

# How Do Top Management Team Characteristics Affect the Firm Innovation in China Growth Enterprise Market? The Moderating Role of Managerial Incentives

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## Abstract

This article aimed to study how the top management team (TMT) demographic characteristics affect the innovation of firms in China Growth Enterprise Market. Besides, the paper tended to find out what the role of managerial incentive scheme plays in the relationship between the TMT characteristics and the innovation. The samples were the listed firms in China Growth Enterprise Market. The TMT characteristics of sample firms were obtained from the CSMAR database and the annual reports. Analysis data by Descriptive statistics and Content Analysis. The research results were found as follows; 1. Take age, gender, professional background, educational level and team size as proxy variables to measure the characteristics of TMT. It found out that the age and the proportion of female managers are negatively with the Research and Development (R&D) investment. The professional background, the educational level and the team size affect the R&D investment positively. This influence remains even after controlling for the impact of enterprise scale and performance. 2. The presence of managerial incentive schemes (salary incentive and stock option incentive) increases corporate innovation effort, and the impact of salary incentive is significant; whereas, the stock option incentive is not. 3. The moderating influence of salary incentive and stock option incentive on the relationship between TMT characteristics and R&D investment behavior has been tested. The results showed that the salary incentive strengthens the effect of the TMT characteristics on the R&D investment. However, the stock option incentive does not.

**Keywords:** TMT; TMT Characteristics; Managerial Incentives; Firm innovation; R&D investment

## Introduction

In a world full with rapid changes, firms are supposed to supply competitive and innovative products and services. Innovation is regarded as the key for long-term development (Daellenbach et al., 1999). Sufficient and efficient Research and Development(R&D) investment is the guarantee of technological innovation. The increasingly importance of R&D investments has been recognized, which induces researches on factors that affect enterprise's decisions on R&D investments. Numerous studies investigate the determinants of R&D decisions in the view of Schumpeterian hypothesis and inter-industry. Upper-echelons theory, agency theory, and resource-based view are also applied to illustrate the decisions on R&D investments. Furthermore, some researchers have reviewed the influences of industries, financial constraints, ownership structure, institutional ownership, board of directors, compensation policy on R&D investments. The above studies related to factors of R&D investment mainly concentrate on firm, board or ownership. Top management team (TMT) who integrates the information via individual's sense of values and perceptions; acts as a vital role in making R&D investment decisions. Thus, a manager's age, educational and functional background are important, owing to those demographic characteristics are identified as the determinants of manager's sense of value and perceptions (Hambrick and Mason,1984). Motivation acts on activities, which stimulates, drives and strengthens individual's behavior. Scientific and reasonable incentive scheme is beneficial to dealing with the relationship between individual's needs, goals and behaviors, and stimulates enthusiasm and creativity. The TMT members in different backgrounds, has the same awareness in dealing with the relationship between individual's needs, goals and behaviors. Based on the motivation caused by the needs, managers will choose behaviors reasonably, so as to promote the realization of their goals. Incentive scheme reinforces or inhibits TMT characteristics; which may strengthen or weaken the impacts of TMT characteristics on R&D investment decisions. Therefore, it is necessary to study the relationship between TMT characteristics and the firm R&D investment in the angle of managerial incentive. Lots of papers focus on the effects of TMT demographic characteristics on R&D investments, the moderating role of top management incentives is excluded. Based on it, a empirical study that systematically exams the relationship conducted. This research paper presents how the TMT characteristics, such as the average age, the educational background and functional background, affect the R&D investment. Furthermore, it examines the moderating impacts of managerial incentives exert on the relationship between TMT characteristics and R&D investment.

## Research objectives

This study developed and tested several hypotheses finding out:

1. How TMT characteristics impact the R&D investment?
2. How managerial incentives affect the R&D investment?
3. How managerial incentives moderate the relationship between TMT characteristics and R&D investment?

