

# Fiscal Decentralization and Green Innovation - Evidence from Listed Firms in China

Yuankai Xu

School of Nankai University, Tianjin 300071, China

**Abstract.** This paper takes the reform of "Province-Managing-County(PMC)" as a natural experiment, utilizes the data of listed enterprises and green patent data from 2007 to 2019, and applies the method of the difference-in-differences(DID) to investigate the impact of fiscal decentralization on enterprises' green innovation. The study finds that the PMC reform makes the green innovation of enterprises decrease by 27.34%, and this phenomenon is more significant in state-owned enterprises and non-heavy pollution industries. The main mechanism lies in the fact that local governments, in pursuit of economic development, reduce the amount of sewage charges paid by enterprises and lower the entry threshold of enterprises, and at the same time, this behavior influences the decision makers of enterprises to reduce the amount of environmental protection investment of enterprises. Additionally, the study found that government environmental protection subsidies can ease financial constraints on enterprise green innovation, mitigating the inhibitory impact of PMC reform. The paper advocates shifting from a traditional rapid economic development model to embracing green development, integrating it into core government management, and methodically advancing fiscal decentralization reform.

**Keywords:** Province-Managing-County; fiscal decentralization; corporate green innovation; difference-in-differences.

## 1. Introduction

Since Reform and opening-up, China's economy rapidly advanced, yet the rough economic model spurred rising environmental pollution. Innovation emerges as the prime mover for green development, notably at the microenterprise level, where it not only fosters green, high-quality development but also yields eco-friendly products, driving fresh market demand and bolstering firms' green sector competitiveness [1]. This discovery accelerates the realization of a win-win situation for both economic efficiency and environmental protection.

The 7th National Environmental Protection Conference stressed basic environmental quality as a public good, mandating government assurance. In traditional environmental federalism, local governments provide key public goods like environmental quality. Effective alignment of financial and administrative powers drives policy implementation and ecological civilization. Local governments' leadership in environmental protection is vital, highlighting the governmental role in promoting green innovation.

There's no consensus on fiscal hierarchy reform's impact on corporate green innovation. Some argue under "Chinese decentralization," government gains greater financial autonomy [2], fostering lax development that neglects local environmental governance. This approach, encouraging rapid, short-term economic growth, hinders green innovation [3]. Conversely, since 2005, the central govt prioritized energy and environmental targets, integrating environmental performance into officials' assessments [4]. This shift emphasizes environmental spending and suggests increased financial and administrative authority could enhance enterprise green innovation, promoting ecological civilization. This paper investigates fiscal decentralization's effect on enterprise green innovation using PMC as a proxy variable.

For PMC reform, existing studies mainly focus on: ① Air pollution management, utilizing methods like DID to gauge fiscal decentralization's impact on haze pollution [5], and employing satellite inversion of PM2.5 data to analyze air pollution trends pre and post PMC reform [6]. ② Finance and taxation, investigating PMC reform's impact on industrial enterprises' tax burden [7], grassroots government fiscal expenditure decisions post-decentralization [8], and municipal

governments' potential alleviation of fiscal burden via stricter tax administration [9].<sup>③</sup> Economic growth, estimating PMC reform's impact using DID [10] and evaluating its economic growth effect [11]. From the above literature, it can be found that few studies have examined whether the reform of "province directly supervising counties" has an impact on the level of green innovation of enterprises.

Utilizing listed enterprise and green patent data (2007-2019) alongside the PMC reform natural experiment, this study employs the multi-period DID method to probe the fiscal vertical tier reform's impact and mechanism on county enterprise green innovation levels. Results indicate the PMC reform hampers green innovation in pilot counties, validated by parallel trend, placebo, and variable replacement tests. Mechanistically, the PMC reform lowers enterprise sewage charges, curbing environmental protection investment and constraining green innovation funds. Notably, state-owned enterprises and non-heavily polluting industries suffer more pronounced negative effects, mitigated by government environmental subsidies and regulations in pilot counties.

The marginal contributions of this paper are: Firstly, it pioneers an examination of the fiscal hierarchy reform's influence on enterprise green innovation through the PMC lens, offering micro-level evidence for environmental governance. Secondly, employing the multi-period DID method, the study identifies the causal link between fiscal hierarchy and corporate green innovation, supplemented by robustness tests to bolster credibility. Additionally, it delves into the impact of PMC reform on enterprise ownership and industry pollution levels, enhancing precision in identifying affected subjects and sectors. Furthermore, it investigates the effects of financial incentives and environmental regulations, exemplified by government subsidies and carbon emissions trading pilots, on decentralization reform and corporate green innovation. Thirdly, leveraging microdata, the paper offers insights for future fiscal system reform. Given China's ongoing reform drive, particularly in financial and administrative decentralization, and ecological civilization construction, the study's focus on the impact of sub-provincial government decentralization on enterprise green innovation holds substantial practical significance. Through comprehensive research, it furnishes valuable recommendations for China's governmental system reform, informing future policy directions.

