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Green credit policy and investment-cash flow sensitivity: Evidence from a quasi-natural experiment

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A B S T R A C T

The green credit policy (GCP) in China aims to achieve green development by reducing credit allocations to heavily polluting enterprises. Using the implementation of the GCP as a shock to the cost of external financing, we conduct a difference-in-differences approach and find that the investment-cash flow sensitivity of heavily polluting enterprises increases significantly after the implementation of the GCP. The effect is more pronounced in firms with high investment opportunities and high financial leverage and in firms without ownership in commercial banks. Our paper provides new insights into the impact of the GCP on financial constraints and contributes to the investment-cash flow sensitivity debate by using an exogenous shock to measure financial constraints. The results suggest that investment-cash flow sensitivity may be a reasonable indicator of financial constraints in the context of China.

1. Introduction

China, the world's second largest economy, has achieved unprecedented economic development over the past 40 years. Accompanying its rapid urbanization and industrialization, environmental problems, such as air pollution, ecological damage and energy depletion, have become major concerns for policy makers. In response to the deteriorated environment, the Chinese government has introduced a wide range of environmental policies and regulations to achieve environmental protection and the sustainable development of the economy (Huang et al., 2021).

In 2012, the former China Banking Regulatory Commission issued the "Green Credit Guides", which clarified the principles and guidance for green credit policy (GCP) and required financial institutions to promote green credit businesses, increase credit support for a green and low-carbon economy, and adjust their credit structures to prevent environmental and social risks. Based on corporate environmental behavior, the GCP plays a guiding role in the allocation of bank credit to achieve environmental protection. Specifically, the policy induces credit resources away from heavily polluting industries by adjusting the credit scale, rate and maturity (Li et al., 2022; Wen et al., 2021). As bank loans are an important source of corporate debt financing, the implementation of the GCP may reduce the financial capability of heavily polluting enterprises. Some research finds that the debt financing of heavily polluting enterprises dropped significantly after the implementation of the GCP (Li et al., 2022; Liu et al., 2019). Considering the importance of capital allocation to the real economy, this paper investigates the impact of the GCP on the sensitivity of investment to internal cash

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flow.

From a traditional viewpoint, the sensitivity of investment to cash flow arises due to the frictions in capital markets caused by a cost wedge between external and internal capital. In line with the pioneering work of Fazzari et al. (1988), a large body of literature documents a positive investment-cash flow sensitivity for financially constrained firms. In recent years, however, there has been an intense academic debate over whether investment-cash flow sensitivity can be interpreted as an indicator of financial constraints. While previous studies that investigate the effect of financial constraints on investment are mostly conducted in developed countries, little research focuses on developing countries. Firms in emerging markets are more likely to experience financial constraints than those in developed countries. This paper aims to explore the appealing setting in China to provide emerging market evidence by using a difference-in-differences (DID) design.

We utilize Chinese A-share listed firms as our research sample that covers 17,415 observations from 2007 to 2016. Using the implementation of the GCP as an exogenous shock to heavily polluting enterprises' debt financing constraints, we find that, on average, the investment-cash flow sensitivity of heavily polluting enterprises increases significantly after the implementation of the GCP. A dynamic DID analysis shows that the effect of the GCP on investment-cash flow sensitivity only occurs after the GCP is implemented, supporting the parallel trends assumption. To further verify the robustness of our results, we conduct several sensitivity tests. Our findings are robust when we perform a propensity score matching (PSM) procedure and placebo test. Moreover, these results still hold after controlling for measures of corporate governance. We also find consistent results after controlling for region-by-year and industry-by-year fixed effects.

The cross-sectional analyses further reveal the underlying mechanism of the baseline results. We find that increases in investment-cash flow sensitivity are more pronounced for firms with high investment opportunities, with high financial leverage and without ownership in commercial banks.

Our study makes several contributions. First, this study contributes to the existing research on the impact of the GCP on corporate behaviors (Li et al., 2022; Liu et al., 2019). We add to this line of research by exploring the effects of the GCP on heavily polluting enterprises' investment activities from the perspective of financial constraints. Second, this study contributes to the ongoing debate over the relationship between corporate investment and cash flow (Andrén and Jankensgård, 2015; Chen and Chen, 2012). Through a quasi-natural experiment, we find a greater investment-cash flow sensitivity in heavily polluting firms who face higher outside financing costs owing to the GCP. The results are consistent with the financing constraints explanation of the investment-cash flow sensitivity in the Chinese institutional context. Finally, we enrich the research on the effectiveness and economic consequences of environmental policies and reveal important policy implications for emerging markets that attempt to balance economic development and environmental protection.

