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Economic Policy Uncertainty, Heterogeneity of Executives and Enterprise Innovation

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ABSTRACT

This study analyzes how economic policy uncertainty affects corporate innovation, and the moderating effects of executive heterogeneity. A three-phase dynamic investment and financing model is first built to analyze the mechanism. Empirical analysis confirms that the increase in the degree of economic policy uncertainty promotes enterprise innovation. Further results show that this promotion effect is more significant in enterprises with male executives, low educational level, no financial experience and political background. Moreover, the positive impact is only found in enterprises with moderate executive ability, and the overconfidence of senior executives plays a positive regulating role in it.

1. Introduction

As an important means to promote industrial upgrading, technological innovation plays an important role in improving economic vitality. Innovation is the original power of sustainable economic development and the core of national international competitiveness. How to promote enterprise innovation to drive high-quality economic development has become an important economic issue to be explored. Therefore, exploring the factors that drive enterprise innovation plays a key role in promoting enterprise independent R&D and realizing long-term and sustainable economic development.

In recent years, China has issued a series of fiscal policy, monetary policy and industrial policy. In 2008, China launched the “4-Trillion-Yuan Stimulus Package”

to promote investment, consumption and stabilize the economy, which led to the year of China’s economic policy uncertainty index rose rapidly. Since 2012, China has introduced numerous measures to strengthen the regulation of local government financing platforms, promote the development of emerging financial format such as internet finance, and supply-side structural reform to achieve the goal of stable growth and structural adjustment, the degree of policy uncertainty increases.

The successive introduction of economic policies has played an important role in improving the consumption structure, promoting industrial upgrading and improving the real investment environment. However, the change and adjustment of economic policy inevitably lead to the increase of the uncertainty of economic policy and affect the micro-enterprises’ investment and financing behavior

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by influencing the industry and market environment.

Most research has focused on the effects of economic policy uncertainty on Corporate Investment, R&D innovation, asset allocation behavior, and executive turnover^[1-4]. The rise in economic policy uncertainty delays the decision to invest in R&D^[1,5], increase the number of patent applications filed by listed companies^[6], and strengthen their cash holdings^[7], and reduce the probability of executive change^[8].

As for the relationship between economic policy uncertainty and enterprise innovation, on the one hand, the external market risk and the bank's credit grudging due to the increase of economic policy uncertainty restrains the willingness of R&D and Innovation. On the other hand, the increase of economic policy uncertainty strengthens the motivation of enterprises to use policy change and industrial structure adjustment to accelerate the innovation of enterprises to increase market power. As the decision-makers and executors of the company's production and operation, the senior managers' gender, age characteristics, educational experience, employment experience, political background and personal ability, it is inevitable that the behavioral mechanisms will have an impact^[9-12]. In view of this, this paper attempts to explore the impact of economic policy uncertainty on enterprise innovation, as well as the regulatory mechanism of top management heterogeneity on the above relationship.

Using the data of non-financial listed companies in Shanghai and Shenzhen stock markets from 2007 to 2018, this paper empirically analyzes the impact of economic policy uncertainty on enterprise innovation, and the heterogeneity of the above effects in the east, the middle and the west, the allocation of credit resources, and the degree of patent protection; Secondly, we use the method of replacing the core variable and IV tool variable to test the robustness of baseline regression model. Then, the paper further analyzes the mechanism of the relationship between economic policy uncertainty and enterprise innovation, including the personal characteristics, executive competence and overconfidence.

Compared with the previous studies, the contributions of this paper are as follows: First, it breaks away from the traditional research perspectives of economic policy uncertainty and corporate investment, financial asset allocation and tax collection and management intensity, this paper analyzes the two opposite influence mechanisms of economic policy uncertainty on enterprise innovation, and makes a useful supplement for the research of macroeconomic policy on micro-enterprise behavior mechanism. Secondly, the paper explores the heterogeneity of economic policy uncertainty on

innovation in firms with different gender, education level, financial experience and political background. Thirdly, it further analyzes the regulation mechanism of the dynamic relationship between the uncertainty of economic policy and the innovation of enterprises by the personal ability and the overconfidence of senior managers, thus providing a theoretical basis for the field of policy uncertainty and the investment behavior mechanism of micro-enterprises, provides a new perspective.

The rest of this paper is arranged as follows: Section 2 reviews the relevant literature and develops the research hypothesis. Section 3 describes the research design and data. Section 4 is the empirical analysis. Section 5 further discusses the moderating effects of executive heterogeneity. Section 6 concludes.

2. Theoretical Analysis and Research Hypotheses

The research on the relationship between economic policy uncertainty and enterprise investment can be summarized in two points of view. The first view is that the increase of economic policy uncertainty restrains the investment scale of corporate entities^[8,13,14]. The rising uncertainty of economic policy discourages corporate investment by increasing the cost of capital and marginal return on capital channels^[15]. Another view is that the rise of economic policy uncertainty promotes enterprise R&D innovation, and the macroeconomic environment affects the relationship between policy uncertainty and business investment^[16]. The relationship between economic policy uncertainty and innovation activities is influenced by government subsidies, financial restraint, the nature of enterprise ownership, industry characteristics and other factors, as well as incentive and selection effects on enterprise innovation behavior^[6].

The changes of industry policy, market competition and credit availability caused by the uncertainty of economic policy also affects the R&D investment activities of enterprises. The rising uncertainty of economic policy increases the volatility of the macro-economy and aggravate the deterioration of the enterprise management style and the external market environment, increased competition in the industry reinforces the incentive for firms to respond to external risks through R&D and innovation^[17].

On the one hand, an increase in uncertainty about economic policy is likely to spur innovation. First, the increase of economic policy uncertainty means that the future industry and market uncertainty increased, increased investment risk. Once the enterprise can accurately predict

the future industry development trend, through R&D innovation to achieve the goal of industrial transformation and increase market share, it is bound to lead to the enterprise in the future production and management of first-mover advantage. Obviously, under the stimulation of industrial transformation and increasing market share, the increase of economic policy uncertainty will promote enterprise R&D innovation. Secondly, the increase of economic policy uncertainty increases the uncertainty of cash flow, executives prefer to hold more liquid financial assets, so they sell a lot of fixed assets to mitigate the adverse impact of the external environment in order to achieve the goal of reducing business risk^[2]. The increasing uncertainty of economic policy increases the operating risk of enterprises, which leads to diversification through R&D and innovation in order to reduce the liquidity risk caused by single business model. Third, in an environment of rising economic policy uncertainty, the opportunity cost and risk of managers and technicians changing jobs increases, and the mobility of labor decreases. Therefore, the increase of economic policy uncertainty reduces the mobility of core R&D personnel, which promotes the continuity of R&D innovation and increases the scale of effective output, thus enhancing R&D innovation Input, with the uncertainty of economic policy increasing, external investors are more sensitive to the release of negative news, and the "herd behavior" is obvious. R&D innovation can send a positive signal to outside investors, reduce the stock price crash risk, and improve the availability of financing and consumer confidence in enterprises. Therefore, in order to stabilize the expectations of external investors and enhance consumer confidence, managers tend to conduct R&D innovation when economic policy uncertainty is rising.

