

Research on the Relationship between Equity Incentive and Enterprise Performance Based on Propensity Score Matching

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Abstract: In corporate governance, the separation of ownership and management rights has always been a difficult problem for enterprises and academic circles. The introduction of equity incentive plan has alleviated the separation of the two rights to a certain extent. Ordinary OLS regression is difficult to overcome the influence of endogeneity. Therefore, the companies selected in this paper are Shanghai and Shenzhen A-share listed companies in China, and their financial data from 2010 to 2022 are selected for research, uses propensity score matching method to divide the samples into incentive group and control group, and conducts co-support test and balance test on the samples, so as to study the relationship between equity incentive and enterprise performance. Linear regression method is used to analyze the effect of government subsidies on firm performance. It is found that the implementation of equity incentive can improve the performance level of enterprises. Through the role of government subsidies, the influence of equity incentive on the performance level of enterprises will be enhanced.

Keywords: Equity Incentive; Enterprise Performance; Propensity Score Matching; Regulating Effect

1. Introduction

With the continuous expansion of enterprise operation scale, a management mode of separation of two rights has emerged. The separation of ownership and management rights can better improve work efficiency, but the principal-agent problem has also arisen. In order to solve the principal-agent problem, the goals of managers and shareholders are consistent, and equity incentive has emerged. Stock incentive can reduce agency cost and make enterprises

develop in the long run. In 1952, Fezer enterprises first implemented equity incentive. In the early stage, Western countries were mainly represented by the United States. As early as 1998, more than 90% of the top 500 American enterprises ranked by Fortune magazine had implemented equity incentive plans [1]. Over time, equity incentives have gradually expanded globally.

In the past, scholars have done some research on the effect of stock incentive on the value level of enterprises, and the research results are different. Some scholars believe that the implementation of stock incentive will have a certain effect on the improvement of enterprise value level. Based on the optimal contract theory, Richardson [2], Liu [3], Chen et al [4], Kanne [5], Zattoni and Minichilli [6] believe that owners can realize the benefit bundling by signing contracts with operators, and operators will operate enterprises with a "sense of ownership". To maximize the benefits of enterprises; Some believe that equity incentive has a negative impact on enterprise performance. Based on the moat efficiency hypothesis, Fama and Jensen [7], Kadan and Yang [8], Hasegawa et al [9] believes that when enterprise management is weakened, operators will have rent-seeking behaviors and "free-riding" behaviors, and they will disregard the long-term development of enterprises for their own interests, and even damage the interests of enterprises. Due to the different scale of enterprises and the different intensity of supervision, the incentive results are different. In order to improve enterprise performance, many scholars have done a lot of research. Xingwu et al [10] found that government subsidies can improve enterprise performance. Hu et al [11] believes that government subsidies and equity incentives have synergistic effects and can promote enterprise innovation together. Zhao et al [12] believes that government R&D subsidies can promote enterprise innovation. Na et al [13]

found that government subsidies can increase enterprise innovation input, alleviate short-sighted behavior of management, and promote the improvement of enterprise performance. It is difficult to avoid the endogenous problem with OLS method in previous studies. Therefore, this paper attempts to solve the problem of sample selection bias by using propensity score matching method, and tries to solve the following problems: Will equity incentives have an impact on firm performance? Does the difference of enterprise nature affect the incentive effect? Whether the growth of enterprises will affect the incentive effect? Does government subsidy affect the relationship between equity incentive and firm performance?

2. Theoretical Analysis and Research Hypothesis

2.1 Mechanism Analysis of Equity Incentive and Enterprise Performance

In the modern enterprise governance model, the right of management and the right of ownership are separated. The information asymmetry between the owner and the management leads to the principal-agent problem, which increases the agency cost. The equity incentive is an incentive method designed to reduce the agency cost. By giving the management the remaining equity, equity incentive avoids the divergent interests between the owner and the operator, improves the corporate governance structure, and enables the management and the owner to realize the community of interests and contribute to the development of the enterprise together. Some scholars have expressed that, the performance target set by the enterprises implementing the executive equity incentive plan is higher than the industry average. This is to make the management actively work to obtain equity incentives through the setting of performance indicators, which not only improves corporate performance but also alleviates agency problems. The reason why equity incentive is considered as a method that can improve enterprise performance is embodied in giving incentives to senior executives, encouraging them to work funds to specific industries or technological fields, which can help enterprises grasp the market trend and enhance their competitiveness. Finally, government subsidies are sometimes accompanied by requirements on corporate

actively, providing corporate information, reflecting business conditions through stock prices, guiding market capital flow, attracting market investment, bringing opportunities to enterprises, and developing enterprises from a long-term perspective. Shareholders give equity incentives to executives, so that the stock price of the company, the behavior of the executives and the earnings of the executives are closely related, so that the interests of the management and the company tend to be consistent, and the executives will keep their behavior direction consistent with the shareholders through their own efforts, rationally allocate resources, and promote the performance of the company. Therefore, hypothesis H1 is proposed in this paper:

H1: The implementation of equity incentive is conducive to improving the performance level of enterprises.