2. Related literature and hypothesis development

2.1. Financial constraints and investment-cash flow sensitivity

In a perfect market as described by Modigliani and Miller (1965), a firm's investment decisions and growth are independent from the availability of internal cash flows, since external and internal financing are perfect substitutes. However, frictions in the capital markets imply that the cost of external capital is higher than that of internal financing, which results in firms' financial constraints and reliance on internal capital for new investments. When firms do not have sufficient access to external capital, the investment spending may be sensitive to the availability of internal finance (Fazzari et al., 1988). Since the pioneering work of Fazzari et al. (1988), a large body of literature has suggested that investments of more financially constrained firms are more sensitive to the availability of internal cash flows than investments of less financially constrained firms (Andrén and Jankensgård, 2015; Attig et al., 2012; Bond et al., 2003; Mulier et al., 2016). As a form of market frictions, investment-cash flow sensitivity has typically been interpreted as indicative of the existence of financial constraints. In contrast, some studies find higher investment to cash flow sensitivity for less financially constrained firms. For example, Kaplan and Zingales (1997) and Cleary (1999) find that investment outlays of firms that appear least financially constrained are the most sensitive to internal cash flows, contrary to the previous evidence in Fazzari et al. (1988). A recent study by Chen and Chen (2012) finds that investment-cash flow sensitivity declined and even completely disappeared during the 2007–2009 financial crisis when financial constraints became more binding. They question the interpretation of investment-cash flow sensitivity as a measure of financial constraints.

The correct interpretation of investment-cash flow sensitivity remains controversial. One of the reasons is the difficulty in directly measuring financial constraints. Empirical studies in this area usually rely on indirect proxies, such as size, age, and credit rating (Attig et al., 2012). We contribute to this line of the literature by providing evidence from a shock in which heavily polluting firms in China experience an exogenous decrease in the supply of external financing.

2.2. GCP, financial constraints and investment-cash flow sensitivity

In 2012, the former China Banking Regulatory Commission issued the "Green Credit Guides", making the formal implementation of the green credit policy. The main goal of this policy is to achieve environmental sustainability and economic growth through green finance. Banks are required to consider corporate environmental performance and prevent environmental risk when allocating credit resources. Specifically, they are encouraged to increase credit support for green, low-carbon and circular economy, and reduce or even not allow financial support for polluting projects and firms with poor environmental performance. China's bank-centered financial system determines that bank loans are the primary source of corporate debt financing (Qiu and Shen, 2017). Prior research finds that the implementation of the GCP increases the external financing cost of heavily polluting firms, resulting in serious financing constraints (Liu et al., 2019). For example, Li et al. (2022) show that the debt financing scale of heavily polluting firms decreases after the implementation of the GCP. Liu et al. (2019) find that the implementation of GCP has reduced the financing capacity of heavily polluting firms, resulting in a reduction in bank borrowing and the shortening of debt maturity.

The above analysis shows that heavily polluting firms experience an unexpected and exogenous increase in the cost of external financing following the implementation of the GCP. Therefore, we use the implementation of the GCP as an exogenous shock to heavily polluting enterprises' financing constraints. If a positive investment-cash flow sensitivity indicates financing constraints, we expect that the sensitivity of heavily polluting enterprises increases following the implementation of the GCP. Therefore, we propose the following:

Hypothesis 1: The implementation of the GCP increases the investment-cash flow sensitivity of heavily polluting enterprises.