On the other hand, the uncertainty of economic policy may also inhibit enterprise innovation. The increase of economic policy uncertainty restrains firms' innovation input by increasing cash flow volatility, increasing the degree of financing constraint and increasing the value of waiting options. Specifically, first, the increased uncertainty in economic policy has increased the volatility of cash flows, and the corporate sector is more willing to allocate funds to more liquid assets in order to achieve the incentive of precautionary reserves. Secondly, the credit crunch caused by the uncertainty of economic policy also leads to the increase of external financing cost and the inhibition of enterprises' R&D willingness. The uncertainty of economic policy increases the systemic risk to a certain extent, which makes financial intermediaries strengthen risk control, tighten financing channels, and raise the threshold of business loans, which is not conducive to business technological innovation, the frequent change

of economic policy means that the uncertainty of future industry development increases, and most investors hold a wait-and-see attitude, waiting for the option value to rise. The decline in investor confidence and the unpredictability of stock price movements brought about by the rise in economic policy uncertainty may directly lead to a decline in senior executives willingness to invest in enterprise innovation^[8,9], an increase in uncertainty about economic policy also makes investors more sensitive to corporate decisions. Once negative expectations of corporate R&D projects are maintained, the likelihood of voting with feet is higher, resulting in a higher risk of corporate R&D, not conducive to enterprise R&D investment. It can be seen that the uncertainty of economic policy may have a positive or negative impact on enterprise innovation.

In order to describe the effect of economic policy uncertainty on R&D behavior, we build a three-phase investment and financing decision-making model, to analyze the possible mechanism of the rising uncertainty of economic policy on enterprise innovation. The model period is marked $t = (0,1,2,3)$. Suppose a representative firm i in phase 0 decides whether to invest in R&D project j , the investment period of the project is 3 years, and once the firm decides to participate in the R&D project, it cannot withdraw halfway. The project requires an investment of $I_{j,1}$ and $I_{j,2}$ in the first and second phases, respectively, assuming that the probability of project failure σ_j is independent of changes in the external market environment and depends only on the technical barriers and market prospects of the project itself. If an enterprise i decides to invest in R&D, the probability of bankruptcy risk $\varphi_{i,j,t}$ is due to the tight liquidity caused by R&D investment in the t period. When the uncertainty of economic policy is high, the financial intermediary's loan-sparing behavior makes it more difficult and costly for the enterprises to obtain funds from the outside.

Suppose that in period t , the degree of uncertainty of economic policy is EPU_t . $\partial(\varphi_{i,j,t})/\partial((EPU_t) > 0$ can be obtained. Whether the research and development of the project can be successful or not, the enterprise cannot predict in advance, only can estimate the potential risk of the project, whether the research and development success of the project can be observed in period 3. If the project is successful in period 3, there are two benefits for the enterprise. Part of the revenue comes from the cash income $F_{i,j,3}$ generated by the transformation of the current results. The other part comes from the potential future income of industry transformation, decentralization and increasing market share, which is discounted to the present value $\vartheta_{i,j,3}$. Assuming a discount rate of $\gamma_{i,t}$, the higher the uncertainty of economic policy, the higher the present value

of future earnings from R&D, $i, e. \partial(\vartheta_{i,j,3})/\partial((EPU_t) > 0$.

Furthermore, it is assumed that the principal-agent and information asymmetry problems between the shareholders and the managers make the investment and financing decisions by the managers. Managers make investment and financing decisions based on their own profit maximization, in which the effectiveness of managers depends on the level of profits and risk aversion. That is, $\delta V(\pi_{i,t}) - \rho_i \delta_{i,t}^2$, in which, $\pi_{i,t}$ represents the level of profit of enterprise i in the t period, $V(w)$ corresponding to the current level of corporate earnings. ρ_i indicates that the degree of risk aversion of managers is determined by the characteristics of executives themselves. If the degree of risk aversion of executives is higher, then $\rho_{i,t}$ is higher. $\delta_{i,t}$ represents the current external risk, and when the degree of economic policy uncertainty increases, it means that the external risk to the enterprise is higher, that is, $\partial(\delta_{i,t})/\partial((EPU_t) > 0$. Therefore, if an enterprise decides not to invest in R&D Project j during the period 0, then the profit level of the company during the period t is $V(\pi_{i,t})$ respectively. According to the above analysis, the utility function of the top management is shown in formula (1) when the enterprise does not invest in Project j .

$$L(i, t) = \sum_{t=1}^{t=3} \gamma_{i,t}^{-(t-1)} \{ \delta V(\pi_{i,t}) - \rho_i \delta_{i,t}^2 \} \quad (1)$$

If the enterprise decides to conduct R&D, then the value of the firm in period $t = (1,2)$ is $V(\pi_{i,t} - I_{i,t})(1 - \varphi_{i,j,t})$. In period 3, the expected utility function of the manager is: $(1 - \sigma_j - \varphi_{i,j,3}) * \{ \delta * V(\pi_{i,3} + F_{i,j,3}) + \vartheta_{i,j,3} \} - \rho_i \delta_{i,3}^2$. Therefore, the utility function of the entire project investment period expected by the top management in the first period is shown in formula (2).

$$U(i, t) = \sum_{t=1}^{t=2} \gamma_{i,t}^{-(t-1)} \{ \delta (1 - \varphi_{i,j,t}) V(\pi_{i,t} - I_{i,t}) \} + \gamma_{i,t}^{-2} * [(1 - \sigma_j - \varphi_{i,j,3}) * \{ \delta * V(\pi_{i,3} + F_{i,j,3}) + \vartheta_{i,j,3} \} - \sum_{t=1}^{t=3} \gamma_{i,t}^{-(t-1)} \rho_i \delta_{i,t}^2] \quad (2)$$

Therefore, as the actual decision-maker and executor of the investment and financing decision-making, the manager chooses whether to invest in Project j according to the maximization of its effect function. The trigger condition of R&D investment can be found as shown in formula (3).

$$\gamma_{i,t}^{-2} \{ \delta (1 - \sigma_j - \varphi_{i,j,t}) V(\pi_{i,3} + F_{i,j,3}) - V(\pi_{i,3}) \} + \gamma_{i,t}^{-2} (1 - \sigma_j - \varphi_{i,j,t}) * \vartheta_{i,j,3} - \delta \{ \{ V(\pi_{i,1}) - V(\pi_{i,1} - I_{i,1}) \} (1 - \varphi_{i,j,t}) \} + \gamma_{i,t}^{-1} \{ V(\pi_{i,2}) - V(\pi_{i,2} - I_{i,2}) * (1 - \varphi_{i,j,t}) \} > 0 \quad (3)$$

If at the end of the payback period ($t = 3$), the present value of the difference between the expected return on investment from the R&D investment in project j and the profitability of the project j not invested, R& D innovation

occurs when the present value of the future potential return from project investment j is greater than the present value of the previously uninvested project ($t = 1,2$) minus the expected return on R&D investment. Otherwise, the enterprise will not invest Project j .

