



How Does Executive Environmental Background Enhance Corporate Total Factor Productivity? Empirical Evidence from Chinese A-Share Listed Companies

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Abstract. Based on the upper echelons theory, this study investigates how executives' environmental backgrounds influence corporate total factor productivity (TFP) and explores the underlying mechanisms. Utilizing a comprehensive sample of Chinese A-share listed companies from 2010 to 2023, we construct a two-way fixed effects model for our empirical analysis. The core findings reveal that the presence of executives with environmental backgrounds significantly enhances corporate TFP. This positive effect remains highly robust even after conducting a series of rigorous robustness checks and addressing potential endogeneity issues. Furthermore, our mechanism analysis indicates that this productivity enhancement is driven by three primary mediating pathways: the promotion of green technological innovation, the alleviation of corporate financing constraints, and the optimization of the internal labor structure. Subsequent heterogeneity analysis demonstrates that the productivity-enhancing effect of environmentally conscious executives is particularly pronounced within labor-intensive firms and state-owned enterprises. Ultimately, this paper expands the existing literature on the micro-determinants of corporate productivity by highlighting the critical role of executive characteristics. The findings provide valuable empirical evidence and managerial insights for advancing the high-quality development and sustainable growth of enterprises amid the ongoing global green economic transition.

Keywords: Executive environmental background; Total factor productivity; Green innovation; Financing constraints.

1 Introduction

Driven by the "Dual Carbon" goals and high-quality development strategies, improving corporate efficiency under tightening environmental constraints has emerged as a core challenge in China's economic transition. While existing research largely attributes variations in corporate total factor productivity (TFP) to institutional environments, factor allocation and technological progress, it pays insufficient attention to internal governance factors — specifically, executives' individual characteristics [1].

According to the theory of upper echelons, the cognitive structures and value orientations of top managers determine the company's strategy and operating results [2].

With stricter environmental regulations, managers' different views on the problems of the environment have begun to affect their conduct in their companies. Although it has been shown that the corporate environment can promote green innovation and improve environmental performance [1], whether and how this is realized in practice for various enterprises has not been studied in depth.

The Environment of Executives and Corporate Total Factor Productivity (TFP). First of all, they will promote green technological innovation to increase production efficiency through technological progress and better resource utilization. Secondly, these executives can enhance the quality of environmental disclosures and improve the corporate image to obtain financing advantages and fund new business. Third, they raise the level of productivity by improving the structure of human resources and labor allocation efficiency. All these routes are not well-studied in the current research, and there is no combined analytical system.

Therefore, this paper will take a sample of Chinese A-share listed companies to carry out an organized study on the effect of executives' environmental back-ground on corporate total factor productivity (TFP). In the following three places, we will carry out all-round mechanism tests for green technological innovation, relief of financing constraints and optimization of the labor structure. This paper has made the following two minor additions. First, it expands the theoretical system of research on the factors that influence the productivity of upper-management companies. Secondly, it will also reveal the micro-mechanisms to promote the efficient development of enterprises in the green economy.

2 Research Hypotheses

2.1 Green Technological Innovation Mechanism

The management is not well-versed in green technology. Driven by their own sense of environmental protection [3] and professional abilities, they consider the green development of the economy and the environment to be a "win-win" situation, so companies have increased investment in research and development for new clean energy technologies and other related works.

Green Innovation can boost the Total Factor Productivity of a company. Optimize the production process to reduce unit energy and raw material consumption and enhance the technical efficiency and productivity of the company [4][5]. With the development of the digital economy, green innovation and data-driven management are also advancing at the same time. With the help of big data and the Internet of Things (IoT), data-driven green business models and scientific decisions can be made to optimize the production process and resource allocation; resource waste will be reduced, precise production control and optimal resource scheduling will be achieved, and thus the maximum productive force of the enterprise can be realized [6][7].

Green innovation can improve the external operating environment of enterprises and promote continuous development of TFP. It can improve the whole-life environmental performance of the product, help the company meet new environmental protection regulations, and avoid fines and other penalties [8]. Solid environmental compliance can

ensure the normal operation of the company, and obtained environmental legitimacy is a form of intangible wealth that supports the firm's development [9]. A good green image will be appealing to high-quality investors and lower financing costs, so it will be easier for the company to carry out continuous innovation and optimization. In short, green innovation led by executives can boost the overall factor productivity (TFP) of the economy in two ways: Firstly, it drives technological progress to enhance production efficiency and use of resources; Secondly, by improving public acceptance of the environment and creating a good public image, it lowers transaction costs. On the other hand, previous studies have mainly concentrated on the general determinants of green innovation[10]; this paper finds that the environmental background of executives is one of the reasons at the individual level for promoting green innovation and TFP growth.

