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The influence of returnee technology executives on enterprise innovation: the innovation patent data of global exchange market listed companies

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ABSTRACT

In this paper, the innovation patent data of 344 Chinese Global Exchange Market (GEM) listed companies from 2014 to 2018 is manually collected, and the effect of returnee technology executives (RTEs) on enterprise innovativeness is examined based on the empirical theory of the high ladder team. The study finds that RTEs promote enterprise innovation and that this effect persists after controlling for endogeneity and self-selection problems. By comparing the difference in the effect of RTEs on breakthrough innovation and non-breakthrough innovation, the study found that RTEs had a more significant role in promoting enterprise breakthrough innovation. Furthermore, through executive group analysis, it is found that Returnee Technology Chief Executive Officers (CEOs) have more potently positive effect on promoting enterprise innovation especially breakthrough innovation and RTEs exert greater prominence in fostering innovation in companies across developed coastal areas. The research theoretically expands and deepens the investigation on the rapport between enterprise executive characteristics and innovation, highlights the importance of the human capital of overseas returnees in practice, and has a certain guiding significance for enterprise talent introduction policies.

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1. Introduction

Innovation is an important means for that a country can improve its core competitiveness and achieve sustainable development and a strong driver of the transformation and upgrading of enterprises. Currently, many scholars are adopting different perspectives to investigate the factors affecting enterprise innovation, such as government innovation policy (Baležentis & Balkienė, 2014), government innovation subsidy (Wu & Zhao, 2022; Xinle et al., 2021; Zhang et al., 2021), Market environment (Hu et al., 2021), the degree of financing constraints (Brown et al., 2012; Li & Shen,

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2022), corporate governance (Chung et al., 2003; Mohamad et al., 2022; Zeng & Lin, 2011.), management shareholding (Podolski & Jiang, 2022; Zeng & Lin, 2011), equity incentives for core employees (Abd et al., 2019; Lerner & Wulf, 2007), pay gap (Li et al., 2021), and executive overconfidence (Zavertiaeva et al., 2018). Among those studies in the literature that has examined the effect that government policy and other factors have on enterprise innovation, some studies use the method of text analysis. Text analysis uses machine learning methods to extract and structure information from complex texts (Onan, 2019a, 2022), which is widely used in psychology and research in areas such as management (Onan, 2020a, 2021). Due to the restrictions on the disclosure of information on the personal characteristic data of executives in corporate annual reports, the characteristic data of executives often still needs to be obtained from authoritative databases. Therefore, the research on the characteristics of executives often adopts the method of setting dummy variables or proxy variables. In general, the two most important factors in relation to improving the innovation ability of enterprises are how to acquire more technology research and development resources and how to optimize the allocation of these resources (Wang, 2021; Wang et al., 2008). The overseas experience of senior executives, as an important personal characteristic of these individuals, profoundly affects the agglomeration of enterprise innovation resources and the optimal allocation of innovation resources (Wang et al., 2008; Yuan & Wen, 2018). As one of their important personal characteristics, the overseas experiences of executives possess a profound impact on the agglomeration of innovation of corporate resources, and also on the optimal allocation (Yuan & Wen, 2018).

Currently, the academic community generally agrees that overseas executives are considered to be quite influential in enterprise innovation, but the relationship between the two is unclear in terms of experience and evidence. Some scholars point out that senior managements overseas learning experiences give them a greater international vision and solid professional knowledge, enabling them to compensate for the shortsightedness of corporate management. Some investigators believed that it was easier to ameliorate the innovation ability of enterprises under the influence of the internationalization tendencies and strong professional ability of returnee entrepreneurs (Bai et al., 2016, 2021). Some investigators pointed out that returnee executives may be more willing to share experience and foreign knowledge and insights with colleagues surrounding them, objectively improving their companies awareness of foreign products, foreign culture, and thereby facilitating the development of new products (Haupt et al., 2021; Shunlong & Weiming, 2012). However, some scholars hold the opposite view, arguing that overseas executives may curb corporate innovation. Some investigators investigated the linkage between returnee executives and corporate innovation activity based on sample data from small to medium-scale high-tech companies, finding that the innovation capabilities of companies with returnee Chief Executive Officers (CEOs) do not show an significant improvement (Lin et al., 2014). Some investigators conducted an empirical study based on corporate sample data from China's listed companies especially enterprises of information technology industry and found that only when companies are growing, the role of returnee executives in promoting corporate innovation capabilities turns to be significant (Chen

et al., 2015; Wang, 2021). The existing literature on corporate innovation is not deep enough to study the returnee technology executive group, and it focuses on the number of innovations and ignores the different types of innovations. Therefore, this paper will assess the impact of returnee technocrats on diverse types of innovation in firms.

