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The Impact of Executive Pay Gap on R&D

Based on the Perspective of Financing Constraints

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***Abstract*—This paper selects the panel data of China's GEM listed companies in 2013-2018 as a sample. Based on the tournament theory, it examines the impact of the internal compensation gap of the executive team on the R&D. The research shows that under the full sample, the internal salary gap of the senior management team of the GEM listed companies is significantly positively correlated with the R&D intensity. In addition, this paper uses the SA index to calculate the degree of financing constraints to further group the samples of China's GEM listed companies. The study finds that the impact of the executive pay gap between the sample of companies with strong financing constraints and the sample of companies with weak financing constraints on R&D exists certain differences: the positive correlation between the executive compensation gap and R&D in the sample of companies with weak financing constraints will be further enhanced, while the incentive effect of the executive compensation gap on R&D is weakened in the sample of companies with strong financing constraints.**

***Keywords*—executive pay gap; R&D; financing constraints; high-tech enterprises**

I. INTRODUCTION

As an important decision of the enterprise, R&D is considered as one of the main ways to enhance the core competitiveness of the enterprise in modern enterprise management. Of course, it is also related to the development and growth of a country. However, compared with the general scale investment, R&D has the risk characteristics of long project cycle, large investment scale, lag in earnings and high uncertainty of R&D results [1]. In the GEM market, which is dominated by high-tech enterprises in China, the demand for improving the ability of independent innovation is even stronger. The proportion of high-tech enterprises in the GEM market has exceeded 90%, making an important contribution to promoting China's economic restructuring and building an innovative national strategy [2].

Executives are the decision-making body of enterprise R&D. Therefore, the executive compensation incentive mechanism has an important impact on the R&D behavior and its performance. In recent years, the issue of the pay gap has begun to attract the attention of scholars in China and foreign countries, because salary design is related to the incentive effect on the management of the company, which affects the decision-making of the management and the business performance of the company. At present, the research on salary gap mainly focuses on the relationship with corporate performance. Few scholars have discussed the impact of salary gap on R&D.

Based on the existing literature, the research on the relationship between executive pay gap and R&D is insufficient. This paper takes the GEM listed companies with the most concentrated R&D and innovation as a sample to study the impact of executive pay gap on R&D. On the basis of constructing the financing constraint index, the grouping research is further based on the financing constraint SA index, which makes the research results more complete and reliable.

This paper may contribute in the following two aspects: Firstly, the executive compensation gap is a hot topic of current corporate governance, and the relationship between executive compensation gap and the company's R&D is still in the discussion stage. This paper enriches the literature on executive pay gap and R&D; Secondly, the introduction of financing constraints as a moderator to study the differences in the impact of executive pay gaps on R&D when companies face different levels of financing constraints, enriching the research perspective in this area.

II. LITERATURE REVIEW AND RESEARCH HYPOTHESIS

A. Executive Pay Gap and R&D

At present, there are few studies on the executive pay gap and the company's R&D in China and foreign countries. The existing research shows that the pay gap has a positive or negative impact on R&D.

The empirical findings of most scholars show that the executive pay gap is positively related to the company's R&D and supports the tournament theory proposed by Lazear and Rosen [3]. Goel and Thakor [4] believe that high-level executives will be more willing to choose investment projects with higher risks in order to win the championship. The salary gap can expand the company's R&D. According to Kini and Williams, [5] the pay gap among executives will generate tournament incentives, which will encourage managers to accept greater risks and increase R&D intensity. Wang Dongqing and Guo Xiang [6], Wang Xiufen and Yang Xiaoxing [7], Meng Xiangjia [8], Zhu Fangfang and Li Haijian [9] selected the Chinese A-share listed companies in

2010-2014, 2010-2016 2010-2017 and 2011-2015 respectively as samples, and reached the same conclusion: the executive compensation gap is positively related to the company's R&D, supporting the tournament theory. Li Yuyun [10] found that the executive pay gap can improve the R&D of listed companies in the pharmaceutical industry. Liu Yinguo and Shao Xikang [11] took the 2012-2016 A-share manufacturing listed company as a sample. The research results show that the internal compensation gap of executives is significantly positively correlated with the R&D intensity.

