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The Impact of Command-and-Control Environmental Regulations on Firms' Maturity Mismatch: Evidence from Chinese 2015 New Environmental Protection Law

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Abstract:

Amid increasingly stringent environmental governance, firms' investment and financing maturity structure directly shapes liquidity risk exposure and capital chain resilience, thereby influencing the green transition and high-quality development. Exploiting the 2015 revision of China's New Environmental Protection Law as a quasi-natural experiment and using panel data on A-share manufacturing firms from 2009 to 2021, this study implements a difference-in-differences approach to identify the effect of command-and-control environmental regulation on debt–investment maturity mismatch. Empirical results show that after China's New Environmental Protection Law, maturity mismatch increases significantly among heavily polluting firms, which indicates a materially higher reliance on short-term funding to bridge long-horizon investment and therefore greater rollover and liquidity risk. Mechanism analyses show two channels, namely an increase in long-term investment and a tightening of credit, reflecting compliance-driven capital expenditures together with a contraction in long-maturity credit supply, which pushes firms toward short-term borrowing for long-horizon projects and raises rollover and liquidity risk. Heterogeneity analyses show that the mismatch effect is concentrated among private firms, younger firms, and larger firms, while no statistically significant adjustment is detected for state-owned or foreign-invested firms. These findings demonstrate that command-and-control environmental regulation strengthens compliance but may inadvertently exacerbate firms' financial fragility through maturity mismatch. Author recommend establishing a coordination mechanism between enforcement and green finance by setting up earmarked credit lines, issuing green bonds, and providing government-backed guarantees to expand medium and long-term funding for pollution-intensive sectors, and by offering targeted support to

private firms, early-stage growth firms, and entities with heavier financial burdens that are more severely affected.

Keywords: Command-and-Control environmental regulation; Maturity mismatch; New environmental protection law; Credit constraints

1. Introduction

According to the rapid development of China's financial system, corporate debt maturity mismatch has become increasingly salient. A prominent manifestation is the use of short-term debt to finance long-term investments. Following canonical corporate-finance views of maturity choice, author define maturity mismatch as reliance on short-term liabilities to fund long-horizon and relatively illiquid investment, a configuration that heightens rollover exposure when refinancing conditions tighten. This practice has been prevalent among the private as well as small and middle enterprises in China because of financing limitations in the bifurcated Chinese financial system. The accessibility of long-term loans, poor growth of capital markets and need by the banks to lend on short-term loans are some of the structural constraints that have forced many companies to consider short term liabilities as a source of funding long term projects which have long payback periods [1].

The material vulnerabilities are brought by the short-term financing strategies. When the maturity of asset and liability mismatch is high, lending risk and default chances are enhanced in times of market stress or regulatory ambiguity. Financially, in terms of financial stability maturity mismatch may spread liquidity spirals, which pass firm-level rollover risk to other creditors and the entire banking system. It is even more effective in the emerging market where the precautionary buffers and the backstops acquired through market-based methods are very few. These risks are manifested in the experience of the once tech conglomerate LeTV, which funded long-term expansions through the use of short-term borrowing and found itself severely strained in terms of cash-flows. This is why researching how companies can attain sustainable equilibrium between compliance with the regulatory frameworks and ongoing financing limit is a vital issue both to academia and to policymakers.

Simultaneously with these financial difficulties, the growing rate of climate change has triggered the governments to embrace stricter environmental policies. China, as a leading economy in the world, adopted the new law concerning environmental protection, the New Environmental Protection Law (NEPL) in 2015. The NEPL, which was often called the very strictest environmental law ever, signified a change of soft guidance into hard law. This regulatory shock heightened compliance pressure and more so to the firms in the intensive pollution sectors. Such a command-and-control shock works, mechanically, at two margins: on the one hand, it increases the pressure on the long-term investment in environmental retrofits and cleaner technologies; on the other, it increases the accessibility of long-term external finance in the face of increased policy uncertainty. Canonical maturity-choice models surmise that in situations of increased need of long-horizon capitals as well as the diminished provision of long-term credit, firms are compelled to shift towards short-term searching. This is probably intensified in China, where the elasticity of long-term funding has been constrained by bank-based intermediation and collateralization.

Although this problem is very significant, the existing literature has centered much on the impacts of environmental regulation on innovation, operating performance and emissions with little regard on how this control affects the corporate capital organization. In particular, existing research can hardly consider the use of short-term debt to fund long-term investments or the heterogeneous ways in which regulation affects the choices of financing. These practical issues and gaps in the literature drive this paper to use a panel data of Chinese A-share listed firms and employ a difference-in-differences (DID) design in analyzing the impacts of strict environmental regulation on maturity mismatch in the highly polluting sectors.

Empirical evidence suggests that NEPL played a major role in increasing maturity mismatch by firms operating in industries that consume a lot of pollution and had to make a larger use of short-term debt to finance long term capital projects. According to the analysis, based on mechanism, this change is mainly provoked by two pressures: the growth of compliance costs and an understandable limitation of access to long-term funding at the same time. Moreover, we observe a high degree of heterogeneity of such responses among various types of ownership, life cycle and firm sizes which indicates that the effect of the regulatory shock on firms varies based on the internal features of the firms.