## Literature review

### Age and R&D investment

The TMT age shows a negative influence on the R&D investment. Empirical research shows that the older the managers are, the less conducive to the strategic change of enterprises (Wiersema and Bantel, 1992, Grimm and Smith, 1991). Older managers tend to reduce R&D investment (Lei and Liu, 2013; Tihanyi et. al, 2000) and commitment to innovation (Bantel and Jackson, 1989). With the increase of managers' age, managers are more and more likely to be risk-averse (Tao and Xu, 2012), older managers focus on the stability of strategic decisions, so as to minimize R&D investment and reduce risks the R&D investment takes in. According to the researches, we hypothesize that:

Hypothesis 1: The TMT average age shows a negative relationship with the R&D investment.

Educational background and R&D investment

The TMT educational background affects the R&D investment positively. Enterprises are in a complex business environment where competitors are likely to make important business decisions all the time. It requires managers to have professional knowledge, and positive and open attitude towards the innovation (Hambrick and Mason, 1984). Thus, hit (1991) pointed out that managers are supposed to accept the new things put forward by the outside, so as to take advantage of all kinds of opportunities beneficial to the development of enterprises and identify innovation opportunities in the external environment. At the same time, well-educated managers who have stronger information handling power are more easily to make rational judgement and obtain more effective information (Tihanyi et al, 2000). Columbello (2015) indicated that managers provide rational advice for strategic decisions of companies. Therefore, managers with better education are inclined to make flexible strategies; which supports the R&D investment and finally produces good corporate performance. Overall, this paper hypothesizes that:

Hypothesis 2: The level of education shows a positive relationship with the R&D investment.

Functional background and R&D investment

The TMT with diverse functional backgrounds shows a positive influence on the R&D investment. Cannella et al (2008) conducted a study on 11 industries and found that the departmental diversity of executives is conducive to the improvement of corporate performance. The diversity of working experiences refers to top managers from different departments, industries and countries. The departmental background affects the TMT cognitive base (Hambrick and Mason, 1984), for example, top managers with technical experiences in R&D, engineering or production focus more on R&D decisions and are more willing to make R&D decisions than those with professional experiences in finance, law or administration (Bentel and Jackson, 1989). Consequently, this paper hypothesizes that:

Hypothesis 3: The proportion of managers with functional background in production and R&D shows a positive relationship with the R&D investment. Proportion of female managers and R&D investment

The proportion of female managers impacts the R&D investment negatively. Behrend and Strom (2007) indicated that the proportion of female board members is negatively with the firm performance. Gender-diverse TMT is likely to encounter more conflicts, even if the final decisions the team make are beneficial for the company. However, the required quick market response, which cannot be met because of the time spent on the settlement of the conflicts is long (Hambrick et al, 1996). Hereby, some scholars put forward that the gender difference is negatively related with the firm performance. Thus, this paper hypothesizes that:

Hypothesis 4: The proportion of female managers shows a negative relationship with R&D investment. Team size and R&D investment TMT size shows a positive influence on the R&D investment. Large TMT have a broader vision and better information handling power; which solves problems better. Meanwhile, Liu and Liu (2007) argued that large TMT size represents rich social resources which increases R&D investment and is more conducive to the improvement of performance (Certo et al., 2006; Pegels et al., 2000) and development (Haleblian and Finkelstein, 1993). Overall, we hypothesize that:

Hypothesis 5: The team size shows a positive relationship with the R&D investment. Stock option incentive and R&D investment the stock option incentive influences the R&D investment positively. Liu and Liu (2007) found out that making interests of managers and shareholders be in consistent, many companies regard stock options as incentive to managers; which increases

awareness of managerial ownership, weakens the short-term behavior of managers, prompts managers undertake R&D investments and adopts new technologies to improve enterprise performance and core competence (Jensen, 1976). This is beneficial to ensuring long-term earnings of enterprises and improving corporate performance. Thus, we hypothesize that:

Hypothesis 6a: The stock option incentive shows a positive moderating impact on the relationship between the TMT characteristics and the R&D investment. Salary incentive and R&D investment the salary incentive influences the R&D investment positively. Jensen (1976) found a correlation between managerial salary and performance measurements of accounting indicators and market indicators. As the salary of managers reflects their value, the enterprise provides managers with a tempting salary that not only meets the material needs of managers and their families, but also reflects the enterprise's affirmation of them. High salary not only enhances the sense of honor of managers, but also improves the sense of belonging. Managers will consciously increase their efforts and give full play to the innovation; which is beneficial to formulating the long-term R&D investment strategy. Hence, this paper hypothesizes that:

Hypothesis 6b: The salary incentive shows a positive moderating influence on the relationship between the TMT characteristics and the R&D investment.

## Conceptual Framework

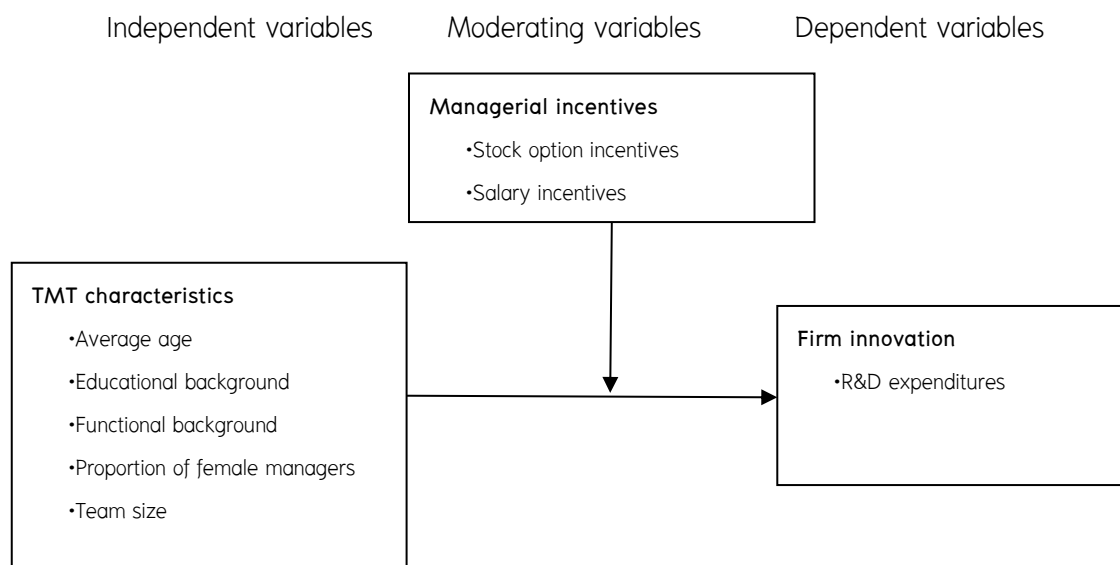


Fig 1 Conceptual Framework

## Research methodology

Quantitative research method is applied in the research. The descriptive and inferential statistics are used to analyze the quantitative data. *Samples* This paper takes the firms which listed between 2012 and 2017 in China Growth Enterprise Market as the samples. Follow the following principles to select the samples: (1) Enterprises that disclosed R&D expenditures, and the data disclosed are between year 2014 and 2016. (2) Eliminate companies that are ST and \*ST. (3) Excluding companies with incomplete data. After filtering the data, finally, 1224 balanced panel data of 366 GEM listed companies which listed during 2012 to 2017 were selected. The TMT characteristics of GEM listed companies used were obtained from CSMAR database. Some missing data were collected and sorted out manually. Data analysis was achieved by SPSS 25.0 and Excel 2007. As for the definition of TMT, the paper draws on the ideas of some scholars, the TMT is defined as the chairman, general manager, deputy general manager, supervisor and department directors (such as financial director, sales director, personnel director) and others. *Variables*