Next, we further discuss the impact of rising economic policy uncertainty on corporate R&D decisions. Based on the above analysis and hypothesis, the uncertainty of economic policy increases, which means that enterprises are more likely to have a liquidity crisis because of R&D investment in project j . That is, $\partial(\varphi_{i,j,t})/\partial((EPU_t) > 0$. The rising uncertainty of economic policy also increases the potential gains of enterprises in terms of increasing market share, diversification and industrial restructuring due to the success of research and development projects, i.e. $\partial(\vartheta_{i,j,3})/\partial((EPU_t) > 0$. It is also assumed that the increase in economic policy uncertainty increases the external risks to management decisions, that is, $\partial(\delta_{i,t})/\partial((EPU_t) > 0$. If we take the first derivative of the manager's utility function for the degree of uncertainty in economic policy, we get:

$$\begin{aligned} \partial U(i, t) / \partial EPU_t &= \sum_{t=1}^{t=2} \gamma_{i,t}^{-(t-1)} \{ \delta (1 - \partial \varphi_{i,j,t} / \partial EPU_t) \\ &V(\pi_{i,t} - I_{i,t}) \} + [\gamma_{i,t}^{-2} (1 - \sigma_j - \partial \varphi_{i,j,t} / \partial EPU_t) * \{ \delta * V(\pi_{i,t} \\ &+ F_{i,j,t}) + \vartheta_{i,j,3} \}] |_{t=3} + [\gamma_{i,t}^{-2} (1 - \sigma_j - \varphi_{i,j,t}) * \{ \delta * V(\pi_{i,t} \\ &+ F_{i,j,t}) + \partial(\vartheta_{i,j,3}) / \partial((EPU_t)) \}] |_{t=3} - \sum_{t=1}^{t=3} \gamma_{i,t}^{-(t-1)} - \sum_{t=1}^{t=3} \\ &- \sum_{t=1}^{t=3} \gamma_{i,t}^{-(t-1)} \{ 2 \rho_i \delta_{i,t} \partial(\delta_{i,t}) / \partial((EPU_t)) \} \quad (4) \end{aligned}$$

Since $\partial L(i, t) / \partial EPU_t = - \sum_{t=1}^{t=3} \gamma_{i,t}^{-(t-1)} \{ 2 \rho_i \delta_{i,t} \partial(\delta_{i,t}) / \partial((EPU_t)) \}$, according to the formula (4), if the uncertainty of economic policy increases, the negative impact of the increase in the liquidity risk of R&D investment on operating performance is smaller than the positive impact of the transformation of the results of the current period and the potential return on the performance of the firm after the R&D success, an increase in uncertainty about economic policy would promote innovation. On the contrary, it inhibits enterprise innovation.

Therefore, based on the mechanism analysis and theoretical model, this paper proposes two opposite hypotheses about the impact of economic policy uncertainty on firm innovation:

H1a: Increased uncertainty in economic policy promotes entrepreneurial innovation.

H1b: Increased uncertainty about economic policy can inhibit entrepreneurial innovation.

Furthermore, consider that the manager is the executor of the enterprise's investment and financing decisions. In this part, we analyze the influence of managerial competence MA_i and managerial overconfidence MC_i on the innovation behavior of enterprises. The improvement of top

management ability can strengthen corporate governance and cash management level, thus reducing the probability of bankruptcy of enterprises due to long-term and large-scale R&D investment, that's $\frac{\partial \varphi_{i,j,t}}{\partial MA_i} < 0$. Overconfidence in the executive means that he or she underestimates the risk of the investment itself, which is $\frac{\partial \varphi_{i,j,t}}{\partial MA_i} < 0$.

Therefore, the utility function $U(i, t)$ of R&D investment is used to solve the first derivative for executive competence and overconfidence respectively, and the results are shown in formulas (5) and (6).

$$\frac{\partial U(i,t)}{\partial MA_t} = \sum_{t=1}^{t=2} \gamma_{i,t}^{-(t-1)} \left\{ \delta \left(1 - \frac{\partial \varphi_{i,j,t}}{\partial MA_t} \right) V(\pi_{i,t} - I_{i,t}) \right\} + \gamma_{i,t}^{-2} \left[\left(1 - \sigma_j - \frac{\partial \varphi_{i,j,t}}{\partial MA_t} \right) * \{ \delta * V(\pi_{i,t} + F_{i,j,t}) + \vartheta_{i,j,3} \} \right]_{t=3} - \sum_{t=1}^{t=3} \gamma_{i,t}^{-(t-1)} \rho_i \delta_{i,t}^2 \quad (5)$$

$$V(\pi_{i,t} + F_{i,j,t}) + \vartheta_{i,j,3} \Big|_{t=3} - \sum_{t=1}^{t=3} \gamma_{i,t}^{-(t-1)} \rho_i \delta_{i,t}^2 \quad (6)$$

Because, according to formula (6), the improvement of senior management ability will increase the income of enterprise R&D investment, and then promote enterprise R&D innovation behavior under the situation of economic policy uncertainty. Similarly, , which means that during periods of high economic policy uncertainty, overconfidence of top management can also have a positive effect on firm R&D innovation behavior.

3. Research Design and Research Data

3.1 Sample Selection and Data Sources

This paper selects the data of non-financial listed companies in Shanghai and Shenzhen stock markets from 2007 to 2018 as the research sample, and excludes the ST sample. On the measurement of economic policy uncertainty, this paper uses Davis et AL's index of economic policy uncertainty in China, which is based on the key words in The People's Daily and Guangming Daily¹. The index calculates the number of articles with keywords such as "Finance", "Currency", "Securities Regulatory Commission", "Banking Regulatory Commission", "People's Bank" and "National Development Reform Committee", divide the number of articles that appear by the total number of articles for that month to get the exact value of policy uncertainty for that month, and use January 1995 as a benchmark to calculate China's economic uncertainty. Corporate financial data come from the CSMAR database. All continuous variables are winsorized at the 99th percentile.

3.2 Empirical Models and Variable Definitions

In order to study the impact of economic policy uncer-

tainty on enterprise innovation behavior, this paper constructs an empirical model as shown in Formula (7).

$$R\&D_{i,t} = \beta_0 + \beta EPU_t + \rho X_{i,t} + \mu_i + \delta_t + \varepsilon_{i,t} \quad (7)$$

Among them, the lower corner i represents the enterprise, the t represents the year, β_0 is the constant, μ_i is the enterprise fixed effect, δ_t represents the year fixed effect, $\varepsilon_{i,t}$ as the unobserved residual term, Standard error clustering of regression model to enterprise level.