There are also a small number of scholars who have reached the opposite conclusion based on behavioral theory. Lv Wei and Zhang Shuzhen [12] used the manufacturing companies in the SME board and the GEM as a sample. The study found that the executive compensation gap is significantly negatively correlated with the R&D intensity of the company. Chen Hui et al [2] selected GEM listed companies as a sample, and found that the internal salary gap and the innovation input of the executive team were significantly negatively correlated. Huang Guoliang and Yang Guang [13] used the data of A-share listed companies in 2013-2016 as a research sample, which found that the internal compensation gap of executives is significantly negatively correlated with corporate R&D.

The tournament theory proposed by Lazear and Rosen sees managers as competitors in the tournament, and sees the pay gap between the different levels within the organization as a bonus for the company to be promoted to a higher level in the tournament because of the win. If a manager wins the promotion, he will receive the majority of the prizes in the tournament, but the losers may have no gains [3]. Therefore, if the competition bonus is high enough, that is, the salary gap is large enough, it will give the manager a great incentive to work hard, improve the manager's risk-taking ability, and make them more willing to invest in research and development projects. On the other hand, according to the principal-agent theory, because the cooperation between the senior executives is frequent and the tasks are interdependent, the degree of effort is difficult to quantify. Therefore, the difficulty of monitoring the agent by the principal will increase and the monitoring cost will increase. The tournament-style relative performance incentive method is more effective than the absolute performance incentive, which can reduce the client's supervision cost. Based on the above analysis, this paper proposes hypothesis 1.

H1: The executive compensation gap has a significant positive correlation with the R&D of listed companies on the GEM.

B. *Executive Pay Gap, Financing Constraints and R&D*

Pu Wenyan and Wang Shanhui [14] believe that executive compensation and R&D will lead to cash outflows for listed companies. For companies facing financing constraints, executive compensation and R&D will be subject to overall financial resources constraints, making the incentive affect non- financing constrains companies to make a difference.

Because R&D innovation has the characteristics of persistence, complexity and risk, it requires long-term investment of a large amount of capital, and sufficient funds are an important guarantee for R&D of enterprises. When executives make investment decisions for R&D, the degree of financing constraints faced by companies is also an important factor to consider [15]. For companies listed on the GEM, many companies are faced with the situation that the cash flow generated by their own operations cannot fully meet the future investment demand. The internal financing alone cannot meet the demand for innovative investment, and it is urgent to use external financing channels to alleviate funds pressure [16]. Therefore, if the GEM companies face more serious financing constraints, they may weaken the positive incentive effect of the executive compensation gap on R&D. Based on the above analysis, this paper proposes hypothesis 2.

H2: Other things being equal, compared with enterprises with strong financing constraints, the executive compensation gap of enterprises with weak financing constraints has a more significant impact on R&D.

III. RESEARCH DESIGN

A. *Data Source and Sample Selection*

This article selects China’s GEM listed companies as the research object. The main reasons are: (1) The proportion of high-tech enterprises in the GEM market has exceeded 90%, and R&D is expected to be more important for enterprise development; (2) Compared with the main board, the GEM Companies are mostly at a high-risk, high-yield stage, and financing constraints may be more pronounced.

The research period of this paper is 2013-2018. The screening criteria for raw data are as follows: (1) select companies listed before December 31, 2013; (2) exclude listed companies with missing financial data; (3) exclude samples with asset-liability ratio greater than 1. Finally, 3224 observations were obtained. The financial data in this paper is mainly from the CSMAR database, and the executive compensation data comes from the RESSET database. The data analysis software is mainly Stata12.0 and EXCEL.

B. *Variable Design*

1) R&D: Drawing on the methods of Chen Hui et al. [2] and Zhu Fangfang [17], the ratio of R&D expenditure to operating income is selected to measure R&D. In the robustness test, the ratio of R&D expenditure to total assets is used to replace the dependent variable for testing.

