The Promotion Effect of Executive Compensation Stickiness on Corporate R&D Investment: Empirical Evidence Based on PSM

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Abstract. The impact of executive compensation stickiness on corporate R&D investment behavior is a new issue in the financial and financial field. A small amount of literature has analyzed the above issues, but they have ignored the possible adverse effects of sample selection bias on the research results. This paper takes the 2008-2016 China Shanghai and Shenzhen A-share listed companies as the research samples, uses propensity score matching (PSM) to empirically test whether the executive pay viscous significantly promotes R&D investment. The study found: under the premise of controlling sample selection bias, the R&D investment level of the executives with sticky and high-viscosity group is significantly higher than that of the sample companies with no sticky and low-viscosity groups. As a kind of salary incentive mechanism with failure tolerance characteristics, executive pay sticky has a significant promotion effect on Chinese R&D investment. Further research has also found that, especially for non-state-owned enterprises and high-tech enterprises, executive compensation stickiness has a stronger effect on corporate R&D investment.

1. Proposal of the problem

In reality, the practice of executive compensation incentives shows that executive compensation is linked to corporate performance to some extent, both in Western developed countries with relatively perfect corporate governance mechanisms and in developing countries with relatively backward corporate governance mechanisms. However, this kind of linkage is not strictly speaking, but the marginal increase of executive compensation in the case of increased business performance is greater than the marginal reduction in the decline of corporate performance, and the sensitivity of executive compensation performance is selective. Asymmetrically related features (Jackson et al., 2008; Fang Junxiong, 2009; Shaw & Zhang, 2010; Budan and Zhang Chenyu, 2012; Lu, Abeysekera & Li, 2014; Chen Xiude, Peng Yulian, and Wu Xiaojie, 2014). The academic community refers to the phenomenon that the above-mentioned salary performance is asymmetrically related as the executive compensation viscosity. It is not difficult to see from the expression of executive pay sticky that the essence is not to follow the optimal contract theory to emphasize paying wages strictly according to performance, but to show the “failure tolerance” and “reward blitz” of corporate (shareholders) on executive behavior. (Budan and Wenhong, 2013). According to the latest researches such as Wu Xiaoman et al. (2016a, b), the characteristics of “failure tolerance” and “reward blitz” of executive...
compensation viscosity, to some extent, fit well with R&D innovation-oriented executive compensation incentives. Mechanism requirements. Therefore, in theory, the executive pay viscosity should be conducive to more R&D investment.

Although the promotion of executive compensation for corporate R&D investment has been supported by some theoretical research (for example: Wu Xiaoman et al., 2016a, b), therefore, for Chinese listed companies, this mainly comes down to an empirical research question. From the research method, the preliminary research mainly faces a difficult problem that remains unresolved: when measuring the effect of executive pay sticky on corporate R&D investment, all of them ignore the “sample selection bias” proposed by Heckman (1979). (sample-selection bias) problem. In other words, companies with higher R&D investment levels may be more inclined to adopt a sticky executive incentive mechanism, which makes us even more expensive R&D investment in listed companies that observe sticky executive compensation. However, it is impossible to judge whether the difference stems from the salary of the executive compensation itself or the influence of other factors.

In view of this, this paper uses the newly developed propensity score matching method (PSM) to control sample selection biases in order to obtain more scientific research conclusions. This paper focuses on the following three questions: (1) Does the executive compensation viscosity have an effect on the overall R&D investment level of enterprises? (3) Under the different ownership characteristics of enterprises, the effect of executive compensation stickiness on corporate R&D investment is, what is the difference? (3) Does the executive pay viscosity have different R&D investment promotion effects for different technology types?

The subsequent structure of this paper is organized as follows: the second part is the research method; the third part is the sample data and index structure; the fourth part is the empirical result and analysis; the final part is the main research conclusion.

2. Research methods

The goal of this paper is to examine the impact of executive compensation stickiness on corporate R&D investment levels. However, the difficulty in dealing with such studies is that mixed bias and selectivity bias often interfere with the estimation results, leading to significant bias in the empirical results. To achieve the goal of inferring the causal relationship between executive pay sticky and corporate R&D investment, the use of stochastic experiments to control covariates is an ideal alternative. Specifically, this paper will achieve the research target by testing the differences in the R&D investment levels of the sample companies in the four types of different situations: the viscous (high degree of viscosity) and the non-viscous (low degree of viscosity). In terms of measurement methods, this paper plans to use the "Potential Score Matching" (PSM) method proposed by Rosenbaum & Rubin (1983). The basic idea of the PSM method is to find a control group that is as similar as possible to the processing group when evaluating the implementation effect of a policy, so that the problem of sample selection bias can be effectively reduced. However, the process of finding a control group is complicated, because if only one feature (such as the size of the enterprise) is matched, the result often fails to achieve a satisfactory matching effect. The PSM method uses a series of special methods to condense a set of features for matching into an index, propensity score (PS value), to achieve the purpose of multi-feature matching, so as to find a satisfactory matchsample.