The influence of RTEs on firm innovation can be varied. Some scholars found that, when compared with other executives, returnee executives who serve as CEOs significantly improve the innovation capabilities of Chinese high-tech industries (Lin et al., 2011). As enterprise managers who control the overall situations of companies, CEOs have a strong voice in the internal decision-making of enterprises. Differences in positions may change the impact of RTE on the enterprises decision-making involving innovation. Therefore, it is necessary to perform further analyses that take into account the positions of technical executives who are overseas returnees. In this paper, RTEs are grouped and examined based on whether they serve as CEOs, and it is found that RTEs who serve as CEOs were better at promoting innovation of the enterprise.

In addition, the different regions in which enterprises are located may affect the relationship of RTEs and enterprise innovation. According to the new economic geography theory, the natural first-mover advantages of transportation and trade in coastal areas bring the firms in these areas additional public resources and the advantages of industrial agglomeration, thus causing an economic development gap between coastal areas and inland areas (Li, 2019; Onan, 2018a). This gap may affect the role of RTEs in enterprise innovation. Thus, this paper further analyzes regional differences.

The contribution of our article is arised as follows. (1) This paper starts by analyzing the professional technical backgrounds and types of returnees and deepens the existing research on the executive characteristics influencing enterprise innovation. (2) This paper examines differences in positions and in the influence of returnee technocrats regarding enterprise innovation, showing that enterprises should hire technically talented returnees according to their own conditions.

There are several sections to the remainder of this study. The second section provides a review to relevant literature, sets out the hypotheses of this project and defines variables. The third part describes the project methodology, including the model design, sample selecting, and data sources. The fourth part expounds and analyzes the empirical results of the article, and conducts endogeneity test and robustness test. The fifth part draws conclusions.

2. Literature review and hypothesis

2.1. Research hypotheses development

Many factors can affect the innovation output of enterprises, as shown in Table 1. Among these factors, executive characteristics have attracted attention in recent years. The corresponding literature on the effect of returnee executives on corporate innovation is enumerated in Table 2, and the observation of those literature is compared. According to high-level team theory, corporate performance and major decisions are affected by the values and knowledge of senior management.

Table 1. Existing literature on factors influencing enterprise innovation.

Factors Affecting Enterprise Innovation	References in Literature
government innovation policy	Baležentis and Balkienė (2014)
government innovation subsidy	Wu and Zhao (2022), Xinle et al. (2021), and Zhang et al. (2021)
market environment	Hu et al. (2021)
the degree of financing constraints	Brown et al. (2012) and Li and Shen (2022)
corporate governance	Chung et al. (2003), Zeng and Lin (2011), and Mohamad et al. (2022)
management shareholding	Zeng and Lin (2011) and Podolski and Jiang (2022)
equity incentives for core employees	Lerner and Wulf (2007) and Abd et al. (2019)
pay gap	Li et al. (2021)
executive overconfidence	Zavertiaeva et al. (2018)

Table 2. Literature available for the implications of returnee executives in terms of firm innovation.

Literature References	Research perspectives regarding theimplications of returnee executives in terms of firm innovation
Shunlong and Weiming (2012)	Returnee executives may be more willing to share experience and foreign knowledge and insights with colleagues surrounding them, and thereby facilitating the development of new products.
Lin et al. (2014)	The innovation capabilities of companies with returnee Chief Executive Officers (CEOs) do not show significant improvement.
Chen et al. (2015)	Only when companies are growing, the role of returnee executives in promoting corporate innovation capabilities turns to be significant.
Bai et al. (2016)	The innovation capacity of companies is more likely to be improved with the internationalization tendencies and strong professional competence of returnee entrepreneurs.
Bai et al. (2021)	Returned executives promote corporate innovation and improve corporate performance by strengthening corporate internationalization.
Haupt et al. (2021)	Returned executives are more willing to share their own knowledge and help corporate management improve the level of internationalization.
Wang (2021)	The role of returnee executives in promoting corporate innovation capabilities is significant,especially during the growth period