2.2 Financing Constraint Alleviation Mechanism

The company does not have the necessary resources or funds for green innovation. Green technology is new and experimental, so it has high technical uncertainty and risk, requires a large amount of capital investment, and is difficult to obtain financing [11]. At the same time, there is a long R&D cycle and a high failure rate of green innovation. Although enterprises with strong internal resources are in a good position to carry out green innovation under the pressure [12] of the external environment, cost-benefit enterprises may reduce green R&D investment to lower costs and avoid risks [13]. As a result, although the top management of the environment-protection industry hopes to achieve some green development in this regard, it is difficult to do so due to a lack of funds and high risks for investment.

Therefore, the environmental background of the executive group can be used to address the problem of financing constraints. First, companies that have had environmentally conscious leaders show strong pro-environmental behavior and environmental responsibility [14], thus giving other parts of the company and the public a sense of an environmental concern for development. Therefore, it is unlikely that the market will be concerned about the company's environmental liabilities. Secondly, the executives have had different experiences in green work and in the government's [14] environmental department, so they are familiar with the new policies and have many connections [10]. These advantages can help the company access green subsidies, credits and bonds, and good environmental performance will earn it the support of the public; therefore, the financing cost will be lower.

A Lower Financing Constraint will free up more funds for the expansion of TFP. First, it can reduce the resource constraints on green innovation and enable the company to allocate more human and financial resources to carry out the green ideas proposed by management effectively and boost productivity [12]. Secondly, due to the relaxed financial situation, the company has been more focused on long-term strategic investment rather than short-term cost control; thus, the problem of underinvestment in green innovation caused by cost-benefit trade-offs [13] has been addressed and supporting investments have been made in improving production equipment, digital systems and talent development. Thirdly, better financial flexibility will help to optimize the use of

internal resources and focus the company's cash flow on essential production and research and development to increase total factor productivity. The top management's environment is usually not in a state of financing constraint because of signaling and relational capital. Enhanced financial flexibility will provide stable funds for green innovation and investment in the improvement of efficiency, building a chain of transmission from the background of executives in the environment to reduce financing constraints, expand investment capacity and increase TFP.

2.3 Labor Structure Optimization Mechanism

The traits and values of executives from the environmental sector are likely to shape the direction of internal human resource management by raising the environmental consciousness of senior management and all employees in the company. The green cognition and actions of these executives are very commendable and have inspired more people in the company to be environmentally responsible [14]. In addition, companies that have introduced green development ideas are more attractive to young people and other students. Therefore, it can be integrated into the overall plans of development for the company [15].

A high-purpose organization's culture and reasons for doing good will make people work harder and be more satisfied with life. To help achieve the company's environmental goals, some people are now revising their work processes to save energy and lower emissions, and they have started to learn green skills [16]. The above actions will boost the efficiency and save resources of the company in daily work. Therefore, in order to promote the development of TFP, a green organizational culture should be built to attract high-quality green talent and optimize the labor structure; at the same time, environmental support needs to be provided by senior management.

Based on the above theoretical analysis, the following main hypotheses are put forward in this paper:

H1: The environmental background of the executive is positively correlated with the total factor productivity of the company.

H2a: Green technological innovation is a mediator of the effect of the environmental background of top management on total factor productivity.

H2b: H2b is a mediator of the effect of executive environmental background on total factor productivity.

H2c: Optimal restructuring of the labor force is a mediator in the effect path between the executive environment and total factor productivity.

3 Research Design

3.1 Data Sources

This paper uses Chinese A-share listed companies as the research sample, with the sample period selected as 2010-2023.

To ensure the quality of sample data, referring to the practices of existing literature, the following data were excluded: (1) listed companies in the financial industry; (2) ST

sample data; (3) corporate sample data with missing major variables. Corporate micro-level data are sourced from the Wind database, and industry macro-level data are sourced from the CSMAR database, yielding a total of 21,736 industry-year observations.

