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SPECIALTY SECTION
This article was submitted to
Environmental Economics and
Management,
a section of the journal
Frontiers in Environmental Science

RECEIVED 24 May 2022
ACCEPTED 24 August 2022
PUBLISHED 12 September 2022

CITATION
Zhang Y-B, Qu S-Y, Li H-B and Li M-M
(2022), An empirical analysis of talent
policy, executive incentive, and
enterprise green technological
innovation based on China's A-share
listed companies.
Front. Environ. Sci. 10:952057.
doi: 10.3389/fenvs.2022.952057

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An empirical analysis of talent policy, executive incentive, and enterprise green technological innovation based on China's A-share listed companies

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This article investigates how talent policies affect corporate green technological innovation through executive incentive strategies based on signaling theory and principal-agent theory, by examining samples from 1,536 A-share listed companies between 2010 and 2020. The findings indicate that talent policy helps enterprises boost green technological innovation while accelerating it by improving executive compensation incentives. This effect path is more significant in high-tech enterprises and enterprises with weak solvency ratios. However, we find that the current talent policy has inhibited the green innovation of enterprises. The conclusions provide micro-evidence for the impact mechanism by which talent policy affects enterprise green technological innovation and offer scientifically based guidelines for optimizing talent policy to promote innovation-driven development strategy.

KEYWORDS

enterprise green technological innovation, executive incentive, talent policy, China A-shares listed companies, innovation-driven development strategy

Introduction

To cultivate, introduce, and maximize talent holistically while incorporating it into a vital talent center and global innovation hub, China has implemented a strategy of reinforcing the country's talent in line with Xi Jinping's New Era of Socialism with Chinese Characteristics (hereafter the "New Era") (Lo and Pan, 2021; Jacob and Subba, 2022). To this end, in response to the world's emerging technological frontiers and the country's major needs, governments at all levels in China have gradually established a corresponding talent policy system that includes initiatives such as the Changjiang Scholars Program sponsored by the Ministry of Education, the National Million Talents Project sponsored by the State Personnel Board, the Pearl River Talents Program of Guangdong Province, the Qianjiang Scholars of Zhejiang Province, and Shandong Province's Taishan Scholars (Shi et al., 2018; Chen et al., 2019a; Yue et al., 2020; Miao et al., 1978-2020). Talent, particularly at the highest level, is the pre-eminent resource for enterprise innovation (Rao and Drazin, 2002;

Doloreux and Dionne, 2008; Hu, 2008; Lewin et al., 2009). This prompts the question of whether the government's macro-level talent policy can provide the necessary critical support for micro-level enterprise technological innovation activities. In particular, what is the impact of the current talent policy on the green innovation of enterprises? This scientific issue has attracted significant attention in both political and academic circles in recent years.

Chinese and international scholars have conducted extensive research on the impact that talent policy has on enterprise technological innovation, but the conclusions offered to date are inconsistent (Yang et al., 2019; Zhu et al., 2021). Some studies have suggested that government talent policies positively impact corporate technological innovation, given that talent policy signals government recognition and preferential treatment of talents to the outside world and makes it convenient for enterprises to secure the various requisite resources for innovation (Feldman and Kelley, 2006; Meuleman and De Maeseineire, 2012; Wu, 2017; Wei and Zuo, 2018; Li et al., 2019). Meanwhile, other studies maintain that enterprises manipulate their talent numbers to cater to policies, resulting in a considerable waste of innovation resources (Wang et al., 2021). Moreover, a small number of studies believe that, because government investment in talent policy is significantly lower than investment in R and D subsidy policies, talent policy's impact on enterprises' technological innovation is limited (Yang and Pan, 2020).

Among the reasons for the divergent conclusions of existing research is that of the tendency to overlook the role of executives in corporate innovation activities (Shao et al., 2020). As the main decision-making body, who are also responsible for the execution and supervision of innovation activities, enterprise executives' decisions and willingness with respect to innovation directly affect the allocation efficiency of innovation resources, which in turn impacts the extent to which enterprises engage in technological innovation (Hao et al., 2019; Sarfraz et al., 2020; Ersahin et al., 2021; Zhao et al., 2021; Zhou et al., 2021). Research based on principal-agent theory has demonstrated that, as a result of the high uncertainty and lengthy return cycles associated with innovation activities, executives choose less innovation investment based on self-interest, resulting in diminished resource allocation efficiency (Huang et al., 2014; Si et al., 2020; Zheng et al., 2020; Jin et al., 2022). The implementation of incentives for corporate executives can effectively reduce the agency costs that enterprises incur in the allocation of innovation resources and improve the efficiency of innovation resource allocation (Coles et al., 2006; Xu et al., 2019). Given that talent policy offers the dual incentive effects of currency and reputation, it can directly affect executives' approach to innovation decision-making and willingness, thereby affecting the allocation efficiency of innovation resources (Shapiro et al., 2017; Ullah et al., 2022). However, few studies have explored the

relationship between talent policy, executive incentives, and corporate technological innovation.