The advantages of returnee technical executives related to values and knowledge are conducive to giving full play to their professional advantages and promoting enterprise innovation for the following causes. (1) From the perspective of executive psychological capital, RTEs study and work overseas, and they have certain psychological capital advantages after gaining experience in foreign environments. For example, through empirical research, it is found that returnee executives believe that their intelligence is superior to that of local management and that such executives are more willing to pay attention to corporate innovation and long-term development strategies (Jiang et al., 2021; Onan et al., 2017; Onan & Korukoğlu, 2017). Moreover, some investigators found that the psychological capital formed through the optimistic attitudes of executives achieved a visibly positive effect regarding the area of innovation of enterprises (Onan, 2018b; Purwanto et al., 2021). (2) From the perspective of senior executive knowledge and skills, RTEs generally have more professional skills and knowledge, a deeper technical understanding of their specific industries. Therefore, RTEs could better play their enterprise information and supervision roles (Lerner & Wulf, 2007; Li & Xiang, 2022; Onan, 2020b). Basing on the two perspectives above, hypothesis 1 is proposed and described as follows:

Hypothesis 1: RTEs improve small and medium enterprise innovation capacity significantly.

Hypothesis 1a: RTEs significantly improve small and medium corporate breakthrough innovation capabilities.

Hypothesis 1b: RTEs significantly improve small and medium corporate non-breakthrough innovation capabilities.

Hypothesis 1c: RTEs have a more significant role in promoting enterprise breakthrough innovation.

Considering the decision-making power conferred by a CEOs special position in the senior management team, CEOs may have a relatively important influence on the strategic decision-making of their enterprises, concluded by the previous studies (Lin et al., 2011; Loukil & Yousfi, 2022; Onan, 2018b, 2019b). Higher executive positions are more influential on innovation decisions in firms; thus, it is expected that overseas RTEs who serve as CEOs have relatively considerable impacts on enterprise innovation. Thus, hypothesis 2 is proposed:

Hypothesis 2: An RTE who is a CEO promotes small and medium enterprise innovation more significantly than other RTEs.

Hypothesis 2a: RTEs who serve as CEOs promote small and medium enterprise breakthrough innovation more significantly than other RTEs.

Hypothesis 2b: RTEs who serve as CEOs promote small and medium enterprise non-breakthrough innovation more significantly than other RTEs.

Based on the new economic geography perspective, coastal areas benefit from additional resources, industrial agglomeration, and regional first-mover advantage, thus having a higher degree of economic and social development than inland areas (Chen, 2021; Li et al., 2021). Some investigator compared with the corporate culture of coastal areas, the corporate culture of inland areas is more conservative and has more complex social relations (Li, 2019; Onan et al., 2016). It represents a greater hindrance in conducting enterprise innovation activities, leaving relatively little space for returnee technical experts to give play to their own advantages. Thus, hypothesis 3 is proposed:

Hypothesis 3: RTEs is an essential part for promoting innovation in small and medium enterprises located in developed coastal areas.

Hypothesis 3a: RTEs is an essential part for promoting breakthrough innovation in small to medium enterprises located in developed coastal areas.

Hypothesis 3b: RTEs is an essential part for promoting non-breakthrough innovation in small to medium-scale enterprises located in developed coastal areas.

2.2. Variable definition

2.2.1. Enterprise innovation

Similar to the studies of Sunder et al. (2017) and Yan (2022), this article uses the account of patent applications made by enterprises to evaluate the innovation of enterprises (PATENT). According to the different types of patents, the invention

patent applications made by enterprises are defined as breakthrough innovation (PATENT1), and the pragmatic model and utility design patent applications made by enterprises are defined as incremental innovation (PATENT2).

2.2.2. Returnee technology executives (RTEs)

Referencing the research of Hao et al. (2016) and Loukil and Yousfi (2022), we regard the board members, and senior managers disclosed in the annual reports of the examined listed companies as executives. Senior executives with R&D experience, production and design work experience, or overseas study or work backgrounds are defined as RTEs, that is, returnee technical executives. Three specific measures are used: RTE_N (the number of RTEs), RTE_D (for enterprises with at least one RTE, this variable is equal to 1; otherwise, it is equal to 0), and RTE_R (the proportion of executives who are RTEs).