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This research paper makes its contribution to the body of research in four ways. First, it brings the gap between environmental economics and corporate finance to define debt maturity as one of the channels of transmission. Through the structure of analysis on the impact of command-and-control policies on financing structure, we expose the dynamism of financing decision making of corporate entities under the influence of environmental shocks. Second, based on the NEPL as a quasi-natural experiment, this paper has presented a causal argument that hard law regulations may cause unwittingly increase the risks of the maturity mismatch. Third, in writing about heterogeneity among types of firms we can provide a better degree of fine-grained insight into strategic corporate response to regulation. Lastly, the paper provides policy implications that are urgent, in that enforcement of the environment needs to be accompanied by financial tools that increase access to medium- and long-term green finance to enhance financial stability in the process of transitioning to green.

The rest of this paper continues in the following way. Section 2 provides a review of the policy context and the literature related to it. Part 3 talks about the data sources, construction of variables, and empirical strategy. Section 4 indicates the baseline regression findings and robustness tests. Section 5 has investigated the underlying mechanism and has performed heterogeneity analyses. The paper ends with Section 6 that provides policy recommendations.

2. Policy Background and Literature Review

2.1 Policy Background

The history of the development of the Chinese legal system of environmental protection may be split into the phases of the exploration and the formation of legal framework, and the modernization of the system and the category of the management. China China In institutional terms China In 1973, the institutionalized environmental governance of China began with the promulgation of the Regulations on Environmental Protection by the State Council. This happened in 1979 when the Environmental Protection Law was issued and the first law codifying the principles of environmental protection, a guiding principle and extent of applicability of these laws, and the fundamental purpose of environmental protection and formed the legislative basis of environmental regulation in the country. The issue of a rather coherent and systematic legal framework was created by the formal promulgation of the Environmental Protection Law in 1989. But in the face of an accelerated economic growth and wider industrialization the flaws of the law were becoming more pronounced, and especially in the absence of coherent regional standards, a low level of enforcement, and deterrent effect of the punishment as such. These restrictions resulted in making it more and more challenging to satisfy the new requirements of green development and building ecological civilization. To overcome these institutional gaps, in April 2014 the Standing Committee of the 12th National People's Congress undertook a full overhaul of the Environmental Protection Law.

The redesigned NEPL is essentially a change in philosophies of legislation and a change in institutional design. Rather than making small compromises, the new law established severe punishment to be applied in case non-compliance becomes no longer profitable to the polluters. Besides mere punishment, the law transformed the government by providing information disclosure, as well as by authorizing social organizations to make public interest litigation. This shifts the system towards a multi-stakeholder model rather than a system that is solely focused on the government. More importantly, the responsibility is now narrowed down at the official level; the environmental performance is now made of the centre of governmental assessment implying a shared responsibility between Party and Governmental officials. Lastly, the administrative enforcement has been integrated with criminal justice to ensure that there are no loopholes that would have enabled the perpetrators of great crimes to get out of criminal responsibility.

There are indications that these reforms have been successful. Since the passing of the law, regulations have been enforced more. The government had handled nearly 1.295 million cases in the country where fines worth 86.02 billion RMB were imposed. It is interesting to note that the cases and total fines increased drastically in the 13th Five-Year Plan, in which the latter increased by 1.4 times in comparison to the previous period. This regulatory pressure has been converted into actual environmental outcomes. Its Central Environmental Protection Inspection (CEPI) program on its own had a population of more than 18, 000 officials standing to be answerable in its inaugural round. The air quality had improved greatly by 2023: the national means of PM 2. 5 concentrations decreased to 30 μg/m 3, the count of days with good air quality grew to 85.5 days. Strong force by heavy industries this has been the response of heavy industries like Nanjing Iron and Steel Co. Ltd. which have had to spend billions of dollars on ultra-low emission technologies, which proves that stringent laws can bring about the green transformation in industry.

2.2 Literature Review

2.2.1 Effects of Command-and-Control Environmental Regulation on Firm Outcomes

Command-and-control (CAC) environmental regulation

is main type of institutional intervention that radically changes the cost structure and strategic behavior of the firm in a fundamental way. CAC regulation gives direct restrictions on production and emissions by applying statutory standards, permits and penalties. The academic discussion on its effects on the economy often leads to two contradictory lines.

The standard wisdom holds that regular regulations put on a compliance burden that increases marginal costs and chokes productive investment. According to preliminary surveys, the threat of losing vast competitiveness may be exaggerated, although compliance costs in some circumstances are clearly reducing the measured productivity [1]. As an example, the 11 th Five-Year Plan in China stated that CAC regulation would be influential in limiting green innovation efficiency in the short term [2]. More specifically, under the NEPL, increased enforcement pressure may induce firms to hold more precautionary cash in order to reduce compliance risk, thereby crowding out resources that might otherwise be allocated to research and development [3].

On the other hand, the second line of literature holds that properly designed and realistically implemented regulations can trigger innovation. Sectoral evidence suggests that, although China's emission permit reforms imposed short-term costs, they may also have contributed to greater green patenting and higher productivity in the longer term. Quasi-natural experiments are another way of supporting this positive externality. Related research using the CEPI as an exogenous policy shock suggests that command-and-control environmental regulation may have a positive but gradual effect on firm value, and that this effect may operate through improved ESG performance [4, 5]. At the city level, existing evidence also suggests that CEPI inspections not only reduced carbon intensity but also promoted a sustained process of green industrial upgrading [6].

2.2.2 Determinants of Firms' Maturity Mismatch

Quite different to the above-informed operational results, another set of research studies the redesign of the corporate financing policies by a regulatory and institutional environment namely, debt maturity structure. Mimicry of maturity occurs when companies fund illiquid, long-term assets through short-term debt, which is prone to exposure to refinancing risk as well as liquidity crises to high levels. The motivation behind this phenomenon is usually divided into firm specific attributes and external environmental motivations.