3.2 Variable Selection

Explained Variable: Corporate Total Factor Productivity (TFP). Given that the LP method has less sample loss when measuring corporate TFP and can more accurately obtain consistent and valid estimations of input factors, the corporate TFP calculated by the LP method is used as the proxy variable for high-quality corporate development in the main effect test.

Core Explanatory Variable: Executive Environmental Background (Green). Whether an executive with an environmental background is appointed is used as a dummy variable to reflect the degree of the executive's environmental orientation.

Control Variables: ① Financial Leverage (Lev), measured as the ratio of total liabilities to total assets; ② Return on Assets (Roa), measured as the ratio of net profit to total assets, reflecting overall profitability; ③ Firm Age (Age), as differences in establishment years affect operating efficiency through experience accumulation; ④ Cash Adequacy (Cash), measured as the ratio of ending cash and cash equivalents to current liabilities, reflecting short-term liquidity security; ⑤ Proportion of Fixed Assets (PPE), measured as the ratio of fixed assets to total assets, acting as a proxy for capital intensity; ⑥ Leadership Structure (Dual), where CEO duality (the chairman and general manager being the same person) may have dual effects on corporate governance efficiency; ⑦ Ownership Concentration (Top1), measured by the shareholding ratio of the largest shareholder, reflecting the control power of the ownership structure over decision-making; ⑧ Industry Attributes (Ind), using industry codes to control for external influences brought by industry characteristics; ⑨ Board Independence (Indep), the ratio of independent directors, reflecting the perfection of the board's supervisory function; ⑩ Executive Incentives (Mshare), the proportion of executive shareholding, which affects corporate governance and performance orientation through interest binding effects.

3.3 Model Construction

To examine the effect of executive environmental background on corporate total factor productivity, this study constructs the following regression model for empirical analysis:

$$TFP_{it} = \alpha + \beta Green_{it} + \gamma Controls_{it} + \lambda_t + u_j + \epsilon_{it} \quad (1)$$

In Equation (1), i and t represent firm and year, respectively. The dependent variable, TFP_{it} , refers to corporate total factor productivity measured using the LP method, which serves as an indicator of firms' high-quality development. The key explanatory variable, $Green_{it}$, is a dummy variable reflecting whether a firm employs executives with

environmental backgrounds. Specifically, the variable equals 1 when such executives are present in a given year and 0 otherwise. Controls_{it} denotes a set of control variables, including Return on Assets (Roa), Asset-Liability Ratio (Lev), and other firm-level characteristics. In addition, λ_t and u_j represent year fixed effects and industry fixed effects, respectively, while ϵ_{it} denotes the random error term. To reduce the potential influence of extreme observations, winsorized at the 1st and 99th percentiles human resource. Firm-level clustered robust standard errors are also employed to ensure the reliability of the regression results.

4 Empirical Results and Analysis

4.1 Descriptive Statistics

Table 1 reports the descriptive statistics of the main variables. The mean of total factor productivity calculated by the LP method (TFP_LP) is 9.1148, with a standard deviation of 1.1122, indicating that the overall production efficiency of the sample enterprises is relatively high and exhibits some variation. Regarding corporate financial characteristics, the mean of the asset-liability ratio (Lev) is 0.3989, and the mean of the return on equity (Roa) is 0.0429, indicating moderate debt levels and good profitability among the sample enterprises. The mean of firm age (Age) is 18.512 years, reflecting that the sample is predominantly composed of mature enterprises.

Table 1. Descriptive statistics of main variables.

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) p25	(6) p50	(7) p75	(8) max
TFP_LP	24,506	9.1148	1.1122	7.0018	8.3126	8.9612	9.7684	12.1917
Lev	24,506	0.3989	0.2069	0.0487	0.2285	0.3855	0.5523	0.8849
Roa	24,506	0.0429	0.0577	- 0.1909	0.0167	0.0423	0.0725	0.2008
Age	24,506	18.5122	5.9448	6.0000	14.000	18.0000	22.0000	35.0000
Cash	24,506	1.0948	1.8015	0.0316	0.2245	0.4702	1.0987	11.5265
PPE	24,506	0.1972	0.1528	0.0024	0.0786	0.1632	0.2785	0.6723
Green	24,506	0.2634	0.4405	0.0000	0.0000	0.0000	1.0000	1.0000
Dual	24,506	0.3216	0.4671	0.0000	0.0000	0.0000	1.0000	1.0000
Top1	24,506	0.3494	0.1515	0.0844	0.2315	0.3298	0.4509	0.7572
Indep	24,506	0.3766	0.0519	0.3333	0.3333	0.3636	0.4286	0.5714
Mshare	24,506	0.1164	0.1852	0.0000	0.0000	0.0000	0.2032	0.6781