To this end, based on signaling theory and principal-agent theory, this paper is focused on the relationship between talent policy, executive incentive strategy, and corporate technological innovation based on panel data from China's A-share listed companies for the period between 2010 and 2020. The findings indicate that talent policy can directly promote enterprises' technological innovation while indirectly promoting investment through executive compensation incentives; this effect path varies considerably as a result of enterprises' divergent solvency ratios and the heterogeneity of the industry.

This paper is distinguished from existing research in several respects. First, in light of the "New Era" initiative, this paper is focused on the unique tool of talent policy, revealing its impact on enterprises' technological innovation while resolving the research dilemma caused by the generalization of non-R&D subsidy policy in the existing literature. Second, it reveals how the macro talent policy system can influence enterprises' technological innovation through executive incentives at the micro level. Finally, it reveals that the role played by talent policy in incorporating technological innovation through executive incentives varies significantly as a result of corporate heterogeneity. The research conclusions thus provide crucial theoretical support for the formulation of more effective talent policies.

Theoretical basis and research assumptions

Talent policy and enterprise technology innovation

As a significant measure that allows the government to intervene in enterprises' technological innovation, talent policy can compensate for various resources required for technological innovation via signal transmission. First, talent policy support is conducive to enterprises' accumulation of human resources and attraction of outstanding international talent. An enterprise's implementation of talent policy signals that it values and treats talent preferentially. A high level of human capital, the positive external effects of knowledge sharing, and the knowledge spillover formed by the accumulation of human resources are all conducive to mutual exchange and learning, and facilitate knowledge and technology accumulation for the development of enterprise innovation activities (Peter, 1999; Jiang et al., 2020; Zygmunt, 2020). Second, talent policy support allows enterprises to access policy resources. Enterprises that receive talent policy support are often more likely to gain the government's trust, and the government, for its part, is more inclined to extend policy support to such enterprises to save on the costs associated with

prior inspection, in-process supervision, and post-assessment (Kleer, 2010; Sein and Prokop, 2021). For example, the acquisition of R&D subsidies or tax incentives can reduce the innovation risk to enterprises or minimize R&D costs (Colombo et al., 2013; Jourdan and Kivleniece, 2017; Chen et al., 2019b). These policies directly or indirectly stimulate enterprises' enthusiasm for technological innovation. Third, talent policy provides enterprises with access to financial resources, conveying the seal of government approval to the outside world and indicating that the company has strong innovation capabilities and superior innovation projects. This helps secure the favor of external investors, relieves the company's financing constraints to a certain extent, and supplements the resources required for technological innovation. Accordingly, this paper proposes the following hypothesis:

Hypothesis 1. (H1): Talent policy can significantly improve enterprises' technological innovation levels.

Talent policy and executive incentives

Two main types of incentives are available to corporate executives: short-term compensation incentives and long-term equity incentives. First, talent policy can significantly strengthen executives' compensation and incentive levels. From the perspective of policy content, most talent policies emphasize cash rewards or individual tax incentives for talents, thus directly increasing executives' salaries. For example, the Jingxian Plan sponsored by Beijing's Shijingshan District provides appropriate individual tax incentives to corporate executives who have made outstanding contributions, and appropriate incentives for their annual individual income tax exceeding 15% of their taxable income. Second, talent policy can significantly boost executives' equity incentive levels, with some policies providing important guarantees that allow executives to increase their shareholding ratios by establishing relevant equity incentive funds. For example, to enhance enterprises' innovation abilities and stimulate talent vitality, Wuhan's Optical Valley has issued Administrative Measures for Equity Incentive Special Funds to help enterprises establish and improve their long-term incentive systems. The pain point associated with equity incentives is that large amounts of capital are required to invest in shares; this special fund policy requires only the equity of senior executives as a pledge, and the loan has no interest, which allows the proportion of equity held by senior executives to be increased. Accordingly, this paper proposes the following hypothesis:

Hypothesis 2a. (H2a): Talent policies can significantly improve executive compensation incentive levels.

Hypothesis 2b. (H2b): Talent policies can significantly improve executive equity incentive levels.

