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Why are executives interested in technology policy? ——Research on the mechanism of science and technology policy affecting enterprise innovation

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Abstract: This paper selects the A-share non-financial listed companies in China from 2007 to 2018 as the research object to study the impact of science and technology policy on enterprise innovation and its influence mechanism, and further explore the effectiveness boundary of science and technology policy. The results show that there is a significant positive correlation between science and technology policy and executive compensation; there is a significant positive correlation between technology policy and enterprise innovation; there is a significant positive correlation between science and technology policy and enterprise innovation; executive compensation plays a partial intermediary effect between technology policy and enterprise innovation. Further research on the effectiveness boundary of science and technology policy shows that: first, management power can strengthen the positive correlation between science and technology policy and executive compensation; second, regional factors have a greater impact on the relationship between science and technology policy and enterprise innovation. The ethnic regions and western regions with poor economic development level weaken the positive incentive effect of science and technology policies on enterprise innovation.

Keywords: Science and Technology Policy; Executive Compensation; Enterprise Innovation; Effectiveness Boundary

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1. Introduction

Innovative activities have high risk and positive externalities, and they are one of the root causes of 'market failure' leading to insufficient innovation motivation and investment by enterprises. Neoclassical economics and Keynesianism argue that the government can use its 'visible hand' to intervene in the market, compensating for the inadequacies of the 'invisible hand', guiding and enhancing effective resource allocation (Cappelen et al., 2012; Rao, 2016). Science and technology policies, as important tools for government intervention in the enterprise innovation market, can alleviate the dilemma of insufficient innovation resources for enterprises, guide enterprises to increase their investment in innovation resources, and improve the innovation performance of enterprises and society as a whole. Therefore, science and technology policies have become the preferred tool for governments worldwide to regulate the lack of innovation motivation and investment in the innovation process of enterprises (Xu and Li, 2017a). Previous studies have noted that science and technology policies have a positive incentive effect on enterprise innovation (Jiang, 2011; Feng et al., 2015; Li and Du, 2016; Zhou and Pan, 2019); however, some research has found that government intervention in enterprise innovation through science and technology policies is not always effective, as external innovation resources brought about by such policies may crowd out internal innovation resource investments (Li et al., 2017; Zhang and Sun, 2018), or may lead to opportunistic behavior by managers (Li and Zheng, 2016), resulting in new 'market failures' and reducing the technical efficiency and allocation efficiency of public innovation resources. Other studies have discovered a threshold effect between science and technology policies and enterprise innovation, showing an inverted U-shaped relationship (Li et al., 2014). From the conclusions of existing literature, there is inconsistent evidence regarding the effectiveness of science and technology policies on enterprise innovation; however, from the practical experience of enterprises in innovation across various countries, especially in China, it is undeniable that science and technology policies can promote enterprise innovation. Therefore, scholars such as Yang and Hou (2019) believe that the key issue in theoretical research is not to explore whether science and technology policies are effective, but to focus on issues such as why the same science and technology policy shows significant incentive differences for different enterprises, exploring the path mechanisms and boundaries of the effectiveness of science and technology policies.

Whether a company should engage in technological innovation, how much resources to allocate to it, and what mode of innovation to adopt are essentially management issues. How to address and handle these problems depends on the management team, especially the senior executives. Due to the high risk and uncertainty inherent in innovation, under limited corporate resources, driven by short-term performance pressure and personal interests, rational economic agents like senior executives lack the motivation to pursue technological innovation or increase investment in it. Even if science and technology policies can potentially enhance corporate innovation resources, rational executives will not respond significantly to such incentives unless the policies can provide sufficient returns to offset the high risks and potential losses associated with increased innovation investment (Xu et al., 2018). Therefore, if senior executives are not proactive or even resistant to technological innovation, the positive incentive effect of science and technology policies on corporate innovation cannot be realized. In other words, the perception and response level of senior executives to science and technology policies will determine whether the positive incentive effect of these policies on corporate innovation is achieved, and it is one of the intrinsic reasons for the differences in the incentive effects of science and technology policies across different companies. Unfortunately, existing literature has almost entirely neglected to explore the path mechanisms of how science and technology policies incentivize corporate innovation from an internal motivation perspective, leading to a lack of deep understanding of why these policies are effective or ineffective. Based on this, this paper explores the impact of science and technology policies on corporate innovation and its influencing mechanisms from the perspective of executive incentives, which greatly supplements and expands upon existing literature.

2. Theoretical analysis and hypothesis development

2.1. Science and Technology Policies and Executive Compensation

From the perspective of the government's motivation for implementing science and technology policies, the purpose of such policies is to address issues related to knowledge production, dissemination, and application in the field of science and technology. These issues mainly manifest as how to raise, allocate, and utilize research and development funds, guide the distribution of social capital, facilitate the flow and pricing of factors such as talent and technology, and promote the transfer and industrialization of technological patents. Due to the profit-seeking nature of the market, solving these problems solely through market forces is insufficient. Therefore, the government's 'helping hand' is needed to overcome market failures. Science and technology policies, primarily consisting of financial subsidies and tax incentives, become crucial catalysts for promoting corporate innovation (Xu and Li, 2017a). From the perspective of executives' motivations for investing in technological innovation, despite the high risks and uncertainties associated with short-term performance, increasing investment in technological innovation enhances the complexity of R&D and future corporate development, thereby increasing information asymmetry between agents (executives) and principals (shareholders). This information asymmetry allows agents to seek higher compensation (including monetary salaries, stock options, and non-monetary benefits such as on-the-job consumption) and greater internal control power (Chen et al., 2015). Additionally, higher compensation serves as a risk compensation arrangement for executives who take risks by investing in technological innovation (Zhou et al., 2018). Therefore, from the perspective of motivation, the government's implementation of science and technology policies to incentivize corporate technological innovation aligns with executives' motivations to invest in technological innovation to gain personal benefits. It is precisely due to this alignment of intrinsic motivations that we can explain why executives comply with the 'guidance' of government-implemented science and technology policies. Moreover, if executives cannot leverage the policy effects of science and technology policies to secure more personal benefits, it would significantly weaken their enthusiasm for investing in technological innovation. This also explains the significant differences in incentive effects of science and technology policies across different companies. Based on the assumption of rational economic agents, this paper expects that the purpose of companies complying with science and technology policies to increase their innovation efforts is for executives to secure more private gains for themselves. Thus, the hypothesis of this paper is proposed:

H1:Technology policies can bring higher monetary compensation to executives.