## 2. Institutional context and research hypotheses

### 2.1 Institutional context

Since New China's establishment, maximizing cities' economic roles led to the city-county system, with cities overseeing counties, a viable strategy then. This system formed a five-tiered political regime—central government, provinces, prefectural cities, counties, and townships—by the 21st century's onset. However, drawbacks exist: power deprivation and centralization at prefectural and municipal levels, burdening lower tiers with grassroots public service costs. This imbalance skews land allocation, planning, projects, and investment towards prefectural cities, squeezing county and county-level city authority. Consequently, many counties struggle economically, constraining small cities' national economic roles.

In this context, reforming the municipal-county system is imperative. Direct division of county finances with the province bypasses local municipal oversight, with provincial treasury issuing financial transfers, special payments, and subsidies to cities and counties. Streamlining local financial layers bolsters county financial autonomy, mitigating disparities between financial power and county authority exacerbated by municipal "exploitation" of county finances. Pilot initiatives in province-controlled counties, implemented since 2002 in provinces like Zhejiang, Guangdong, Henan, Liaoning, Hubei, Jiangsu, Anhui, Shandong, and Jiangxi, demonstrate progress.

In terms of reform impact, PMC reform directly increased grassroots government spending on infrastructure [8], intensified tax competition among county governments [7], notably reducing urban-rural income disparity while enhancing county-level education and social welfare [12], and driving regional industrial structure upgrades [13]. Yet, studies indicate declines in education, science, technology, and healthcare spending, affecting livelihood fiscal outlays [8], with financial PMC

impeding urban economy growth, potentially disadvantaging certain prefectural-level cities [14]. Implementation-wise, PMC reform's effects vary across provinces..

## 2.2 Research hypotheses

### 2.2.1 Impact of the PMC reform on green innovation

Compared to non-reform counties, reform counties exhibit heightened "pollution discretion" and regulatory tool utilization, influencing environmental pollution levels. Consequently, amidst economic growth and financial strain, county governments possess strong incentives to prioritize economic growth over environmental concerns. They actively attract high-pollution, high-energy-consumption enterprises by easing environmental access thresholds and sewage fees [15]. Moreover, with increased socio-economic management authority at the county level, expenditure responsibilities expand. While some provinces decentralized fiscal and tax management or provided more subsidies, studies suggest overall revenue fails to offset expenditure growth [16]. Amidst intensified fiscal pressure, local governments may favor construction projects for rapid economic and fiscal gains, neglecting environmental concerns. Thus, this paper posits the following research hypothesis:

Hypothesis 1: The implementation of the reform of PMC has a dampening effect on the level of green innovation of enterprises.

### 2.2.2 Mechanisms for the PMC reform's impact on green innovation

The PMC reform likely attracted low-tech, high-pollution, high-energy industries via lenient environmental enforcement policies, like relaxed access thresholds and reduced sewage fees. Though these industries yield quick economic and tax gains, they also heighten pollution and resource use. Local governments may prioritize them for short-term growth and fiscal benefits. Consequently, firms may lack incentives and resources for environmental R&D and innovation. Reduced enforcement weakens environmental investment, hindering green technology adoption and innovation. This environment may steer firms towards traditional, polluting methods over sustainable ones. Hence, Hypothesis 2 posits.

Hypothesis 2: The reform of PMC inhibits the level of green innovation of enterprises by reducing the intensity of environmental enforcement.

Enterprises predominantly shape green innovation levels by moderating environmental investment funds [17]. Amid market competition, firms typically opt for cost-cutting, profit-driven, high-pollution, high-energy production methods over hefty investments in environmental infrastructure and R&D. Simultaneously, local governments lean towards fostering economic growth, often neglecting environmental concerns during policy formulation and implementation, thereby diminishing support for enterprise environmental investments. Hence, this paper posits Hypothesis 3.

Hypothesis 3: The reform of PMC inhibits the level of green innovation of enterprises by reducing their investment in environmental protection.

## 3. Research design

### 3.1 Sample selection and data sources

This paper examines fiscal level reform's impact on listed enterprises' green innovation, using the PMC reform as a natural experiment from 2007-2019. Listed enterprise data sourced from CSMAR, CNRDS, and WIND; PMC reform data from provincial government communiqués; county-level data from the China County Statistical Yearbook. The chosen time interval considers data availability and avoids the 2006 corporate accounting standards change's influence, starting from 2007.