*Dependent variable.* The dependent variable is measured by the R&D(RD) investment (The natural logarithm of the R&D expenditure). There are two opinions about the measurement of the innovation: the first is to use R&D investment indicators, including total R&D investment, R&D intensity, etc.; the second is to adopt indicators of R&D achievements, including R&D revenue, number of new products, number of patent applications, etc. This paper focuses on whether TMT characteristics influence firm's R&D investment, and discusses motivations rather than outcomes. And the R&D revenue is difficult to measure accurately. Hence, we selected the amount of the R&D investment to measure the innovation. Thus, the natural logarithm of the number of the R&D expenditures was regarded as the dependent variable. *Independent variables.* The Independent variables are as follows: Age (AGE) which is measured by the average age of top managers. A manager's educational background (EDU) is measured by setting interval scales covering the education. This paper set education into six scales: (1) high school, (2) college, (3) bachelor's degree, (4) master's degree, (5) doctoral degree. Thus, the educational level of top management is measured by the mean of values of the education interval scales. Functional background (FUN) is measured by the proportion of members whom have spent years in functional tracks such as production and R&D in the total number of TMT members. Team size (TSIZE) is expressed as the total number of TMT members. *Moderating variables.* Stock option incentive (STO) is measured by the proportion of stocks held by the top managers in the total share capital of an enterprise. Salary incentive (PAY) is expressed by the natural logarithm of the total compensation of the top three

members of the TMT. *Controlling variables.* The company size (SIZE) is measured by the natural log of total assets. The corporate profitability is expressed by the return on assets (ROA).

*Model designing* For investigating the relationship between the TMT characteristics and the RD investment, and testing the hypothesis H1, H2, H3, H4 and H5, the paper builds the following models:  $R\&D = \beta_0 + \beta_1 \text{Control variables} + \epsilon$  (1)  $R\&D = \beta_0 + \beta_1 \text{TMT} + \beta_2 \text{Control variables} + \epsilon$

(2) In order to analyze the moderating effects of managers' stock option and salary incentives on the relationship between TMT characteristics and R&D decisions and test the hypothesis H6a and H6b, adding the managerial incentives and the cross-product terms of managerial incentives and TMT characteristics and building the model 3 and 4.

$$R\&D = \beta_0 + \beta_1 \text{TMT} + \beta_2 \text{STO} + \beta_3 \text{TMT} \times \text{STO} + \beta_4 \text{Control variables} + \epsilon \quad (3)$$

$$R\&D = \beta_0 + \beta_1 \text{TMT} + \beta_2 \text{Pay} + \beta_3 \text{TMT} \times \text{Pay} + \beta_4 \text{Control variables} + \epsilon \quad (4)$$

TMT in model 1 to model 4 represents top management age, educational background, functional experience, team size and the proportion of female managers; STO represents the managerial stock option incentive; PAY represents the managerial salary incentive; Control variables represent the controlling variables' is the random error.

## Research Results

### Descriptive statistics, correlation analysis and multicollinearity test

**Table 1** Descriptive statistics

Variable	Mean	S.D.	Min	Max
R&D	18.038	0.991	15.341	21.345
AGE	46.472	4.006	33.000	59.200
EDU	3.500	0.532	1.500	5.500
FUN	0.305	0.232	0.000	1.000
TSIZE	5.900	1.972	4	13
FEMALE	0.204	0.181	0.000	0.750
STO	0.200	0.144	0.000	0.602
PAY	14.498	0.587	12.689	16.588
SIZE	21.665	0.827	19.734	24.934
ROA	0.027	0.100	-0.526	0.408