According to standard corporate finance theory, the maturity decisions are a composition between agency costs and information asymmetry. Prior research has shown that active management of rollover risk is closely related to agency concerns, and that debt structure should be arranged with attention to firm characteristics such as size, asset maturity, and credit quality [7, 8]. These internal decisions are, however, limited by external inefficiency in the emerging markets. Existing evidence suggests that underdeveloped financial markets in developing economies restrict access to long-term credit, thereby pushing firms towards short-term borrowing and aggravating maturity mismatch [9, 10]. In the Chinese context, available research indicates that maturity mismatch may be intensified by the financing frictions faced by small and medium-sized enterprises, and that greater corporate financialisation may further worsen this problem [11].

Macro-institutional policies have a decisive role, other than market structure. Bigger legal and financial institutions have been associated with the lengthening of the debt terms and low rollover risk [9]. The monetary policy is also a lever; Existing evidence also suggests that monetary tightening tends to increase firms' reliance on short-term borrowing, whereas monetary loosening is more conducive to longer debt maturity structures [12]. In addition, the banking environment also matters. Some studies suggest that stronger competition in the banking sector can reduce maturity mismatch by expanding firms' access to long-term credit. Lastly, informal institutions such as social trust may also promote greater financial stability, as higher levels of trust can facilitate relationship-based lending and thereby alleviate maturity mismatch [13].

2.2.3 Critical Assessment and Research Gap

In general, the literature gives comprehensive evidence both on the economic impact of environmental regulation and on the factors that determine corporate debt maturity mismatch. But these two strands do not have much to do with one another. Studies of CAC environmental control have concentrated mainly on real side performance in terms of emissions, innovation, productivity and the value of the firm, and in this case they have inconsistently found out the efforts of firms responding to the regulatory pressure. Conversely, the research on maturity mismatch primarily analyzes the firm-level friction and macro-financial situations but institutional regulation is viewed as a background variable but not as a source of shock.

This division poses a key question that is not adequately answered, and it concerns how the firms respond to the tightening of environmental regulation in their financing arrangements. Specifically, the debt maturity structure is a direct influence on refinancing risk and liquidity vulnerability but the effectiveness of its financial adjustment margin in response to regulatory pressure has not been well studied. This channel should not be overlooked because transmitting regulatory shocks into the financial vulnerability of firms could be important in understanding why heterogeneous outcomes are observed in the regulation-performance literature.

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To fill this knowledge gap, this paper utilizes NEPL as a quasi-natural experiment to determine the causal relationship between CAC environemental regulation and corporate maturity mismatch to combine these two fields of study, environmental economics and corporate finance.

3. Research Design

3.1 Sample and Data

To explore the causal relationship between the NEPL and financing mismatch between corporate investment and financing in high-pollution industry, author utilize the enforcement of the NEPL in 2015 as a quasi-natural experiment to identify causality. This study uses data from listed manufacturing firms which from high-pollution industries in China between 2009 to 2021 as the research sample. Data will be sourced from China Stock Market & Accounting Research (CSMAR) database, and it provides all firm-level information on financial reports, governance structure and stock market performance. Environmental regulatory data is collected from public disclosures mandated by the Ministry of Ecology and Environment of China and cross-validated with corporate sustainability reports.

To ensure data quality and comparability, author will clean and process the data to ensure consistency and completeness, focusing on variables related to financing structure, environmental regulation compliance, and firm characteristics. First, author exclude special treatment (ST) and particular transfer (PT) firms, which are under ST due to unusual financial conditions and do non-representative financial behaviors. Second, author drops observations about where firms change classification codes during sample period and then author removes firms with missing core information, such as total assets and firm age. In addition, author conduct winsorization at the first and ninety-nine precents to all continuous variables which used to decline the impact of outliers and measurement error. Finally, the final dataset will consist of firm-level data from 2009 to 2021, allowing for the inclusion of lagged variables while still capturing observation before and after the 2015 NEPL implementation. Based on the above sample selection criteria, the final sample consists of 2997 firms 22,783 firm-year observations.

3.2 Empirical Strategy

As those samples are unrepresentative to normal industry, author removes them to ensure data are correct. At the base of sample left, this paper used DID model will be employed to estimate the impact of the NEPL on the financing mismatch. The model will compare firms affected by the law with those unaffected, controlling for other variables that may influence financing behavior. The specific DID model is constructed as follows:

$$\text{Mismatch}_{it}=\alpha_0+\alpha_1\text{Treat¡ÁPost}+\gamma X_{it}+\lambda_i+\delta_t+\epsilon_{it} \quad (1)$$

In the above model, Mismatch_{it} represent the maturity mismatch measure for firm I in year t. α_0 (alpha zero) is the constant term in the regression model. α_1 is the coefficient of the interaction term Treat×Post as if it greater than zero, financing mismatch increases. Treat is a variable equal to 1 if firm I belong to a heavy-polluting industry, and 0 otherwise. Post is a time that takes the value 1 for years 2015 and after 2015, and 0 otherwise. Treat × Post is the interaction term capturing the differential impact of the NEPL on treated firms. γX_{it} is a vector of time-varying firm-level control variables, including size, age, ROA, Tobin's Q, leverage, growth rate, cash flow, state ownership, and CEO duality. λ_i denotes firm fixed effects, controlling for unobserved time-invariant characteristics. δ_t represents year fixed effects, capturing macroeconomic trends or shocks affecting all firms. ϵ_{it} is the error term. Standard errors are clustered at the firm level to address serial correlation and heteroskedasticity.