4.2 Main Regression Results

This study uses the model to examine the impact of executive environmental background on corporate TFP. As shown in column (1) of Table 2, in the baseline model controlling for year and industry fixed effects, the coefficient of the core explanatory variable Green (dummy variable for executive environmental background) is 0.162,

which is significantly positive at the 1% level, indicating that the executive's environmental background has a significant enhancing effect on corporate TFP.

In column (2), after controlling for variables such as firm age (Age), profitability (Roa), and cash flow level (Cash), the coefficient of Green remains significantly positive. Among the control variables, Age and Roa both show a significant positive correlation at the 1% level, while Cash shows a significant negative correlation, consistent with theoretical expectations.

Column (3) further includes corporate governance and financial structure variables such as ownership concentration (Top1), proportion of fixed assets (PPE), asset-liability ratio (Lev), CEO duality (Dual), proportion of independent directors (Indep), and management shareholding (Mshare). The coefficient of Green is still significant at the 1% level with a value of 0.100, indicating that after controlling for multiple influencing factors, an executive's environmental background can still significantly promote the enhancement of corporate TFP.

Table 2. Regression results.

VARIABLES	TFP LP	TFP LP	TFP LP
Green	0.162*** (0.040)	0.157*** (0.036)	0.100*** (0.029)
Controls	YES	YES	YES
Constant	9.072*** (0.011)	8.683*** (0.119)	7.790*** (0.134)
Observations	24,506	24,506	24,506
Firm Fixed Effects	YES	YES	YES
Year Fixed Effects	YES	YES	YES
Adjusted R ²	0.241	0.350	0.527

4.3 Endogeneity Analysis

To address potential endogeneity concerns arising from omitted variable bias or reverse causality (i.e., highly productive firms may be more likely to appoint environmental executives), we employ an instrumental variable (IV) approach to test the robustness of our baseline findings.

(1) Instrumental Variable Selection and Validity

Following Niu et al.[17], we construct the instrument as the proportion of other firms within the same industry-year employing executives with environmental backgrounds. This IV satisfies both the relevance and exogeneity conditions. First, due to peer mimicry effects in executive appointments within a given industry, the instrument is highly correlated with the endogenous explanatory variable. Second, the proportion of environmental executives in peer firms does not directly impact the focal firm's TFP, thereby satisfying the exclusion restriction.

(2) Instrumental Variable Regression Results

Table 3 reports the two-stage least squares (2SLS) estimation results. In the first-stage regression, the coefficient of the IV is 2.492, which is significantly positive at the

1% level. Furthermore, the F-statistic significantly exceeds the conventional threshold of 10, rejecting the weak instrument null hypothesis.

Table 3. 2SLS regression results with instrumental variables.

VARIABLES	IV_new1 TFP LP	IV_new2 TFP LP	IV_new3 TFP LP
Green_hat_new	0.426*** (0.159)		
Green		0.426** (0.177)	0.394**(0.183)
Constant	7.554***(0.167)		
Controls	Yes	Yes	Yes
Observations	13,222	13,222	13,222
R ²	0.535	0.358	0.294
Industry Fixed Effects	YES	YES	YES
Year Fixed Effects	YES	YES	YES

4.4 Robustness Tests

To guarantee the reliability of baseline empirical results, we carry out five robustness tests: we adopt 1:1 and 1:4 nearest-neighbor propensity score matching based on a 10-covariate Logit model to alleviate self-selection bias; re-estimate the benchmark with Tobit, random-effects Tobit and Poisson regressions to avoid estimation bias; add interaction items of control variables with linear time trends or year dummies to control time-varying confounders; narrow the sample range to 2010–2019 to exclude COVID-19 macro interference; and adopt province-by-year interactive high-dimensional fixed effects to absorb unobservable time-varying regional factors. The significantly positive coefficient of Green at the 1% level survives all above adjustments, proving the productivity-enhancing influence of executives’ environmental backgrounds is robust.