2) Executive pay gap (Paygap): There are two main indicators for measuring the executive pay gap. The first is the difference between the executives' absolute pay gap, that is, the difference between the two levels of compensation, and the second is the ratio of the executive's relative pay gap, that is, the ratio between the two levels of compensation. Referring to the methods of Wang Xiufen and Yang Xiaoxing [18], Zhu Fangfang and Li Haijian [9], this paper selects the absolute salary gap as an explanatory variable,

and uses the natural logarithm of the average salary of the top three executives and the average salary difference of other executives as an indicator to measure the executive pay gap.

3) Financing constraints (SA): Combined with relevant literature in Chian and foreign countries, the main models for measuring financing constraints are WW index, SA index, KZ index, investment-cash flow model and cash-cash flow model. Since the SA financing constraint index does not have endogeneity problems, and this index has been used by Chinese scholar Wang Shuqin [19], this paper selects the SA index to measure financing constraints. The SA index is estimated by Hadlock and Pierce [20] using the Ordered Probit model, which is calculated as -0.737*SIZE+0.043*SIZE2- 0.04*AGE. SIZE is generally the natural logarithm of company assets, while AGE often refers to the age of the business. The greater the absolute value of the SA index, the lower the degree of financing constraints on the company.

4) Control variables: Referring to the existing research results, this paper sets 8 corporate governance and characteristic factors that have important influence on the company's R&D as the control variables, namely, asset-liability ratio, company size, growth opportunity, cash flow ratio, board size, duality, management shareholding and annual dummy variable. The specific definition of each variable is shown in "Table I".

TABLE I. VARIABLE DEFINITIONS

Variable name	Variable symbol	Variable description
R&D	R&D	R&D expenditure/operating income
Executive pay gap	Paygap	Ln (average salary of the top three executives - average salary of other executives)
Financial constraint	SA	-0.737*SIZE+0.043*SIZE^2- 0.04*AGE
Debt to asset ratio	Lev	Total liabilities / total assets
Company Size	Size	Ln (total assets)
Growth opportunity	Growth	Operating income growth rate
Cash flow ratio	OCF	Net cash flow from operating activities / Total assets
Board size	Board	Number of board members at the end of the year
Duality	Dual	The chairman and general manager are one person and the assignment is 1; otherwise the assignment is 0
Management shareholding ratio	Magsh	Management Shareholding / Total Shares
Annual dummy variable	Year	Established 6 annual dummy variables based on 2013

C. Model Establishment

According to the research ideas and research hypotheses of this paper, the executive internal pay gap of executives is the independent variable, and the R&D is the dependent variable. In order to verify the relationship between the internal compensation gap between the executives and the R&D, the following model (1) is established:

$$R\&D_{i,t}=\alpha_0+\alpha_1 Paygap_{i,t}+\alpha_2 Lev_{i,t}+\alpha_3 Size_{i,t}+\alpha_4 Magsh_{i,t}+\alpha_5 Growth_{i,t}+\alpha_6 OCF_{i,t}+\alpha_7 Board_{i,t}+\alpha_8 Dual_{i,t}+\sum Year+\varepsilon_{i,t} \quad (1)$$

IV. EMPIRICAL TEST AND RESULTS ANALYSIS

A. Descriptive Statistics

According to the statistical data in "Table II", in the sample year, the average R&D intensity of listed companies on the GEM is 0.0725, and the minimum and maximum values are 0 and 0.7275 respectively, indicating that the overall R&D of China's GEM listed companies need to be improved. There are different levels of R&D in the sample. The average of the natural logarithm of the executive pay gap is 12.4942, the minimum is 9.67, and the maximum is 14.49, indicating that the internal pay gap of the sample company executives is generally large. The average value of the financing constrained SA index is 3.2013, which indicates that there are widespread financing constraints in China's GEM listed companies, and the standard deviation is 0.9308, the minimum value is as low as 0.8465, and the maximum value is as high as 8.2064, indicating that the difference in financing constraints faced by different sample companies is quite big.