2.2. Executive Compensation and Corporate Innovation

Neo-classical economic efficiency theories, represented by X-efficiency theory, argue that within a given level of resource input, the internal institutional arrangements, operational mechanisms, and organizational culture of an organization determine its output performance (Leibenstein, 1966). New Institutional Economics posits that institutions are crucial elements and driving forces for innovation and development in economic organizations. Institutions reduce friction among individuals within the organization and transaction costs between external stakeholders, thereby promoting innovation and development in economic organizations (Williamson, 1975). Technological innovation involves uncertainty and high risk. Given limited corporate resources, increasing investment in innovation and R&D means higher short-term performance risks and increased uncertainty in executive compensation due to uncertain performance outcomes. Therefore, to incentivize executives to engage in innovation investments, it is necessary to enhance the incentive intensity of executive compensation contracts to encourage them to take on the uncertainties associated with innovation investments. Executive compensation, as a key component of corporate incentive systems, significantly motivates executives to proactively assume risks, increase their effort levels, and improve corporate operating performance. Research has found that increasing executive and employee compensation can promote sustainable corporate growth (Xia and Dong, 2014); monetary executive compensation positively enhances corporate R&D efficiency but this positive relationship is constrained by regional market development and industry external environments (Chen et al., 2015). Zhou et al. (2018) pointed out that executive compensation serves as a compensation mechanism for risk-taking, motivating executives to accept the uncertainties of innovation and short-term performance declines. Xu et al. (2018) noted that sticky executive compensation, as an institutional arrangement encouraging executives to engage in innovation activities and tolerate initial failures, alleviates overly conservative investment behaviors from risk-averse executives; however, sticky executive compensation is not always better, but only maintains a positive incentive effect on R&D innovation when it reduces penalties or provides appropriate rewards during performance declines.

In summary, technology policies aim to encourage companies to increase their investment in innovation, enhance their innovative capabilities, and boost their innovative outputs. However, executives may lack enthusiasm for innovation investments due to concerns about the uncertainty risks of short-term performance and the uncertain risks of their own performance-based compensation. Therefore, whether executives' compensation is guaranteed or expected to sustainably improve becomes the key to motivating them to take on the uncertainties associated with innovation investments. Consequently, to elevate a company's level of innovation, it is essential to first raise the compensation levels of its executives. This leads to the hypothesis proposed in this paper:

H2:Executive compensation can enhance corporate innovation levels.

2.3. Science and Technology Policies and Corporate Innovation

From the perspective of the spillover effects of public policy, the purpose and function of science and technology policies are to address inherent market failures in the process of corporate innovation (Stiglitz, 1989; Yang et al., 2015). The ability of science and technology policies to address market failures during corporate innovation demonstrates that such policies have positive externalities. These positive externalities influence corporate innovation motivation, behavior, and performance through two mechanisms: resource acquisition and signal transmission. From the perspective of resource acquisition, science and technology policies directly enhance the scarce innovation resources available to enterprises, reduce the marginal costs of their innovation activities, alleviate the risks associated with innovation investment due to uncertainty, thereby addressing market failures related to insufficient innovation drive and inadequate resource investment in corporate independent innovation (Techer, 2002; Hussinger, 2008). From the perspective of signal transmission, the government uses fiscal, tax, and financial policy tools to send positive signals to the market. These signals indicate the prospects, technological level, and economic importance of certain industries and enterprises to the national economy, suggesting that the government may continue to support these sectors (Guo, 2018). Such signals not only boost the confidence of enterprise owners and managers regarding the future development prospects of their businesses but also attract various stakeholders in the market, helping enterprises gain better recognition and support from them. Additionally, they can attract and guide innovation resources to flow towards these enterprises, alleviating financing constraints for innovation (Ren and Lu, 2014), sharing the risk of innovation failure (Xie et al., 2009), and bridging the gap between private and social returns (Clausen, 2009), thus achieving a positive incentive effect on corporate innovation motivation, investment behavior, and performance. Based on this, we propose the following research hypothesis:

H3:Technological policies have a positive incentive effect on corporate innovation.

2.4. The mechanism by which technological policy incentivizes corporate innovation: The mediating effect of executive compensation

In summary, innovative investment involves uncertainty and high risk. Under the constraint of limited corporate resources, increasing resource allocation to innovation activities means an increased risk of short-term performance uncertainty. Additionally, due to the increased uncertainty in performance, there is also greater uncertainty in executive compensation, which leads to a lack of enthusiasm among executives for innovative investments. The purpose of the government's implementation of science and technology policies is to use the 'visible hand' to incentivize enterprises to increase their innovation input, enhance their innovation capabilities, and improve innovation outcomes, thereby addressing market failures in corporate innovation. However, whether enterprises are willing to engage in innovation investments or increase their innovation inputs depends on the executives responsible for managing and operating the enterprise. Whether executives have the motivation to increase technological innovation investments mainly depends on whether the company has established a reasonable risk-sharing and compensation mechanism. Executive compensation, as the most commonly used incentive system arrangement by enterprises, is an important incentive mechanism for encouraging executives to take risks, alleviating the tendency towards moral hazard among executives, and reducing principal-agent costs (Wang et al., 2014; Xia and Dong, 2014; Xu et al., 2018; Zhou et al., 2018; Huang et al., 2019). Therefore, executive compensation is both a key factor in whether executives are willing to engage in innovation investments and a crucial factor in achieving the goals of science and technology policies. Increasing executive compensation levels should be an important intermediary path mechanism for reducing principal-agent costs and enhancing the positive incentives of science and technology policies for corporate innovation. Based on this, we propose the following hypothesis:

H4:Technology policies positively incentivize corporate innovation by increasing executive compensation.