This paper conducts the following data cleansing process on the acquired database: 1. Organizing relevant enterprise data into a table using stock codes and fiscal years, subsequently integrating and matching county-level data with enterprise data based on county regional codes to form an unbalanced panel dataset. 2. Omitting data from the jurisdictions of Zhejiang, Ningxia, and Hainan provinces, which have undergone long-term PMC reform. 3. Excluding data from Zhejiang, Ningxia,

and Hainan provinces, historically managed under "province directly supervising county" policy. Since municipal county administrative levels differ from other provinces, data from Beijing, Tianjin, Shanghai, and Chongqing, along with Xinjiang and Tibet, are excluded due to significant missing data and the unique nature of autonomous region management. 4. Removing data from enterprises with abnormal or missing key financial variables. Key continuous variables are truncated at the 1% and 99% levels to mitigate the influence of outliers. Following these procedures, 34,431 observations are obtained.

### 3.2 Specification and variable

$$y_{i,c,p,t} = \alpha_0 + \alpha_1 PMC_{c,t} + \alpha_2 X_{i,t} + \alpha_3 Z_{c,t} + \lambda_i + \delta_t + \varphi_{p,t} + \varepsilon_{i,c,p,t} \quad (1)$$

Where the subscript *i* represents the enterprise, *c* represents the county, *t* represents the year; *y* represents the level of green innovation of the enterprise, this paper use the number of green patent applications of the enterprise plus 1 and then take the natural logarithm to measure [18]. The main considerations are as follows: It has been found that the patented technology will have an impact on the enterprise in the process of application [19], so it is more accurate and effective to choose the number of green patent applications.  $PMC_{c,t}$  It is a dummy variable for the financial PMC reform;  $X_{i,t}$  is a control variable at the enterprise level, and  $Z_{c,t}$  is a control variable at the county level;  $\lambda_i$  is a firm fixed effect,  $\delta_t$  is a year fixed effect, controlling for factors that do not change over time at the listed company level and those that remain constant from year to year; in addition, this paper adds province-time interaction fixed effects  $\varphi_{p,t}$  to control for possible differences in PMC policies across provinces over time. [20].  $\varepsilon_{i,c,t}$  is a random perturbation term, and the regression standard errors are clustered to the county level.

For the core explanatory variables  $PMC_{c,t}$  In this paper, the county where enterprise *i* is located, *c*, is a pilot of the PMC reform at time *t* and in subsequent years, then it takes 1, otherwise it takes 0 [6].

For control variables, this paper mainly include [18,21]: (1) Regional development level (GDP) (2) Value added of primary industry (Ind1) (3) Value added of secondary industry (Ind2) (4) Value added of tertiary industry (Ind3) (5) Population size (Pop): the total local year-end population Take the natural logarithm (6) regional standard of living (GDPper): per capita gross domestic product to take the natural logarithm (7) equity concentration (Concen): the first major shareholder shareholding ratio (8) enterprise size (Size): total assets to take the natural logarithm (9) operating income (OI) (10) the nature of enterprise property rights (SOE): state-owned enterprises to take 1, or else to take 0 (11) Total Assets Growth (Assets Growth) (12) Government Subsidy (Government Subsidy) (13) Actual environmental protection tax paid by the enterprise (Environment Tax): the environmental protection tax in 2007-2017 is replaced by sewage charges (14) Equity Multiplier (EM): total assets / Total Owner's Equity (15) Operating Leverage (Dol): (Net Profit + Income Tax Expense + Financial Expense + Depreciation of Fixed Assets, Depreciation of Oil and Gas Assets, Depreciation of Produced Biological Assets + Amortization of Intangible Assets + Amortization of Long-term Amortization Expense) / (Net Profit + Income Tax Expense + Financial Expense) (16) Total Profit Growth: (Current Single Quarter of the Year) Total Profit - Total Profit of the previous single quarter)/(Total Profit of the previous single quarter), and the descriptive statistics of the main variables are shown in Table 1.

Table 1 Descriptive statistics of main variables

variant	Description of variables	observed value	average value	(statistics) standard deviation
Lnenvrpat	Number of green patents filed by companies plus one and then take the logarithm	4528	0.434	0.845
PMC	PMC Reform	4528	0.307	0.461

Environment_Tax	Actual payment of sewage charges and environmental protection tax of RMB 10,000,000	4528	192.155	464.421
GDP	Gross regional product million yuan	4528	6.79E+06	6.77E+06
Ind1	Value added of primary industry, ten thousand yuan	4528	2.33E+05	1.98E+05
Ind2	Value added of secondary industry, ten thousand yuan	4528	3.36E+06	3.64E+06
Ind3	Value added of tertiary industry, ten thousand yuan	4528	3.14E+06	3.52E+06
Size	Enterprise size	4528	22.001	1.178
OI	revenues	4528	4.89E+09	9.16e+09
Concen	Shareholding ratio of the largest shareholder	4528	35.636	14.453
SOE	Nature of enterprise ownership	4528	0.321	0.467
EM	equity multiplier	4528	2.014	1.069
Dol	business leverage	4528	1.690	2.196
Assets_Growth	Total asset growth rate	4528	0.222	0.341
Profit_Growth	Total profit growth rate	4528	0.269	72.217
Government_Subsidy	government grant	4528	2.29E+07	5.76E+07
Pop	Total population at the end of the year in logarithms	4528	4.180	0.570
GDPper	Logarithmic GDP per capita	4528	11.097	0.603