The ratio of R&D investment to total assets is regarded as the agency variable of R&D innovation ($R\&D$). In the robustness test, the R&D investment to revenue ratio ($R\&D_2$), the natural logarithm of patent validity ($R\&D_3$) and the natural logarithm of patent validity ($R\&D_4$) are used as the proxy indexes of enterprise innovation.

The EPU is the core explanatory variable of this paper, that is, economic policy uncertainty, which is measured by all monthly averages for the year². If β 's estimated value is significantly greater than 0, then the increase of economic policy uncertainty promotes enterprise innovation, and H1a is established, whereas if the estimated value is significantly less than 0, then the increase of economic policy uncertainty inhibits enterprise innovation, H1b verified.

$X_{i,t}$ is the control variable. This paper further controls the company size ($Size$), financial leverage ratio (Lev), profitability (ROA), capital intensity (Int), enterprise market age (Age), main business growth rate ($Growth$), the dummy variable of actual controller (Soe) and the dummy variable of independent director ($Isindirecotre$). Definition and statistical description of variables are shown in Table 1.

4. Empirical Results Analysis

4.1 Benchmark Regression

Table 2 reports the results of a baseline regression on the impact of economic policy uncertainty on enterprise innovation. Individual fixed effect and year fixed effect are controlled in the regression model. The coefficient of economic policy uncertainty (EPU) is 0.0194 on the basis of controlling three basic control variables: Company Size(-Size), Financial Leverage ratio(Lev), Profitability(ROA), and it is significantly positive at 1% statistical level. The last three columns of the table add other control variables one by one. The results show that the coefficient of economic policy uncertainty (EPU) is significantly positive at 1% statistical level considering different information sets. Column (4) of Table 2 shows the regression results after adding all the control variables that affect the enterprise innovation. The result shows that the EPU co-

1 Data from the http://www.policyuncertainty.com/china_monthly.html

2 In the empirical analysis, The EPU index is reduced 100 times

Table 1. Main variable definitions and descriptive statistics

Variable definition	Variable	Variable measure	Sample size	Standard deviation	Median	Mean value
R&D investment as a percentage of total assets	<i>R&D</i>	Enterprise R&D input/total assets	22178	0.0172	0.0078	0.0137
Uncertainty about China's economic policy	<i>EPU</i>	China's economic policy uncertainty index, measurement methods are detailed in the body	22178	0.3372	1.2217	1.2542
Scale of enterprise	<i>Size</i>	natural logarithm of total assets	22178	1.2935	21.8651	22.0243
Leverage ratio	<i>Lev</i>	Total liabilities/total assets	22178	0.2164	0.4386	0.4436
Profitability	<i>ROA</i>	net profit/total assets	22178	0.0581	0.0356	0.0378
Capital intensity	<i>Int</i>	Total assets/operating income	22178	2.3742	1.9021	2.5850
Enterprise Market Age	<i>Age</i>	year of study-year of company listing	22178	5.4315	16.000	15.6649
Growth rate of main business income	<i>Growth</i>	current year main business income/previous year main business income-1	22178	0.5509	0.1197	0.2145
Nature of the actual controller	<i>Soe</i>	state-owned enterprises = 1, Non State-owned enterprises = 0	22178	0.4941	0.0000	0.4233
Nature of independent director	<i>Isindirecotre</i>	independent director = 1, non-independent director = 0	22178	0.0092	0.0000	0.0001

efficient is 0.1332, which is significantly positive at 1% statistical level, it shows that the increase of uncertainty level of economic policy will promote enterprise innovation, i.e. H1a assumption holds.

Table 2. Economic policy uncertainty and enterprise innovation

Variable	(1) <i>R&D</i>	(2) <i>R&D</i>	(3) <i>R&D</i>	(4) <i>R&D</i>
<i>EPU</i>	0.0194*** (0.001)	0.0255*** (0.009)	0.1144*** (0.036)	0.1332*** (0.041)
<i>Size</i>	-0.0016*** (0.000)	-0.0014*** (0.000)	-0.0009*** (0.000)	-0.0009*** (0.000)
<i>Lev</i>	0.0000 (0.001)	-0.0004 (0.001)	-0.0026*** (0.001)	-0.0026** (0.001)
<i>ROA</i>	0.0130*** (0.002)	0.0098*** (0.002)	0.0041** (0.002)	0.0055*** (0.002)
<i>Int</i>		-0.0006*** (0.000)	-0.0006*** (0.000)	-0.0006*** (0.000)
<i>Age</i>		-0.0004 (0.001)	-0.0012 (0.001)	-0.0015* (0.001)
<i>Growth</i>			-0.0003** (0.000)	-0.0004*** (0.000)
<i>Soe</i>				0.0005 (0.001)
<i>Isindirecotre</i>				-0.0122 (0.010)
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
<i>N</i>	27,627	27,548	24,145	22,178
<i>adj-R²</i>	0.157	0.166	0.161	0.159

Note: ***, **, * are significant at 1%, 5%, and 10% statistical levels, respectively. In parentheses are robust standard errors clustered to enterprise level, the same as below.

4.2 Regional Heterogeneity

There are great differences in economic development level, institutional environment and industrial policy among different regions in China [20]. The effect of economic policy uncertainty on the behavior mechanism of micro-enterprises may have regional heterogeneity. In general, in areas with a higher degree of economic development, the capital market is more complete, the system design is more reasonable, and the external economic environment is more favorable for enterprises to engage in R&D and innovation Activities. The effectiveness of capital market can provide timely liquidity support for enterprise R&D innovation, ease enterprise financing constraints, and promote enterprise innovation. Wang et al. (2014) [2] found that firms in more market-oriented regions were more motivated to innovate when economic policy uncertainty was on the rise. In areas with a higher degree of economic development, the proportion of overseas investment and the degree of market opening are stronger. With the increase of economic policy uncertainty, enterprises can make R&D innovation to realize decentralized management and increase market share.

The regional heterogeneity of the impact of economic policy uncertainty on firm innovation is reported in Table 3. The first two columns and the last two columns in the table give the regression results of some control variables and all control variables, respectively. The results show that the coefficient of economic policy uncertainty (EPU) is 0.0308 in the eastern region, which is significant at the 1% statistical level. However, the EPU coefficient is not

significant in the midwest. When controlling variables were added to columns (3) and (4) of the table, the results still showed that the positive correlation between economic policy uncertainty and firm innovation was only significant in the eastern developed regions, the above influence does not exist in the less developed areas of the central and western regions.