3. Research Design

3.1. Sample Selection and Data Sources

To obtain large-scale empirical evidence, this paper uses A-share non-financial listed companies in China from 2007 to 2018 as the research sample, taking government subsidies disclosed in their financial statement notes as an alternative variable for science and technology policies, to examine the incentive effects of science and technology policies on corporate innovation. The data in this paper comes from the Wind database, and the continuous variable data undergoes winsorization at the 1st and 99th percentiles.

3.2. Empirical Model Design

3.2.1. Variable Definition

Li and Zheng (2016) believe that the number of patent applications better reflects a company's innovation motivation and capability than the number of granted patents, making it more suitable as an alternative variable for measuring corporate innovation output. Therefore, in this paper, the dependent variable-corporate innovation-is measured by the number of patent applications made by the company. The explanatory variable is technological policy, which is measured by the fiscal subsidies disclosed in the notes to the company's financial statements, following Li and Du(2016). The mediating variable is executive compensation, including both managerial compensation and CEO compensation. Following Li and Du(2016), this paper controls for the impact of other important variables affecting corporate innovation, such as company asset size, financial leverage, growth potential, return on net assets, and company age, as well as industry and year fixed effects. Variable definitions are shown in Table 1.

3.2.2. Regression Model

To test the impact of technology policies on executive compensation (i.e., Hypothesis H1), construct regression model (1):

$$Pay_{i,t} = \alpha_0 + \alpha_1 Gov_{i,t} + \sum \alpha_k Controls_{k,i,t} + Indu + Year + \varepsilon_{i,t} \tag{1}$$

To test the impact of executive compensation on corporate innovation (i.e., Hypothesis H2), construct regression model (2):

$$Innov_{i,t} = \lambda_0 + \lambda_1 Pay_{i,t} + \sum \lambda_k Controls_{k,i,t} + Indu + Year + \omega_{i,t} \tag{2}$$

To test the impact of science and technology policies on corporate innovation (i.e., Hypothesis H3), construct regression model (3):

$$Innov_{i,t} = \alpha_0 + \alpha_1 Gov_{i,t} + \sum \alpha_k Controls_{k,i,t} + Indu + Year + \mu_{i,t} \tag{3}$$

To test Hypothesis H4, we follow the approach of Wen and Ye(2014) and construct a mediation effect testing model. In the first step, we build a path model Path a that does not include executive compensation Payi,t, to examine the impact of science and technology policies Govi,t on corporate innovation Innovi,t, observing the regression coefficient β1 of the path model Path a. In the second step, we construct a path model Path b for the impact of science and technology policies Govi,t on executive compensation Payi,t, observing the regression coefficient (1. In the third step, we build a path model Path c that includes both science and technology policies Govi,t and executive compensation Payi,t on corporate innovation Innovi,t, observing the regression coefficients β1 and β2. If the regression coefficient β1 of path model Path a is significantly positive, Hypothesis H3 is supported. If the regression coefficient β1 of path model Path a is significantly positive and the regression coefficient β2 of path model Path c is also significantly positive, it indicates that Hypothesis H4 holds, meaning that executive compensation Payi,t plays a mediating role between science and technology policies and corporate innovation; if the regression coefficient β1 of path model Path c is significantly positive, it indicates that executive compensation Payi,t plays a partial mediating role between science and technology policies and corporate innovation; if the regression coefficient β1 of path model Path c is not significantly positive, it indicates that executive compensation Payi,t plays a full mediating role between science and technology policies and corporate innovation.

$$Innov_{i,t} = \beta_0 + \beta_1 Gov_{i,t} + \sum \beta_k Controls_{k,i,t} + Indu + Year + \mu_{i,t} \tag{Path a}$$

$$Pay_{i,t} = \alpha_0 + \alpha_1 Gov_{i,t} + \sum \alpha_k Controls_{k,i,t} + Indu + Year + \varepsilon_{i,t} \tag{Path b}$$

$$Innov_{i,t} = \beta_0 + \beta_1 Gov_{i,t} + \beta_2 Pay_{i,t} + \sum \beta_k Controls_{k,i,t} + Indu + Year + \mu_{i,t} \tag{Path c}$$

In the above model, Innovi,t is the dependent variable-corporate innovation, Govi,t is the explanatory variable-science and technology policy, with current fiscal subsidies received by the company serving as an alternative variable (Gov). Payi,t is the mediating variable-executive compensation, including managerial compensation Pay_m and the compensation of the top three executives Pay_3m; other variables are defined as shown in Table 1.

Table 1. Variable Definitions

variable name	variable symbol	variable definition
Enterprise Innovation	Innov	The natural logarithm of the total number of enterprise patent applications plus one
Executive pay	Pay_m	The sum of executive compensation divided by employee compensation payable
	Pay_3m	The sum of the top three executive salaries divided by employee compensation payable
Science and technology policy	Gov	The financial subsidy is divided by the total assets at the end of the year
	LagGov	The Gov. is one period behind schedule
asset size	ASSET	Natural logarithm of total assets at the end of the year
financial leverage	LEV	Total liabilities divided by total assets
Enterprise growth	Growth	The rate of change in operating income for the first and second periods
Return on equity	ROE	Net profit divided by total assets
enterprise age	Age	Establishment year of the company

4. Empirical results analysis

4.1. Descriptive Statistics

Table 2 shows that the average innovation output (Innov) of sample enterprises is 0.6001 (the average number of patent applications before taking the natural logarithm is 17.2793); management compensation (Pay_m) accounts for 63.92% of employee compensation, indicating a significant gap between management and employee compensation; the top three executives' compensation (Pay_3m) accounts for 23.23% of employee compensation; the intensity of technological policy support received by sample enterprises is 0.0054, and the intensity of technological policy support lagged by one period is 0.0051. The average asset size of sample enterprises is 21.9730; financial leverage is 43.72%; the average growth rate of operating revenue is 20.6689%; return on net assets is 7.1146%; and the average age of enterprises is 17 years. The correlation table in Table 5-3 shows that the explanatory variable (Gov) is significantly positively correlated with the explained variable (Innov), indicating that technological policies have a positive incentive effect on corporate innovation, which preliminarily verifies Hypothesis H4 of this paper; the intermediary variables (Pay_m and Pay_3m) are significantly positively correlated with the explained variable (Innov), preliminarily verifying Hypothesis H2 of this paper; the explanatory variable (Gov) is significantly positively correlated with the intermediary variables (Pay_m and Pay_3m), indicating that technological policies can increase the level of management compensation, preliminarily verifying Hypothesis H1 of this paper.