According to Rosenbaum & Rubin (1983), the propensity score is defined as the sample characteristics before the given acceptance treatment. In the case of a sample company, executive compensation has a viscous (highly viscous) conditional probability:
\[
p(X) = \Pr[D = 1|X] = E[D|X]
\]  

In equation (1) \( D \) Represents the indicator function. If the executive compensation of a sample company is sticky or highly viscous, then \( D = 1 \), otherwise \( D = 0 \). Right? For sample companies, they tend to score \( p(X) \) Under the known circumstances, the average handling effect of executive pay stickiness is known. (Average effect of Treatment on the Treatment, Abb ATT) Can be expressed as:
\[
ATT = E[Y_{1t} - Y_{0t}|D_t = 1] = E[E[Y_{1t} - Y_{0t}|D_t = 1], p(X_t)] = E[E[Y_{1t}|D_t = 1], p(X_t)] - E[E[Y_{0t}|D_t = 0], p(X_t)]
\]  

(2)
Where: in the formula (2) $Y_{1,1}$ with $Y_{0,1}$ represents the R&D investment level of the same sample company in the case of the viscous (high degree of viscosity) and non-viscosity (low degree of viscosity) of the executive compensation. We can pass ATT whether it is significantly different from 0 to determine whether the sample companies have different R&D investment levels under the above-mentioned different circumstances, and then statistically infer the causal relationship between executive pay sticky and corporate R&D investment.

3. Sample data and indicator construction

3.1 Sample data

This paper selects the companies listed on the Shanghai and Shenzhen Stock Exchanges in 2008-2016 as the research samples, and preprocesses the sample data as follows: (1) Excluding the sample of listed companies in the financial industry and insurance industry; (2) Excluding ST, *ST, suspension Samples of listed companies whose stocks, such as listing, suspension, and termination, are in an abnormal trading state. Sample company financial, corporate governance, executive compensation and other relevant data from the CSMAR database, listed companies R & D investment amount, date of establishment and other data from the Wind database.

In terms of the setting of the processing group and the control group, this paper sets two processing groups and two control groups according to the existence of the executive compensation viscosity and the degree of the executive compensation viscosity: (1) when the executive compensation exists When it is sticky, it is set as the processing group, the sample company with no sticky salary is set as the control group; (2) According to the median salary viscosity, the sample enterprises are divided into high and low degree sticky groups, which will be high The viscous sample company is set as the processing group, and the low-level viscous sample enterprise is set as the control group.

3.2 Indicator construction

Interpreted variables: corporate R&D investment. This paper uses the logarithmic form (LnRDSpend) of the amount of R&D investment of the company disclosed in the annual report of the listed company as a measure.

Interpret variables: executive pay sticky virtual variables and executive pay viscosity degree dummy variables. Firstly, this paper refers to the method of Budan and Wenhong (2013) to measure the degree of stickiness of executive compensation of sample companies. On this basis, two explanatory variables are defined: one is the executive pay viscosity dummy variable IsNX. When the calculated executive payroll viscosity of the sample company is greater than 0, the IsNX value is 1, otherwise the value is 0; the second is the executive Pay viscosity degree dummy variable HNX, when the sample company's executive pay viscosity is greater than or equal to the median of the executive pay sticky, HNX takes a value of 1, otherwise it takes a value of 0.

In addition, based on the research on the factors affecting R&D investment, this paper chooses executive compensation (LnPayTop3), company growth (Growth), company size (LnSize), total return on assets (Roa), stock returns. Rate (Ret), Asset Responsibility (Lev), Free Cash Flow (FCF), Large Shareholders (ORECTA), Administrative Expense Rate (ADM), Enterprise Development Time (Age), State-Owned Enterprise Virtual Variables (Isstate), High-tech Technology Enterprise Virtual Variables (HTEC), Executive Shareholding (Share), Industry Virtual Variables (Ind), and Year Virtual Variables (Year) are used as matching variables.

