# Research on the Influence of Executives' Academic Experience on Green Innovation Based on SPSS

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**Abstract.** Implementing green innovation is an important way for enterprises to enhance their competitiveness in the context of high-quality development. This study uses the data of A-share-listed manufacturing companies from 2015–2020 as samples. SPSS software was used to conduct correlation analysis and regression analysis on the academic experience of executives and the green innovation of enterprises. Furthermore, this study used the SPSS software to test the regulatory role of government subsidies. The results show that the academic experience of executives can improve the green innovation ability of enterprises. The conclusion remains valid after multiple tests, including lagged variables and changing variable measures. Government subsidies have a positive moderating effect on the influence process of executives' academic experience on the green innovation of enterprises. The research results enrich the literature of upper-echelon theory and provide a reference for enterprises to improve green innovation.

**Keywords:** SPSS · correlation analysis · linear regression analysis · green innovation · academic experience of executives

## 1 Introduction

Since the reform and opening up, with the rapid development of China's economy, problems including lack of resources, environmental degradation, and climate change have seriously hindered social development. It is essential that China's economy to switch from rapid expansion to high-quality development. Green innovation is an inventive activity focused on environmentally friendly products and processes that help businesses economically and reduce environmental degradation during a product's life cycle [1]. Green innovation, combining "innovative development" and "green ecology," is the key concept to achieving high-quality development. However, the long time, high investment, high risk, and dual externalities of green innovation activities hinder the motivation of most enterprises to pursue green innovation. Enterprises are the main driver of green


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innovation, so improving the green innovation level of enterprises has become a research focus of local and international academic circles. However, the current research on the senior executive level of China's green innovation is less, and more research is on the institutional and organizational levels.

The assistance of top managers is necessary to increase the degree of green innovation in the enterprise because executives are the ones who make and drive business decisions. With the introduction of a number of policies by relevant national ministries and commissions to promote the integrated development of production, education, and research, more and more academic talents are joining enterprises as CEOs, directors, and other important positions [2]. Academic executives are increasingly becoming the core of enterprise executive teams. According to the upper-echelon theory, managers' age, gender, education, and work experience influence their values, leading to different management styles and decision-making preferences [3, 4]. The unique academic experience and professional background shape the individuals' ability to innovate. It improves their professionalism, while academic executives have a strong sense of social responsibility and are more focused on green R&D projects [5].

This paper takes China's A-share-listed manufacturing companies from 2015 to 2020 as a sample to investigate the impact of executives academic on the green innovation ability of enterprises, and to examine whether government subsidies play a moderating role in this relationship. The upper-echelon theory and the related research on green innovation are both improved by this paper.

## 2 Materials and Methods

### 2.1 Theoretical Analysis and Research Assumptions

**1) Academic experience of executives and enterprise green innovation**

According to the upper-echelon theory, executives' values and cognitive abilities influence their business decisions. At the same time, their basic characteristics, such as age, gender, and early work experience, will continue to influence the cognitive base of executives. Previous studies have shown that the green innovation activities of enterprises are closely related to the early experiences of executives [6]. It is essential to study the green innovation behavior of enterprises from the perspective of executives' experience.

The theoretical analysis is as follows. First, academic research is the process of constant exploration that builds on failure to succeed. This process shapes the innovative spirit of researchers and increases their tolerance for failure of high-risk innovation activities, thus ensuring the continued enhancement of corporate green innovation projects. Second, long-term academic training cultivates the independent thinking ability and creative thinking of academic executives. It improves the sensitivity of enterprises to cutting-edge technology, which is conducive to improving the quality of enterprise green innovation decision-making and reducing the uncertainty in the implementation process.

In terms of social capital, the network of academic executives in universities and research institutes can make up for the insufficiency of enterprises in technology and professional knowledge, and provide enterprises with an advantage of acquiring innovation resources. Finally, Cho et al. demonstrated that companies with academic executives exhibit better social responsibility performance ratings [7]. Academics generally have a higher sense of social responsibility. Executives with academic experience may be more inclined to take societal responsibility for protecting the environment, which will influence their decision-making in favor of green R&D projects and encourage the adoption of green innovation initiatives. Therefore, this study proposes the following assumptions.