Table 2. Descriptive Statistics

variable quantity	sample capacity	mean value	standard deviation	minimum value	median	maximum
Innov	25991	0.6001	1.3300	0.0000	0.0000	5.4337
Pay_m	25801	0.6392	2.0056	0.0048	0.1859	17.4549
Pay_3m	25756	0.2323	0.6747	0.0015	0.0676	5.4541
Gov	25991	0.0054	0.0073	0.0000	0.0029	0.0414

LagGov	23936	0.0051	0.0072	0.0000	0.0026	0.0414
ASSET	25991	21.9730	1.2779	19.0811	21.7989	25.8881
LEV	25991	0.4372	0.2191	0.0495	0.4281	1.1285
Growth	25991	20.6689	52.1731	-64.8795	12.1615	399.6405
ROE	25991	7.1146	13.6431	-73.8852	7.6562	41.8673
Age	25991	17.3586	5.6559	1.0000	17	64.0000

Table 3. Correlation Coefficient Table

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1)Innov	1									
(2)Gov	0.048***	1								
(3)LagGov	0.065***	0.535***	1							
(4)Pay m	0.008*	0.031***	0.022***	1						
(5)Pay 3m	0.012*	0.034***	0.025***	0.979***	1					
(6)ASSET	0.042***	-0.187***	-0.140***	-0.149***	-0.168***	1				
(7)LEV	-0.057***	-0.085***	-0.104***	-0.072***	-0.080***	0.432***	1			
(8)Growth	-0.002	-0.021***	-0.0010	0.014**	0.015**	0.057***	0.024***	1		
(9)ROE	0.043***	0.046***	-0.003	0.002	0.001	0.089***	-0.198***	0.234***	1	
(10)Age	-0.042***	-0.084***	-0.046***	-0.020***	-0.012*	0.176***	0.120***	-0.015**	-0.064***	1

4.2. Empirical Results

As shown in column (1) of Table 4, the regression coefficient for science and technology policy (Gov) is significantly positive, indicating that the more financial subsidies a company receives and the stronger the support from science and technology policies, the higher the compensation level of senior management. This suggests that science and technology policies aimed at encouraging corporate innovation require companies to increase their innovation investments through financial subsidies. Increasing innovation investment increases the information asymmetry between principals and agents, thereby providing opportunities for senior executives to seek private benefits and raise monetary compensation. In other words, science and technology policies that promote corporate innovation increase internal information asymmetry within enterprises, providing opportunities for senior executives to seek higher compensation, thus supporting Hypothesis H1 of this paper. Column (2) of Table 4 shows that science and technology policy (Gov) is significantly positively correlated with the compensation of the top three executives (Pay_3m), also supporting Hypothesis H1 of this paper.

Table 4 column (3) shows that the regression coefficient of executive compensation (Pay_m) is significantly positive, indicating that the higher the executive compensation, the higher the company's level of innovation. This suggests that through compensation incentives, corporate executives are more willing to take on the uncertainty risks associated with innovation, fully demonstrating that monetary compensation serves as an effective risk-bearing compensation mechanism for companies. It has a significant motivational effect on encouraging executives to proactively assume risks, overcome conservative inaction, and actively engage. This evidence supports the research hypothesis H2 of this paper (Zhou et al., 2018). Table 4 column (4) shows that there is a significant positive correlation between the compensation of the top three executives (Pay_3m) and corporate innovation (Innov), which also supports the research hypothesis H2 of this paper.

Table 4 column (5) shows that the regression coefficient of science and technology policy (Gov) is significantly positive, indicating that the higher the amount of financial subsidies received by enterprises and the stronger the support from science and technology policies, the higher the compensation level of top management. This suggests that science and technology policies aimed at encouraging corporate innovation require companies to increase their innovation investments through financial subsidies, and an increase in innovation investment inevitably enhances the company's innovation level (Wu, 2006; Li et al., 2017), which aligns with the logic of the resource acquisition theory of innovation (Teicher, 2002; Hussinger, 2008). This evidence supports the research hypothesis H3 of this paper. Table 4 column (6) shows that the relationship between the lagged one-period science and technology policy (LagGov) and corporate innovation is also significantly positive, providing further support for the research hypothesis H3 of this paper.

Table 4. Empirical Regression Results

VARIABLES	(1) Pay_m	(2) Pay_3m	(3) Innov	(4) Innov	(5) Innov	(6) Innov
Gov	3.473*	1.251*			6.328***	
	(1.961)	(0.658)			(1.168)	
Pay_m			0.0077**			
			(0.0038)			
Pay_3m				0.0213*		
				(0.0111)		
LagGov						7.533***
						(1.272)
ASSET	-0.249***	-0.0967***	0.119***	0.120***	0.123***	0.119***
	(0.0113)	(0.0039)	(0.0086)	(0.0086)	(0.0086)	(0.0089)
LEV	-0.329***	-0.112***	-0.250***	-0.250***	-0.268***	-0.258***
	(0.0741)	(0.0255)	(0.0415)	(0.0415)	(0.0415)	(0.0428)
Growth	0.0008**	0.0003**	-0.0002	-0.0002	-0.0001	-0.0002*
	(0.0006)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
ROE	-0.0004	-0.0001	0.0031***	0.0031***	0.0028***	0.0034***
	(0.0009)	(0.0003)	(0.0006)	(0.0006)	(0.0006)	(0.0006)
Age	0.0015	0.0016**	-0.0092***	-0.0092***	-0.0089***	-0.0099***
	(0.0023)	(0.0008)	(0.0017)	(0.0017)	(0.0017)	(0.0018)
Year	control	control	control	control	control	control
Indu	control	control	control	control	control	control
Constant	5.655***	2.197***	-2.205***	-2.228***	-2.302***	-2.178***
	(0.241)	(0.0834)	(0.198)	(0.199)	(0.198)	(0.205)
Observations	25,801	25,756	25,801	25,756	25,991	23,936
R-squared	0.042	0.050	0.062	0.062	0.063	0.066
F	28.61***	34.17***	85.91***	85.69***	86.58***	81.78***