Table 3. Economic policy uncertainty and enterprise innovation: Sample regression in east, Midwest regions

Variable	(1)	(2)	(3)	(4)
	R&D The East	R&D The Midwest	R&D The East	R&D The Midwest
<i>EPU</i>	0.0308*** (0.009)	-0.0137 (0.010)	0.1462*** (0.042)	-0.0359 (0.052)
<i>Control variable</i>	No	No	Yes	Yes
<i>Year FE</i>	Yes	Yes	Yes	Yes
<i>Firm FE</i>	Yes	Yes	Yes	Yes
<i>N</i>	19,229	8,258	15,360	6,817
<i>adj-R²</i>	0.153	0.201	0.147	0.193

As a long-term, high-risk investment activity, R&D innovation requires periodic and continuous cash inflows. Studies have found that the problem of credit constraints caused by the low degree of financial market development is the cause of the decline in investment rates and consumption levels in developing countries [21], the increase in the efficiency of credit resource allocation is the effect of industrial agglomeration. An important channel for corporate financing costs [22], at the same time, political connections will also have a negative impact on the efficiency of credit resource allocation [23]. Rising uncertainties in economic policies increases financial market volatility and exacerbate financial intermediaries' credit-grass behavior, thereby increasing the difficulty and cost of external financing for enterprises. However, the increase in the allocation of credit resources will reduce the inhibitory effect of financing difficulties caused by policy uncertainty on corporate innovation. Therefore, the promotion effect of economic uncertainty on enterprise innovation only exists in regions with a high degree of marketization of credit resource allocation.

The enterprise innovation decision-making depends on the trade-off between the monopoly profit and the development cost. In areas with low patent protection, R&D results are more likely to be copied and stolen by other enterprises, thus reducing their willingness to engage in R&D innovation. In areas with high patent protection, government departments tend to support enterprises' R&D

activities and provide them with government subsidies, financial guarantee and personnel support. However, in regions with poor patent protection, the process of patent application and approval is more complicated, and the research results cannot be guaranteed effectively, which will restrain the enterprises' innovation motivation. Based on the above analysis, it can be concluded that the increasing uncertainty of economic policy has a positive impact on R&D innovation of enterprises only in areas with high patent protection.

Table 4, columns (1) and (2), respectively, report on the relationship between economic policy uncertainty and business innovation, and the impact on the allocation of credit resources in different regions. The results show that the coefficient of economic policy uncertainty (EPU) is 0.1535 in the regions with high credit resource allocation, which is significantly positive at 1% statistical level. On the contrary, the EPU coefficient is significantly negative at the level of 10% in the regions with low marketization of credit resource allocation. The effects of economic policy uncertainty on innovation in high-and low-patentability regions are reported in paragraphs (3) and (4) of Table 4. The results show that the EPU coefficient is 0.1518 in the regions with high patent protection, which is significantly positive at 1% statistical level. These effects do not exist in regions where patent protection is low.

Table 4. Economic policy uncertainty and enterprise innovation: Regional Heterogeneity

Variable	(1)	(2)	(3)	(4)
	R&D High degree of credit resource allocation	R&D Low allocation of credit resources	R&D High degree of patent protection	R&D Low degree of patent protection
<i>EPU</i>	0.1535*** (0.050)	-0.0514* (0.030)	0.1518*** (0.045)	-0.0219 (0.025)
<i>Control variable</i>	Yes	Yes	Yes	Yes
<i>Year FE</i>	Yes	Yes	Yes	Yes
<i>Firm FE</i>	Yes	Yes	Yes	Yes
<i>N</i>	15,378	5,658	15,545	5,646
<i>adj-R²</i>	0.165	0.140	0.162	0.172

4.3 Robustness Test

In order to verify the reliability of the empirical results, this paper uses three methods for robustness testing.

(1) Replace the explained variable. In the robustness test, the proportion of enterprise R&D investment in operating income (R&D_2), the natural logarithm of the effec-

tive number of patents (R&D_3) and the natural logarithm of the effective number of invention patents (R&D_4) are selected as the explained variables for empirical testing. The results show that after changing the measurement method of the explained variables, the economic policy uncertainty (EPU) coefficients are 0.1091, 0.0153, and 0.0312, respectively, which are significant at the 1% statistical level, indicating that economic policy uncertainty promotes enterprise innovation.

Table 5. Robustness test: replacing the explained variable

	(1)	(2)	(3)
Variable	R&D_2	R&D_3	R&D_4
<i>EPU</i>	0.1091*** (0.032)	0.0153*** (0.005)	0.0312*** (0.005)
<i>Control variable</i>	Yes	Yes	Yes
<i>Year FE</i>	Yes	Yes	Yes
<i>Firm FE</i>	Yes	Yes	Yes
<i>N</i>	22,178	16,828	14,359
<i>adj-R²</i>	0.152	0.564	0.664

(2) Change the measurement method of core variables. In order to ensure the validity and applicability of the empirical results, this paper adopts another method to calculate the uncertainty of economic policy. Specifically, this paper selects the data of Baker et al. (2016) [24] and uses the number of articles in the South China Morning Post that include keywords such as "China", "Economy", "Uncertainty" and "Policy" and the total number of articles issued in the month as a proxy indicator of economic policy uncertainty, and all monthly averages of the year are used as the measurement indicator¹ of the economic policy uncertainty index for that year. Table 6 reports the regression results of economic policy uncertainty and corporate innovation after changing the measurement methods of core variables. Gradually adding control variables, the coefficients of EPU are significantly positive at the 1% statistical level. It can be seen that changing the measurement method of economic policy uncertainty, the promotion of enterprise innovation by the increase of economic policy uncertainty has not changed.

(3) Endogenous problems. This paper uses the global economic policy uncertainty and the US economic policy uncertainty index as the instrumental variables of China's economic policy uncertainty, and uses the two-stage least squares method for regression to ensure the robustness of the empirical model. The principle of selecting instrumen-

tal variables is that global economic policy uncertainty or US economic policy uncertainty will affect China's economic policy uncertainty, but will not directly affect micro-enterprises' investment and financing behavior. Therefore, this paper selects the global and US economic policy uncertainty indices² as the IV instrumental variables respectively. The global economic policy uncertainty index includes current price GDP and post-purchasing power parity GDP data, and the US economic policy uncertainty index includes US ten key words index of domestic newspapers³, a list of interim federal tax laws compiled by the Congressional Budget Office (CBO) report⁴, and the Philadelphia Federal Reserve Bank's survey of professional forecasters⁵. Database synthesized data. This paper uses the 2sls two-stage least square method to re-estimate the relationship between economic policy uncertainty and enterprise innovation. Table 7 reports the results of IV instrumental variable regression. The results show that the EPU coefficient is still significant at the 1% statistical level. That is, after considering the endogenous problem, a consistent conclusion is reached.