The mediating effect of executive incentives

As the direct object of talent policy, executives' innovation decisions and willingness to innovate affect enterprises' innovation output. First, talent policy has a salary compensation effect, and the misalignment of executives' and shareholders' goals is the chief cause of the principal-agent problem. Since the level of executive compensation is often related to the company's performance, in consideration of short-term benefits, such as wages and bonuses, executives typically avoid the innovative activities that can bring shareholders long-term benefits (Holmstrom, 1989; Tosi et al., 2000; Wang et al., 2022). The compensatory effect of talent policy inhibits this risk aversion tendency, encouraging executives to invest in innovation based on the long-term benefits, thereby improving the enterprise's technological innovation level (Gibbons and Murphy, 1992; Lui et al., 2016). Second, talent policy has a reputational incentive effect: executives who are supported by talent policies have greater prestige and are more likely to receive equity incentives. According to agency theory, equity incentives can bind the interests of executives and shareholders together, prompting executives to opt for innovation investments based on the company's long-term interests while also helping to sustain the innovation process (Jensen and Meckling, 1976; Bertrand and Mullainathan, 2003; Alessandri and Pattit, 2014). This solidarity is conducive to the development of enterprises' technological innovation activities (Lin et al., 2011). Because of the dual externalities faced by green innovation, the problem of innovation power becomes more serious. The above effect may be reversed. And, accordingly, this paper proposes the following hypothesis:

Hypothesis 3a. (H3a): Talent policy can positively impact corporate technological innovation by improving executive compensation incentive levels. The above effect may be reversed for green innovation.

Hypothesis 3b. (H3b): Talent policy can positively impact corporate technological innovation by improving executive equity incentive levels. The above effect may be reversed for green innovation.

Research samples and data

Sample screening

This paper takes China's A-share listed companies from 2010 to 2020 as the research sample using data derived from the Guotai'an China Stock Market & Accounting Research (CSMAR) database. During the research process, the initial

samples were screened according to the following principles: first, eliminate samples with missing or ambiguous data on the main variables; second, eliminate financial industry and real estate enterprises in view of the particularity of their business objectives and financial structures; and third, exclude ST, *ST, PT, and other financially abnormal enterprise samples to avoid extreme value interference. Ultimately, 1,536 companies were retained, with 5,004 valid observations.

Definition of the variables

- (1) Enterprise Technological Innovation: The existing literature mainly measures enterprises' technological innovation from two aspects: innovation output and innovation input (Balkin et al., 2000; Argyres and Silverman, 2004; Lerner and Wulf, 2007; Cornaggia et al., 2015). As such, this paper mainly discusses how talent policy affects corporate technological innovation by influencing executives' decision-making and willingness with respect to innovation, thus adopting corporate technological innovation investment to measure corporate technological innovation. At present, the enterprise's R&D investment index is commonly applied to measure the technological innovation investment of enterprises (Flor and Oltra, 2004; Falk, 2012). Moreover, to eliminate the dimension problem, this study adopts the natural logarithm of corporate R&D investment as a measure of corporate technological innovation (lnRD). For green innovation, we use the enterprise green patent measurement and match the samples (Grepai). Because green patents belong to counting data, we use Poisson regression.
- (2) Talent Policy: Referring to the measurement method devised by Chen et al. (2018) for talent policy, a keyword search was conducted on the government subsidy details in the appendix of the financial statements from the Guotai'an database, screening for the keywords "talent" (*rencai*), "person" (*renwu*), and "excellent" (*yingcai*). The project finally verified whether the enterprise had obtained talent policy support. If the enterprise government subsidy detail contains the above keywords, the talent policy variable (*Tal*) is 1; otherwise, it is 0. This paper also uses the above retrieval method to test the model's robustness and use the corresponding subsidy amount as a surrogate variable for talent policy (*Tal* 1).
- (3) Executive Incentive Strategies: Executive incentives mainly include compensation incentives and equity incentives. The current standard practices reported in domestic and foreign literature are adopted. Among these, the measurement of compensation incentives is expressed by the total compensation of the sample enterprises' executives in accordance with Mehran's (1992) methods; equity incentive is expressed by the shareholding ratio of senior

executives, drawing on the practices implemented by Lin et al. (2011).

- (4) Controlled Variables: To control the influence of other factors on the research results, based on the relevant literature, the controlled variables used in this paper include Enterprise Size (Size), Human Capital (HC), Separation Rate of Two Rights (SRTR), Main Business Income Growth Rate (Grow), Operating Cash Flow (CF), the Gearing Ratio (GR), Return on Total Assets (Roa), Nature of Property Rights (NPR), Board Size (Bsize), and Enterprise Age (Age). The specific variable names and their descriptions are shown in Table 1.