Robust standard errors in parentheses， *** $p<0.01$, ** $p<0.05$, * $p<0.1$

The focus of both theoretical and practical circles is on how technological policies influence corporate innovation through path mechanisms. Existing literature, from the perspective of resource acquisition, suggests that technological policies enhance innovation levels by introducing external innovative resources, ultimately improving corporate innovation levels (Sun and Wang, 2017; Cao and Yi, 2018). However, it overlooks the decisive role of senior executives in corporate innovation investment decisions. To test the mediating effect of senior executive compensation between technological policies and corporate innovation, the regression results of the mediation effect path model are shown in Table 5. The second column of Table 5 shows the Path a model testing the impact of technological policies on corporate innovation performance, where the regression coefficient of the technological policy Gov is significantly positive, indicating a significant positive incentive effect of technological policies on corporate innovation, supporting Hypothesis H3 of this study. The third column of Table 5 shows the Path b model testing the impact of technological policies on executive compensation, where the regression coefficient of the technological policy is significantly positive, indicating a significant positive incentive effect of technological policies on executive compensation, supporting Hypothesis H1 of this study. The fourth column of Table 5 shows the empirical results of the Path c model, where the regression coefficients of both the technological policy Gov and executive compensation Pay_m are significantly positive, indicating that executive compensation plays a partial mediating role between technological policies and corporate innovation, supporting Hypothesis H4 of this study.

Table 5. Results of Mediation Effect Test

VARIABLES	Path a Innov	Path b Pay_m	Path c Innov
Gov	6.328***	3.473*	6.325***
	(1.168)	(1.961)	(1.175)
Pay_m			0.00747**
			(0.00377)
ASSET	0.123***	-0.249***	0.125***
	(0.00859)	(0.0113)	(0.00873)
LEV	-0.268***	-0.329***	-0.265***
	(0.0415)	(0.0741)	(0.0417)
Growth	-0.000137	0.000789**	-0.000146
	(0.000141)	(0.000355)	(0.000141)
ROE	0.00281***	-0.000430	0.00281***
	(0.000572)	(0.000895)	(0.000574)
Age	-0.00894***	0.00152	-0.00896***
	(0.00167)	(0.00229)	(0.00167)
Year	control	control	control
Indu	control	control	control
Constant	-2.302***	5.655***	-2.349***
	(0.198)	(0.241)	(0.201)
Observations	25,991	25,801	25,801
R-squared	0.063	0.042	0.063
F	86.58***	28.61***	83.42***

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

4.3. Robustness Test

4.3.1. Replace Independent Variables

Using technology policy lagged by one period (LagGov) as an explanatory variable can alleviate endogeneity problems caused by omitted variables and reverse causality. The empirical results of replacing the explanatory variable are shown in columns (1)-(2) of Table 6: technology policy lagged by one period (LagGov) is significantly positively correlated with executive compensation (Pay_m and Pay_3m), robustly supporting Hypothesis H1; technology policy lagged by one period (LagGov) is significantly positively correlated with corporate innovation (Innov), robustly supporting Hypothesis H3.

Table 6. Robustness Test Results

VARIABLES	(1) Pay_m	(2) Pay_3m	(3) Innov	(4) Innov	(5) Innov
LagGov	6.412***	2.483***			7.533***
	(1.945)	(0.688)			(1.272)
Pay_m			0.00774**		
			(0.00378)		
Pay_3m				0.0213*	
				(0.0111)	
Other control variables	control	control	control	control	control
Year	control	control	control	control	control
Indu	control	control	control	control	control
Constant	-0.0807	-0.00917	-2.205***	-2.228***	-2.178***
	(0.0555)	(0.0208)	(0.198)	(0.199)	(0.205)
Observations	23,780	23,742	25,801	25,756	23,936
R-squared	0.015	0.016	0.062	0.062	0.066
F	16.08***	15.22***	85.91***	85.69***	81.78***

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

4.3.2. Replace the Mediating Variable

Among the top executives, the top three executives are generally core members of corporate decision-making, with the CEO being the core of these core members, having a decisive impact on corporate investment decisions. Innovation investments are related not only to the long-term sustainable development of enterprises but also to short-term resource allocation and short-term business performance; short-term business performance directly affects the tenure and compensation of the CEO and core executive members (Summering and Dongyan, 2014; Zhou et al., 2018). Based on the 'economic man' hypothesis and principal-agent relationships, CEOs are averse to innovation investments that add uncertainty risks to future performance. Therefore, appropriate compensation for CEOs and core executive members will become an effective incentive mechanism for them to bear innovation risks (Zhou et al., 2018). To further test the mediating role of executive compensation in the positive incentive effect between science and technology policies and corporate innovation, this paper uses the proportion of compensation for the top three executives (Pay_3m) and the proportion of the CEO's compensation (Pay_ceo) as mediating variables, replacing the proportion of managerial compensation (Pay_m). The empirical results of substituting the mediating variables are shown in columns (2)-(3) of Table 7, showing that science and technology policies (Gov) are significantly positively correlated with stable executive compensation (Pay_3m and Pay_ceo), robustly supporting Hypothesis H2; science and technology policies (Gov), stable executive compensation (Pay_3m and Pay_ceo), and corporate innovation (Innov) are significantly positively correlated, robustly supporting Hypothesis H4, indicating that executive compensation plays a mediating role between science and technology policies and corporate innovation.

Table 7. Results of Robustness Test for Mediation Effect

VARIABLES	(1) Innov	(2) Pay_3m	(3) Pay_ceo	(4) Innov	(5) Innov
Gov	6.328***	1.251*	0.423*	6.347***	6.648***
	(1.168)	(0.658)	(0.246)	(1.179)	(1.413)
Pay_3m				0.0204*	

				(0.0110)	
Pay_ceo					0.0633*
					(0.0342)
Other control variables	control	control	control	control	control
Year	control	control	control	control	control
Indu	control	control	control	control	control
Constant	-2.302***	2.197***	0.779***	-2.371***	-2.485***
	(0.198)	(0.0834)	(0.0369)	(0.202)	(0.238)
Observations	25,991	25,756	18,233	25,756	18,233
R-squared	0.063	0.050	0.049	0.063	0.068
F	86.58***	34.17***	23.39***	83.21***	69.44***

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

4.3.3. Sobel test of mediation effect

Following the method provided by Wen and Ye (2014), this paper conducts a Sobel test on the mediating effect of executive compensation between science and technology policies and corporate innovation. The test results are shown in the last three rows of Table 8, where all Sobel Z-values are significant at the 10% level. The above evidence robustly supports Hypothesis H4 of this study.