Table 6. Robustness test: changing the measurement method of core variables

	(1)	(2)	(3)	(4)
Variable	R&D	R&D	R&D	R&D
<i>EPU</i>	0.0017*** (0.000)	0.0023*** (0.001)	0.0033*** (0.001)	0.0039*** (0.001)
<i>Control variable</i>	Yes	Yes	Yes	Yes
<i>Year FE</i>	Yes	Yes	Yes	Yes
<i>Firm FE</i>	Yes	Yes	Yes	Yes
<i>N</i>	27,627	27,548	24,145	22,178
<i>adj-R²</i>	0.157	0.166	0.161	0.159

2 Global data comes from http://www.policyuncertainty.com/global_monthly.html; US data comes from http://www.policyuncertainty.com/us_monthly.html

3 Ten newspapers include: "USA Today", "Miami Herald", "Chicago Tribune", "Washington Post", "Los Angeles Times", "Boston Globe", "San Francisco Chronicle", "Dallas Morning News", "Houston Chronicle" and "Wall Street Journal". To construct the index, each paper is searched once a month for vocabulary related to economic and policy uncertainty. In particular, search for articles containing "uncertainty" or "uncertainty", "economy" or "economy", and one or more of the following terms: "Congress", "Legislation", "White House", "Regulation", "Federal Reserve" or "deficit".

4 Temporary tax measures are a source of uncertainty for businesses and households, because Congress often extends tax measures at the last minute, undermining the stability and certainty of tax laws.

5 The individual level dispersion of three predictor variables directly affected by government policies is measured: CP, state and local government procurement of goods and services, and federal government procurement of goods and services. For each series, look at the quarterly forecast for the next year. The reason for choosing these variables is because they are directly affected by monetary policy and fiscal policy actions.

1 Data comes from www.policyuncertainty.com/china_monthly.html

Table 7. Robustness test: IV instrumental variable regression

	(1)	(2)	(3)	(4)
Variable	<i>IV_GEPU_1</i>	<i>IV_GEPU_2</i>	<i>IV_USEPU_1</i>	<i>IV_USEPU_2</i>
<i>EPU</i>	0.0044*** (0.001)	0.0044*** (0.001)	0.0044*** (0.001)	0.0044*** (0.001)
<i>Control variable</i>	Yes	Yes	Yes	Yes
<i>Year FE</i>	Yes	Yes	Yes	Yes
<i>Firm FE</i>	Yes	Yes	Yes	Yes
<i>N</i>	21,814	21,814	21,814	21,814
<i>adj-R²</i>	0.159	0.159	0.159	0.159
<i>Sargan statistic</i>	0.000	0.000	0.000	0.000

5. Further Discussion: Executive Heterogeneity

Senior management is a hidden soft factor within a company, and its background characteristics also have an impact on the quality of the company's internal control. The increase in economic policy uncertainty has an impact on the financial market and the external industry environment, which in turn affects corporate R&D investment behavior. However, senior management as the actual executor of business decision-making means that the heterogeneity of senior management inevitably affects the relationship between economic policy uncertainty and corporate innovation. At present, there are many studies on the influence of executive characteristics on corporate behavior, but there are few literature on the influence mechanism of executive heterogeneity on the relationship between economic policy uncertainty and corporate innovation. In view of this, based on the analysis of the relationship between economic policy uncertainty and corporate innovation, this paper further examines the impact of executive heterogeneity on the economy from the three dimensions of executive characteristics, executive capabilities, and executive overconfidence.

5.1 Executive Characteristics

5.1.1 Executive Gender

Studies have shown that female executives inhibit corporate R&D investment and excessive investment^[25,26], and the relationship between the proportion of female executives and earnings management is also reflected as an inverted U-shaped relationship^[27]. Studies have found that gender significantly affects the degree of risk appetite of microeconomic entities^[28]. Compared with men, women have a higher degree of risk aversion and are more sensitive to negative information. Therefore, female executives

are less innovative than male executives, have smaller debt financing scales, and are more cautious in investment decisions. The increase in economic policy uncertainty has increased the degree of uncertainty in the external market environment, and the risk of R&D investment is also higher. Compared with male executives, female managers have a lower degree of risk tolerance, which means that they are more cautious in their investment and financing decisions during periods of rising policy uncertainty. Therefore, the increase in economic policy uncertainty may promote corporate innovation more significantly in companies with male executives. In order to examine the impact of the heterogeneity of executives on corporate innovation in companies with gender differences in executives. In this paper, the full sample is divided into two sub-samples according to the gender of executives, and group regression is performed.

Table 8 reports the impact of executive gender heterogeneity on economic policy uncertainty and corporate innovation behavior. The results show that without controlling all variables, the coefficient of economic policy uncertainty (EPU) is 0.0269 in the group of male executives, which is significantly positive at the 1% statistical level; however, if executives gender is female, the coefficient of economic policy uncertainty (EPU) is 0.0318, which is not significant, indicating that the positive correlation between the degree of economic policy uncertainty and corporate innovation is only significant in companies with male executive gender. The last two columns in the table add all the information sets. The results show that if the executive is male, the EPU coefficient is significant at the statistical level of 1%; however, in companies with female executives, the EPU coefficient is only 5%. It can be seen that the role of economic policy uncertainty in promoting corporate innovation behavior is more pronounced in companies with male executives. In order to further investigate whether there is a significant difference in the EPU coefficient between male executives and female executives, this paper adopts the method of Chow test to test the difference of group coefficients. The results show that, regardless of whether all control variables are included, there is no significant difference in the EPU coefficient between male and female executives, that is, the degree of influence of economic policy uncertainty on corporate innovation does not exist among executives of different genders significant differences. However, from the perspective of statistical significance, the promotion of business innovation by economic policy uncertainty is more significant in companies with male executives.

Table 8. Economic policy uncertainty, executive gender and corporate innovation

variable	(1)	(2)	(3)	(4)
	R&D Male executives	R&D Female executives	R&D Male executives	R&D Female executives
<i>EPU</i>	0.0269*** (0.010)	0.0318 (0.042)	0.1241*** (0.043)	0.3289** (0.161)
<i>Control variable</i>	No	No	Yes	Yes
<i>Year FE</i>	Yes	Yes	Yes	Yes
<i>Firm FE</i>	Yes	Yes	Yes	Yes
<i>N</i>	23,859	1,684	20,703	1,475
<i>adj-R²</i>	0.167	0.110	0.162	0.126
<i>Year FE</i>	0.109		0.419	

5.1.2 Education Level of Executives

The level of education can reflect the cognitive ability and level of an individual. The improvement of education level can enhance the information processing ability of microeconomic entities. Therefore, the improvement of the education level of executives may have a positive impact on corporate performance by strengthening the tendency of executives to transcend boundaries [29]. However, on the other hand, some scholars believe that if executives have too high or too low academic qualifications, there may be problems with poor resilience and insufficient cognitive abilities, respectively, which has a negative impact on capital market performance and corporate operating performance [30]. In the context of rising economic policy uncertainty, future industry development trends will be less clear, and the uncertainty of the market operating environment will also increase. The high degree of executive education is accompanied by higher cognitive ability, but also has the characteristics of poor coping ability and more conservative investment tendency, which is not conducive to corporate R&D and innovation. In order to further examine the relationship between economic policy uncertainty and corporate innovation, the impact of heterogeneity among samples of different levels of executive education. This paper divide the whole sample into two sub-samples with an education level of master and above and below master's level according to the level of executive education for empirical analysis.