3. Research design

3.1. Data and sample

We obtain financial data from the China Stock Market & Accounting Research (CSMAR) database. We begin with the population of Chinese firms listed on the A-share market from 2007 to 2016. The sample period starts from 2007 because China adopted a new set of accounting standards at that time. The sample period ends in 2016 because we use firm-years spanning five years before and five years after the GCP. We do not focus on a longer post period to avoid possible confounding effects of other policies or events that may result from longer horizons and to better establish causality (Amberger et al., 2021; Thapa et al., 2020). In addition, a relatively short window can alleviate the concern that the DID estimators may be biased due to the autocorrelation (Aghamolla and Thakor, 2022; Bertrand et al., 2004). We delete firm-year observations with missing financial data and exclude firms listed in the financial industry. Our final sample consists of 17,415 firm-year observations. To mitigate the influence of outliers driving our results, we winsorize all continuous variables at the 1st and 99th percentiles.

3.2. Model specification

The implementation of the GCP can be regarded as a plausible exogenous shock to the financial constraints of heavily polluting firms, which increases the cost of external debt financing. Following Xu et al. (2021), we establish the following DID model to examine the effect of the GCP on the investment-cash flow sensitivity:

$$INV_{i,t} = \beta_1 CF_{i,t} * TREAT_i * POST_t + \beta_2 CF_{i,t} * TREAT_i + \beta_3 CF_{i,t} * POST_t + \beta_4 TREAT_i * POST_t + \beta_5 CF_{i,t} + \sum \gamma_k Control_{i,t-1} + \alpha_i + \gamma_t + \varepsilon_{i,t} \quad (1)$$

where α_i and γ_t represent firm-fixed effects and year-fixed effects, respectively. $INV_{i,t}$ is investment expenditure, which is defined as the sum of the yearly growth in fixed assets, intangible assets, and construction in process scaled by total assets. $CF_{i,t}$ is the net operating cash flow of firm i in year t scaled by total assets. $TREAT_i$ equals 1 for heavily polluting enterprises and 0 otherwise. According to the Classified Management List of Environmental Protection Verification Industry of Listed Companies issued by the Ministry of Environmental Protection in 2008, the following industries are defined as heavily polluting industries, including thermal power, steel, cement, electrolytic aluminum, coal, metallurgy, chemical industry, petrochemical industry, building materials, paper making, brewing, pharmaceutical, fermentation, textile, leather, and mining industry. We define firms that belong to these industries as heavily

Table 1
Variable definition and descriptive statistics.

Panel A: Variable definition	
INV	Sum of yearly growth in fixed assets, intangible assets, and construction in process scaled by total assets.
TREAT	A dummy variable that is set to one for heavily polluting enterprises.
POST	A dummy variable that is set to one for years after 2012.
CF	Operating cash flow scaled by total assets.
SIZE	Natural logarithm of total asset.
TobinQ	The market value of equity plus total debt scaled by book value of assets.
ROA	Net income over total assets.

Panel B: Descriptive statistics

VarName	Obs	Mean	SD	P25	Median	P75
INV	17,415	0.031	0.084	-0.006	0.015	0.059
TREAT	17,415	0.330	0.470	0.000	0.000	1.000
POST	17,415	0.558	0.497	0.000	1.000	1.000
CF	17,415	0.043	0.078	0.002	0.042	0.088
SIZE	17,415	21.853	1.288	20.939	21.712	22.605
TobinQ	17,415	2.584	1.917	1.382	1.965	3.049
ROA	17,415	0.034	0.055	0.010	0.031	0.059

polluting firms. $POST_t$ equals 1 for the five years from 2012 to 2016 (post-implementation period) and 0 for the years from 2007 to 2011 (pre-implementation period). Because the firm- and year-fixed effects subsume the coefficients on *TREAT* and *POST*, respectively, the latter is omitted from the specification. We also control for firm size (*SIZE*), Tobin's Q (*TobinQ*) and return on assets *(ROA*). The variable of interest is the interaction term $CF_{i,t}*Treat_i*Post_t$, which measures the changes in investment-cash sensitivity before and after the implementation of the GCP for treatment firms compared with control firms. The definitions of the variables are presented in Panel A of Table 1.

3.3. Descriptive statistics

Panel B of Table 1 presents the descriptive statistics for the main variable. The mean and median values of *INV* are 0.031 and 0.015, respectively. Approximately 33% of the firm-years are in the treatment sample. The mean of *POST* is 0.558, indicating that approximately 55.80% of the observations are in the post-implementation period. On average, the sample firms have an average (median) *CF* of 0.043 (0.042), a log-transformed size of 21.853 (21.712), and a return on assets ratio of 0.034 (0.031).