Empirical analysis

Descriptive statistics and correlation analysis

Table 2 presents the samples' descriptive statistics and the Pearson correlation coefficient matrix. The average value of enterprise R&D investment cost is 17.95, and the standard deviation is 1.287, indicating that the observed sample enterprises' technological innovation levels are relatively discrete. The mean and standard deviations of executive compensation incentives are 14.89 and 0.759; the mean and standard deviation of equity incentives are 9.204 and 15.16, indicating that the dispersion degree of executive equity incentives in sample companies is greater than that of salary incentives. Table 2 also shows that 76.08% of enterprises have received talent subsidies, indicating that it has become common for listed companies to obtain government talent subsidies. The average company size is 22.04, the average human capital is 7.683, the average board size is 0.187, and the average company age is 16.88. The correlation coefficient matrix demonstrates that talent policy is positively correlated with executive compensation incentives and corporate technological innovation indicators, which initially supports the positive relationship between talent policy and corporate technological innovation. Executive equity incentives and corporate technological innovation are negatively correlated, which is inconsistent with this paper's hypothesis and warrants further testing. The variance inflation factor test was also performed on the variables, and the mean value of the variance inflation factor was 1.46, indicating no severe multicollinearity problem.

Regression analysis

After the Hausman Test, the two-way fixed effect model was selected, and the specific analysis results are shown in Table 3.

TABLE 1 Variable names and descriptions.

Variable name		Symbol	Variable description
Enterprise Technology Innovation	R&D Investment Cost	<i>lnRD</i>	Natural logarithm of the company's R&D expenses for the year
	Green Innovation	<i>Grepat</i>	The enterprise green patent numbers
Talent Policy	Talent Subsidy	<i>Tal</i>	Whether the company receives talent subsidies, 1 = yes, 0 = no
	Talent Subsidy Amount	<i>Tal1</i>	Natural logarithm of the talent subsidy amount received by the enterprise in the current year
Executive Incentive	Salary Incentives	<i>MSS</i>	Natural logarithm of total executive compensation
	Equity Incentive	<i>MH</i>	The shareholding ratio of executives * 100
Controlled Variable	Enterprise Size	<i>Size</i>	Natural logarithm of total assets
	Human Capital	<i>HC</i>	Natural logarithm of the number of employees
	Separation Rate of Two Rights	<i>SRTR</i>	The actual controller has the difference between control and ownership
	Main Business Income Growth Rate	<i>Grow</i>	(Main business income in the current period - Main business income in the previous period)/Main business income in the previous period
	Operating Cash Flow	<i>CF</i>	Net cash flow from operating activities/Total assets
	Asset-Liability Ratio	<i>GR</i>	Total liabilities/Total assets × 100
	Nature of Property Rights	<i>NPR</i>	Whether the company is a state-owned enterprise, 1 = yes, 0 = no
	Return on Total Assets	<i>Roa</i>	Net profit after interest and tax/Total assets at the end of the year*100
	Board Size	<i>Bsize</i>	Total number of board members/100
Enterprise Age	<i>Age</i>	The difference between the current year and the year in which the company was established	

First, Model 1) in Table 3 shows that the talent policy positively impacts enterprises' technological innovation and is significant at the 5% level ($\beta = 0.037, p < 0.05$). This demonstrates that implementation of the talent policy boosts enterprises' technological innovation, and Hypothesis 1 is tested. Second, Model 2) and Model 3) in Table 3 examine the impact of talent policies on executive incentive levels. The results demonstrate that talent policy positively impacts executive compensation incentives ($\beta = 0.037, p < 0.05$), and it is significant at the 5% level but has no significant positive impact on executive equity incentives ($\beta = 0.129, p > 0.1$). Therefore, Hypothesis 2a is verified, while assumption 2b is not verified. According to the mediation effect test procedure

proposed by Baron and Kenny 1986) (Baron and Kenny, 1986), if the coefficient of Model 3) in Table 3 is not significant, the Sobel test must be further performed to confirm whether executive incentives are the mediating variable of the relationship between talent policy and corporate technological innovation. Third, Model 4) in Table 3 is used to test the mediating effect of executive compensation incentives—that is, to test Hypothesis 3a. Model 4) in Table 3 demonstrates that after adding executive compensation incentives, compensation incentives have a significant positive impact on corporate technological innovation ($\beta = 0.076, p < 0.01$), while the positive impact of talent policy on corporate technological innovation remains ($\beta = 0.034, p < 0.1$).

TABLE 2 Descriptive statistics and correlation coefficients of core variables.