Table 8. Results of Sobel Test for Mediation Effect

VARIABLES	(1) Innov	(2) Innov	(3) Innov	(4) Innov	(5) Innov	(6) Innov
Gov	6.325***	6.347***	6.648***			
	(1.175)	(1.179)	(1.413)			
LagGov				7.584***	7.563***	6.761***
				(1.277)	(1.279)	(1.501)
Pay_m	0.00747**			0.00850**		
	(0.00377)			(0.00402)		
Pay_3m		0.0204*			0.0239**	
		(0.0110)			(0.0118)	
Pay_ceo			0.0633*			0.0892**
			(0.0342)			(0.0370)
Other control variables	control	control	control	control	control	control
Year	control	control	control	control	control	control
Indu	control	control	control	control	control	control
Constant	-2.349***	-2.371***	-2.485***	-2.234***	-2.250***	-2.394***
	(0.201)	(0.202)	(0.238)	(0.208)	(0.209)	(0.245)
Observations	25,801	25,756	18,233	23,780	23,742	17,118
R-squared	0.063	0.063	0.068	0.066	0.066	0.070
F	83.42***	83.21***	69.44***	78.73***	78.65***	64.08***
Sobel Z	2.917*	4.922**	4.731**	2.867*	3.475*	4.081*
The corresponding P value for Sobel Z	0.0705	0.0226	0.0361	0.0719	0.0628	0.0575
The proportion of intermediary effect	15.02	25.37	21.3	14.61	16.66	17.45

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

4.4. Further exploration

4.4.1. The moderating effect of management power on the relationship between technology policies and executive compensation

As per the theoretical analysis of Hypothesis H1, the government's motivation for implementing science and technology policies is to encourage enterprises to increase their innovation investment and improve their innovation levels. In contrast, executives' motivation to align with government science and technology policies is to seek higher personal gains (compensation) under the guise of innovation. There is consistency in their motivations. In modern enterprises, executive compensation results from the bargaining process between management and the board of directors. Whether executives can receive corresponding compensation for taking on the responsibility of corporate innovation depends on whether management power is strong (Bebchuk and Fried, 2003; Wang and Hu, 2011; Chen and Bu, 2015). Therefore, management power may have a significant impact on the positive relationship between science and technology policies and executive compensation, thereby further affecting the positive incentive effect of science and technology policies on corporate innovation. To test the influence of management power on the relationship between science and technology policies and executive compensation, this paper refers to the approach of Lu et al. (2008) and Fu et al. (2014), examining whether the positions of chairman of the board (chairman) and CEO are separated to construct a management power dummy variable—Power[1]. Empirical results are shown in Table 9. In the sample group with low management power (Table 9 column (1)), the coefficient of the science and technology policy (Gov) is not significantly positive, indicating that the implementation of science and technology policies does not provide compensation incentives for management to increase their salaries, which inevitably affects management's willingness and intensity to promote corporate innovation. In the sample group with high management power (Table 9 column (2)), the coefficient of the science and technology policy (Gov) is significantly positive, indicating that the implementation of science and technology policies can provide compensation incentives for management to increase their salaries, which will enhance management's willingness and intensity to promote corporate innovation.

4.4.2. The moderating effect of regional factors on the relationship between science and technology policies and corporate innovation.

Enterprise innovation depends not only on the investment in innovation resources and the establishment of internal incentive mechanisms within the company, but also on the promotion of government science and technology policies to correct market failures, as well as on the cultivation and promotion of external conditions such as the focus of market elements and competitive market environments (Li et al., 2017). Due to historical and current economic development lag, ethnic minority regions have significant gaps compared to developed areas in terms of innovation elements, market development, and other aspects of resource aggregation, and they lag behind developed areas in talent cultivation, education, and thinking concepts. The poor innovation environment faced by ethnic minority regions will inevitably constrain the effectiveness of science and technology policies in promoting enterprise innovation. Based on this, this paper predicts that ethnic regions[2] will weaken the

[1] When the positions of Chairman of the Board and CEO are combined, Power takes a value of 1, indicating significant managerial power; when these positions are separate, Power takes a value of 0, indicating lesser managerial power.

[2] This article constructs a dummy variable (Minreg) for ethnic regions, where the administrative region of the listed company belongs to 5 provincial-level ethnic minority autonomous regions and takes a value of 1, otherwise it takes a value of 0.

positive incentive effect of science and technology policies on enterprise innovation. Empirical test results, as shown in Table 10 column (1), indicate that the coefficient of science and technology policy (Gov) is significantly positive, while the coefficient of ethnic regions (Minreg) is significantly negative, and the coefficient of the interaction term between science and technology policy and ethnic regions (GovxMinreg) is significantly negative, indicating that ethnic regions weaken the positive incentive effect of science and technology policies on enterprise innovation. Similarly, robustness tests using a dummy variable for the western region (Westreg)[3] (Table 10 column (2)) show that the western region also weakens the positive incentive effect of science and technology policies on enterprise innovation. These findings suggest that the geographical factors of ethnic minority regions and western regions will negatively impact the effectiveness of science and technology policies, and areas with lower levels of economic development will weaken the positive correlation between science and technology policies and enterprise innovation. This implies that policymakers need to differentiate the actual situations of different regions during the policy-making process to ensure that the effectiveness of science and technology policies is fully realized.