2.2.3. Other variables

With reference to the literature of Lin et al. (2014) and Weili and Guangqi (2021), the size of the firm, age of the firm, property of ownership, and various financial indicators (net operating cash flow, financial leverage, asset structure, and return on assets) are selected as corporate-level control variables. With reference to the studies of Lin et al. (2011), both the size and age of the senior management team are selected as senior management-level control variables, and year and industry effects are considered.

3. Research method

A multiple linear regression model is utilized to evaluate the effects of RTEs on corporate innovation and the underlying mechanism of this influence. First, least squares regression (OLS) is used to analyze the differences between the examined companies related to the role of RTEs in enterprise innovation; then, the role of RTEs in enterprise innovation in different industries is analyzed. In addition, considering the potential for reverse causality and other endogeneity issues, this article uses propensity score matching (PSM) and instrumental variables (IV-2SLS) to conduct robustness tests. The model is built as follows:

$$\mathrm{PATENT1}_{,\,t} = a_1 + \beta_1 \mathrm{RTE}_{i,\,t} + \beta_2 \mathrm{ControlVariable}_{i,\,t} + \mathrm{YEAR} + \mathrm{IND} + \varepsilon_{i,\,t} \quad (1)$$

The explained variable PATENT represents enterprise innovation, the explanatory variable RTE denotes returnee technical executives, and Control Variable represents the control variables. All the variables are definitized accordingly in Table 3.

3.2. Selection of sample and sources of data

The Chinese Global Exchange Market (GEM)-listed corporates from 2014 to 2018 were selected for the study. The RTE information of these companies was taken from the CSMAR executive personal characteristics database, and any missing data were collected from the Sina Finance website. The enterprise innovation data were collected and collated manually from the patent retrieval database, and financial data

Table 3. Definitions of the variables.

Symbol of the variable	Name of the variable	Definition of the variable definition
PATENT	Enterprise innovation	The natural log of patent application accounts for inventions, utility models and designs + 1
PATENT1	Breakthrough innovation	The natural log of the account of invention patent applications + 1
PATENT2	Progressive innovation	The natural log of patent application accounts for inventions, utility models and designs + 1
RTE_D	Companies with RTEs	Equal to 1 for companies with executives who have overseas study (or work) experience and research and development or design work experience; otherwise, it is equal to 0
RTE_N	Number of RTEs	Number of RTEs
RTE_R	RTE scale	Percentage of the total number of senior executives who are RTEs
AS	Asset structure	Net fixed assets/Asset
SIZE	Corperate size	Natural log of asset
CFO	Cash ratio	(Cash + negotiable securities)/current liabilities
LEV	Asset-liability ratio	Gross liabilities/Asset
NUM	Executive team size	Natural log of number of overall executives plus + 1
ROA	Return on assets	Net margin/general assets
MAGE	Average age of executives	The natural log of the mean age of executives + 1
YEAR	Focal year	Dummy variable
STATE	Property of ownership	State-owned enterprises equal 1, otherwise equal 0
IND	Trade	Dummy variable

Source: Authors.

Table 4. Results of descriptive statistics of the main variables.

Name	Size of the sample	Minimum	Maximum	Average value	Standard deviation	Median value
RTE_D	1720	0.000	1.000	0.119	0.206	0.000
RTE_N	1720	0.000	2.000	0.128	0.260	0.000
RTE_R	1720	0.000	0.780	0.044	0.088	0.000
PATENT	1720	0.000	7.577	2.739	1.457	2.944
PATENT1	1720	0.000	7.192	1.952	1.319	1.946
PATENT2	1720	0.000	6.465	2.117	1.463	2.303

Source: Authors.

included in the study were obtained from the China Stock Market & Accounting Research Database. Financial data that cannot be obtained in the database was obtained by the author manually through the company's annual report. Following research practice, we exclude samples from (1) companies received special treatment and particular transfer and (2) companies with inaccessible executive information. Finally, 1,720 observations of 344 companies are collected. All continuous variables and analysed included were winsorized at both 1st and 99th percentiles in order to eliminate the effect of outliers.