4. Empirical results

4.1. Baseline results

Table 2 reports the results of the effect of the GCP on investment-cash flow sensitivity. As shown in Columns (1) and (2), the coefficients of interest, *CF_TREAT_POST,* are 0.080 (significant at the 10% level) and 0.108 (significant at the 5% level), respectively, supporting Hypothesis 1, which states that the implementation of the GCP significantly increases the investment-cash flow sensitivity of heavily polluting enterprises. As the implementation of the GCP increases the cost of external financing of heavily polluting firms, the results are consistent with the financing constraints interpretation of investment-cash flow sensitivity.

4.2. Parallel trends analysis

An important underlying assumption of the DID approach is parallel trends, which requires that the average change in investment be the same for treated and control firms in the absence of a shock. To validate the parallel trends assumption, we follow prior studies (Bertrand and Mullainathan, 2003) and examine the dynamic effect on investment-cash sensitivity before and after the implementation of the GCP. We plot the coefficients on a set of dummy variables indicating the years relative to the event year. Fig. 1 shows that investment-cash flow sensitivity increases significantly only after the implementation of GCP, confirming the validity of the DID research design.

Table 2
Baseline results.

	(1)	(2)
VARIABLES	INV_t	INV_t
CF_TREAT_POST	0.080*	0.108**
	(0.044)	(0.043)
CF_TREAT	-0.012	-0.051
	(0.032)	(0.032)
CF_POST	-0.066***	-0.071***
	(0.021)	(0.021)
TREAT_POST	-0.016***	-0.018***
	(0.004)	(0.004)
CF	0.037**	0.043***
	(0.016)	(0.016)
SIZE		-0.015***
		(0.002)
TobinQ		0.005***
		(0.001)
ROA		0.274***
		(0.023)
Firm, Year FE	YES	YES
Obs.	17,415	17,415
Adj. R2	0.143	0.181

Note: The regression clusters the standard error at the firm level, with robust Std. Err in parentheses. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

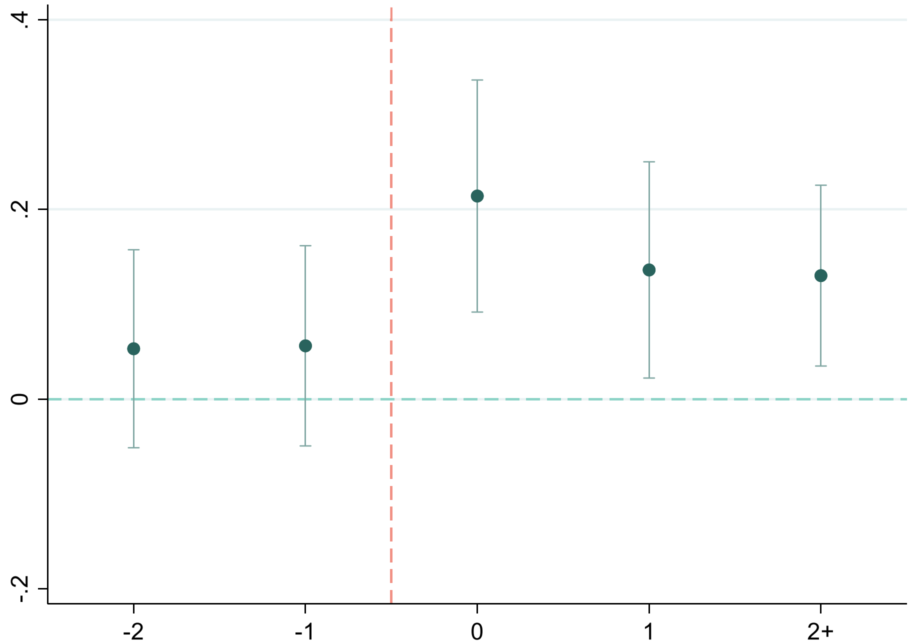

Fig. 1. Testing the parallel trends assumption.

Table 3
Propensity score matching approach.