3.3 Variable Definition and Description

3.3.1 Dependent Variable

The dependent variable captures financing–investment maturity mismatch, that is, the extent to which short-term funding is used to cover long-horizon investment. Following existing research [14], our baseline indicator is the Short-Term-Liabilities-to-Long-Term-Investment ratio (STLTI):

$$\text{STLTI}_{it}=\frac{\text{CAPEX}_{it}\,0\text{LT\_Sources}_{it}}{\text{TA}_{it-1}} \quad (2)$$

where CAPEX_{it} denotes firm's cash outlays for long-term investment in year □, including cash paid for acquiring fixed assets, intangible assets, and construction-in-progress in year □, LT_Sources_{it} denotes the stable/long-term sources available to finance those outlays, comprising of four parts: (i) ¡÷LTD_{it}, which calculated as (long-termborrowing$_{it}$ - long-termborrowing$_{it-1}$)+(currentportionofnoncurrentliabilities$_{it}$ - currentportionofnoncurrentliabilities$_{it-1}$); (ii) ¡÷Equity_{it}, which is the net equity inflow from the financing section, i.e., cash received from equity issuance minus cash dividends/repurchases; (iii) CFO_{it}, which denotes the net cash flow from operating activities); and (iv) DISP_{it}, which denotes cash proceeds from disposal of long-term

assets. TA_{it-1} is beginning-of-year total assets used for scale normalization. Hence, $STLTI_{it}$ measures the share of long-horizon investment that must be bridged by short-term funding; larger values imply higher rollover/liquidity risk, while $STLTI_{it} < 0$ indicates a surplus of stable long-term financing.

For robustness, this study also constructs the Short-Term-Liability–Asset Gap (STLAG) [15]:

$$STLAG_{it} = ST\_Share_{it} 0 SA\_Share_{it} \quad (3)$$

which

ST_Share_{it} ¡ÔShort0termliabilities$_{it}$ /Totalliabilities$_{it}$,

with short-term liabilities including short-term borrowings, notes and accounts payable, the current portion of non-current liabilities, and other current liabilities; and

SA_Share_{it} ¡ÔCurrentassets$_{it}$ /Totalassets$_{it}$, where current assets comprise cash and cash equivalents, net receivables, net inventories, the current portion of non-current assets, and other current assets. This measure summarizes the imbalance between near-term obligations and liquid-asset buffers; larger values indicate a more severe structural maturity mismatch. In particular, $STLAG_{it} > 0$ indicates that short-term obligations outweigh the buffer provided by liquid assets, implying a greater short-term funding gap.

3.3.2 Independent Variable

The core independent variable is the interaction term Treat × Post. Its coefficient alpha sub 1 captures the causal change in maturity mismatch among treated firms relative to controls after the NEPL took effect. Including Treat is an indicator variable, equal to 1 if a heavily polluting industry owns firm and 0 otherwise. Following the relevant classification standards and existing research, heavy-polluting industries include 28 two-digit (or comparable) categories, such as mining, chemicals, textiles, and pharmaceuticals [16]; firms in these categories form the treatment group, and the remaining manufacturing firms serve as controls. Post is a time indicator equal to 1 for 2015 and onward and 0 for pre-2015 years.

3.3.3 Control Variable

To mitigate omitted-variable bias in equation (1), author includes standard firm-level controls linked to capital structure and maturity choices. Table 1 provides precise definitions.

Table 1. Control Variable Definition

Variable Name	Symbol	Definition/Measurement
Firm Size	Size	Natural logarithm of total assets
Firm Age	Age	In (Current year – establishment year)
Financial Health	ROA	Net Profit divided by total assets
Leverage Ratio	Lev	Total liabilities divided by total assets
Operating Cash Flow	Cash	Net operating cash flow/opening net fixed assets
Growth Opportunity	Tobin	Tobin's Q ratio
Ownership Structure	Top1	Shareholding ratio of the largest shareholder
CEO Duality	Dual	Dummy variables: 1 if CEO also serves as board chairman;

3.4 Descriptive Statistics

Table 2 reports summary statistics of all primary variables in the analysis. For the dependent variables, STLTI has a mean of 0.191 and a standard deviation of 0.238, indicating considerable variation in maturity mismatch across firms. The second indicator, STLAG, has a meaning of -0.104 with a standard deviation of 0.214, which further demonstrates heterogeneity in financial structures.

Table 2. Summary Statistics

Variables	Obs	Mean	Std. dev.	Min	Max
STLTI	22,783	0.191	0.238	-0.517	0.777
STLAG	20,549	-0.104	0.214	-2.502	0.407
Treat	22,783	0.538	0.499	0.000	1.000
Post	22,783	0.679	0.467	0.000	1.000
Treat×Post	22,783	0.352	0.478	0.000	1.000

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Size	22,783	22.069	1.246	19.943	25.950
Age	22,783	2.843	0.361	0.693	4.159
ROA	22,783	0.398	0.200	0.050	0.900
Lev	22,783	0.053	0.066	-0.132	0.241
Cash	22,783	0.044	0.059	-0.210	0.205
Tobin	22,783	2.079	1.282	0.877	8.357
Top1	22,783	34.697	14.631	9.050	74.090

4. Empirical Results

4.1 Baseline Results

Table 3 reports our baseline DID estimates of the effect of NEPL implementation on firms' maturity mismatch. Specifically, columns (1) and (2) use STLTI as the dependent variable, while columns (3) and (4) use STLAG as an alternative outcome for robustness. Across specifications, the estimated coefficient on Treat × Post is positive and statistically different from zero. In columns (2), the coefficient on the interaction term Treat × Post is 0.020 and statistically significant at 5% levels, which corresponds to about 10.5% of the mean value equal to 0.191. These results suggest that NEPL led to an increase in maturity mismatch. The estimates are consistent with stricter enforcement advancing environmental accountability while, in the short run, raising compliance-driven capital expenditures and tightening access to long-maturity credit, especially for firms with high pollution outputs and weaker environmental management systems. The robustness specification in column (4) using STLAG as the outcome yields qualitatively similar conclusions.