## 4. Analysis of empirical results

### 4.1 Baseline regression results

Columns (1)-(3) in Table 2 analyze the PMC reform's impact on enterprise green innovations. The explanatory variables include total green patent applications plus one, and the logarithm of total green patents, alongside the PMC reform. Columns (1)-(3) control for enterprise and regional variables, sequentially adding enterprise, year, and province-year fixed effects. Regardless of fixed effects inclusion, the PMC reform coefficient on enterprise green patent applications is notably negative. Column (3), accounting for fixed effects, exhibits significantly negative PMC coefficients at the 1% level. The PMC reform reduces county enterprise green patent applications by 27.34% on average, indicating fiscal reform's adverse effect on enterprise green innovation, confirming Hypothesis 1.

Table 2 Benchmark model regression

	(1)	(2)	(3)
	Lnenvrpat	Lnenvrpat	Lnenvrpat

PMC	-0.1882*	-0.2270**	-0.2734***
	(0.1131)	(0.1082)	(0.1048)
Enterprise control variables	YES	YES	YES
County control variables	YES	YES	YES
firm fixed effect	YES	YES	YES
Year fixed effects		YES	YES
Province-Year Fixed Effects			YES
N	4528	4528	4528
r2	0.7281	0.7312	0.7466

Note: \*, \*\*, and \*\*\* indicate significant at the 10%, 5%, and 1% confidence levels, respectively, and standard errors clustered to the county level are in parentheses. Same below.

#### 4.2 Parallel trend test

The DID model hinges on meeting the parallel trend assumption, ensuring consistent pre-policy change trends between experimental and control groups. Failure risks misestimating policy effects. Hence, we establish an econometric model scrutinizing policy implementation's yearly effects and verifying the parallel trend assumption.

$$y_{i,c,t} = \beta_0 + \sum_{k=-4}^{k=2+} \beta_k D_{c,t}^k + \beta_2 X_{i,t} + \beta_3 Z_{c,t} + \lambda_i + \delta_t + \varphi_{p,t} + \varepsilon_{i,c,t} \quad (2)$$

where  $D_{c,t}^k$  is a series of time dummy variables denoting the time relative to the initial year of the reform.  $k=-4$  represents four years pre-reform,  $k=2$  represents the second year post-reform and subsequent years,  $k=0$  denotes the reform year, and  $k<-4$  serves as the base year, omitted from the equation. Figure 1 depicts  $\beta_k$  coefficient estimates and 95% confidence intervals, illustrating pre-reform parallel trends and post-reform dynamics. Pre-reform  $\beta_k$  parameters are insignificantly different from 0, indicating no disparity in green patent applications between pilot and non-pilot counties, satisfying parallel trend assumptions. Post-policy implementation,  $\beta_k$  coefficient for experimental group green innovation patents significantly decreases compared to the control group, post-reform PMC policy.