Panel A: Covariance Balance						
	Treated		Control			
Variables	**Obs**	**Mean**	**Obs**	**Mean**	**Mean-diff**	**t-stat**
SIZE	580	21.917	580	21.916	-0.001	-0.017
TobinQ	580	2.094	580	2.099	0.005	0.068
CFO	580	0.039	580	0.039	0.000	0.012
GROWTH	580	0.270	580	0.254	-0.016	-0.502
CASH	580	0.187	580	0.186	-0.001	-0.114

Panel B: PSM results		
	(1)	(2)
VARIABLES	INV_t	INV_t
CF_TREAT_POST	0.115**	0.133***
	(0.051)	(0.051)
CF_TREAT	-0.063*	-0.097***
	(0.037)	(0.037)
CF_POST	-0.114***	-0.109***
	(0.034)	(0.034)
TREAT_POST	-0.013***	-0.015***
	(0.005)	(0.005)
CF	0.075***	0.078***
	(0.025)	(0.024)
SIZE		-0.021***
		(0.003)
TobinQ		0.004***
		(0.001)
ROA		0.295***
		(0.031)
Firm, Year FE	YES	YES
Year FE	YES	YES
Obs.	10,584	10,584
Adj. R2	0.145	0.183

Note: The regression clusters the standard error at the firm level, with robust Std. Err in parentheses. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

4.3. Robustness tests

4.3.1. Propensity score matching

To further alleviate the endogeneity concerns, we construct a PSM procedure. We match each treatment firm to a control firm with the closet propensity score based on a caliper width of 0.01 and without replacement. This procedure yields 1160 firms and 10,584 firm-year observations. Panel A of Table 3 shows that the differences in the covariate means of the treatment and control firms are not significant. As shown in Panel B of Table 3, the baseline results still hold when using the PSM sample.

4.3.2. Placebo test

One concern is that the DID results could have captured a general time effect or been driven by chance rather than reflecting the effect of the GCP. To mitigate this concern, we perform placebo tests, in which we use the lagged investment relative to the current year's cash flow. As shown in Table 4, the coefficients of *CF_TREAT_POST* are insignificant in all columns.

4.3.3. Additional controls and more fixed effects

We also control for other firm characteristics and more fixed effects. Table 5 shows that our results still hold after controlling for measures of corporate governance. As shown in Table 6, the results are still consistent after controlling for region-by-year and industry-by-year fixed effects.

4.3.4. Alternative sample period

To further ensure the robustness of the results, we re-estimate Eq. (1) using the following sample period: three years before and after the GCP, four years before and after the GCP and a longer post period. The results in Table 7 show that our results remain qualitatively similar when we use alternative sample period.

4.4. Cross-sectional analysis

4.4.1. Investment opportunity

The implementation of the GCP increases the external financing cost of heavily polluting enterprises. For those who have more investment opportunities, the firm relies more on internal cash flow, resulting in a greater investment-cash flow sensitivity after the implementation of the GCP. We partition our sample based on the median value of Tobin's Q and sales growth before the implementation year and perform the regression in Eq. (1) for the subsamples. Table 8 shows that the coefficient of *CF_TREAT_POST* is positive and significant for the subsample with a high investment opportunity and is insignificant for the subsample with a low investment opportunity, which is consistent with our expectation.

4.4.2. Financial leverage

We conjecture that firms with high financial leverage might respond more aggressively to the change in external financing costs. We partition our sample into a high financial leverage group and a low financial leverage group based on the media value of financial

Table 4
Placebo test.

	(1)	(2)
VARIABLES	INV_{t-1}	INV_{t-1}
CF_TREAT_POST	0.037	0.011
	(0.050)	(0.046)
CF_TREAT	-0.039	-0.024
	(0.036)	(0.033)
CF_POST	-0.011	-0.009
	(0.023)	(0.022)
TREAT_POST	-0.015***	-0.009**
	(0.005)	(0.004)
CF	-0.016	-0.014
	(0.018)	(0.017)
SIZE		0.041***
		(0.003)
TobinQ		0.001
		(0.001)
ROA		0.197***
		(0.022)
Firm, Year FE	YES	YES
Obs.	16,822	16,822
Adj. R2	0.147	0.199

Note: The regression clusters the standard error at the firm level, with robust Std. Err in parentheses. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

Table 5
Additional controls.