Table 3. Baseline Result

	(1)	(2)	(3)	(4)
	STLTI	STLTI	STLAG	STLAG
Treat×Post	0.015*	0.020**	0.026***	0.034***
	(0.009)	(0.009)	(0.008)	(0.008)
Size		-0.004		-0.095***
		(0.008)		(0.006)
Age		0.111***		-0.112***
		(0.029)		(0.024)
Lev		-0.030		0.106***
		(0.027)		(0.022)
Cash		-0.023		-0.947***
		(0.030)		(0.029)
Roa		-0.178***		-1.059***
		(0.037)		(0.036)
Tobin		-0.001		0.004*
		(0.002)		(0.002)
Top1		-0.001		0.000
		(0.000)		(0.000)
Constant	0.185***	0.001	-0.113***	2.335***
	(0.003)	(0.182)	(0.003)	(0.139)
Firm FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Observations	22,783	22,783	20,549	20,549

R2	0.624	0.627	0.186	0.341

Notes:*** p<0.01, ** p<0.05, * p<0.1, Robust standard errors in parentheses.

4.2 Parallel Trend Test

To test the parallel-trends assumption, this study estimates an event-study model and examines whether pre-policy coefficients are statistically indistinguishable from zero. The model is specified as follows:

$$STLTI_{it}=\alpha+\sum_{k=-6}^{6(k_i\dot{U}-1)}\beta_k Treat_{i}\acute{i}\acute{A}Year_k+\gamma X_{it}+\lambda_i+\delta_t+\epsilon_{it} \quad (4)$$

Figure 1 presents the estimated coefficients of β for each year. The coefficients of the year before 2015 are insignificant. Therefore, this confirms the parallel trend assumption and strengthens the match interpretation of our DID estimates. After 2016, the coefficients show a sharp and continuous increase in financial mismatch for the treated group, which same as the increasing control leading by NEPL. These dynamic effects further highlight that the impact of NEPL is most concentrated on the year after enforcement, which shows the stability and correctly of baseline finding.

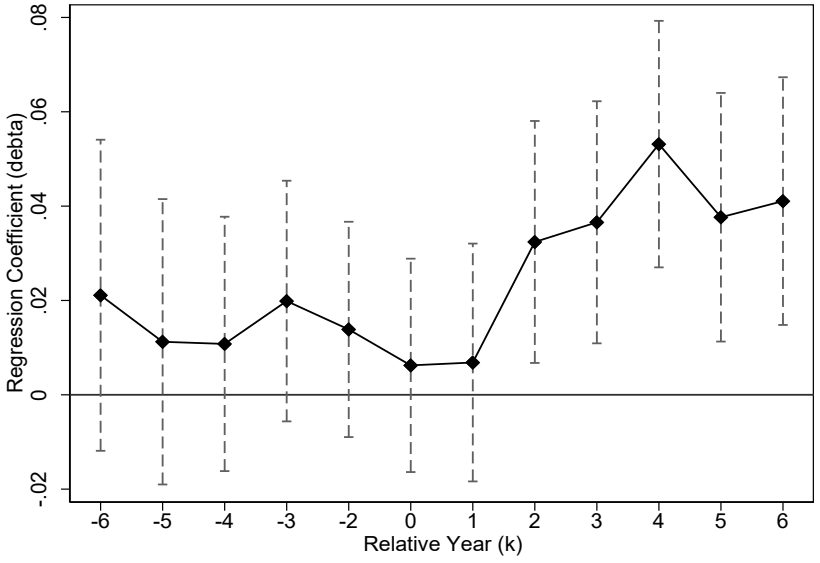

Fig. 1 Parallel Trend Test

4.3 Robust Test

4.3.1 No Anticipatory Effect Test

Another key identifying assumption underlying the DID methodology is the absence of anticipatory effects, meaning that firms in the treatment group ought not alter their behavior in expectation of the NEPL. To test this, an interaction term, Treat × Pre2014, is introduced into Equation (1) to capture the year immediately prior to implementation, and the analysis examines whether its coefficient differs significantly from zero. Furthermore, author implement placebo exercises by restricting the sample to the pre-policy period 2009–2014, assigning fictitious policy years Policy_2014, Policy_2013, and Policy_2012, and re estimating the model for each pseudo treatment.

Table 4 reports the results of the anticipatory effects tests. In Column (1), the coefficient of Treat × Pre2014 is 0.001 and statistically insignificant. Additionally, the coefficient on. Columns (2) to (4) report the placebo tests based on fictitious treatment years. The coefficients on DID_2014, DID_2013, and DID_2012 are 0.001, 0.001, and 0.004, respectively, all close to zero and not statistically significant. Overall, these results consistently indicate that there is no evidence of firms adjusting their financing mismatch behaviors prior to the actual implementation of the NEPL, thereby supporting the credibility of the baseline estimates.