Descriptive statistical results of the main study variables in this paper are reported in Table 1, and will not be described in detail here.

| VarName   | Obs | Mean   | SD    | Min  | Median | Max   |
|-----------|-----|--------|-------|------|--------|-------|
| LnRDSpend | 9053| 17.825 | 1.515 | 13.305 | 17.801 | 22.392 |
| IsNX      | 9137| 0.851  | 0.356 | 0.000 | 1.000  | 1.000 |
| HNX       | 9137| 0.439  | 0.496 | 0.000 | 0.000  | 1.000 |
4. Empirical results and analysis

4.1 Correlation analysis results

Table 2 reports the results of the correlation analysis of the main variables. It can be seen from the results that the correlation coefficient between the enterprise R&D investment and the executive compensation viscous variable is positive, and all of them are highly significant at the 1% significance level. This is consistent with the findings of the existing literature. It can be preliminarily judged that there is a significant positive correlation between the executive pay viscosity and the enterprise R&D investment level, but this is the result of not controlling other variables and cannot be used as the basis for the final empirical research. And the causal relationship between the above variables still needs further study. In addition, we can clearly find that there is a significant positive correlation between state-owned enterprise dummy variables and high-tech enterprise dummy variables and enterprise R&D investment variables, which indicates that state-owned enterprises and high-tech enterprises have significantly higher R&D investment levels.

Table 2: Correlation analysis of major variables

|                  | LnRDSpend | IsNX | HNX | IsState | HTEC |
|------------------|-----------|------|-----|---------|------|
| LnRDSpend        | 0.115***  | 0.330*** | 0.161*** | 0.074*** |
| IsNX1            | 0.101***  | 0.370*** | 0.063*** | 0.051*** |
| HNX1             | 0.314***  | 0.370*** | 0.077*** | 0.034*** |
| IsState          | 0.159***  | 0.064*** | 0.077*** | -0.087*** |
| HTEC             | 0.073***  | 0.051*** | 0.032*** | -0.085*** |

Note: The Pearson correlation coefficient is reported in the lower left corner of the diagonal of the above table; the Spearman correlation coefficient is reported in the upper right corner.

4.2 propensity score matching result

In this paper, the samples are matched by the nearest neighbour matching method. The sub-graphs (a) and (b) in Fig. 1 respectively show the kernel density functions of the PS values of the processing group and the control group grouped by whether or not the executive pay is sticky. It can be seen from the results of subgraphs (a) and (b) that there is a certain difference in the probability distribution of the PS values before the matching. This may be because the sample company itself presents this pattern, or it may be because of the executive pay viscosity. Impact. If the R&D investment level difference between the two groups of sample companies is directly compared, the statistical inference results obtained may be biased, but the previous related theoretical research often ignores this problem. After the completion of multi-feature matching, the proximity of the probability distribution of the PS values of the two groups of samples is greatly improved, indicating that the processing group and the control group are very close in all aspects, except for differences in executive pay viscosity. Other aspects have been very similar, indicating that the sample matching effect is better. The sub-graphs (c)
and (d) in Fig. 1 show the kernel density functions of the PS values of the processing group and the control group grouped according to the degree of the salary of the executives before and after matching. Similarly, the results presented in Figures (c) and (d) also show that the sample matching works well.

Figure 1: Comparison of PS value probability distributions between “processing group” and “control group” before and after nearest neighbour matching

4.3 Analysis of the average effect of the sample population

The average impact effect (ATT) obtained by using the nearest neighbour matching method for the sample population is shown in Table 3. The results of grouping according to the variable IsNX show that the explanatory variables (LnRD Spend) that measure the R&D investment level of the enterprise are significantly different from zero at the 1% level, both before and after matching, and the R&D investment level of the processing group is higher. This indicates that the sample companies with viscous executive compensation have significantly higher R&D investment levels. The results of grouping according to the variable HNX also show that sample companies with high payroll viscosities have significantly higher R&D investment levels. Based on the results of the two-part test, we believe that the attractiveness of executive compensation can effectively improve the R&D investment level of Chinese listed companies, and this result overcomes the adverse effects that may be caused by sample selection bias, compared with the results of existing research. Be more accurate.

| Variable name | Sample | Processing group | Control group | ATT   | Standard error | T value   |
|---------------|--------|------------------|---------------|-------|----------------|-----------|
| IsNX          | Before matching | 17.959 | 17.523   | 0.435 | 0.049          | 8.97***   |
|               | After matching  | 17.968 | 17.468   | 0.501 | 0.056          | 8.91***   |
| HNX           | Before matching | 18.430 | 17.468   | 0.960 | 0.033          | 29.42***  |
|               | After matching  | 18.431 | 17.491   | 0.940 | 0.041          | 23.03***  |
Note: (1) “Before matching” refers to the sample before the trend score pairing is not implemented, “after matching” refers to the sample after the nearest neighbour matching; (2) “Processing group” and “Control group” respectively indicate executive compensation There are samples with high viscosity (high degree of viscosity) and no paying for executives (low degree of viscosity); (3) *** , ** and * indicate significant at 1%, 5% and 10%, respectively.