Table 9 reports the regression results of economic policy uncertainty and corporate innovation in a sub-sample of executives with high and low levels of education. Columns (1) and (3) in Table 9 are the regressions of companies with a master’s degree or above in the education level of executives. Columns (2)

and (4) show the corresponding regression results for undergraduate and below. Columns (3) and (4) in the table give the regression results after controlling all the information sets. It can be seen that the EPU coefficient is 0.0875 in enterprises with higher executive education, which is significant at the 5% statistical level, which shows that the economic policy uncertainty index has risen by 1%, and the level of R&D and innovation of companies with high executive education will increase by 0.0875%. Correspondingly, in the sample with a bachelor's degree or less of executive education, the EPU coefficient is 0.1714, indicating that the uncertainty of economic policies has increased by 1%, and the scale of enterprise R&D innovation has increased by 0.1714%. From a statistical point of view, the EPU coefficient is significant at the 1% statistical level among the samples with lower education levels of executives, and the coefficient (0.1714) is higher than the EPU coefficient (0.0875) in enterprises with higher education levels. Therefore, compared with companies with higher levels of executive education, the positive impact of rising economic policy uncertainty on corporate innovation is stronger in companies with lower levels of executive education.

Table 9. Uncertainty of economic policy, education level of executives and corporate innovation

variable	(1)	(2)	(3)	(4)
	R&D Highly educated	R&D Low educated	R&D Highly educated	R&D Low educated
<i>EPU</i>	0.0154** (0.007)	0.0460*** (0.016)	0.0875** (0.039)	0.1714*** (0.062)
<i>Control variable</i>	No	No	Yes	Yes
<i>Year FE</i>	Yes	Yes	Yes	Yes
<i>Firm FE</i>	Yes	Yes	Yes	Yes
<i>N</i>	10,279	10,380	8,992	8,802
<i>adj-R²</i>	0.142	0.177	0.134	0.173

5.1.3 Financial Experience of Senior Executives

Individuals' special work experience often affects their values, handling styles, and behavioral decision-making methods, which in turn determine the "stigma" of economic agents' behavior choices [31]. The senior management echelon theory proposes that the physiological characteristics and personal experiences of senior management lead them to make highly personalized choices for the production and operation of the enterprise. The work experience of executives also affects their work style, social network

relationships, and risk tolerance attitudes, which in turn affects the behavioral selection mechanism of micro-enterprises. Compared with executives without financial background, the relationship between senior executives with financial experience and senior bank management is closer, and there is a bank-enterprise relationship. The establishment of bank-enterprise relationships can reduce financing difficulties, increase credit lines, and reduce mortgage conditions, thereby helping to improve corporate investment efficiency. Therefore, the financial background of executives makes the investment behavior of their companies less negatively impacted by the phenomenon of bank lending caused by economic policy uncertainty, which in turn leads to the positive impact of economic policy uncertainty on corporate R&D and innovation. This paper classifies companies according to whether they have work experience in financial regulatory agencies, policy banks, or commercial banks. For executives, there are samples with and without financial experience, and a sub-sample regression is performed.

Table 10. Uncertainty of economic policy, financial experience of senior management and corporate innovation

	(1)	(2)	(3)	(4)
variable	R&D Financial experience	R&D No financial experience	R&D Financial experience	R&D No financial experience
<i>EPU</i>	0.0428** (0.020)	0.0307*** (0.010)	0.1685** (0.075)	0.1382*** (0.042)
<i>Control variable</i>	No	No	Yes	Yes
<i>Year FE</i>	Yes	Yes	Yes	Yes
<i>Firm FE</i>	Yes	Yes	Yes	Yes
<i>N</i>	1,013	23,143	883	20,303
<i>adj-R²</i>	0.132	0.156	0.135	0.160
<i>Chow test p value</i>	0.534		0.638	

Table 10 reports the impact of the heterogeneity of executive financial background on economic policy uncertainty and corporate innovation. The first two columns in the table report the regression results of not controlling the entire information set. The results show that the coefficient of EPU is only significant at a statistical level of 5% in companies with executives with a financial background; while in companies with no financial background, the coefficient of EPU is significant at a statistical level of 1% positive. In the last two columns of the table, all control variables are added. The results show that the EPU coefficient is 0.1685 in the

sample of executives with financial industry experience, which is only significantly positive at the 5% statistical level. However, in companies where executives do not have financial experience, the EPU coefficient is 0.1382, which is significantly positive at the 1% statistical level. The results show that the positive impact of economic policy uncertainty on corporate innovation is more significant in companies whose executives do not have financial experience. Table 10 also shows the difference between the EPU grouping coefficients in samples with and without financial experience of senior executives. The Chow test results show that according to whether there is financial experience in group regression, the EPU coefficient is not significantly different in different samples.

5.1.4 Political Background of Executives

Our government departments play an important role in resource allocation and economic activities. Existing studies have found that politically connected companies can improve corporate performance by obtaining tax relief, financial subsidies, and financing facilities^[33-35]. However, the administrative appointment and dismissal characteristics of the promotion of official executives also causes some companies to assume some social functions that are not conducive to the increase of profit margins for the purpose of political promotion, which causes a negative impact on corporate value^[36]. On the whole, companies with political backgrounds in executives have implicit guarantees from the government, which has led to a stronger tendency for government departments to favor such companies in terms of financing, tax relief, and industry policies. Therefore, the increase in uncertainty in the future industry development and the increase in the uncertainty of the external financing environment caused by the increase in policy uncertainty leads to greater negative impacts on the production and investment decisions of companies where there is no political background. In order to further examine the relationship between economic policy uncertainty, the political background of executives and corporate innovation, this paper classifies the political background of executives according to whether they have work experience in government departments. The regression results are shown in Table 11.

Table 11 reports the heterogeneous impact of economic policy uncertainty and corporate innovation in a sub-sample of executives with and without political background. The results in the table show that after controlling all the information sets, the coefficient of economic policy uncertainty (EPU) is 0.1376, which

is significant at the 5% statistical level. The EPU coefficient corresponds to -0.4924 in enterprises without political background, which is significantly negative at the 1% statistical level. It can be seen that the effect of economic policy uncertainty in promoting corporate innovation is only significant in companies where the senior management has a political background; however, economic policy uncertainty has a negative impact on corporate innovation in companies with executives without political background.