H1: The academic experience of executives can enhance the green innovation level of enterprises.

**2) The moderating effect of government subsidies**

As one of the important tools for the government to regulate the market, government subsidies have a significant impact on the green innovation of enterprises. Enterprises need to invest heavily in R&D personnel and equipment, which exposes them to huge innovation costs. Direct financial support from the government can help companies build the financial stability they need to participate in green innovation activities. Furthermore, according to the signaling theory, when a company receives government funding, it sends a clear signal to the outside world [8]. External stakeholders are more likely to trust their green R&D initiatives. Therefore, government subsidies encourage companies to participate in green innovation by directly funding efforts and projecting a positive image to the outside world. In summary, this paper proposes the following assumptions.

H2: Government subsidies positively moderate the effect of academic experience of executives on green innovation.

### 2.2 Research Design

**1) Data and samples**

The green innovation-related data used in this paper comes from the CNRDS database; Other data are from the CSMAR database. This paper takes the A-share-listed manufacturing enterprises from 2015 to 2020 as the initial sample and carries out the following treatment: (1) Removing ST and *ST companies. (2) Deleting companies in the financial and insurance industry. (3) Deleting companies with missing variables. After the above screening, 7969 valid observations were obtained. To exclude the interference of extreme values, this paper shrinks the tails of the main continuous variables at the 1% and 99% percentiles.

**2) Variable constructions**

*a) Green innovation.*

The number of green patent applications is used in this article to indicate the degree of green innovation among companies [9, 10]. Therefore, this paper measures the green innovation of enterprises by the number of green invention patents applied by listed companies in the same year.

*b) Academic experience of executives.*

Referring to the research of Zhou et al. [11], this paper used a dummy variable method to measure the academic experience of executives, if the executive team members have one of the following three experiences: teaching in a university, working in a research institution, or conducting research within an association, the executives' academic experience (Acad-dum) was considered equal to 1, and otherwise, it was similar to 0. Additionally, We conducted robustness tests using the variable academic managers as a percentage of all managers.

*c) Government subsidies.*

This paper refers to the research methods of Zheng et al. to measure government subsidies [12].

*d) Control variables.*

Following previous research, we take into account firm characteristics such as firm size (Size), asset-liability ratio (Lev), return on equity (Roe), growth potential (Growth), governance structure characteristics such as ownership type (State), equity concentration (Share), the proportion of independent directors (Indp), and dual positions (Dual), as well as annual fixed effects and industry fixed effects.

**3) Research design**

To test the influence of academically experienced executives on corporate green innovation, this paper constructs a research model (1).

$$\mathrm{GI} = \beta_0 + \beta_1 \mathrm{Acad\_dum} + \beta_2 \mathrm{Control} + \beta_3 \mathrm{Year} + \beta_4 \mathrm{Industry} + \varepsilon \tag{1}$$

This paper added government subsidies (Subsidy) and the cross-product term of executive academic experience and government subsidies (Acad_dum × Subsidy) based on model (1) to confirm the moderating influence of government subsidies.

$$\begin{aligned} \mathrm{GI} = & \beta_0 + \beta_1 \mathrm{Acad\_dum} + \beta_2 \mathrm{Subsidy} + \beta_3 \mathrm{Acad\_dum} \times \mathrm{Subsidy} \\ & + \beta_4 \mathrm{Control} + \beta_5 \mathrm{Year} + \beta_6 \mathrm{Industry} + \varepsilon \end{aligned} \tag{2}$$

## 3 Results and Discussion

### 3.1 Descriptive Analysis

This study used the SPSS software to perform a descriptive statistical analysis of the primary variables. As shown in Table 1, the sample mean of green invention patent applications, which comes from the Panel A total sample statistics, is 0.468, indicating