Table 4. No Anticipatory Effects Test Results

	(1)	(2)	(3)	(4)
Treat×Post	0.019**			

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	(0.009)			
Treat × Pre2014	0.001			
	(0.008)			
DID_2014		0.001		
		(0.009)		
DID_2013			0.001	
			(0.007)	
DID_2012				0.004
				(0.007)
Size	-0.004	-0.004	-0.004	-0.005
	(0.008)	(0.015)	(0.015)	(0.015)
Age	0.111***	0.299***	0.299***	0.299***
	(0.029)	(0.035)	(0.035)	(0.036)
Lev	-0.030	0.020	0.020	0.020
	(0.027)	(0.038)	(0.038)	(0.038)
Cash	-0.023	-0.067	-0.067	-0.067
	(0.030)	(0.043)	(0.043)	(0.043)
Roa	-0.178***	-0.116	-0.116	-0.116
	(0.037)	(0.081)	(0.081)	(0.081)
Tobin	-0.001	0.004	0.004	0.004
	(0.002)	(0.005)	(0.005)	(0.005)
Top1	-0.001	-0.000	-0.000	-0.000
	(0.000)	(0.001)	(0.001)	(0.001)
Constant	0.001	-0.547*	-0.546*	-0.544*
	(0.183)	(0.321)	(0.320)	(0.320)
Firm FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Observations	22,783	7,312	7,312	7,312
R2	0.627	0.744	0.744	0.744

Notes:*** p<0.01, ** p<0.05, * p<0.1, Robust standard errors in parentheses.

4.3.2 Time-Window Sensitivity Test

To verify that author baseline results are not artifacts of listing timing and to reinforce identification, author re-estimate the DID model on two alternative subsamples that sequentially tighten the listing window. First, author retains only firms listed before 2015, and then author restrict further to firms listed before 2009. In Column (1), the estimated coefficient on the interaction term Treat × Post is 0.020 and statistically significant at the 5% level in the pre-2015 sample. Column (2) shows a highly significant coefficient ($p < 0.01$) of 0.030 when the sample is limited to firms listed before 2009. These findings confirm that the positive effect of environmental regulation on financing mismatch persists even after removing the influence of listing timing, confirming the validity and reliability of our baseline results.

4.3.3 Multilayer Fixed Effects

These contemporaneous shocks may affect industries heterogeneously through credit supply and demand channels, potentially confounding the estimated NEPL effect. To ensure that the NEPL effect is not confounded by contemporaneous policies or macro events, author conduct a set of robustness checks. Treat is defined at the two digits industry level. Sector by year fixed effects are defined at the letter level such as B mining, C manufacturing, and D utilities, which do not absorb Treat × Post. As reported in Table 5, column 3, the coefficient on Treat × Post equals 0.019 and is statistically significant at the five percent level, which indicates that the NEPL induced increase in maturity mismatch is not driven by regional or sectoral common shocks.

Table 5. Anticipatory Effects Test Results and Multilayer Fixed Effects

	(1)	(2)	(3)
Treat×Post	0.020**	0.030***	0.019**
	(0.009)	(0.011)	(0.010)
Size	-0.005	-0.005	-0.004
	(0.008)	(0.010)	(0.007)
Age	0.105***	0.085*	0.115***
	(0.029)	(0.043)	(0.029)
Lev	-0.002	-0.020	-0.028
	(0.028)	(0.037)	(0.026)
Cash	-0.012	0.025	-0.031
	(0.033)	(0.043)	(0.030)
Roa	-0.167***	-0.191***	-0.180***
	(0.040)	(0.052)	(0.037)
Tobin	-0.003	-0.009**	0.000
	(0.003)	(0.004)	(0.002)
Top1	-0.001	-0.001	-0.001
	(0.000)	(0.001)	(0.000)
Constant	0.039	0.116	0.001
	(0.190)	(0.249)	(0.172)
Firm FE	YES	YES	YES
Year FE	YES	YES	YES
Prov×Year FE	NO	NO	YES
Ind×Year FE	NO	NO	YES
Observations	18,606	11,187	22,448
R2	0.594	0.594	0.631

Notes:*** p<0.01, ** p<0.05, * p<0.1, Robust standard errors in parentheses.

5. Mechanism Analysis and Heterogeneity Discussion

5.1 Mechanism Analysis

5.1.1 Increase in Long-term Investment

Under the pressure of stringent environmental regulation, heavily polluting firms often impose stricter environmental standards, more frequent inspections, and levy heavier penalties for non-compliance, thereby raising compliance requirements for heavily polluting firms. These mandates compel firms to reallocate capital toward long-horizon, compliance-related assets such as plant upgrades, pollution-control facilities, and other fixed assets. To test this mechanism, author use the ratio of long-term investment to total assets (inva) as the dependent variable. Column (1) of Table 6 reports the regression results, showing that the coefficient on Treat×Post is 0.109 and is statistically significant at the 5% level, indicating that heavily polluting firms significantly increased the share of long-term investment in their asset structure after the NEPL came into effect. In economic terms, this magnitude implies a material and persistent shift of capital expenditure toward the long end under the policy shock. Given the nondeferrable and capital-intensive nature of these investments, firms rely on external debt to meet contemporaneous compliance outlays, which increases the likelihood of using short-term funding for long-horizon projects and thereby exacerbates maturity mismatch.