VARIABLES	(1) INV_t	(2) INV_t
CF_TREAT_POST	0.108**	0.104**
	(0.042)	(0.042)
CF_TREAT	-0.061*	-0.052
	(0.032)	(0.032)
CF_POST	-0.067***	-0.070***
	(0.021)	(0.022)
TREAT_POST	-0.017***	-0.017***
	(0.004)	(0.004)
CF	0.041**	0.440**
	(0.016)	(0.189)
INSINVESTOR	0.001***	0.001***
	(0.000)	(0.000)
BSIZE	0.020**	0.026***
	(0.009)	(0.010)
BINDEP	0.005	0.014
	(0.024)	(0.025)
DUAL	0.001	-0.000
	(0.003)	(0.003)
CF*Governance Traits	No	Yes
Controls	Yes	Yes
Firm, Year FE	YES	YES
Obs.	17,304	17,304
Adj. R2	0.200	0.201

Note: We control for measures of corporate governance and their interaction with CF in Table 5, including institutional investors' ownership (*INSINVESTOR*), board size (*BSIZE*), board independence (*BINDEP*) and the duality of bard chairman and CEO (*DUAL*). The regression clusters the standard error at the firm level, with robust Std. Err in parentheses. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

Table 6
More fixed effects.

VARIABLES	(1) INV_t	(2) INV_t	(3) INV_t
CF_TREAT_POST	0.117***	0.087**	0.100**
	(0.043)	(0.044)	(0.044)
CF_TREAT	-0.053	-0.036	-0.041
	(0.033)	(0.033)	(0.033)
CF_POST	-0.072***	-0.054**	-0.056**
	(0.021)	(0.022)	(0.022)
TREAT_POST	-0.020***	-0.016***	-0.019***
	(0.004)	(0.005)	(0.005)
CF	0.045***	0.028*	0.031*
	(0.016)	(0.016)	(0.016)
SIZE	-0.018***	-0.016***	-0.018***
	(0.002)	(0.002)	(0.002)
TobinQ	0.004***	0.005***	0.005***
	(0.001)	(0.001)	(0.001)
ROA	0.270***	0.263***	0.259***
	(0.022)	(0.023)	(0.022)
Region*Year FE	YES	NO	YES
Industry*Year FE	NO	YES	YES
Firm, Year FE	YES	YES	YES
Obs.	17,415	17,415	17,415
Adj. R2	0.190	0.186	0.196

Note: The regression clusters the standard error at the firm level, with robust Std. Err in parentheses. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

leverage prior to GCP implementation. Table 9 shows that the coefficient of *CF_TREAT_POST* is significantly positive for firms with high financial leverage (Column (1)) but insignificant for firms with low financial leverage (Column (2)). The results indicate that the increase in investment-cash flow sensitivity is more pronounced for heavily polluting firms with high financial leverage after the implementation of the GCP.

Table 7
Alternative sample period.

	(1) 2009–2014	(2) 2008–2015	(3) 2007–2018
VARIABLES	INV_t	INV_t	INV_t
CF_TREAT_POST	0.087*	0.117**	0.079**
	(0.049)	(0.047)	(0.040)
CF_TREAT	-0.020	-0.054	-0.056*
	(0.037)	(0.034)	(0.031)
CF_POST	-0.054**	-0.078***	-0.074***
	(0.024)	(0.023)	(0.019)
TREAT_POST	-0.007	-0.013***	-0.020***
	(0.004)	(0.004)	(0.004)
CF	0.016	0.038**	0.047***
	(0.016)	(0.015)	(0.015)
SIZE	-0.027***	-0.019***	-0.010***
	(0.004)	(0.003)	(0.002)
TobinQ	0.004***	0.004***	0.004***
	(0.001)	(0.001)	(0.001)
ROA	0.239***	0.256***	0.291***
	(0.029)	(0.026)	(0.019)
Firm FE	YES	YES	YES
Year FE	YES	YES	YES
Obs.	10,802	14,161	21,263
Adj. R2	0.250	0.207	0.171

Note: The regression clusters the standard error at the firm level, with robust Std. Err in parentheses. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

Table 8
Cross-sectional analysis: investment opportunity.