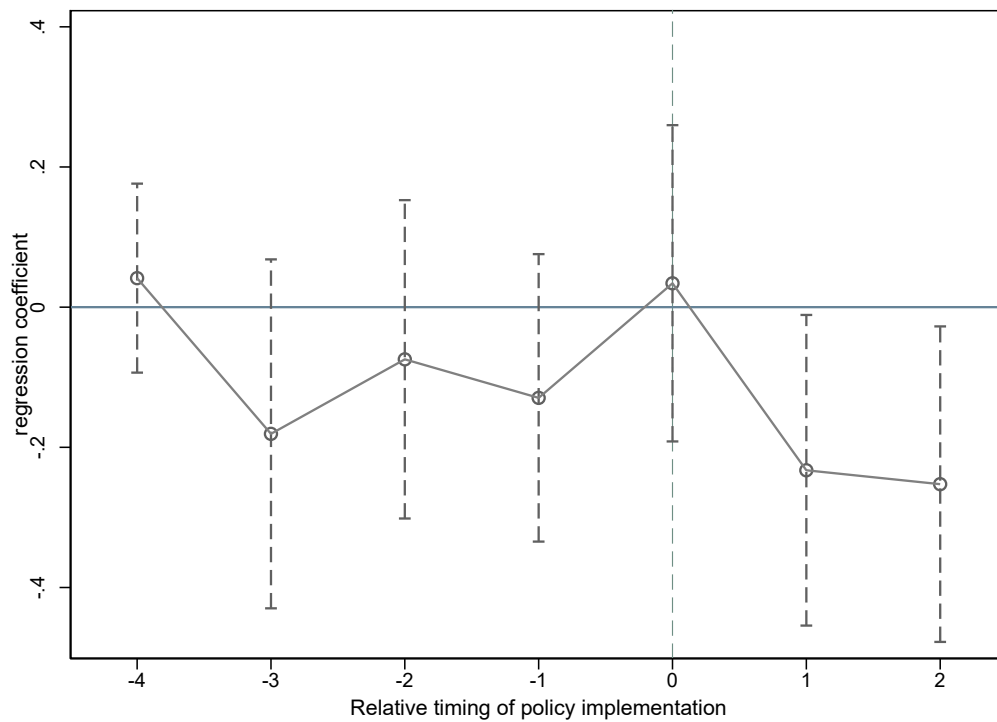


Fig 1 Parallel trend test

### 4.3 Placebo test

The experimental and control groupings may be affected by other randomization factors, and a placebo test is needed to enhance the robustness of the results in this paper. To exclude this interference, the placebo test is performed in this paper using the nonparametric permutation test [20]. From Figure 2, it can be seen that the estimated coefficients obtained from random sampling are normally distributed centered on 0 and are significantly higher than the true estimated coefficients (-0.273). This suggests that the decline in the number of green innovation patents of enterprises is indeed caused by the policy of "province directly supervising the county", and its policy effect is not interfered by other unobserved random factors.

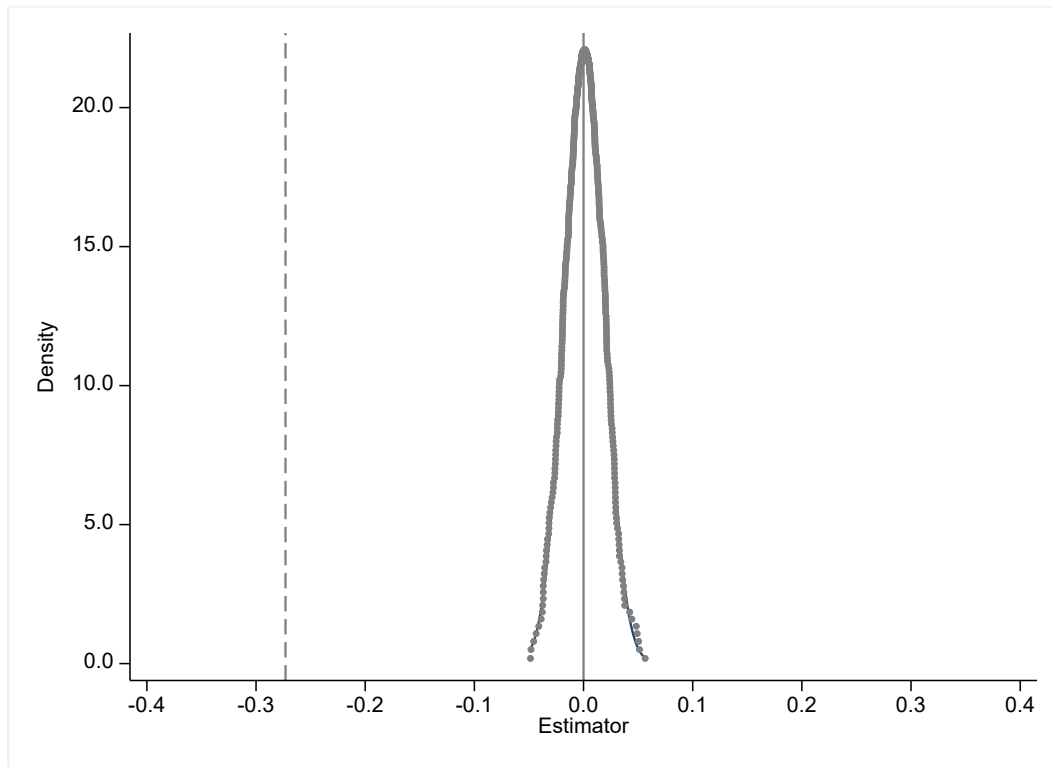


Fig 2 Placebo test

#### 4.4 Other robustness tests

Additionally, this study conducts a robustness test by altering the explanatory variables. The replacement of indicators includes RatioEnvrPat, RatioEnvrInvPat, and RatioEnvrUtyPat, which help mitigate confounding factors affecting both the numerator and denominator [22]. Regression results in Table (3) indicate the PMC reform coefficient in column (1) is significant at the 1% level, while in columns (2) and (3) it's significant at the 5% level, affirming the robustness of the baseline regression analysis.