5.1.2 Credit Constraint Tightening Mechanism

The NEPL's high-intensity oversight significantly elevates the perceived regulatory risk for heavily polluting firms. Unlike transitory shocks, environmental regulation introduces persistent and potentially irreversible uncertainty regarding firms' future operating viability, including the risk of forced shutdowns, costly retrofits, or regulatory

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litigation over a multi-year horizon. Confronted with a worsened risk profile, financial institutions adopt more conservative lending standards and curb the supply of long-maturity credit, with the result that even compliance-oriented projects encounter tighter access to long-term financing. To verify this mechanism, author examine two measures—the ratio of long-term loans to total assets (debtlra) and the natural logarithm of the absolute value of long-term loans (lndebtl). Columns (2) and (3) of Table 6 show that the coefficients on Treat×Post are -0.006 and significance at the1% levels for debtlra, and -0.576, significant at the10% levels for lndebtl. These results provide consistent evidence that by increasing compliance risk, the NEPL tightened access to long-maturity credit and thereby reshaped firms' debt-maturity structure.

Table 6. Mechanism Analysis results

	(1)	(2)	(3)
	inva	debtlra	lndebtl
Treat×Post	0.109**	-0.006***	-0.576*
	(0.046)	(0.002)	(0.322)
Size	1.426***	0.019***	4.347***
	(0.053)	(0.002)	(0.212)
Age	-0.524***	-0.002	0.878
	(0.124)	(0.007)	(0.947)
Lev	-0.340*	0.119***	15.476***
	(0.201)	(0.007)	(0.756)
Cash	-0.050	-0.019**	-3.619***
	(0.210)	(0.007)	(0.930)
Roa	1.219***	-0.017	-1.002
	(0.316)	(0.011)	(1.272)
Tobin	-0.016	-0.001***	-0.263***
	(0.021)	(0.000)	(0.068)
Top1	0.005**	0.000	-0.012
	(0.002)	(0.000)	(0.013)
Constant	-11.306***	-0.427***	-93.023***
	(1.058)	(0.050)	(5.352)
Firm FE	YES	YES	YES
Year FE	YES	YES	YES
Observations	22,448	22,448	22,448
R2	0.783	0.733	0.668

Notes:*** p<0.01, ** p<0.05, * p<0.1, Robust standard errors in parentheses.

5.2 Heterogeneous Analysis

5.2.1 Corporate Ownership

In China, state-owned, private, and foreign-invested enterprises exhibit marked differences in financing channels, resource access, and governance structures, all of which shape how they adjust debt and investment strategies when facing new regulations like the NEPL. This study classifies firms into three ownership categories and then estimates subsample regressions accordingly.

As shown in Table 7, the effect is significant for private firms but not for state-owned or foreign-invested firms. Overall, the NEPL significantly raises the extent of short-term debt used for long-term investment among private firms, while it does not have a significant effect on state-owned or foreign-invested enterprises. A plausible interpretation is that private firms face stronger competition and greater financing constraints, with limited access to long maturity credit. To meet compliance and technology-upgrading needs, they tend to short-term debts, resulting in maturity mismatch. By contrast, state-owned enterprises tend to have more stable bank financing, reflecting

their policy status and stronger credit support. insulating them from adverse shifts in the external financing conditions. Foreign firms rely more on funding from parent companies or international capital markets, which attenuates the influence of domestic regulatory changes on their debt-maturity choices.

Table 7. Heterogeneous Analysis: Enterprise Ownership

	(1)	(2)	(3)
	state-owned	private	foreign
Treat×Post	0.018	0.028**	0.032
	(0.013)	(0.012)	(0.040)
Size	-0.022	-0.007	-0.002
	(0.014)	(0.009)	(0.026)
Age	0.130**	0.085**	0.190*
	(0.058)	(0.036)	(0.112)
Lev	0.039	-0.062*	-0.257**
	(0.047)	(0.033)	(0.108)
Cash	0.051	-0.122***	0.055
	(0.054)	(0.035)	(0.120)
Roa	-0.185***	-0.126***	-0.296*
	(0.065)	(0.048)	(0.154)
Tobin	-0.011**	0.004	0.012
	(0.005)	(0.002)	(0.008)
Top1	-0.001	-0.001	-0.000
	(0.001)	(0.001)	(0.001)
Constant	0.334	0.141	-0.230
	(0.381)	(0.212)	(0.645)
Firm FE	YES	YES	YES
Year FE	YES	YES	YES
Observations	7,605	13,790	1,388
R2	0.661	0.634	0.664

Notes:*** p<0.01, ** p<0.05, * p<0.1, Robust standard errors in parentheses.

5.2.2 Firm Life Cycle

Firms at different stages of development also respond heterogeneously to regulatory shocks. Younger firms are characterized by high growth potential, limited internal funds, and greater external financing dependence. It may react differently to the NEPL compared to mature counterparts, which typically enjoy stable cash flows, stronger reputations, and established credit channels. To examine life-cycle heterogeneity, this study splits firms by the median establishment year, defining firms founded after the median year as "young" and those founded before the median year as "old", and then estimates subsample regressions accordingly.

As reported in Table 8 (cols. 1–2), the Treat×Post estimate for young firms is 0.021 ($p < 0.10$), indicating a post-NEPL increase in maturity mismatch. For old firms, the corresponding coefficient is 0.015 and is statistically insignificant, suggesting no detectable adjustment in debt-maturity structure.