The detailed results are reported in Tables 4 and 5. Table 4 presents the results of the PSM and Tobit robustness tests, while Table 5 reports the results based on Poisson regression, time-trend controls, year-dummy interactions, and the shortened sample period. Across all specifications, the coefficient of Green remains significantly positive at the 1% level, indicating that the baseline conclusion is robust to different matching methods, model choices, control strategies, and sample restrictions.

Table 4. Robustness test results: PSM and Tobit models.

VARIABLES	PSM1	PSM2	Tobit1
Green	0.131*** (0.040)	0.140*** (0.038)	0.134*** (0.017)
Observations	5,628	9,258	13,222
Year_FE	YES	YES	YES
Industry_FE	YES	YES	YES
Controls	YES	YES	YES
Adjusted R ²	0.571	0.545	.
N	5628	9258	13222

Table 5. Robustness test results: Alternative specifications and sample restriction.

VARIABLES	Poisson TFP_count	Trend1 TFP_LP	Trend2 TFP_LP	ShortWindow
Green	0.015*** (0.002)	0.126*** (0.037)	0.127*** (0.037)	0.136*** (0.038)
Observations	13,222	13,222	13,222	13,222
Year_FE	YES	YES	YES	YES
Industry_FE	YES	YES	YES	YES
Controls	YES	YES	YES	YES
Adjusted R ²	.	0.537	0.537	0.533
N	13222	13222	13222	13222

5 Mechanism Tests

We explore three mediating mechanisms underlying the productivity-enhancing effect of executives with environmental backgrounds: green technological innovation, financing constraint alleviation, and labor structure optimization.

Eco-oriented executives actively spur green innovation amid prevailing environmental trends[5]. Measured by green patent applications, Column (1) of Table 6 yields a significantly positive Green coefficient. It verifies that such innovation improves productivity by saving resource costs and securing policy dividends[18], acting as a vital mediator.

These executives enhance environmental disclosure to build stakeholder confidence and ease financing constraints[19]. Adopting the FC index as the constraint indicator, Column (2) shows a markedly negative coefficient, meaning relaxed funding access supports productive investment and TFP growth.

Via green human resource management, they attract highly educated employees[20]. Using the share of bachelor-or-above workers as the proxy, the positive coefficient in Column suggests optimized high-skilled labor absorbs advanced technology and fuels productivity gains.

Table 6. Mechanism tests.

VARIABLES	Green Tech. Innovation	Financing Constraints	Labor Structure
Background	2.646*** (9.30)	-0.017*** (-5.27)	0.016*** (5.66)
Control Variables	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes
Adjusted R ²	0.186	0.608	0.418
Observations	17616	17616	17616

6 Heterogeneity Analysis

To identify heterogeneous effects, we implement four-group heterogeneity tests in Table 7 covering industry pollution characteristics[21], executive age[22], labor intensity and ownership[23]. The Green coefficient is larger for heavily polluted firms[21] and firms with elder executives[22]. The promotion effect is markedly stronger in labor-intensive enterprises and exists significantly only among SOEs[23].

Table 7. Heterogeneity test results.

VARIABLES	Heavily	Non-heavyly	Young	Older	Labor Intensive	Balanced	State-owned	Non-state-owned
Green	0.1741*** (0.0523)	0.0675** (0.0334)	0.0645* (0.0342)	0.1155*** (0.0387)	0.1976*** (0.0513)	0.0220 (0.0403)	0.1572*** (0.0510)	0.0516 (0.0321)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	3878	13026	8950	7952	5857	8010	6476	10426
Adjusted R ²	0.5259	0.5744	0.5691	0.5414	0.5810	0.5448	0.5542	0.5450

7 Conclusion

Using 2010–2023 China A-share listed firm data, this paper empirically finds executives’ environmental backgrounds significantly boost corporate TFP; the result survives controls, fixed-effect regulation and instrumental-variable endogeneity treatment. Mechanism analysis identifies three mediating channels: green innovation promotion, financing constraint relief and labor structure optimization. Heterogeneity checks show the productivity improvement effect is stronger for state-owned and labor-intensive firms, with insignificant gaps across industrial pollution levels and executive ages. In short, executive environmental traits raise firm productivity via technology, financing and human capital pathways.

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