Table 1 shows that the average natural log of the corporate R&D expenditures is 18.038, the maximum value is 21.345 and the minimum value is 15.341, which manifests that there are gaps in RD investment among enterprises. Managers are generally young because the average age is 46.472. The mean of the educational level (3.500) shows that most managers have a bachelors or higher degree. The average proportion of top managers with functional background in production and R&D is 30.5%, which means that technical experience plays a promoting role in making R&D decisions. There is a large difference in team size, while female participation is not high, only 20.4%, indicating that most companies are still dominated by men. The moderating variables manifest that the average number of stocks held by top managers is 0.200, the maximum value is 0.602 and minimum value is 0. It is observed that there is a big gap in stock option incentives given to top managers by different enterprises. The average natural log of the top three managers' compensation is 14.498, the maximum value is 16.588 and the minimum value is 12.689; which illustrates that there are lots of prospects in TMT incentives.

**Table 2** Correlations for the sample

	R&D	AGE	EDU	FUN	TSIZE	FEMALE	SIZE	ROA
RD	1							
AGE	0.04	1						
EDU	0.205***	-0.840	1					
FUN	0.080*	0.235**	-0.064	1				
TSIZE	0.258***	0.084	-0.008	0.230***	1			
FEMALE	-0.138***	-0.145**	0.091	-0.144***	-0.028	1		
SIZE	0.625***	0.031	0.184**	-0.086*	0.183***	-0.112**	1	
ROA	0.123**	0.125**	-0.093	0.154***	0.055	-0.049	-0.004	1

Dependent variable: R&D investment

Significance level \*P<0.1 \*\*P<0.05 \*\*\*P<0.01

The correlation coefficient matrix in table 2 indicates that there is no significant correlation between TMT age and R&D investments. It is probably because older managers tend to avoid risky programs. Meanwhile, most of the firms in the sample are tech-oriented firms, the managers reach a consensus that innovation is a source of sustainable competitive advantages. MT is willing to invest in the R&D programs; which is the support of the innovation. Thus, the impact of manager age on R&D investment is not significant. The table 2 presents that the top manager amount of education shows a positive influence on the R&D investment, which tests the hypothesis 2. As the table shows



that the functional background is not correlated to the RD investments, we will make a further test in the following. The table shows that the TMT size affect the R&D investment positively; which means that the larger the TMT size the more willing to make R&D decisions. The proportion of female managers is negatively associated with the R&D investment; which manifests that female managers adverse to the R&D strategies. As some women tend to be risk adverse, they don't want to make investment in the risky R&D programs.

**Table 3** Multicollinearity test results of variables

	Collinearity diagnostics		Collinearity statistics	
	Eigen value	Condition index	Tolerance	VIF
(Constant)	7.919	1.000		
SIZE	0.937	2.907	0.754	1.327
ROA	0.460	4.149	0.908	1.101
AGE	0.080	9.944	0.914	1.093
EDU	0.018	21.219	0.922	1.084
FUN	0.005	39.721	0.849	1.178
TSIZE	0.317	4.997	0.895	1.118
FEMALE	0.262	5.493	0.940	1.064
STO	0.001	93.766	0.913	1.096
PAY	0.001	115.525	0.790	1.265

The indicator of Eigenvalue, Tolerance and variance inflation factor (VIF), and Condition Index are introduced to determine the existence of multicollinearity among variables. Generally, if  $Tolerance \leq 0.1, VIF \geq 10$ , it illustrates that there is multicollinearity among variables. The results of multicollinearity test are shown in Table 3. It is found that VIF is less than 10 and the tolerance between independent variables is greater than 0.1. Therefore, no multicollinearity exists in the variables.