This pattern is consistent with life-cycle differences in financing frictions. Young firms typically have limited internal funds and weaker credit histories, which makes long-maturity financing harder to obtain when regulatory risk rises. As compliance-related investment needs increase after the NEPL, young firms are more likely to bridge these outlays with short-term borrowing, thereby exacerbating maturity mismatch. By contrast, old firms tend to have more stable cash flows and better access to long-term credit, which dampens their adjustment along the debt-maturity margin.

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Table 8. Heterogeneous Analysis: Firm Life Cycle and Firm Size

	(1)	(2)	(3)	(4)
	young	old	sizesmall	sizebig
Treat×Post	0.021*	0.015	-0.002	0.022**
	(0.012)	(0.016)	(0.015)	(0.011)
Size	-0.013	0.015	0.033**	-0.042***
	(0.011)	(0.012)	(0.014)	(0.013)
Age	0.153***	-0.257	0.189***	0.105***
	(0.037)	(0.222)	(0.046)	(0.038)
Lev	-0.054*	-0.100**	0.013	-0.135***
	(0.032)	(0.045)	(0.036)	(0.040)
Cash	-0.119***	0.013	-0.077**	-0.082**
	(0.035)	(0.045)	(0.038)	(0.039)
Roa	-0.193***	-0.139**	-0.102**	-0.207***
	(0.050)	(0.060)	(0.050)	(0.053)
Tobin	0.010***	-0.007*	0.007***	-0.006*
	(0.003)	(0.003)	(0.003)	(0.003)
Top1	-0.000	-0.001	0.000	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)
Constant	0.089	0.742	-1.064***	0.959***
	(0.248)	(0.729)	(0.297)	(0.321)
Firm FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Observations	12,177	10,606	11,392	11,391
R-squared	0.686	0.708	0.664	0.712

6. Conclusion

This research takes advantage of the 2015 NEPL and deploys DID with event-study into establishing the cause and effect of NEPL on the debt-investment mismatch in debt maturity of Chinese A-share manufacturing industry.

The NEPL leads to large maturity mismatch of heavily polluting companies; the Treat×Post estimate is 0.020, approximately 10.5% of the result mean of 0.191. These findings are also sound to parallel trend tests and alternative specifications and the event study reveals a long-lasting post policy curve. Second, mechanism tests indicate two drivers that are complementary to each other. On the investment front, the companies increase the proportion of long term capital expenditure, and this indicates the compliance-based spending on environmental retrofits, replacement of cleaner technology, and other firm capital expenditures. In the financing side, there is a contraction of the supply of long-term bank credit, and therefore, the percentage and the amount of long-term borrowing reduces drastically meaning that the accessibility of long-term credit to polluting firms becomes tight. Third, the results of the heterogeneity analyses show that the mismatch effect exists only within selected groups of firms, that is, private firms, younger firms, and larger firms, and the estimates of the corresponding state owned and foreign invested firms are not significant. Conversely, the statistically significant adjustment in firms which are state-owned and those which are foreign-owned which are subject to favorable access to credit facilities or global funding networks show little or no adjustment.

In addition to describing such empirical patterns, this study made an impact to the literature in various significant aspects. First, it enriches the existing study on environmental control, by refocusing the interest not on firm performance, but on corporate finance organization. This article focuses on an area where the environmental policy has not been adequately explored as a way of creating financial weak points. Second, insights of environmental economics and corporate finance are also incorporated into the analysis, reflecting that regulatory stringency also combines with credit allocation mechanism, and it poten-

tially increases liquidity and refinancing risks. Third, the focus on the NEPL of China can give evidence of an important emerging economy where the role of finance and regulatory interference of banks remain prevalent. The implication that such finding has is boarder implications on the effect that environmental regulation have on economics as it goes on.

These findings allow formulating three specific policy recommendations.

Less regulatory uncertainty to reduce short term bias in financing. Since the uncertainty caused by NEPL elicited precautionary short term borrowing, the policy makers ought to improve the predictability and consistency in the various policies. Publication of gradual compliance plans, explanation of the emission limits and even to maintain a equal level of conformity on different geographical areas would aid companies to avoid over-dependence on short-term loans to offset the policy risk. This would enhance a better financing form and lessened the distortions of the rush-to-comply.

Enhance green finance supply in medium and long terms. Long-term compliance-driven investments are long-term in nature thus regulatory authorities and financial institutions should increase access to long-term compliant-driven investments. These steps encompass increasing green credit facilities, sale of green bonds, as well as provision of interest subsidies or government guaranteed. Notably, these tools ought to be aimed at the private and mature firms. This would relieve debts in the short term on long term investments, facilitate sustainable compliance and mitigate systemic liquidity risks.

Firm type specific, firm size specific support. In case of the private and mature companies, the regulators might create long-term green financing windows, inclusive of first-loan guarantees and transitional interest-subsidies. It should also be enforced regularly and progress reporting should be made transparent, to avoid refinancing shocks, instead of ad hoc crackdowns, which can only be done with a campaign-style one. This would save compliance loads on vulnerable groups, lowering refinancing risks, and encouraging an orderly move towards green upgrading.

There are a number of suggestions to further research. To begin with, future research might investigate the further dynamics of post-regulations to determine the continuation of maturity mismatch and even the anti-mismatch in the future as green finance markets are increasingly developed and firms align to the more stringent environmental policies. Second, micro-level information of bank-firm relationship may be useful to investigate the possibility that the tightening of the long-term credit is not an effect of risk-based screening, but rather strategic credit reallocation to greener firms. Third, some cross-country comparative work would be useful to discuss the possibility of similar mechanisms working in more developed capital markets economies or in various regulatory environments.

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