Variable	Mean	Sd	Min	Max	1	2	3	4	5	6	7	8
<i>lnRD</i>	17.95	1.287	0	22.14	1							
<i>MSS</i>	14.89	0.759	0	18.42	0.386***	1						
<i>MH</i>	9.204	15.16	0	77.78	-0.087***	-0.072***	1					
<i>Tal</i>	0.761	0.427	0	1	0.079***	0.035**	0.010	1				
<i>Size</i>	22.04	1.063	19.70	26.85	0.539***	0.436***	-0.293***	0.032**	1			
<i>HC</i>	7.683	1.003	3.33	11.71	0.556***	0.383***	-0.246***	0.045***	0.750***	1		
<i>Bsize</i>	0.187	0.0462	0.08	0.450	0.120***	0.272***	-0.254***	-0.018	0.326***	0.304***	1	
<i>Age</i>	16.88	5.621	2	51	0.099***	0.175***	-0.176***	-0.017	0.252***	0.175***	0.106***	1

Note: *, **, *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

TABLE 3 Regression analysis and sobel test.

Model serial number	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Variable	lnRD	MSS	MH	lnRD	lnRD	Grepat	Grepat
Tal	0.037** -0.018	0.037** -0.016	0.129 -0.223	0.034* -0.018	0.036* -0.018	-0.182*** -6.43	-0.172*** -6.06
MSS				0.076*** -0.02		0.0368* -1.71	
MH					0.007*** -0.001		0.0123*** -14.06
Size	0.434*** -0.034	0.280*** -0.029	0.127 -0.419	0.413*** -0.035	0.433*** -0.034	0.0853*** -4.1	0.123*** -5.89
HC	0.366*** -0.033	0.031 -0.028	-0.568 -0.404	0.364*** -0.033	0.370*** -0.033	0.114*** -5.66	0.0989*** -4.9
SRTR	-0.353 -0.268	0.506** -0.228	-8.634*** -3.284	-0.391 -0.268	-0.296 -0.268	-0.908*** -5.30	-0.288 -1.63
Grow	0.28 -0.329	-1.219*** -0.28	-2.54 -4.029	0.372 -0.329	0.297 -0.328	-44.20*** -9.32	-48.75*** -10.09
CF	0.112 -0.156	0.061 -0.132	0.415 -1.909	0.107 -0.156	0.109 -0.155	-2.164*** -9.15	-2.116*** -8.92
GR	-0.133 -0.106	-0.239*** -0.0899	-0.256 -1.295	-0.115 -0.106	-0.132 -0.105	0.603*** -6.29	0.647*** -6.69
NPR	-0.477*** -0.078	0.105 -0.066	-2.113** -0.955	-0.485*** -0.078	-0.463*** -0.078	-0.327*** -9.99	-0.240*** -7.15
Roa	-0.460*** -0.135	0.145 -0.114	5.564*** -1.647	-0.471*** -0.134	-0.497*** -0.134	2.942*** -9.44	2.847*** -9.21
Bsize	-0.08 -0.273	0.179 -0.232	-3.121 -3.345	-0.094 -0.273	-0.059 -0.272	1.062*** -3.52	1.727*** -5.97
Age	-0.004 -0.02	0.023 -0.017	-0.086 -0.244	-0.006 -0.02	-0.004 -0.02	0.0169*** -6.3	0.0158*** -5.88
Constant	5.250*** -0.675	7.977*** -0.574	17.50** -8.268	4.645*** -0.693	5.134*** -0.674	-2.163*** -5.46	-2.619*** -7.63
Firm	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.421	0.21	0.094	0.423	0.425		
Number of Samples	1,536	1,536	1,536	1,536	1,536	1227	1227
Sobel Z				1.976**	0.932		
The Proportion of Mediation Effect				0.086			

Notes as above.

According to the Sobel test, the ratio of the mediation effect to the total effect of executive compensation incentives is 0.086, indicating that the executive compensation incentive level can explain 8.6% of government talent policies' promotion of corporate technological innovation. Executive compensation incentives partially mediate the relationship between talent policy and corporate technological innovation; thus, Hypothesis 3a is verified. Finally, Model 5) in Table 3 is used to test the mediating effect of executive equity incentives—that is, to test Hypothesis 3b. Model 5) in Table 3 reveals that, after adding executive equity

incentives, equity incentives have a significant positive impact on enterprises' technological innovation ($\beta = 0.007, p < 0.01$), while talent policies also exert a significant positive impact ($\beta = 0.036, p < 0.1$). However, the results of the Sobel test reveal that the mediating role of executive equity incentives between talent policy and corporate technological innovation is not significant, and so Hypothesis 3b was not verified. The reason for this may be related to the motivations behind equity incentives. Existing research has demonstrated that the key motivation of corporate equity incentives is to attract excellent managers

TABLE 4 Robustness test.