### Regression analysis

**Table 4** Results of regression analysis of model 1–4

Variable	Model 1	Model 2	Model 3	Model 4
SIZE	0.626*** (15.480)	0.581*** (14.033)	0.586*** (13.721)	0.524*** (12.062)
ROA	0.125**	0.116**	0.110***	0.090***

Variable	Model 1	Model 2	Model 3	Model 4
	(3.103)	(2.898)	(2.693)	(2.249)
AGE		−0.023	−0.009	0.694
		(−0.556)	(−0.127)	(0.693)
EDU		0.120**	0.136*	0.292
		(2.964)	(1.926)	(0.261)
FUN		0.086**	0.145**	−1.462
		(2.040)	(1.992)	(−1.566)
TSIZE		0.126***	0.124*	−0.268
		(3.058)	(1.764)	(−0.281)
FEMALE		−0.065*	−0.123*	2.137*
		(−1.614)	(−1.867)	(2.270)
STO			0.189	
			(0.328)	
AGE×STO			−0.114	
			(−0.236)	
EDU×STO			−0.058	
			(−0.222)	
FUN×STO			−0.091	
			(−0.970)	
TSIZE×STO			0.000	
			(−0.001)	
FEMALE×STO			0.087	
			(1.076)	
PAY				0.524
				(0.962)
AGE×PAY				−0.790
				(−0.713)
EDU×PAY				−0.209
				(−0.173)
FUN×PAY				1.560*
				(1.674)

Variable	Model 1	Model 2	Model 3	Model 4
TSIZE×PAY				0.384 (0.393)
FEMALE×PAY				-2.210** (-2.345)
R <sup>2</sup>	0.407	0.450	0.455	0.483
F-value	124.452***	41.830***	22.604***	25.321***

Dependent variable: R&D investment

Significance level \*P<0.1 \*\*P<0.05 \*\*\*P<0.01

### Principle effect analysis

The column 1 in table 4 shows the regression analysis results of control variables. The results verify the influences of control variables on R&D investment, which points out that the coefficient of company size and profitability are significant at the level of 1% and 5%. Enterprises with larger scale and stronger profitability attach more importance to R&D investment and have stronger desire to improve R&D investment. Controlling the company size and the company profitability, adding the TMT characteristics, the regression analysis results are presented in the column 2 in the table 4. The value of R<sup>2</sup> increases from 0.407 to 0.450, which manifests that the participation of TMT characteristics enhances the explanatory ability of the model 1. It makes clear that effects of TMT characteristics on R&D investments are relatively significant. Specifically, the relationship between the average age of managers and R&D investments have not been tested significant, while the regression coefficient is negative. The regression coefficients of the top managers' educational background, working experience in area in production and R&D, team size and the proportion of female managers are 0.12, 0.086, 0.126 and -0.065, respectively. And they are significant, which tests the hypothesis 2, 3, 4 and 5.

### Moderating effect analysis

The results of the moderating effects of the stock option incentive in model 3 table 4 show that the statistic of F is 22.604, and its corresponding p-value is smaller than 0.001; which indicates that the model is significant. And the goodness-of-fits of the model's sample is 0.455, showing that the model is able to interpret 45.5% of the R&D investment decisions. Moreover, the findings illustrate that the interaction coefficient of R&D investment and stock option incentive of top managers are not significant. Therefore, H6a is not supported. The results of the moderating effects of the

salary incentive in the model 4 table 4 show that the statistic of F is 25,321, and its corresponding P-value is smaller than 0.01; which indicates that the model is significant. Further, the goodness-of-fits of the model's sample is 0.483, showing that the model is able to interpret 48.3% of the R&D investment. Further, the findings show that the interaction coefficient of functional work experience and salary incentive is positive (significant at the level of 10%). The interaction coefficient of proportion of female manager and salary incentive is negative (significant at the level of 5%). The symbols of interaction coefficient are the same with the regression coefficient of functional background and female manager proportion. It illustrates that the salary incentive is able to strengthen the positive effects of TMT working experiences in production and R&D on the R&D investment. Similarly, the salary incentive exerts a positive moderating effect on the relationship between the female manager proportion and the R&D investment. Thus, H6b is supported.