**Table 1.** Descriptive statistical analysis

| PanelA: total sample statistics | | | | | |
|---|---|---|---|---|---|
| Variables | N | Mean | Std | Min | Max |
| GI | 7,969 | 0.468 | 0.934 | 0 | 4.736 |
| Acad_dum | 7,969 | 0.429 | 0.495 | 0 | 1 |
| Subsidy | 7,969 | 1.696 | 5.048 | 0.000 | 37.092 |
| Size | 7,969 | 22.297 | 1.141 | 20.175 | 25.791 |
| Lev | 7,969 | 0.396 | 0.179 | 0.0621 | 0.808 |
| Roe | 7,969 | 0.0672 | 0.107 | -0.438 | 0.345 |
| Growth | 7,969 | 0.150 | 0.325 | -0.445 | 1.866 |
| State | 7,969 | 0.300 | 0.458 | 0 | 1.000 |
| Share | 7,969 | 32.823 | 13.445 | 9.560 | 70.420 |
| Indp | 7,969 | 37.564 | 5.399 | 33.330 | 57.140 |
| Dual | 7,969 | 0.278 | 0.448 | 0 | 1 |

| PanelB: mean difference test | | | |
|---|---|---|---|
| Variables | Acad_dum (1) | Acad_dum (0) | mean-diff |
| GI | 0.418 | 0.535 | -0.117*** |

that the sample's average level of green innovation is low. It is clear that China's green technology innovation is at a low level and lags behind other developed nations. The average value of executives academic experience is 0.429, which shows that most enterprises hire executives with academic experience and that scholarly executives play an increasingly significant role in the executive team.

From the results of Panel B mean difference test, the mean value of green innovation is 0.535 in the sample with executives having academic experience and 0.418 in the example with executives having no academic experience, and the t-means test results are significant at the 0.01 level. It indicates that the level of green innovation in enterprises with academic executives is significantly higher than that without academic executives, which tentatively confirms hypothesis H1.

### 3.2 Correlation Analysis

This study used the SPSS software to analyze the variables for correlation, and Table 2 shows the correlation coefficients between the variables. The correlation coefficient between Acad_dum and GI is significantly positive at 0.01 level. In addition, the correlation coefficients between most of the variables are less than 0.5, indicating that there is no multicollinearity problem in the model.

**Table 2.** Correlation analysis

| Variables | GI | Acad_dum | Subsidy | Size | Lev | Roe | Growth | State | Share | Indp | Dual |
|---|---|---|---|---|---|---|---|---|---|---|---|
| GI | 1 | | | | | | | | | | |
| Acad dum | 0.062*** | 1 | | | | | | | | | |
| Subsidy | 0.223*** | 0.000 | 1 | | | | | | | | |
| Size | 0.354*** | -0.0130 | 0.359*** | 1 | | | | | | | |
| Lev | 0.215*** | -0.040*** | 0.172*** | 0.501*** | 1 | | | | | | |
| Roe | 0.087*** | 0.017 | 0.071*** | 0.152*** | -0.153*** | 1 | | | | | |
| Growth | 0.007 | 0.051*** | 0.007 | 0.054*** | 0.040*** | 0.282*** | 1 | | | | |
| State | 0.126*** | -0.083*** | 0.171*** | 0.311*** | 0.239*** | -0.022** | -0.064*** | 1 | | | |
| Share | 0.023** | -0.056*** | 0.107*** | 0.141*** | 0.026** | 0.134*** | 0.013 | 0.141*** | 1 | | |
| Indp | 0.015 | 0.011 | 0.029** | -0.024** | -0.021* | -0.022** | 0.003 | -0.053*** | 0.060*** | 1 | |
| Dual | -0.012 | 0.152*** | -0.048*** | -0.129*** | -0.064*** | -0.003 | 0.042*** | -0.274*** | -0.002 | 0.135*** | 1 |

Statistical significance is indicated by the symbols *, **, and *** at 10%, 5%, and 1%, respectively. The following table is the same.

