			0.769*			0.367**
			(0.446)			(0.159)
Export	−0.041***	−0.042***	−0.040***	−0.026***	−0.039***	−0.029***
	(0.010)	(0.010)	(0.010)	(0.002)	(0.009)	(0.003)
Size	0.177***	0.169***	0.158***	0.080***	0.161***	0.082***
	(0.038)	(0.038)	(0.038)	(0.010)	(0.033)	(0.011)
Size^2	−0.017***	−0.017***	−0.016***	−0.008***	−0.016***	−0.008***
	(0.003)	(0.003)	(0.003)	(0.001)	(0.003)	(0.001)
Age	−0.007	−0.006	−0.004	−0.018***	−0.008	−0.020***
	(0.007)	(0.007)	(0.007)	(0.002)	(0.006)	(0.002)
Observations	34,235	34,235	34,235	34,235	34,235	34,235
R-squared	0.163	0.161	0.161			
Log pseudolikelihood				−3075.8	−3756.1	−3406.4
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Note: See above.

Table 4
The effect of financial constraint on exhaust gas expense: instrument variables.

	IV-Probit (1)	IV-Tobit (2)	2SLS (3)	Probit (4)	Tobit (5)	OLS (6)
FC-Industry-Province	−5.070***	−8.511***	−3.490***			
	(0.783)	(0.431)	(0.436)			
Net working capital				−0.084**	−0.050***	−0.153***
				(0.037)	(0.003)	(0.016)
Export	−0.049**	−0.092***	−0.054***	0.002	−0.010***	−0.037***
	(0.022)	(0.011)	(0.010)	(0.025)	(0.002)	(0.010)
Size	−0.009	0.216***	0.160***	0.264**	0.050***	0.170***
	(0.094)	(0.048)	(0.038)	(0.110)	(0.009)	(0.038)
Size^2	0.007	−0.020***	−0.016***	−0.033***	−0.005***	−0.017***
	(0.008)	(0.004)	(0.003)	(0.009)	(0.001)	(0.003)
Age	−0.029*	−0.045***	−0.003	−0.011	−0.004***	0.002
	(0.017)	(0.008)	(0.007)	(0.019)	(0.002)	(0.007)
Observations	34,235	34,235	34,235	33,125	33,140	33,140
R-squared			0.163			0.165
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Note: See above.

the controlled variables, we observe significantly inverse-U shape effect of firms' size on the gas exhaust expense for the intensity of gas exhaust expense, but not for the decision of investment. In consistent to previous studies, we find the negative nexus between the age of firms and the intensity of gas exhaust expense.

Based on the primary results, the heterogeneity of ownership should be considered. We classify the whole sample into state, non-state, and foreign firms. Due to the potential censored distribution of the intensity of exhaust expense, we employ Tobit model as robust check. Table 2 clearly find that the negative effect of financial constraint on the intensity of exhaust gas expense is more severe in non-state and foreign firms than in state firms, either using OLS or Tobit model.

The high level of leverage has been a threat of economic growth and industrial upgrade of China. We further try to explore the mechanisms of external financial resources and the heterogeneity across ownerships. Table 3 reports the regression results with the leverage interterms. The positive effect in state firms is mainly contributed by those firms with high level of leverage. Moreover, the negative effects of financial constraint are lower for those firms with high level of leverage.

Furthermore, the concern of the endogeneity of the relationship between financial constraint and the pollution abatement, we use two instrument variable – the 2-digit industry-province level average of the ratio of cash flow to investment and net working capital – to check the robustness the results in the case of firm-level constraint variable used. Moreover, we use the indicators in year 2012 to reduce the probability of inversed causality. The negative effect of financial constraint when instruments used can be easily observed (Table 4).

4. Conclusion

This paper investigates the causal effect of financial constraint on the pollution abatement by using a novel merged data of Chinese firms. The results show that, the negative effects mostly contributed by private firms and foreign firms. The average

Table A.1
Summary of key variables.

Variable	Obs	Mean	Std. Dev.	Min	Max
Exhaust gas expense/Assets*1000	34,321	0.415	0.879	0.000	5.472
Size	56,075	11.724	1.532	8.676	15.863
Age	55,968	2.314	0.626	0.693	4.007
SA index	55,968	2.721	0.476	0.964	3.252
Investment–cash flow Sensitivity	56,075	0.055	0.051	−0.075	0.075

effect and heterogeneous effects among ownerships have insightful implication on the policy designed to promote the pollution reduction through financial liberalization and structural reform to alleviate the degree of financial constraint for non-state firms.

Acknowledgments

Appendix

See Table A.1.

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