4. Results and analysis of the empirical evidence

4.1. Results of descriptive statistics

According to Table 4, enterprises with RTEs account for approximately 4.4% of the sample of GEM enterprises. The average value of PATENT is 2.739, the average-value of PATENT1 turns to be 1.952, and the mean-value of PATENT2 is 2.117. There are fewer inventing patents than non-inventing patents, indicating that the overall quality of the applications of patents in Chinese business is not high.

Table 5. Impact of RTEs on enterprise innovation.

	PATENT			PATENT1			PATENT2		
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
RTE D	0.331***			0.332***			0.208***		
	(3.223)			(3.599)			(1.979)		
RTE R		0.974***			1.040***			0.501***	
		(3.654)			(4.347)			(1.837)	
RTE N			0.322***			0.349***			0.168***
			(3.503)			(4.223)			(1.786)
SIZE	0.554***	0.553***	0.552***	0.567***	0.563***	0.565***	0.465***	0.469***	0.470**
	(11.786)	(11.724)	(11.692)	(13.528)	(13.403)	(13.427)	(9.635)	(9.670)	(9.688)
LEV	0.482**	0.465**	0.502	−0.074	−0.068	−0.072	0.998***	0.969***	0.967***
	(2.109)	(2.037)	(2.192)	(-0.365)	(-0.334)	(-0.354)	(4.250)	(4.130)	(4.118)
CFO	−0.021	−0.021	−0.021	−0.008	−0.007	−0.008	−0.023	−0.023	−0.023
	(-1.554)	(-1.529)	(-1.538)	(-0.623)	(-0.608)	(-0.623)	(-1.643)	(-1.617)	(-1.621)
AS	−0.130*	−0.113	−0.107	−0.184*	−0.190*	−0.185*	−0.024	0.007	0.010
	(-0.415)	(-0.359)	(-0.342)	(-0.658)	(-0.682)	(0.048)	(-0.074)	(0.022)	(0.032)
ROA	0.349*	0.265	0.274*	−0.074*	0.038	−0.662	0.459	0.397	0.401
	(1.005)	(0.767)	(0.790)	(-0.365)	(0.125)	(0.156)	(1.288)	(1.116)	(1.128)
NUM	0.562***	0.571***	0.551	0.569***	0.578***	0.556***	0.426**	0.436***	0.427**
	(3.443)	(3.500)	(3.369)	(3.913)	(3.978)	(3.812)	(2.541)	(2.599)	(2.543)
MAGE	0.388*	0.470	0.417	0.130	0.199	0.196	0.034	0.098	0.098
	(0.808)	(0.981)	(0.868)	(0.303)	(0.466)	(0.459)	(0.070)	(0.200)	(0.198)
YEAR/IND	Control	Control	Control	Control	Control	Control	Control	Control	Control
N	1720	1720	1720	1720	1720	1720	1720	1720	1720
R^2	0.182	0.180	0.179	0.207	0.207	0.205	0.144	0.141	0.141

Note: *, **, and *** indicate prominence at the 10%, 5%, and 1% levels accordingly.
Source: Authors.

4.2. The impact of RTEs on innovation of enterprise

It is summarized that the OLS regression results reflected the impact on small and medium enterprise innovation of RTEs from Table 5. First, PATENT was utilized as the explained variable, and the following findings were showed from columns (1) to (3): RTE_D($\beta = 0.331$, $t = 3.323$), RTE_R($\beta = 0.974$, $t = 3.654$) and RTE_N ($\beta = 0.322$, $t = 3.503$). The regression coefficients were greater than zero at the level of one percent. Second, PATENT1 was used as the explained variable, and columns (4) to (6) showed the following results: RTE_D($\beta = 0.332$, $t = 3.599$), RTE_R($\beta = 1.040$, $t = 4.347$) and RTE_N ($\beta = 0.349$, $t = 4.223$). The regression coefficients at the 1% level were all positive. Third, PATENT2 was used as the explained variable, and columns (7) to (9) showed the following results: RTE_D($\beta = 0.208$, $t = 1.979$), RTE_R($\beta = 0.501$, $t = 1.837$) and RTE_N ($\beta = 0.168$, $t = 1.786$). The regression coefficients were all positive at the level of 1 percent. The above empirical evidence shows that RTE significantly promotes enterprise innovation, and the value of the β coefficient also proves that RTEs have a more notable effect on the breakthrough innovation of enterprises, verifying hypotheses 1, 1a, 1 b and 1c and supporting the need for enterprises to employ RTEs.