### 3.3 Regression Analysis

**1) Regression analysis of the main effect**

To further verify the impact of executive academic experience on the green innovation of enterprises, this paper used the SPSS software to conduct a regression analysis. According to the regression results in column (1) of Table 3, the regression coefficient of the executive academic experience is positively significant at 0.01 level when the annual and industry fixed effects are not controlled. The regression results in column (2) show that after holding the annual and industry fixation effects, The coefficient of the executive academic experience is still significant, implying that academic executives contribute to the level of corporate green innovation. In the economic sense, enterprises with academically experienced executives had a significant increase in green innovation levels of approximately 11.6% compared to enterprises without academically experienced executives. Hypothesis H1 is further verified.

**2) The regulatory effect of government subsidies**

To test the moderating influence of government subsidies, we added Government subsidies (Subsidy) and the cross-product of executive academic experience and government subsidies (Acad_dum × Subsidy) based on column (2). According to the regression results in Table 4, the coefficient of the cross-product term between executive academic

experience and government subsidies (Acad_dum × Subsidy) in column (3) is 0.014, which is significantly positive. It indicates that the more subsidies a company receives from the government, the stronger the role of academic executives in promoting corporate green innovation, and hypothesis H2 is verified.

### 3.4 Robustness Test

This study conducted a robustness test using the SPSS software to ensure the reliability of the findings. First, this paper performed regression analysis using the independent variables with one period lag and the control variables with one period lag. The regression results show that the coefficient of the executive academic experience (Acad_dum) is still significantly positive at the 0.01 level. Then, we used the proportion of academic managers to all managers (Acad_ratio) to measure the variable of academic experience of senior managers. The estimated coefficient of the Acad_ratio is significantly positive, indicating that executives' academic experience promotes green innovation. This paper also re-measured corporate green innovation (GIO) with 0–1 dummy variables. It performed logit model tests with Acad_dum and Acad_ratio as explanatory variables, respectively, and the conclusion did not change. In addition, since most green innovation level of enterprises is zero, this paper performed a Tobit regression test, and the conclusion was consistent with our original findings.

## 4 Conclusions

### 4.1 Research Conclusions

Based on the data of A-share-listed manufacturing enterprises from 2015 to 2020, this paper used the SPSS software to conduct correlation analysis and regression analysis on the academic experience of executives and the green innovation ability of enterprises. The main conclusions of this article are as follows: First, the academic education background of executives can promote the green innovation of enterprises. This conclusion remains valid after a series of tests, including lagged variables and changing variable measures. Second, government subsidies have a positive moderating effect on the influence process of academic management on the green innovation of enterprises.

**Table 3.** Multiple regression analysis

| Variables | (1) | (2) | (3) |
|---|---|---|---|
| | GI | GI | GI |
| Acad_dum | 0.123*** | 0.116*** | 0.090*** |
| | (6.150) | (5.800) | (4.500) |
| Subsidy | | | 0.013*** |
| | | | (12.568) |
| Acad_dum × Subsidy | | | 0.014*** |
| | | | (14.322) |
| Size | 0.256*** | 0.268*** | 0.236*** |
| | (25.600) | (26.800) | (23.600) |
| Lev | 0.355*** | 0.196*** | 0.205*** |
| | (5.071) | (2.800) | (3.417) |
| Roe | 0.559*** | 0.676*** | 0.660*** |
| | (5.590) | (6.760) | (6.600) |
| Growth | -0.095*** | -0.154*** | -0.146*** |
| | (-3.167) | (-5.133) | (-4.867) |
| State | 0.063*** | 0.071*** | 0.058** |
| | (3.150) | (3.550) | (2.900) |
| Share | -0.002*** | -0.002*** | -0.002*** |
| | (-2.560) | (-2.630) | (-2.582) |
| Indp | 0.004** | 0.005*** | 0.004** |
| | (4.120) | (5.230) | (4.531) |
| Dual | 0.061*** | 0.058*** | 0.059*** |
| | (3.050) | (2.900) | (2.950) |
| Year | NO | YES | YES |
| Industry | NO | YES | YES |
| Constant | -5.579*** | -6.077*** | -5.128*** |
| | (-24.257) | (-26.422) | (-18.993) |
| adj. $R^2$ | 0.137 | 0.173 | 0.181 |
| F | 141.506 | 98.917 | 93.925 |
| *N* | 7969 | 7969 | 7969 |