Model serial number	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Variable	lnRD	MSS	MH	lnRD	lnRD	Grepat	Grepat
Tal1	0.003** -0.001	0.003*** -0.001	0.01 -0.018	0.003** -0.001	0.003** -0.001	-0.0110*** -4.88	-0.0115*** -5.09
MSS				0.076*** -0.02		0.0360* 1.67	
MH					0.007*** -0.001		0.0125*** 14.32
Constant	5.263*** -0.675	7.978*** -0.574	17.430** -8.27	4.660*** -0.693	5.147*** -0.674	-2.218*** -5.58	-2.688*** -7.82
Controlled Variable	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Samples	1,536	1,536	1,536	1,536	1,536	1227	1227
Sobel Z				2.961***	1.166		
The proportion of mediation effect				0.083			

Note the same as above.

and support them in making effective decisions (Lin et al., 2011). The implementation of talent policy has the function of gathering talent resources and often has a good reputation incentive effect, which can effectively improve the efficiency of executives' resource allocation and further reduce the necessity of implementing executive equity incentives. Therefore, talent policy cannot promote corporate technological innovation through executive equity incentives.

We added green patent as a new dependent variable, and compared it with the previous analysis, and obtained more abundant research conclusions and enlightenment, which also provided better guidance and scientific basis for the specific implementation of the policy. From models 6 and 7, the talent policy significantly inhibited green innovation. We argue that on the one hand, the talent subsidy may be used for human capital accumulation, crowding out green R&D; On the other hand, technology R&D is a long-term process, especially the invention of green technology. At present, the impact of human capital investment on green technology has not been effective.

Robustness check

We used the cost of replacing the talent subsidy to test the reliability of the regression results' reliability. The results of the regression analysis are shown in Table 4. The results demonstrate that the relationship between talent policy and corporate technological innovation remains significant, and the direction remains unchanged. The direction of the regression coefficients of executive equity incentives and other controlled variables is

also highly consistent with the previous regression results. Therefore, the previous empirical results are robust.

This study also used a different method to test the mediation effect. Newton and Raftery 1994) (Newton and Raftery, 1994) suggested using the bootstrap test without prior information. Compared with the stepwise regression method and the Sobel test, the confidence interval obtained by the bootstrap test is more accurate and effective. Therefore, this paper uses the bootstrap test method in the robustness test to determine whether executive incentives have a mediating effect. Table 5 presents the results. The results proved consistent with the conclusions reported in previous studies. Talent policy also significantly inhibited green innovation.

Further analysis

Intermediary model analysis of the total sample confirmed that talent policy can promote enterprises' technological innovation by improving executive compensation levels. This section is focused on whether this path differs significantly as a result of the heterogeneity of the enterprises' industry types and solvency ratios. The first difference pertains to the type of industry in which the company operates. Referring to the classification method devised by Sun et al. (2021a), if a company has obtained the national or provincial high-tech enterprise qualification certification, the enterprise is defined as a high-tech enterprise; otherwise, it is a non-high-tech enterprise. After differentiating enterprise types, Table 6 reports relationships

TABLE 5 Bootstrap test method.

Talent policy-executive compensation incentive level-enterprise technological innovation

Effect type	Observed coef	Bootstrap SE	95% conf. Interval
Indirect Effect	0.0014	0.0005	(0.00051, 0.00236)
Direct Effect	0.0173	0.0003	(0.01220, 0.02246)

Talent Policy—Executive Equity Incentive Level - Enterprise Technology Innovation

Effect Type	Observed Coef	Bootstrap SE	95% Conf. Interval
Indirect Effect	0.0002	0.0002	(-0.00012, 0.00049)
Direct Effect	0.0186	0.0027	(0.01338, 0.23777)

Note: Bootstrap N = 500.

TABLE 6 Sub-sample Regression of whether it is a high-tech enterprise.