Table 11. Uncertainty of economic policy, heterogeneity of executive political background and corporate innovation

	(1)	(2)	(3)	(4)
variable	R&D	R&D	R&D	R&D
	Political background	No political background	Political background	No political background
<i>EPU</i>	0.1381**	-0.4944***	0.1376**	-0.4924***
	(0.056)	(0.114)	(0.057)	(0.112)
<i>Control variable</i>	No	No	Yes	Yes
<i>Year FE</i>	Yes	Yes	Yes	Yes
<i>Firm FE</i>	Yes	Yes	Yes	Yes
<i>N</i>	4,060	880	4,060	880
<i>adj-R²</i>	0.118		0.118	
	0.103		0.104	

5.2 Senior Management Ability

The ability of executives also has an impact on the relationship between economic policy uncertainty and corporate innovation. Specifically, companies with strong senior management capabilities can accurately interpret the introduction and changes of economic policies, and make timely and effective judgments on industrial development trends and capital market fluctuations. In companies with strong senior management capabilities, corporate governance is better, the degree of internal diversification is higher, and the ability to resist risks is stronger. It can be seen that in companies with strong executive capabilities and economic policy uncertainty is rising. Managers are less willing to conduct R&D and innovation for increasing market share, stabilizing expectations of external investors, and motives of getting involved in emerging industries. In contrast, the poor ability of executives means that they cannot accurately make judgments about the future development of the industry and the market, and they are more likely to miss

good investment opportunities.

In order to further examine the impact of economic policy uncertainty on corporate innovation, the heterogeneous impact of companies with different executive capabilities. This paper uses corporate investment deviation, that is, investment efficiency to measure executive capabilities. If the company's inefficiency investment is less than 10% of the same industry quantile in the same year, it belongs to a company with strong executive ability; If the company's inefficiency investment level is higher than the annual-industry 90% quantile, it belongs to executive ability poor business. If the company's inefficiency investment level is between 10% and 90% quantile, it is a company with moderate executive capabilities. Table 12 reports the heterogeneous impact of economic policy uncertainty and corporate innovation among companies with strong, moderate and weak executive capabilities. The results show that after adding all the control variables, the EPU coefficients are 0.0122 and 0.0329 in companies with strong executive capabilities and weak executive capabilities, and the coefficients are not significant. In companies with moderate executive capabilities, the EPU coefficient is 0.1424, which is significantly positive at the 1% statistical level. It can be seen that the positive correlation between economic policy uncertainty and enterprises only exists in enterprises with moderate executive capabilities.

Table 12. Uncertainty in economic policies, executive capabilities and corporate innovation

	(1)	(2)	(3)	(4)	(5)	(6)
variable	R&D Strong executive ability	R&D Moderate executive ability	R&D Weak executives ability	R&D Strong executive ability	R&D Moderate executive ability	R&D Weak executives ability
<i>EPU</i>	0.0086	0.1210***	0.0780*	0.0122	0.1424***	0.0329
	(0.013)	(0.038)	(0.041)	(0.046)	(0.045)	(0.048)
<i>Control variable</i>	No	No	No	Yes	Yes	Yes
<i>Year FE</i>	Yes	Yes	Yes	Yes	Yes	Yes
<i>Firm FE</i>	Yes	Yes	Yes	Yes	Yes	Yes
<i>N</i>	6,851	20,697	2,282	3,187	18,991	2,098
<i>adj-R²</i>	0.167	0.169	0.244	0.102	0.168	0.249

5.3 Overconfidence of Executives

Executive overconfidence is also an important factor affecting corporate behavior. Overconfidence behavior of executives expands the scale of corporate investment and increases investment-cash flow sensitivity^[37]. Managers' overconfidence can also lead to an increase in risk-tak-

ing levels ^[38], and promote corporate R&D investment and R&D output behavior ^[12]. Overconfident managers are more inclined to choose high-risk and high-return investment projects, and give up some opportunities with stable risks and low returns. The increase in economic policy uncertainty increases the risk of corporate R&D innovation, but it also means that once R&D is successful, it has a stronger positive role in expanding market share, increasing corporate value, and improving operating performance. Therefore, the overconfidence of executives plays a positive role in regulating the relationship between economic policy uncertainty and corporate innovation. In view of this, this paper selects the proportion of executives' total compensation to the total compensation of supervisors as a measure of executive overconfidence, and compares the proxy variable of executive overconfidence (Netpro) with economic policy uncertainty (EPU). Interactively, the regression results are shown in Table 13.

Table 13. Economic policy uncertainty, executive overconfidence and corporate innovation

	(1)	(2)	(3)	(4)
variable	R&D	R&D	R&D	R&D
<i>EPU*Netpro</i>	0.0001*** (0.000)	0.0001** (0.000)	0.0001*** (0.000)	0.0001** (0.000)
<i>EPU</i>	-0.0042*** (0.000)	-0.0043*** (0.001)	0.0253*** (0.008)	0.1036*** (0.033)
<i>Netpro</i>	-0.0001 (0.000)	-0.0001 (0.000)	-0.0001 (0.000)	-0.0001 (0.000)
Control variable	No	Yes	No	Yes
<i>Year FE</i>	No	No	Yes	Yes
<i>Firm FE</i>	Yes	Yes	Yes	Yes
<i>N</i>	25,191	21,885	25,191	21,885
<i>adj-R²</i>	0.146	0.134	0.162	0.152

Table 13 reports the moderating effect of executive overconfidence on the relationship between economic policy uncertainty and corporate innovation. The first two columns in the table do not control year fixed effects, and the second two columns control year fixed effects. Column (1) of the table reports the empirical results of adding some control variables and not controlling the year effect. The results show that the coefficient of the interaction term (*EPU*Netpro*) between economic policy uncertainty and executive overconfidence is 1%. The statistical level is significantly positive, indicating that the increase in the degree of overconfidence of executives will positively regulate the relationship between economic policy uncertainty and corporate innovation. All the control variables are added to the column (2) of the table, and the year effect is not controlled. The results show that the *EPU*Netpro* interaction coefficient is significantly positive at the 5% statistical level. The last two columns in the table control

the entire information set. The results show that regardless of whether the year fixed effect is controlled, the overconfidence of executives still has a positive adjustment mechanism between economic policy uncertainty and corporate innovation, indicating that the conclusions of this paper are still valid.

6. Main Conclusions and Policy Recommendations

This paper analyzes how economic policy uncertainty affects corporate innovation, and the moderating effects of executive heterogeneity. The study found that: First, the increase in economic policy uncertainty promotes enterprise innovation, and this effect is more pronounced in the eastern region, where the degree of marketization of credit resources is higher and the degree of patent protection is higher. Second, the positive impact of economic policy uncertainty on corporate innovation is more pronounced in companies with male executives, low levels of education, no financial experience, and political backgrounds. Third, the promotion effect of economic policy uncertainty on corporate innovation only exists in companies with moderate executive capabilities. However, the above effects do not hold for companies with too strong executive capabilities and too weak executive capabilities. Fourth, the overconfidence of executives plays a positive role in regulating the relationship between economic policy uncertainty and corporate innovation. Our baseline results are further supported by several robustness tests.

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