To address heteroskedasticity, the t values adjusted on the base of robust standard errors are shown in parentheses; a similar procedure will be followed below.

4.3. The position characteristics of RTEs and enterprise innovation

To examine the differences in the impact of RTEs in different positions, the examined RTEs are divided into two groups, namely, CEOs and non-CEOs, and an regression

Table 6. The impacts of RTEs in different positions on enterprise innovation.

	PATENT			PATENT1			PATENT2		
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
RTE_N	0.322***			0.349***			0.168***		
	(3.503)			(4.223)			(1.786)		
RTE_CEO		0.441*			0.323			0.482	
		(1.744)			(1.422)			(1.873)	
RTE_OTHER			0.292***			0.340***			0.113
			(3.020)			(3.910)			(1.140)
N	1720	1720	1720	1720	1720	1720	1720	1720	1720
R^2	0.179	0.167	0.179	0.205	0.179	0.202	0.141	0.139	0.142

Note: *, **, and *** indicate prominence at the 10%, 5%, and 1% levels accordingly.
Source: Authors.

analysis is run on the entire sample. Table 6 shows the following. First, PATENT is utilized as an explained variable, and the following results are shown in Table 1 Columns (2) to (3): RTE_CEO ($\beta = 0.441$, $t = 1.744$) and RTE_OTHER ($\beta = 0.292$, $t = 3.020$). The regression coefficients are greater than zero at both the 10 percent and 1 percent levels. Second, the explained variable utilized in the calculation is PATENT1, and the following results are listed in columns (5) to (6); the regression coefficient of RTE_CEO is minor than zero, and RTE_OTHER ($\beta = 0.340$, The $t = 3.910$)is greater than zero at the 1 percent level. Third, PATENT2 is used as an explained variable, and the regression coefficient of RTE_CEO and of RTE_OTHER is both not considerable as concluded in Table 6, columns (8) to (9). The above results jointly show that compared with the role of non-CEO returnees, the role of CEOs in promoting innovation in enterprises is more significant; thus, hypothesis 2 is verified.

To address heteroscedasticity, the t values in parentheses are adjusted by the robust standard error, the same below.

4.4. Regional differences regarding the influence of RTEs on enterprise innovation

To verify if the impact of returnees on innovation of enterprise differ from developed and less-developed areas, the sample is divided into samples composed of enterprises from developed areas and less developed areas; subsequently, a regression is run on the two resulting subsample. The following is shown in Table 7. First, PATENT is used as the explained variable, and columns (2) to (3) of Table 7 show that RTE_DEVELOPED ($\beta = 0.545$, $t = 4.765$) and RTE_UNDEVELOPED (β=-0.100, The t=-0.674) are prominently positive at the 1 percent and 10 percent level, respectively. Second, PATENT1 is used as the explained variable, and columns (5) to (6) of Table 7 show that RTE_DEVELOPED ($\beta = 0.510$, $t = 4.955$) is significantly greater than zero at the level of 1%; RTE_UNDEVELOPED regression coefficient is not significant. Third, PATENT2 is used as the explained variable, and columns (8) to (9) of Table 7 show that RTE_DEVELOPED ($\beta = 0.376$, The $t = 3.227$) is significantly positive at 1 percent level. However, RTE_UNDEVELOPED regression coefficient does not exceed zero either. All the results described above jointly show that the role of overseas RTEs in promoting enterprise innovation in developed coastal areas is more

Table 7. The impact of RTEs on enterprise innovation in diverse regions.

	PATENT			PATENT1			PATENT2		
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
RTE_N	0.322***			0.349***			0.168*		
	(3.503)			(4.223)			(1.786)		
RTE_DEVELOPED		0.545***			0.510***			0.376***	
		(4.765)			(4.955)			(3.227)	
RTE_UNDEVELOPED			−0.100			0.139			−0.235
			(-0.674)			(0.704)			(-1.554)
N	1720	1720	1720	1720	1720	1720	1720	1720	1720
R^2	0.179	0.219	0.215	0.205	0.212	0.214	0.141	0.181	0.188

Note: *, **, and *** indicate prominence levels of 10%, 5%, and 1% accordingly.
Source: Authors.

significant than that of overseas RTEs in promoting enterprise innovation in inland areas. Thus, Hypothesis 3, Hypothesis 3a, and Hypothesis 3 b are verified.