Table 3 Other robustness tests

	(1) RatioEnvrPat	(2) RatioEnvrInvPat	(3) RatioEnvrUtyPat
PMC	-0.037*** (0.012)	-0.029** (0.013)	-0.018** (0.008)
Enterprise control variables	YES	YES	YES
County control variables	YES	YES	YES
firm fixed effect	YES	YES	YES
Year fixed effects	YES	YES	YES
Province-Year Fixed Effects	YES	YES	YES
N	7776	8583	8132
r2	0.521	0.475	0.486



## 4.5 Heterogeneity analysis

### 4.5.1 Heterogeneity in the nature of property rights

Given the inherent political ties between State-owned enterprises (SOEs) and the government, governmental policies can profoundly impact SOE management decisions. Thus, we categorize enterprises into state-owned and non-state-owned, conducting separate regression analyses. Our findings reveal significant regression coefficients for PMC in state-owned enterprises at the 5% level, indicating a 29.5% decrease in green innovation patents in pilot counties compared to non-pilot counties. Conversely, the regression coefficients for PMC in non-state-owned enterprises demonstrate significance at the 10% level, suggesting that PMC reform primarily suppresses green innovation in state-owned enterprises. This suppression could stem from SOEs' close government ties, enabling them to mitigate environmental pressures through political influence.

### 4.5.2 Heterogeneity of heavily polluting industries

To probe heavy pollution industry heterogeneity, we assess its susceptibility to "province directly supervising the county" reform. Enterprises are categorized based on the Ministry of Ecology and Environment's Environmental Protection Verification Industry Directory. Regression analysis follows [23]. Table 4 (columns 3 and 4) shows negative, nonsignificant coefficients of PMC for heavy polluting industries, contrasting with significantly negative coefficients for non-heavy polluting industries at the 1% level. This suggests the reform mainly curbs green innovation in non-heavy polluting industries in pilot counties. Likely due to stringent scrutiny on heavily polluting sectors, non-heavy polluting industries face looser regulations and are enticed by short-term profits, rendering them more vulnerable to fiscal decentralization reform.

Table 4 Heterogeneity analysis

	(1) nationalized business	(2) non-state enterprise	(3) Heavily polluting industries	(4) Non-heavy polluting industries
PMC	-0.295** (0.144)	-0.276* (0.157)	-0.142 (0.128)	-0.300*** (0.109)
Enterprise control variables	YES	YES	YES	YES
County control variables	YES	YES	YES	YES
firm fixed effect	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES
Province-Year Fixed Effects	YES	YES	YES	YES
N	2322	5413	4970	2784
r2	0.771	0.502	0.723	0.779

## 5. Analysis of mechanisms

Based on the analysis above, PMC reform inhibits enterprise green innovation. What specific influence pathway does it entail? Subsequent examination delves into financial reform's impact on enterprises' environmental enforcement and protection investment.

### 5.1 Environmental enforcement efforts

As per Article 3 of the Regulations on Sewage Charge Collection and Use, regional environmental protection is overseen by local governments, guiding, managing, and supervising sewage charge activities. This study indicates that sewage charge magnitude relies heavily on local environmental law enforcement[15,24]. Hence, we employ the sewage charge-to-operating profit ratio as an index of local environmental enforcement. We compile data on enterprises' sewage charge payments (substituted by environmental protection tax for 2018-2019) by annotating their annual property statement reports.

In Table 4, column (1) reveals significant negative regression coefficient of PMC at the 5% level. Compared to non-reform counties, enterprises in reformed regions pay approximately 3.6% less in sewage charges. This trend stems from local governments prioritizing swift economic growth, relaxing environmental enforcement by reducing access approval thresholds and sewage fees. Consequently, green innovation capacity of enterprises is hindered, supporting Hypothesis 2.

### 5.2 Business investment in environmental protection

Examining the PMC reform's impact on corporate environmental investment, this study extracts data from listed companies' annual reports [25] and announcements to gauge environmental investment levels via the ratio of environmental investment to operating income. Robustness tests substitute explanatory variables with the ratio of environmental investment to total assets. Through regression analysis (Table 4, columns 2 and 3), it's evident that PMC coefficients are significantly negative at the 10% level. This suggests that PMC reform causes a roughly 2.5% decrease in enterprises' environmental investment asset ratio and a 6.4% decrease in revenue ratio. This decline in environmental investment prompts enterprises to relax pollution emission control, hindering green innovation levels and confirming Hypothesis 3.

Table 5 Mechanism tests

	(1) sewage charge	(2) Environmental Investment Asset Ratio	(3) Environmental investment revenue ratio
PMC	-0.036** (0.017)	-0.025* (0.013)	-0.064* (0.036)
Enterprise control variables	YES	YES	YES
County control variables	YES	YES	YES
firm fixed effect	YES	YES	YES
Year fixed effects	YES	YES	YES
Province-Year Fixed Effects	YES	YES	YES
N	17622	18755	12291
r2	0.204	0.358	0.653