## Knowledge from Research

**Table 5** Summary of research results

Independent variables	Model applied	Predicted relationship with R&D investment	Finding
Independent variables			
H1:Average age	2	–	Not significant
H2:Education	2	+	Significant
H3:Functional background	2	+	Significant
H4:Proportion of female managers	2	–	Significant
H5:Team size	2	+	Significant
moderating variables			
H6a:Stock option incentive	3	+	Not significant
H6b:Salary incentive	4	+	Significant
Controlling variables			
Firm size	1	+	Significant
Firm profitability	1	+	Significant

## Discussion and conclusions

The empirical test results show that the education, the functional background and the team size are positively related with the R&D investment, the proportion of women managers affect the R&D investment negatively. Therefore, turnover in TMT that leads to the addition of well-educated, technically oriented members is necessary.

The average age of managers is not empirically supported, while the regression coefficient is negative. It is probably because older managers tend to avoid risky programs. Meanwhile, most of the firms in the sample are tech-oriented firms, the managers reach a consensus that innovation is a source of sustainable competitive advantages. Top managers are inclined to make investment in the R&D decisions which supports the innovation. Thus, the research results of the average age of the TMT is not as expected. The stock option incentive was examined did not exhibit significant relationship to the TMT characteristics and commitment to innovation. The possible reasons for this may be that, the TMT interest is closely linked to the share price, which may lead to managers' wealth is more influenced by the share price. This will enable the TMT pursue less-risky programs and reduce the R&D expenditures. Existing literature shows that short-term stress in capital markets could increase management's short-sighted decisions and refrain the company innovation. However, the analysis results show comes to a conclusion that the salary incentive has significant impact to strengthen the relationship. It demonstrates that the compensation will stimulate the TMT to make more R&D investment in the strategic decision. According to the research results, it enables us to make recommendations to enterprises. *Reasonably Construct and Optimize the Structure of the TMT* Raise the awareness of the team's education and select well-educated elites to join the TMT to perfect the quality of the TMT. Meanwhile, strengthening the training of the existing TMT to make the TMT equips with stronger information processing ability to deal with different problems in different situations. Then, TMT makes favorable decisions to ensure the enterprise always develops in the right way. Enterprises ought to reasonably employ top managers with functional background in production, R&D and design. Because managers in these professional backgrounds obtain information what market demands acutely, and managers will pay more attention to investments in new products, innovative technologies and innovative processes. Control the TMT size. The larger the TMT size, the greater the pool of individual intelligence, team members communicate and share different values and business ideas and make R&D investment decisions better. *Establish Effective Managerial Incentive Policy* First, integrate stock option incentive with salary incentive. It is necessary to make corresponding incentives for top managers. Thus, managers can align their own interests

with the business. Then, implement the dual system of material and spiritual rewards for the TMT. Sometimes, the spiritual motivation is more powerful than the material motivation, as the sense of achievement of top managers are often incomparable to the material motivation .

## Suggestions

Previous studies have focused much on social and occupational heterogeneity. Future in-depth studies related with these two aspects can be conducted. Dynamic research can be introduced, that is, when and how, such as the influence of different conditions, CEO leadership, organizational structure , corporate culture and so on, can the heterogeneity of TMT exerts a positive impact. In addition, how the internal conflict, communication, cohesion and behavioral of TMT affect the R&D investment of enterprises can also be an important direction of future research.

Incentive policy is composed of two dimensions: internal incentive of top management and external incentive of government subsidy. From the perspective of top management incentive policy, it is necessary to further enrich the researches on TMT governance in China from the perspective of dual incentive. From the perspective of government subsidy incentive , it is necessary to further distinguish the difference between central and local government subsidies, the difference in incentive policies and other specific conditions. These issues need to be tested in future empirical studies. Many existing studies have conducted on the affect of single incentive policy on firms' R&D investment. Future studies can analyze the relationship between TMT heterogeneity and firms' R&D investment based on the effect of government subsidy incentive.

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