**Table 4.** Robustness test

| Variables | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | GI | GI | GIO | GIO | GI | GI |
| Acad_dum | 0.107*** | | 0.238*** | | 0.335*** | |
| | (5.350) | | (4.760) | | (5.583) | |
| Acad_ratio | | 0.404*** | | 0.745*** | | 1.105*** |
| | | (5.771) | | (4.139) | | (5.525) |
| Size | 0.268*** | 0.270*** | 0.395*** | 0.400*** | 0.611*** | 0.618*** |
| | (26.800) | (27.000) | (13.167) | (13.333) | (20.367) | (20.600) |
| Lev | 0.234*** | 0.194*** | 0.737*** | 0.729*** | 0.815*** | 0.802*** |
| | (3.343) | (2.771) | (4.335) | (4.288) | (4.075) | (4.010) |
| Roe | 0.958*** | 0.680*** | 1.457*** | 1.466*** | 2.054*** | 2.069*** |
| | (7.983) | (6.800) | (5.204) | (5.236) | (6.626) | (6.674) |
| Growth | -0.086** | -0.155*** | -0.260*** | -0.261*** | -0.389*** | -0.392*** |
| | (-28.667) | (-5.167) | (-2.889) | (-2.900) | (-3.890) | (-3.920) |
| State | 0.087*** | 0.069*** | 0.206*** | 0.201*** | 0.233*** | 0.225*** |
| | (2.900) | (3.450) | (3.433) | (3.350) | (3.329) | (3.214) |
| Share | -0.002*** | -0.002*** | -0.004** | -0.005** | -0.007*** | -0.007*** |
| | (-2.165) | (-2.620) | (-4.251) | (-5.230) | (-7.450) | (-7.510) |
| Indp | 0.004*** | 0.005*** | 0.003 | 0.003 | 0.005 | 0.006 |
| | (4.582) | (5.761) | (1.692) | (1.855) | (1.630) | (1.762) |
| Dual | 0.080*** | 0.061*** | 0.088 | 0.096 | 0.154** | 0.161** |
| | (2.667) | (3.050) | (1.588) | (1.760) | (2.200) | (2.300) |
| Constant | -6.226*** | -6.126*** | -11.204*** | -11.287*** | -16.574*** | -16.708*** |
| | (-23.946) | (-26.635) | (-18.367) | (-18.503) | (-23.344) | (-23.532) |
| adj. $R^2$ | 0.177 | 0.173 | 0.087 | 0.087 | 0.076 | 0.076 |
| F | 88.902 | 99.017 | | | | |
| *N* | 6538 | 7969 | 7969 | 6538 | 5189 | 7969 |

## 4.2 Suggestions

This paper has the following three suggestions: First, the academic experience of executives can play an internal governance role in promoting the green innovation of enterprises. Enterprises should pay attention to the construction of the executive team, optimize the management structure by employing executives with academic experience, and give full play to scholarly executives' innovation ability to improve corporate green innovation. Second, enterprises can cooperate with academic institutions in green innovation

R&D projects. Through an empirical examination, this paper reveals that university-enterprise cooperation is beneficial to the transformation of corporate green innovation results. Third, Government departments should fully utilize the economic role of government subsidies to provide financial support for the green development of enterprises because they can play a positive role in the governance of green innovation by executive academic experience. As a result, enterprises will be better able to meet the challenges of green transformation development in the new era.

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