## 6. Further analysis

### 6.1 Moderating effect of government environmental subsidies

Green subsidies bolster enterprise green innovation, fostering core competitiveness for sustained development. To scrutinize the interplay between government environmental subsidies and fiscal decentralization, this paper devises the ensuing econometric model:

$$y_{i,c,t} = \alpha_0 + \alpha_1 PMC_{c,t} \times TREAT + \alpha_2 X_{i,t} + \alpha_3 Z_{c,t} + \lambda_i + \delta_t + \varphi_{p,t} + \varepsilon_{i,c,t} \quad (3)$$

In the model, TREAT denotes government environmental subsidies for enterprises; TREAT equals 1 if received, else 0. In Table 5, column (5), the regression coefficient of  $PMC_{c,t} \times TREAT$  is notably positive at the 5% significance level, which indicates government environmental subsidies diminish PMC reform's inhibitory effect on enterprise green innovation. This stems from green tech innovation's capital-intensive nature, prolonged profit cycles, and unpredictable risks [22]. Subsidies partially relieve resource constraints and financing hurdles, thus mitigating fiscal decentralization's inhibitory impact on enterprise green innovation levels.

### 6.2 Moderating effects of environmental regulation

The central government piloted carbon emissions trading to enhance environmental quality. With heightened government environmental focus, regulations may temper PMC reform and enterprise green innovation. Carbon trading, as an environmental policy, incentivizes green innovation [26]. This paper proxies carbon trading with a dummy variable CET, set at 1 for provinces in carbon trading and 0 otherwise. In Table 6, Column (2), interaction terms of PMC and CET are positive and significant, indicating environmental regulation mitigates fiscal barriers to green innovation. Consistent with Porter's hypothesis, effective regulation spurs innovation and efficiency gains [27], affirming the role of environmental policy in fostering innovation..

Table 6 Further analysis

	(1) $PMC_{c,t} \times TREAT$	(2) $PMC_{c,t} \times CET$
PMC	0.062** (0.025)	0.285*** (0.109)
Enterprise control variables	YES	YES
County control variables	YES	YES
Firm fixed effect	YES	YES
Year fixed effects	YES	YES
Province-Year Fixed Effects	YES	YES
N	10548	9789
r2	0.739	0.714

## 7. Conclusions and policy implications

Green development, vital for environmental sustainability, is imperative. This paper leverages the Chinese decentralized context, treating the PMC reform as a quasi-experiment. Analyzing 2007-2019 data on listed enterprises and green patents, employing multi-period DID methodology, it investigates fiscal tier impact on enterprise green innovation. Key findings reveal: PMC reform deters green innovation persistently, validated through trend and placebo tests. It particularly affects state-owned firms and less-polluting enterprises. PMC hampers green innovation via reduced sewage charges and lowered environmental entry thresholds. Moreover, it diminishes enterprise environmental investment, perpetuating green innovation inhibition. Additionally, government environmental subsidies and regulations alleviate PMC reform's impact on green innovation, underscoring their mitigating role.

Based on the above findings, the following policy insights are obtained: first, Enhance incentives for environmental stewardship among state-owned enterprises and less-polluting industries. Intensify

oversight to prevent profit-driven neglect of environmental concerns. Second, Establish clear environmental objectives and long-term plans for enterprises. Encourage increased investment in environmental protection measures. Third, Appropriately augment government subsidies for environmental protection to ease financial burdens on green innovation. Additionally, improve environmental regulations and reinforce the sewage trading market system to foster green development by catalyzing enterprise-driven green innovation.