	(1)	(2)	(3)	(4)
	Tobin's Q		Sales growth	
VARIABLES	High	Low	High	Low
CF_TREAT_POST	0.195***	-0.039	0.190***	0.033
	(0.057)	(0.064)	(0.062)	(0.060)
Controls	YES	YES	YES	YES
Firm, Year FE	YES	YES	YES	YES
Obs.	8764	8651	8901	8514
Adj. R2	0.181	0.194	0.197	0.142

Note: The regression clusters the standard error at the firm level, with robust Std. Err in parentheses. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

Table 9
Cross-sectional analysis: financial leverage.

VARIABLES	(1) High	(2) Low
CF_TREAT_POST	0.117*	0.059
	(0.066)	(0.052)
Controls	YES	YES
Firm, Year FE	YES	YES
Obs.	8052	9363
Adj. R2	0.206	0.166

Note: The regression clusters the standard error at the firm level, with robust Std. Err in parentheses. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

4.4.3. Bank ownership

Prior studies find that firms that have an economic relationship with banks can obtain financing benefits (Lu et al., 2012). We now examine how the effect of the GCP varies between firms with and without ownership in commercial banks. We partition our sample into two subsamples: firms holding bank ownership and those not holding bank ownership, and perform the regression Eq. (1) for the subsamples. Table 10 reports the results. The coefficient of *CF_TREAT_POST* is not significant for the subsample of firms with ownership in banks, while it is positive and significant at the 5% level for the subsample of firms without ownership in banks. The results suggest that the effect of the GCP on investment-cash flow sensitivity is stronger for firms without economic relationships with banks.

Table 10
Cross-sectional analysis: bank ownership.

VARIABLES	(1) with ownership in banks	(2) without ownership in banks
CF_TREAT_POST	0.081	0.118**
	(0.087)	(0.050)
Controls	YES	YES
Firm, Year FE	YES	YES
Obs.	4505	12,910
Adj. R2	0.178	0.179

Note: The regression clusters the standard error at the firm level, with robust Std. Err in parentheses. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

4.5. Additional test

In the research design, we use the implementation of the GCP as an exogenous shock to financing constraints for heavily polluting firms. To validate the identification strategy, we examine whether the implementation of the GCP affects firms' financial constraints. We use the Whited-Wu (WW) [2006] index and the Hadlock-Pierce (HP) [2010] index, two widely used indices to measure financial constraints (Dasgupta et al., 2019). The two indices are supposed to be increasing with financial constraints. The results in Table 11 show that the coefficients of *TREAT_POST* are positive and significant at the 1% level, indicating that heavily polluting firms experience greater increase in financial constraints after the implementation of the GCP relative to other firms.

5. Conclusion

The implementation of the GCP in China aims to achieve green development through green financing, reducing credit allocations to heavily polluting enterprises. Using the promulgation of GCP as a shock to financial constraints for heavily polluting enterprises, we find that investment-cash flow sensitivity increases significantly after the implementation of GCP. The effect of the GCP on investment-cash flow sensitivity is more pronounced for firms with high investment opportunities and high financial leverage and for firms without ownership in commercial banks. Bank loans are important financial resources for firms in emerging markets. Given the increase in external financing costs, the implementation of the GCP causes heavily polluting firms to be more dependent on internal cash flow. Our results provide evidence for the financial constraints explanation of investment-cash flow sensitivity.

CRediT authorship contribution statement

Jing Zhao: Methodology, Writing – original draft, Writing – review & editing, Investigation, Funding acquisition. **Jingchang Huang:** Conceptualization, Methodology, Software, Formal analysis. **Feng Liu:** Conceptualization, Formal analysis, Writing – review & editing.

Declaration of Competing Interest

None

Table 11
Additional test.

VARIABLES	(1) Whited and Wu (2006)	Financial Constraints	(2) Hadlock and Pierce (2010)
TREAT_POST	0.003***		0.016***
	(0.001)		(0.006)
SIZE	-0.034***		-0.159***
	(0.001)		(0.006)
TobinQ	-0.003***		-0.008***
	(0.000)		(0.002)
ROA	-0.013		-0.187***
	(0.012)		(0.044)
Firm, Year FE	YES		YES
Obs.	17,330		17,414
Adj. R2	0.866		0.926

Note: The regression clusters the standard error at the firm level, with robust Std. Err in parentheses.*, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

Data availability

Data will be made available on request.

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