To address heteroscedasticity, the t values described within parentheses are adjusted on the base of robust standard errors; the same procedure is followed below.

4.5. Endogeneity test

4.5.1. Test of instrumental variables

In this study, there may be an endogeneity problem involving reverse causality; namely, innovative enterprises may prefer to have RTEs. Thus, this article points to the research of Ang et al. (2014), using a dummy variable denoting whether the country in which each companys headquarters is located was once a colony or concession (COLONY) as an instrumental variable. We select the above-mentioned instrumental variable because (1) COLONY is an exogenous variable. These data are derived from historical facts from a hundred years ago and are not affected by the current innovation decisions of listed companies. Due to the influence of culture and values, regions with special environments that are biased toward Western culture are more likely to become locations where overseas returnees choose to work and live, and it is easier for companies in such regions to attract RTEs.

In the first phase of the regression, we regress the RTE variables together with the aforementioned control variables and the instrumental variable COLONY. As depicted in Table 8, all the regression coefficients above of COLONY turns to be significantly positive, in line with our expectations. In the second stage, the coefficient value of RTE is significantly greater than zero within the PATENT and PATENT1 regression, but the PATENT2 regression coefficient of progressive innovation was positive but not significant, indicating that the conclusion of this paper was still significant after controlling for endogeneity.

4.5.2. Propensity score matching (PSM)

To address endogeneity due to missing variables, propensity score matching estimates are used. The specific steps of this process are as follows: (1) Giannetti et al. (2015) is drawn upon in this paper to develop a Probit model composed of the factors affecting RTE employment in listed companies. These influencing factors include the property of ownership (STATE), the proportion of shares held by the largest shareholder

Table 8. Regression analysis results regarding the instrumental variables.

	Stage 1			Stage 2								
Variable	RTE_D	RTE_R	RTE_N	PATENT			PATENT1			PATENT2		
RTE_D				9.186*			6.649*			10.190*		
				(1.885)			(1.816)			(1.887)		
RTE_R					21.642**			15.665**			24.007**	
					(2.052)			(1.970)			(2.635)	
RTE_N						8.104*			5.866*			8.989*
						(1.914)			(1.849)			(1.907)
COLONY	0.033**	0.014**	0.037**									
	(2.012)	(2.217)	(2.041)									
N	1720	1720	1720	1720	1720	1720	1720	1720	1720	1720	1720	1720
F-value	9.229	7.286	5.938									
Wald χ^2				169.183	135.247	149.502	240.148	218.156	200.004	117.353	102.025	92.273

Note: Due to space limitations, the regression results regarding the controlled variables are not reported; the same applies below.
Source: Authors.

Table 9. Results of regression analysis for PSM.

	PATENT			PATENT1			PATENT2		
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
RTE_D	0.884***			1.042***			0.507***		
	(5.781)			(7.505)			(2.992)		
RTE_R		2.164***			2.596***			1.072***	
		(6.340)			(7.998)			(2.681)	
RTE_ N			0.711***			0.856***			0.352**
			(5.919)			(7.703)			(2.585)
N	420	420	420	420	420	420	420	420	420
R^2	0.366	0.370	0.366	0.371	0.381	0.375	0.254	0.251	0.250

Note: *, **, and *** indicate proStminence at the 10%, 5%, and 1% levels accordingly.
Source: Authors.

(BLOCK), size of the board (BOARD), the independent director ratio (BIND), corporate age (AGE), company scale (SIZE), financial leverage (LEV), return on assets (ROA), corporate growth (GROWTH), and year and industry effects. (2) A Probit regression is used to calculate the propensity score of each company, and each company that employs RTEs is matched with a company that does not from the sample of companies that do not employ RTEs based on the closest probability.

$$\begin{aligned} RTE_{i,t} = {} & \alpha_1 + \beta_1 STATE_{i,t} + \beta_2 BLOCK_{i,t} + \beta_3 BOARD_{i,t} + \beta_4 BIND_{i,t} \\ & + \beta_5 AGE_{i,t} + \beta_6 SIZE_{i,t} + \beta_7 LEV_{i,t} + \beta_8 ROA_{i,t} \\ & + \beta_9 GROWTH_{i,t} + YEAR + IND + \varepsilon_{i,t} \end{aligned} \quad (2)$$

As seen from Table 9, the PATENT2 regression coefficient values of RTE, PATENT, PATENT1, and PATENT2 turn out to be all significantly positive, consistent with the previous regression results.