Model serial number	High-tech enterprises					Non-high-tech enterprises				
	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
Variable	lnRD	MSS	MH	lnRD	lnRD	lnRD	MSS	MH	lnRD	lnRD
Tal	0.035* (0.020)	0.067** (0.027)	0.020 (0.352)	0.029 (0.020)	0.035* (0.020)	0.073 (0.046)	-0.004 (0.024)	0.317 (0.408)	0.073 (0.046)	0.068 (0.046)
MSS				0.097*** (0.018)					0.033 (0.061)	
MH					0.004** (0.001)					0.018*** (0.004)
Constant	4.258*** (0.832)	7.756*** (1.147)	15.34 (14.89)	3.508*** (0.836)	4.205*** (0.831)	2.766 (1.828)	6.132*** (0.946)	-8.112 (16.12)	2.564 (1.866)	2.912 (1.806)
Controlled Variable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,864	2,864	2,864	2,864	2,864	2,140	2,140	2,140	2,140	2,140
R-squared	0.652	0.201	0.090	0.658	0.654	0.243	0.262	0.149	0.243	0.262
Number of Samples	1,182	1,182	1,182	1,182	1,182	1,113	1,113	1,113	1,113	1,113

Note: *, **, *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

between talent policies, executive compensation incentives, and corporate technological innovation. The results reveal that the influence coefficient of talent policy on the technological innovation of high-tech enterprises is positive and statistically significant at the 10% level. The executive incentives of technology enterprises and the technological innovation of enterprises are not significant. The main

reason is that the technology of high-tech industries changes and the problem of technology spillover are faster and more severe than in non-high-tech enterprises. Therefore, the imbalance between innovation risks and benefits borne by high-tech enterprise executives and the principal-agent problem is more prominent and severe than that of non-high-tech enterprises (Aboelmaged and Hashem, 2019; Khalili

et al., 2019; Sun et al., 2019; Sun et al., 2020; Sun et al., 2021b; Sun et al., 2021c; Shao and Chen, 2022). Talent policy support directly affects executives. It alleviates the principal-agent problem by improving executives' compensation and incentive levels in high-tech enterprises, thereby improving the innovation willingness of executives, which is conducive to the development of innovation activities. The Sobel test demonstrated that, regardless of whether it is a high-tech or non-high-tech enterprise, the executive's equity incentive does not have a significant mediating role, which further verifies that H3b does not hold.

The second difference relates to the differential impact of corporate solvency. In this paper, the average value of the sample enterprises' asset-liability ratio is used as the standard, and the enterprises are categorized based on whether they are high or low asset-liability ratio enterprises. Table 7 reports the relationship between talent policy, executive incentives, and technological innovation after distinguishing the company's debt level. The results show that the influence coefficient of talent policy on the technological innovation of enterprises with high asset-liability ratios is 0.082, and it is significant at the level of 5%. This confirms that talent policy contributes to the technological innovation of enterprises with a high asset-liability ratio. Companies with high debt ratios are often more cautious about innovation investments, associated with higher risks and uncertain returns. The talent policy helps them obtain financial resources and government support,

reducing their innovation costs and uncertainties and thus benefiting their technological innovation activities. Models (31), (32), and (34) reveal a mediating effect between executive compensation and incentive levels. The main reason for this is that when a company's debt level is high, shareholders may reduce compensation to the company's executives, to preserve the company's cash flow. Talent policy indirectly helps companies with high asset-liability ratios to ease their financing constraints and enrich their cash flow. It directly increases executives' remuneration levels through subsidies, thereby improving the efficiency of executives' innovation resource allocation, which is conducive to technological innovation. Companies with low debt-to-equity ratios face relatively low innovation and bankruptcy risks, and so talent policies may play a minimal role. The Sobel test further revealed that, regardless of whether a company is high or low asset-liability, executive equity incentives do not play a significant mediating role, further confirming that H3b does not hold.

Research conclusions and implications

In recent years, governments at all levels—from central to local—have gradually established a relatively complete talent policy system to cultivate, attract, and capitalize on talent

TABLE 7 Sub-sample regression of solvency level.

Model serial number	High gearing ratio					Low gearing ratio				
	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)
Variable	lnRD	MSS	MH	lnRD	lnRD	lnRD	MSS	MH	lnRD	lnRD
Tal	0.082** (0.034)	0.065** (0.030)	-0.078 (0.259)	0.078** (0.034)	0.083** (0.034)	-0.016 (0.019)	0.000 (0.016)	-0.170 (0.348)	-0.016 (0.019)	-0.015 (0.019)
MSS				0.067** (0.030)					0.054* (0.028)	
MH					0.010*** (0.003)					0.005*** (0.001)
Constant	7.655*** (1.212)	5.602*** (1.050)	18.75** (9.219)	7.278*** (1.222)	7.461*** (1.210)	2.729* (1.656)	10.45*** (1.447)	55.03* (31.07)	2.161 (1.681)	2.471 (1.652)
Controlled Variable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,413	2,413	2,413	2,413	2,413	2,591	2,591	2,591	2,591	2,591
R-squared	0.325	0.173	0.067	0.327	0.329	0.565	0.267	0.131	0.566	0.568
Number of Samples	938	938	938	938	938	935	935	935	935	935