4.4 Heterogeneity analysis under different ownership and technology types

The results of the correlation analysis in the previous article show that state-owned enterprises and high-tech enterprises have significantly higher R&D investment levels. So, does the impact of executive compensation stickiness on corporate R&D investment also have significant heterogeneity in the above two types of enterprises? This is the question that needs to be answered below.

In this paper, the relationship between executive compensation stickiness and enterprise R&D investment is further tested by sample grouping, and the average impact effect (ATT) obtained by nearest neighbour matching method is still used, as shown in Table 4. Two basic conclusions can be obtained from Table 4:

(1) Regardless of whether it is for state-owned enterprises or private enterprises, high-tech enterprises or non-high-tech enterprises, the R&D investment levels of the matching pre- and post-processing groups and control groups are significantly different, and the R&D investment level of the processing group is significantly higher. It can be seen that the promotion effect of executive compensation stickiness on corporate R&D investment is common in state-owned enterprises and private enterprises, high-tech enterprises and non-high-tech enterprises.

(2) From the numerical effect of the average impact effect (ATT) obtained from the group analysis, it can be seen that the average impact effect (ATT) of private enterprises and high-tech enterprises is significantly larger than that of state-owned enterprises and non-high-tech enterprises. Through this result, we can find that the incentive effect of executive compensation is more important for R&D investment promotion of private enterprises and high-tech enterprises.

Table 4: Average impact effects of different ownership properties and technology types (nearest neighbour matching)

| Variable name sample | Processing group | Control group | ATT | Standard error | T value |
|----------------------|-----------------|---------------|-----|----------------|---------|
| A: Stata-owned enterprises | Before matching IsNX | 18.218 | 17.911 | 0.307 | 0.111 | 2.77*** |
| | After matching IsNX | 18.230 | 17.757 | 0.473 | 0.136 | 3.49*** |
| | Before matching HNX | 18.289 | 17.361 | 0.928 | 0.035 | 26.79*** |
| | After matching HNX | 18.291 | 17.385 | 0.906 | 0.043 | 20.87*** |
| B: Private enterprises | Before matching IsNX | 17.818 | 17.382 | 0.436 | 0.049 | 8.81*** |
| | After matching IsNX | 17.831 | 17.264 | 0.567 | 0.062 | 9.14*** |
| | Before matching HNX | 18.659 | 17.714 | 0.945 | 0.068 | 13.96*** |
| | After matching HNX | 18.662 | 17.655 | 1.008 | 0.085 | 11.86*** |
| C: Non-high-tech enterprises | Before matching IsNX | 18.076 | 17.674 | 0.402 | 0.058 | 6.88*** |
After matching | 18.097 | 17.710 | 0.386 | 0.064 | 6.04***
Before matching | 18.595 | 17.575 | 1.020 | 0.041 | 25.06***
After matching | 18.595 | 17.612 | 0.983 | 0.052 | 18.95***

D: High-tech enterprise

Before matching | 17.845 | 17.322 | 0.522 | 0.080 | 6.56***
After matching | 17.866 | 17.251 | 0.616 | 0.097 | 6.32***

5. Research conclusions

The impact of salary stickiness on corporate (high-level management) behavior and its performance is an important direction that the theoretical community should explore in depth. However, as of now, only a few scholars have conducted a tentative analysis of this important topic. Among them, the impact of executive compensation stickiness on corporate R&D investment behavior is a hot issue of scholars in the financial and financial fields in recent years. Although a small amount of literature has analyzed the above issues and found a significant positive correlation between executive pay sticky and corporate R&D investment, existing research ignores the possible adverse effects of sample selection bias on research results. More importantly, there is a lack of scientific research on the causal relationship between the two. This paper takes the A-share listed companies in China's Shanghai and Shenzhen stock markets from 2008 to 2016 as the research sample, adopts propensity score matching (PSM) to overcome the problem of sample selection bias, and empirically tests whether the executive pay sticky is significant to promote enterprise R&D investment. The main findings of this paper are: (1) Compared with sample companies that do not have viscous and low-viscosity groups, the R&D investment level of the executives with sticky and high-viscosity group is significantly higher; It shows that executive pay sticky as a salary incentive mechanism with failure tolerance characteristics has a significant promotion effect on Chinese listed company R&D investment as a whole; (2) the effect of executive pay sticky on corporate R&D investment in state-owned enterprises and Private enterprises, high-tech enterprises and non-high-tech enterprises are all prevalent. Especially for private enterprises and high-tech enterprises, the incentive effect of executive compensation is more effective in promoting R&D investment.

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