To address heteroscedasticity, the t values above are adjusted on the base of robust standard error, and the same applies below.

4.5.3. Robustness tests

To validate the trustworthiness of our research conclusion, we also carried out the following detests: (1) we regress a lagged version of the independent variable; (2)

since the volume of enterprise patent applications does not conform to a normal distribution but follows a Poisson distribution instead, as an OLS estimation is used, we repeat the above test using a Poisson count model; and (3) we exclude any samples with an enterprise patent application volume of 0. After this series of robustness tests, the conclusions of this study remain robust.

5. Discussion

In this paper, the innovation patent data of companies listed from 2014 till 2018 is manually collected and sorted. The impact and underlying mechanism of the effect of RTEs on small and medium enterprise innovation are examined based on the theory high-laddeRTEam. The research conclusions are as follows: (1) RTEs is proved to be essential for promoting small and medium enterprise innovation, especially breakthrough innovation; (2) CEO who are RTEs have a more potently positive implications on small to medium-scale enterprise breakthrough innovation; and (3) in developed coastal areas, the impact of RTEs on small and medium enterprise innovation is more significant.

The implications of the above conclusions are as follows. First, enterprises need to constantly optimize the member structure of their executive teams and improve their innovation incentive mechanisms. Moreover, enterprises should pay attention to non-compensation incentives for returnees, such as the promotion of more returnees into management, to improve the innovation preferences of management and enhance the innovation willingness of returnees. Second, enterprises should improve RTEs participation in corporate governance and optimize enterprise governance structures. Chinese enterprises generally have a short-sighted tendency to give more attention to short-term profits and ignore long-term development; thus, their investments in enterprise innovation are often insufficient, which suppresses enterprise innovation. Enterprises should increase their efforts to introduce overseas returnees technical talent into management and improve their discourse power to upscale the innovation abilities of enterprises to achieve long-term sustainable development.

6. Conclusions

In this paper, the innovation patent data of listed companies from 2014 to 2018 is manually collected and sorted, and the impact and underlying mechanism of the effect of RTEs on enterprise innovation is examined based on the theory of high-ladder team. This study yielded similar results to previous studies on the influence of returnee executives on firm innovation (Bai et al., 2016; Onan, 2019c; Yuan & Wen, 2018), but this study further investigates the differences in the role of RTE in promoting different types of innovation, as well as the differences in the influence of RTE on corporate innovation in different positions. The findings of the study can be seen as follows: (1) RTEs is proved to be vital for promoting enterprise innovation activities, especially breakthrough innovation; (2) CEO who are RTEs have a more potently positive effect on promoting enterprise innovation especially breakthrough

innovation; (3) in developed coastal areas, the impact of RTEs is indeed more visible on innovation of enterprises.

This paper verified the role of returnee tech executives in accelerating different types of innovation, and theoretically extends existing research. The research theoretically expands and deepens the investigation on the rapport between enterprise executive characteristics and innovation, highlights the importance of the human capital of overseas returnees in practice. The implications of the above conclusions are as follows. First, enterprises need to constantly optimize the member structure of their executive teams and improve their innovation incentive mechanisms. Moreover, enterprises should pay attention to non-compensation incentives for returnees, such as the promotion of more returnees into management, to improve the innovation preferences of management and enhance the innovation willingness of returnees. Second, enterprises should improve RTEs participation in corporate governance and optimize enterprise governance structures. Chinese enterprises generally have a short-sighted tendency to give more attention to short-term profits and ignore long-term development; thus, the investments they make in enterprise innovation are often insufficient, which suppresses enterprise innovation. Enterprises should increase their efforts to introduce overseas returnees technical talent into management and improve their discourse power to upscale the innovation abilities to achieve sustainability in the long term.

There are three further aspects that this paper could explore: (1) This paper finds that the returnee technical executives promote the innovation output of firms, but whether they have also boosted the innovation efficiency of firms. (2) Whether the promotion effect of RTEs on firms' innovation output brings value to firms, that is, whether the market value of the enterprise will increase accordingly. (3) Drawing on the latest research (Onan, 2021, 2022), machine learning methods can be used to study corporate-related report texts for executive characteristics research.

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