Note the same as above.

through talent policies and provide the necessary support for the innovation and development of local enterprises. This study took 1,536 A-share listed companies from 2010 to 2020 as samples and built a two-way fixed effect model to investigate how macro-level talent policy affects corporate technological innovation through micro-level incentives for corporate executives. The findings indicate that talent policy significantly boosts enterprises' technological innovation levels. Talent policy can also indirectly promote technological innovation by increasing executive compensation rather than equity incentive levels. The main reason for this is that the talent policy has a salary compensation effect, protecting executives' short-term benefits and effectively improving the imbalance between executives' innovation risk-taking and benefits, thus supporting enterprises in performing innovation activities. Moreover, analysis of enterprises' solvency ratios and the heterogeneity of their industries reveal that talent policy exerts a more significant effect on innovation incentives for high-tech enterprises and enterprises with weak solvency. While we find the talent policy significantly inhibited green innovation. Our results are different from those of Shao, which may be due to differences in our variable measurement methods and different perspectives of the mechanism analyzed.

Encouraging the innovation consciousness of enterprise executives will help to guide the scientific innovation of enterprise talents and put enterprises in a favorable position in the incentive competition. Modern enterprises generally adopt salary incentive to encourage technological innovation. Enterprises should be good at equity incentive and give certain equity to senior executives to ease the conflict of interests between senior executives and shareholders in the R and D process. The requirement of high-quality economic development has further increased the attention of environmental protection issues, and all stakeholders have put forward higher requirements for environmental protection. Green technology innovation is becoming an important emerging field in the new round of global industrial revolution and scientific and technological competition. To speed up the construction of a market-oriented green technology innovation system, the government needs to expand the "breadth" of the transformation of scientific and technological achievements, improve the "intensity" of gathering innovation resources, further reduce the burden of scientific and technological personnel, clear the obstacles to the flow of talents, and further improve the enthusiasm of scientific and technological personnel in developing and transforming science and technology. Universities and scientific research institutes that transform their scientific and technological achievements into positions and give individual rewards to scientific and technological talents in the form of shares or capital contribution ratio may temporarily exempt from individual income tax. At the same time, it is necessary to actively create a green scientific and

technological innovation achievement transformation trading platform integrating R and D transformation, technology transfer, achievement transformation and talent training. This paper's conclusions have the following implications for talent policy formulation.

First, the implementation modes of different talent policies should be further reinforced. This study found that talent policy can safeguard the short-term benefits that executives derive through the compensation effect, thereby improving the efficiency with which executives allocate innovation resources. Therefore, government departments should focus on direct support methods, such as monetary incentives and personal tax protection, when introducing talent policies. Meanwhile, enterprises should also incorporate innovation performance into executives' performance appraisals to rectify further the imbalance between innovation risks and benefits and provide necessary guarantees for corporate executives to carry out innovation activities.

Second, the talent policy system should be further refined to improve the efficiency of talent policy support. Through heterogeneity analysis, this study found that talent policy has a more significant effect on high-tech enterprises' technological innovation than other factors. Therefore, talent policy should be further refined and tailored toward high-tech enterprises as much as possible. Governments should thus formulate targeted talent policies, talent service systems, and mechanisms to effectively boost high-tech enterprises' innovation levels and accelerate the realization of high-tech enterprises' high-quality development.

Third, security enterprises should be further screened, and the marginal role that talent policy currently plays should be maximized. This study found that talent policy has a greater impact on the technological innovation of companies with weak solvency through executive compensation incentives. In companies with higher debt ratios, the level of executive compensation is often lower, and talent policy has a more significant marginal effect on executives' compensation levels through cash incentives and personal tax protection. It is thus recommended that a more accurate and targeted talent policy system be formulated for highly indebted enterprises.

Fourth, the role that talent policy plays in transmitting positive signals to enterprises should be maximized. This study also found that talent policy can send positive signals, such as preferential treatment of talents and government recognition, to talents, investors, and stakeholders outside the enterprise and help enterprises obtain various innovative resources. Therefore, companies that have obtained talent policies should disclose relevant positive information to the outside world via multiple channels to reinforce further the role that talent policies play in transmitting positive signals.

Our study also has some limitations. Due to the availability of data, we only tested the sample of Listed Companies in China. Future analysis data can further expand the sample to better test the assumptions and theoretical assumptions of this study,

including comparative analysis of scenarios in different regions and countries.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding authors.

Author contributions

Doctoral candidate YZ wrote the draft, and Professor SQ revised the paper; Professor HL data analysis, Associate Professor ML data processing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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