TABLE II. DESCRIPTIVE STATISTICS OF VARIABLES

Variable	Mean	SD	Min	Median	Max
R&D	0.0725	0.0638	0	0.0524	0.7275
Paygap	12.4924	0.7931	5.7312	12.508	15.9595
SA	3.2013	0.9308	0.8465	3.0921	8.2064
Lev	0.3083	0.1688	0.0111	0.2854	0.9886
Size	21.2703	0.8401	18.9607	21.1719	25.0258

Variable	Mean	SD	Min	Median	Max
Growth	0.256	0.5827	-0.9818	0.1586	16.9082
Magsh	0.2491	0.1935	0	0.2419	0.75
OCF	0.0374	0.0697	-0.3544	0.0365	0.6523
Dual	0.4377	0.4962	0	0	1
Board	7.9637	1.4333	4	8	15

B. Relevance Test

"Table III" shows the results of the Pearson correlation test in the model. It can be seen that there is a positive correlation between the executive pay gap and the R&D at the 1% significance level, and the correlation coefficient is 0.062, indicating that the executive compensation gap does have helping companies to invest in R&D, which initially supported hypothesis 1. However, because the control variables are not included, the test results may be inaccurate. Therefore, multivariate regression test analysis is needed on this basis.

TABLE III. CORRELATION COEFFICIENT BETWEEN VARIABLES

	R&D	Paygap	SA	Lev	Size	Growth	Magsh	OCF	Dual	Board
R&D	1									
Paygap	0.062 ***	1								
SA	-0.125 ***	0.291 ***	1							
Lev	-0.270 ***	0.044 **	0.431 ***	1						
Size	-0.133 ***	0.298 ***	0.981 ***	0.438 ***	1					
Growth	-0.105 ***	0.019	0.212 ***	0.144 ***	0.209 ***	1				
Magsh	0.062 ***	-0.146 ***	-0.279 ***	-0.144 ***	-0.292 ***	-0.034 *	1			
OCF	0.011	0.096 ***	-0.081 ***	-0.242 ***	-0.086 ***	-0.050 ***	0.016	1		
Dual	0.074 ***	0.051 ***	-0.113 ***	-0.022	-0.117 ***	-0.036 **	0.116 ***	0.022	1	
Board	-0.068 ***	0.053 ***	0.110 ***	0.051 ***	0.124 ***	0.028	-0.109 ***	0.009	-0.079 ***	1

[a.] *, **, *** indicate significant at the level of 10%, 5%, and 1%, respectively

C. Regression Analysis

1) Analysis of the results of the full sample test: "Table IV" shows the results of the regression analysis. It can be seen from "Table IV" that the executive compensation gap in model (1) is significantly positively correlated with R&D at the level of 1%, indicating that the internal compensation gap of the executive team has a positive effect on the R&D of the enterprise, which proves the hypothesis. The effect of the tournament is more obvious than the behavioral theory in the GEM listed companies.

2) Analysis of grouping test results:

In order to consider the adjustment effect of the degree of financing constraints on the impact of executive compensation gap on R&D, this paper conducts group test. For the full sample of the financing constraints, the SA index is sorted in descending order, and the sample is divided into two groups by the median, and substituted into the model (1) for regression. The results are shown in "Table IV".

The regression results show that in the sample companies with weak financing constraints, Paygap's coefficient is changed from 0.0068 in the whole sample to 0.0097, and the positive correlation between the executive pay gap and R&D is further enhanced, which is significant at the 1% significance level. In the sample companies with strong financing constraints, the coefficient of Paygap changed from 0.0068 under the full sample to 0.0043, and the positive correlation between the executive pay gap and R&D is weakened, and it is significant at the 10% significance level. The results show that whether in the enterprises with strong financing constraints or enterprises with weak financing constraints, the executive compensation gap plays a positive role in the R&D of enterprises, but in enterprises with weak financing constraints, the positive effect of the executive pay gap on corporate R&D is more obvious, which verified hypothesis 2.