Table 9. The moderating effect of management power on the relationship between technology policy and executive compensation: test results

VARIABLES	**(1)Management power is small** **Pay_m**	**(2)Management has a lot of power** **Pay_m**
Gov	1.191	10.56**
	(2.146)	(4.571)
Other control variables	control	control
Year	control	control
Indu	control	control
Constant	5.530***	5.694***
	(0.272)	(0.536)
Observations	19,234	6,522
R-squared	0.043	0.049
F	21.60***	7.66***

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

Table 10. The moderating effect of ethnic areas on the relationship between science and technology policy and enterprise innovation

VARIABLES	**(1)ethnic regions** **Innov**	**(2)Western region** **Innov**
Gov	6.872***	6.543***
	(1.219)	(1.278)
Minreg	-0.254***	
	(0.0343)	
GovxMinreg	-7.378**	
	(3.707)	
Westreg		-0.175***
		(0.0235)
GovxWestreg		-3.266
		(2.754)
Other control variables	control	control
Year	control	control
Indu	control	control
Constant	-2.230***	-2.193***
	(0.198)	(0.199)
Observations	25,991	25,991

[3] The administrative region of the listed company belongs to 12 central provinces and municipalities, with a value of 1. Otherwise, the value is 0.

R-squared	0.065	0.065
	82.89	82.88

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

5. Conclusion and Insights

Previous literature has focused on whether science and technology policies effectively promote corporate innovation, with significant controversies in research conclusions; however, there is a lack of studies on the path mechanisms and effectiveness boundaries through which science and technology policies impact corporate innovation. This paper takes A-share listed companies in China as the research subjects, using fiscal subsidies as an entry point to examine the impact of science and technology policies on corporate innovation and its influencing mechanisms, and further explores the effectiveness boundaries of such policies. The study finds that first, there is a significant positive correlation between science and technology policies and executive compensation, indicating that the implementation of science and technology policies can increase the monetary compensation of executives, thereby motivating them to take on the uncertainty risks associated with innovation. Second, there is a significant positive correlation between executive compensation and corporate innovation, suggesting that executive compensation can motivate executives to bear the uncertainty risks of innovation, thus enhancing the company's innovative output levels. Third, there is a significant positive correlation between science and technology policies and corporate innovation, indicating that science and technology policies can address market failures during the innovation process, incentivizing enterprises to engage in innovation activities, thereby increasing their innovative outputs. Fourth, executive compensation plays a partial mediating role between science and technology policies and corporate innovation, indicating that science and technology policies enhance executive compensation, which in turn motivates executives to engage in innovation activities and bear the uncertainty risks of innovation, ultimately leading to increased innovation output levels. Further exploration into the effectiveness boundaries of science and technology policies reveals that fifth, managerial power can strengthen the positive correlation between science and technology policies and executive compensation, indicating that science and technology policies provide opportunities for executives to seek higher monetary compensation, especially when managerial power is greater, the contribution of science and technology policies to helping managers negotiate better compensation arrangements with the board is more significant. Sixth, regional factors significantly influence the relationship between science and technology policies and corporate innovation, with underdeveloped ethnic regions and western regions weakening the positive incentive effect of science and technology policies on corporate innovation, indicating that the effectiveness of science and technology policies is influenced by regional factors.

The policy implications of this paper include two aspects. First, whether science and technology policies can address market failures during the corporate innovation process depends on whether these policies can incentivize corporate boards to fully consider the uncertainty risks that innovation activities pose to senior executives, and provide appropriate risk compensation in their remuneration arrangements. This would motivate executives to be willing to take innovation risks. Therefore, if science and technology policies can consider guiding enterprises to appropriately incentivize senior management when being formulated, it will enhance the effectiveness of these policies. Second, the effectiveness of science and technology policies has its limits. Thus, if different regions' differences in innovation resources are considered when formulating science and technology policies, and differentiated support is provided to innovation entities in different regions, it will alleviate the impact of regional disparities on the effectiveness of science and technology policies, thereby enhancing the positive incentive effect of science and technology policies on corporate innovation.

References

[1] Bebchuk L A, Fried J M. (2003). Executive Compensation as an Agency Problem. Journal of Economics Perspectives,17(1): 71-92.

[2] Hall P A. (1993). Policy Paradigms, Social Learning, and the State: The Case of Economic Policymaking in Britain. Comparative Politics, 25(3): 275-296.

[3] Leibenstein H. (1966). Allocative efficiency vs. "X-efficiency". The American Economic Review, 56(3): 392-415.

[4] Mane R S. (2012). Science, Technology and Innovation Policy. Current science, 103(9): 975-976.

[5] Michael S C, Pearce II J A. (2009). The need for innovation is a rationale for government involvement in entrepreneurship. Entrepreneurship & Regional Development, 21(3): 285-302.

[6] Schot J. (2014). Transforming Innovation Policy, Keynote address at Edges, Horizons and Transformations: The Future of Innovation Policy. London: The Royal Society of Art.

[7] Williamson O E. (1975). Markets and Hierarchies: Analysis and Antitrust Implications: A Study in the Economics of Internal Organization. New York, NY: Free Press.

[8] Alfred Marshall wrote; translated by Lian Yunjie. (2017). Principles of Economics. Beijing: Huaxia Publishing House.

[9] Cao Y, Yi Q.Q. (2018). The Impact of Government Subsidies on Corporate R&D Investment and Performance: An Empirical Study Based on the Biopharmaceutical Manufacturing Industry. Science and Technology Management Research, (1): 40-46.

[10] Chen D Q, Bu D L.(2015). Managerial Ability, Power Characteristics, and Compensation Disparity. Journal of Shanxi University of Finance and Economics, 37(3): 91-101.

[11] Chen L, Zhu W P. (2008). Study on the Effects of Export Rebate and Innovation Subsidy Policies. Economic Research, (11): 74-87.

[12] Chen X D, Liang T Y, Lei P, Qin Q D. (2015). Research on the Impact of Executive Compensation Incentives on Corporate R&D Efficiency. Science Research Management, 36(09): 26-35.

[13] Fan C L, Ma X L. (2013). The Development of Science and Technology Policy in the

United States and Its Implications for China. China Soft Science, (10): 168-181.

[14] Feng Y. (2017). Does 'more' necessarily equal 'better'?- A study on the factors influencing environmental protection in China's science and technology policies. Science & Technology Progress and Policy, July 11,advance publication.

[15] Feng H H, Qu W, Li M L. (2015). Do Tax Incentives Promote Increased Corporate R&D Investment? . Science Research, 33(05): 27-35.