## References

- [1] Szczygielski K, Grabowski W, Pamukcu M T, et al. Does government support for private innovation matter? Firm-level evidence from two catching-up countries[J]. *Research Policy*, 2017, 46(1): 219-237.
- [2] Xu C. The fundamental institutions of China's reforms and development[J]. *Journal of economic literature*, 2011, 49(4): 1076-1151.
- [3] Jin Rongxue, Zhang Di. Research on the Efficiency of Environmental Protection Expenditures by Provincial Governments in China [J]. *Business and Management Journal*, 2012, 34(11): 152-159.
- [4] Tao Feng, Zhao Jinyu, Zhou Hao. Does Environmental Regulation Improve the Quantity and Quality of Green Innovation-Evidence from the Target Responsibility System of Environmental Protection [J]. *China Industrial Economics*, 2021, (02): 136-154.
- [5] Zhang Hua. Province-Managing-County Reform and Haze Pollution: Evidence from Chinese Counties [J]. *Nankai Economic Studies*, 2020, (05): 24-45.
- [6] Wang Xiaolong, Chen Jinhua. Province Managing County Reform and Regional Air Pollution: Empirical Evidence from Satellite Inversion Data [J]. *Journal of Financial Research*, 2020(11): 76-93.
- [7] Wang Xiaolong, Fang Jinjin. Reform of "County Directly Administrated by Province" and Tax Competition among the Lower-level Local Governments [J]. *Economic Research Journal (in Chinese)*, 2015, 50 (11): 79-93+176.
- [8] Chen Sixia, Lu Shengfeng. Does Decentralization Increase the Public Services Expenditures: A Quasi-Experiment of "County Administrated by Province" in China [J]. *China Economic Quarterly (in Chinese)*, 2014, 13 (04): 1261-1282.
- [9] Li Guangzhong, Jia Fangsheng. Government Fiscal Incentives, Tax Enforcement, and Enterprise Earnings Management: A Study Based on the Natural Experiment of Fiscal PMC Reform [J]. *Journal of Financial Research*, 2019(02): 78-97.
- [10] Zheng Xinye, Wang Han, Zhao Yizhuo. Can "Provincial Directly Administered Counties" Promote Economic Growth? --Difference-in-difference Method [J]. *Journal of Management World*, 2011, (08): 34-44+65.
- [11] Ye Bing, Huang Shaoqing, He Zhenyu. Does "Province Directly Governing County" Reform Promote Provincial Economic Growth? [J]. *China Economic Studies*, 2014(06): 3-15.
- [12] Tan Zhibo, Zhou Lian, Zhao Yue. "County Administrated by Province" Reform, Fiscal Decentralization and People's Welfare: A Difference-in-Differences Estimation [J]. *China Economic Quarterly (in Chinese)*, 2015, 14 (03): 1093-1114.
- [13] Wang Liyong, Gao Yuyan. Fiscal Decentralization and Upgrading of Industrial Structure: Empirical Evidence from a Quasi-Natural Experiment of Province Managing-County Reform [J]. *Finance & Trade Economics*, 2018, 39 (11): 145-159.
- [14] Cai Guowei, Zhang Xuezhi, Deng Weiguang. Does the Reform of 'County Directly Administrated by Province' Damage the City's Interests? [J]. *Economic Research Journal (in Chinese)*, 2011, 46 (07): 65-77.
- [15] Yu, Jinliang. Polluting Effects of Heterogeneous Decentralisation: Evidence from China's Reform of the Local Governance System [J]. *The Journal of World Economy*, 2022, 45 (05): 185-207.

- [16] Li, Yongyou. The Lower-provincial Diversified Delegation Strategies and Economic Growth [J]. Economic Research Journal (in Chinese), 2021, 56 (02): 39-53.
- [17] Li Yi, Gao Da and Wei Ping. Dose the central environmental inspection induce green innovation in firms? [J]. Studies in Science of Science, 2021, 39(08):1504-1516.
- [18] Huang Jicheng, Zhu Guangshun. The Chinese Green Development Model: Public Procurement and Corporate Green Innovation [J]. The Journal of World Economy, 2023, 46 (11): 54-78.
- [19] Li Wenjing, Zheng Manni. Is it Substantive Innovation or Strategic Innovation?--Impact of Macroeconomic Policies on Micro-enterprises' Innovation [J]. Economic Research Journal (in Chinese), 2016, 51(04):60-73.
- [20] Bai Yanfeng, Lu Shuling. Fiscal Fiscal Hierarchy Reform and Corporate Innovation: A Quasi-natural Experiment Based on the "Province-managing-county" Fiscal Reform [J]. Journal of Central University of Finance & Economics, 2021, (11): 12-23.
- [21] Tian Yaqun, He Guangwen, FAN Yachen, LIU Chang. Does the Fiscal Reform of "Counties Directly Governed by Province" Help Win the Blue Sky Battle? Evidence from County-level Air Quality [J]. Chinese Rural Economy, 2023, (03): 101-119.
- [22] Xu Jia, Cui Jingbo. Low-Carbon Cities and Firms' Green Technological Innovation [J]. China Industrial Economics, 2020, (12): 178-196.
- [23] Pan Ailing, Liu Xin, Qiu Jinlong, SHIN Yu. Can Green M&A of Heavy Polluting Enterprises Achieve Substantial Transformation under the Pressure of Media [J]. China Industrial Economics, 2019, (02): 174-192.
- [24] Cai H, Chen Y, Gong Q. Polluting thy neighbor: unintended consequences of China's pollution reduction mandates [J]. Journal of Environmental Economics and Management, 2016, 76: 86-104.
- [25] Zhang Qi, Zheng Yao, Kong Dongmin. Local Environmental Governance Pressure, Executive's Working Experience and Enterprise Investment in Environmental Protection: A Quasi-natural Experiment Based on China's "Ambient Air Quality Standards 2012" [J]. Economic Research Journal (in Chinese), 2019, 54 (06): 183-198.
- [26] Liao Wenlong, Dong Xinkai, Weng Ming. et al. Economic Effect of Market-oriented Environmental Regulation: Carbon Emission Trading, Green Innovation and Green Economic Growth [J]. China Soft Science, 2020(06):159-173.
- [27] Porter M E, Linde C. Toward a new conception of the environment-competitiveness relationship [J]. Journal of economic perspectives, 1995, 9(4): 97-118.