TABLE IV. REGRESSION RESULTS

	Full sample	Weak financing constraints	Strong financing constraints
Paygap	0.0068***	0.0097***	0.0043*
	(0.0015)	(0.0020)	(0.0022)
Lev	-0.1027***	-0.0864***	-0.1209***
	(0.0073)	(0.0093)	(0.0117)
Size	-0.0014	-0.0074***	-0.0017
	(0.0016)	(0.0027)	(0.0043)
Growth	-0.0066***	-0.0052***	-0.0160***
	(0.0019)	(0.0020)	(0.0054)
Magsh	0.0063	0.0080	0.0065
	(0.0059)	(0.0091)	(0.0078)
OCF	-0.0639***	-0.0292	-0.0922***
	(0.0160)	(0.0225)	(0.0228)
Dual	0.0071***	0.0100***	0.0038
	(0.0022)	(0.0030)	(0.0032)
Board	-0.0021***	-0.0029***	-0.0011
	(0.0008)	(0.0010)	(0.0011)
Constant	0.0651**	0.1626***	0.1007
	(0.0332)	(0.0558)	(0.0883)
Year	control	control	control
N	3224	1612	1612
Adj. R2	0.0924	0.104	0.0761
F	26.23	15.38	11.2

a. *, **, *** indicate significant at the level of 10%, 5%, and 1%, respectively

D. Robustness Test

In the previous section, we used the ratio of R&D expenditure to operating income to measure R&D intensity. In the existing literature, some scholars also used the ratio of R&D expenditure to total assets to measure R&D intensity. The regression analysis is carried out on the above model by taking the ratio of R&D expenditure to total assets as a proxy variable for R&D, and the results are shown in "Table V". The test results are consistent with the previous regression results, and still verify the establishment of the hypothesis of this paper, indicating that the research conclusions of this paper are to a certain extent robust.

TABLE V. ROBUSTNESS TEST RESULTS

	Full sample	Weak financing constraints	Strong financing constraints
Paygap	0.0048***	0.0054***	0.0039***
	(0.0005)	(0.0006)	(0.0009)
Lev	-0.0053**	-0.0075**	-0.0021
	(0.0026)	(0.0029)	(0.0046)
Size	-0.0070***	-0.0070***	-0.0119***
	(0.0006)	(0.0008)	(0.0017)
Growth	0.0002	-0.0004	0.0055***
	(0.0007)	(0.0006)	(0.0021)
Magsh	0.0051**	0.0028	0.0050
	(0.0021)	(0.0029)	(0.0030)
OCF	0.0318***	0.0454***	0.0185**
	(0.0057)	(0.0071)	(0.0089)
Dual	0.0011	0.0014	0.0009
	(0.0008)	(0.0010)	(0.0012)
Board	0.0003	-0.0005*	0.0011**
	(0.0003)	(0.0003)	(0.0004)
Constant	0.1153***	0.1136***	0.2181***
	(0.0119)	(0.0176)	(0.0346)
Year	control	control	control
N	3224	1612	1612
Adj. R2	0.103	0.1357	0.0534
F	29.47	20.45	7.99

a. *, **, *** indicate significant at the level of 10%, 5%, and 1%, respectively

V. CONCLUSION

Based on the theory of tournaments, this paper discusses the relationship between the internal compensation gap of executives and the R&D of enterprises. It also uses the degree of financing constraint as a regulatory variable to test its adjustment effect on the internal compensation gap of executives and the R&D of enterprises. The research in this

paper has the following conclusions: Firstly, the internal compensation gap of executives is significantly positively correlated with corporate R&D. Secondly, relative to enterprises with strong financing constraints, and the effect of internal compensation gaps on R&D is more obvious in enterprises with weak financing constraints.

Based on the above research conclusions, this paper proposes the following suggestions: Firstly, for the current GEM companies in China, the executive compensation gap significantly affects the R&D intensity of enterprises. At this stage, we must formulate a reasonable compensation plan to make the executive compensation gap maintaining at a relatively high level, which allows this gap to reflect the capabilities and value of core executives, thereby motivating managers to focus more on R&D innovation activities in their investment decisions. Secondly, because the existence of financing constraints will inhibit the positive effects of executive compensation incentives on R&D, GEM companies should make full use of relevant policies to broaden financing channels, reduce financing costs and financing risks, and improve the efficiency of capital use to alleviate financing constraints.

There are two limitations in this paper: Firstly, the executive pay gap in the article only considers short-term monetary compensation, and does not consider long-term equity incentives in the executive compensation gap. Secondly, this paper only considers the impact of executive compensation gap on R&D intensity. The impact of executive compensation gap on R&D results and efficiency can be a direction for further research.

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