[16] Fu Q, Wang X Y, Lu J. (2014). Analysis of Management Power, Changes in Executive Compensation, and Corporate Mergers and Acquisitions Behavior[J]. Accounting Research, (11):30-37.

[17] Guo J, Qi C Z. (2017). Policy Support and Technological Innovation Performance: An Empirical Analysis Based on Ethnic Regions. Science and Technology Management Research, (S1): 550-557.

[18] Hu J C. (1988). Western Economic Theories Since 1870. Beijing: Economic Science Press.

[19] Huang Q H, Zhang F F, Chen X D. (2019). Research on the Innovative Incentive Effects of Short-term Compensation for Top Management. Science and Technology Management Research, 40(11): 257-265.

[20] Jiang J. (2011). The Performance of Public Policy Support for Corporate Innovation: A Comparative Analysis Based on Direct Subsidies and Tax Incentives. Science and Technology Management Research, 32(4): 1-8.

[21] Li W J, Zheng M M. (2016). Substantive Innovation or Strategic Innovation? — The Impact of Macro Industrial Policies on Micro Enterprise Innovation. Economic Research, (4): 60-73.

[22] Li C G, Zhang Y A. (2015). Research on the Full Elements Key Pathway of Cluster Technology Policy and Corporate Response Effect. Management Review, 27(2): 145-157.

[23] Li C Y, Meng W Z, Xu Z, Liu Y J. (2019). Evaluation of the quantity, effectiveness, and impact of China's science and technology policies from 1985 to 2017. Journal of Northeast Normal University (Philosophical and Social Sciences Edition), network first release on January 7.

[24] Li M M, Xiao H J, Fu J M. (2014). Fiscal Policy, Corporate R&D Investment, and Technological Innovation Capability: An Empirical Study Based on Listed Companies in Strategic Emerging Industries. Management Review, 26(8): 135-144.

[25] Li W F, Du J, Zhang H. (2017). Does Innovation Subsidy Actually Encourage Corporate Autonomous Investment in Innovation? New Evidence from Listed Companies in China. Journal of Financial Research, (10): 134-149.

[26] Li W F, Du J.(2016).Tax Incentives, Adjustment Costs, and R&D Investment. Accounting Research, (12): 58-63.

[27] Liang Z. (2017). From Science and Technology Policy to Science, Technology, and Innovation Policy: Reflections on Policy Paradigm Transformation under the Strategy of

Innovation-driven Development. Studies in Science Policy, (02): 13-19.

[28] Liu F Z, Sun Y T. (2007). The process, trends, and recommendations of the evolution of China's science and technology policies into innovation policies: An empirical analysis based on 289 Chinese innovation policies. China Soft Science, (5): 34-42.

[29] Lu R, Wei M H, Li W J. (2008). Managerial Power, Perks, and Property Rights Efficiency: Evidence from Chinese Listed Companies. Nankai Business Review, (5): 85-92.

[30] Peng J S, Sun W X, Zhong W G. (2008). Empirical Study on the Evolution and Performance of China's Technological Innovation Policies (1978-2006). Science and Technology Management Research, 29(4): 134-150.

[31] Sun H, Wang H. (2017). Government Subsidies, R&D Investment, and Corporate Innovation Performance: An Empirical Study Based on Growth Enterprises Board High-Tech Enterprises. Science and Technology Management Research, (12): 111-116.

[32] Tan J S, Feng F P, Xu W H. (2017). Industrial Policy and Corporate R&D Investment. Accounting Research, (10): 58-64.

[33] Wang P, Zou Y, Huang L F. (2014). Core Reconstruction of Executive Compensation Incentives: A Perspective of Capital Cost Constraints. China Industrial Economics, (05): 111-123.

[34] Wang J. (2010). Empirical Study on the Impact of R&D Subsidies on Corporate R&D Investment and Innovation Output. Studies in Science of Science, 28(9): 1368-1374.

[35] [35]Wang Q G, Hu Y J. (2011). Research on Managerial Power and Abnormal Executive Compensation Behavior. China Soft Science, (10): 171-180.

[36] Xia N, Dong Y. (2014). Executive Compensation, Employee Compensation, and Company Growth: Empirical Data from Chinese Small and Medium-sized Listed Companies. Accounting Research, (09): 91-97+99.

[37] Xu Y, Liu Y G, Cai G L. (2018). CEO Compensation Stickiness and Corporate Innovation . Accounting Research, 369(07): 45-51.

[38] Xu Z, Li C Y. (2017a). Research on the Evolution of China's Science and Technology Policies and Innovation Performance: Based on the Perspective of Policy Interactions. Economic Issues, (1): 11-16.

[39] Xu Z, Li C Y. (2017b). Research on the Characteristics of China's Science and Technology Policy Mix and Its Impact on Industrial Innovation. Studies in Science Policy, (01): 48-56.

[40] Yang R L, Hou F Y. (2019). The Effective Boundaries of Industrial Policies: A Perspective Based on Incomplete Contracts . Management World, (10): 82-94.

[41] Yu M G, Fan R, Zhong H J. (2016). China's Industrial Policies and Corporate Technological Innovation. China Industrial Economics, (12): 5-22.

[42] Zhang B J, Li P L, Chen J, Guo Q, Wu Y R. (2019). Theme Analysis and Evolution Process of National Innovation Policy: A Perspective Based on Text Mining. Science of

Science and Management of S&T, 11-07, Online First.

[43] Zhang T B, Gao T J. (2012). Fiscal and Tax Policy Incentives, High-Tech Industry Development, and Industrial Structure Adjustment. Economic Research, (5): 58-70.

[44] Zhao L X. (2014). Research on Theoretical Methods of Innovation Policy Evaluation: A Perspective Based on the Logical Framework of Public Policy Evaluation. Studies in Science of Science, 32(2): 195-202.

[45] Zhou Y, Pan Y. (2019). Fiscal Subsidies and Tax Reductions: Analysis of Policies for the New Energy Vehicle Industry from the Perspective of Transaction Costs. Management World, (10): 133-149.

[46] Zhou Z J, Ma J, Hu L F. (2018). Research on Risk Compensation Effect in the Design of Executive Compensation Incentive System. China Industrial Economics, (12): 152-169.