2.2 Analysis of the Regulatory Effect Mechanism of Government Subsidies

Government subsidies, as a tool to support the development of enterprises, aim to help enterprises overcome the initial capital constraints by providing financial support, and promote technological innovation and industrial upgrading of enterprises, so as to promote the improvement of enterprise performance. First of all, government subsidies can directly provide financial support for enterprises, especially for those enterprises in the early stage of entrepreneurship or undergoing major technological innovation. Such financial support can help them tide over difficulties and reduce financial pressure, so that enterprises can focus on product development and market expansion. Secondly, government subsidies will encourage R&D activities of enterprises, which can not only increase R&D investment of enterprises, but also encourage enterprises to carry out technological innovation through tax incentives and other ways, which will help executives to invest more in business operation, reduce the motivation of executives to seek rent, and improve the effect of equity incentive. At the same time, it can promote the adjustment and optimization of industrial structure by guiding governance structure, such as requiring enterprises to establish a sound board of directors and board of supervisors, improve transparency and governance efficiency, and such governance improvement will help reduce

the agency cost of enterprises, optimize the decision-making process, and enhance the transparency of equity incentive schemes will help protect the interests of executives and employees. It ensures the effectiveness and permanence of the implementation of equity incentive, so as to improve the operation efficiency and performance of enterprises. Therefore, hypothesis H2 is proposed in this paper:

H2: Government subsidies have a significant moderating effect on the relationship between equity incentive and firm performance.

3. Research Design

3.1 Sample Screening and Data Sources

The companies selected in this paper are Shanghai and Shenzhen A-share listed companies in China, and their financial data from 2010 to 2022 are selected for research,

excludes the plans passed by the board of directors but not implemented, the plans passed by the general meeting of shareholders but not implemented or cancelled, excludes listed financial companies such as banks and insurance, and excludes companies that are ST, *ST or PT during the sample period. Companies with total asset growth rate and asset-liability ratio greater than 100% are excluded, only state-owned and privately held listed companies are retained, and samples with missing values are excluded. In addition, in order to avoid the influence of extreme values on the regression results, the continuous variables were treated with 1% and 99% Winsor. Finally, 28,634 samples were obtained, including 2869 samples in the incentive group and 25,765 samples in the control group. The relevant data in this paper come from CSMAR database and WIND database, and the data processing is completed by Stata17.0.

Table 1. Variable Names and Definition Methods

Variable	abbreviation	remark
Explained variable	Roa	Net profit/total assets
	Roe	Net profit/net assets
	Ac	Administrative expenses/revenue
	Tagr	Total assets added this year/total assets at the end of last year
Explanatory variable	Incentive	The implementation of equity incentive is 1, otherwise 0
Regulating variable	Sub	The ratio of government subsidies received by the company to its total assets for the year
Control variable	Size	The natural log of total assets
	Tobin	Company market capitalization/total assets
	Prof	Net profit/operating income
	Gpay	Total compensation for the top three executives
	Dual	Both the chairman and the general manager are 1, otherwise 0
	Hhi5	The sum of the top five shareholders
	Zindex	The proportion of shares held by the 2nd to 5th largest shareholder
	Growth	Revenue growth rate
	Board	Total number of directors
	Indr	Number of independent directors/Total number of directors
	Industry	Dummy variable
	Year	Dummy variable

3.2 Variable Categories and Definition Methods

In order to study the relationship between equity Incentive, enterprise performance and government subsidy, return on total assets (Roa), return on equity asset (Roe), agency cost (Ac) and total asset growth rate (Tagr) are selected as explained variables, and the dummy variable of whether equity incentive is implemented is taken as explanatory variable, and the implementation

of equity incentive incentive is 1. Otherwise, it is 0, and government subsidy (Sub) is the adjusting variable. According to previous studies, we select enterprise Size (Size), Tobin's Q value (Tobin), sales profit margin (Prof), executive compensation (Gpay), Dual (Dual), equity concentration (Hhi5), enterprise Growth (Growth), and other factors. Board size (Board) and proportion of independent directors (Indr) are used as control variables. In addition, the industry and year are controlled. The variable

names and definitions are shown in Table 1.

3.3 Research Methods

Using the usual linear regression to study the relationship between equity incentive and firm performance will make the results unreliable because of sample selection bias. Therefore, the propensity score matching method (PSM) was used to divide the samples of the incentive group and the control group to avoid the endogeneity problems caused by selection bias. The specific steps are as follows:

(1) The propensity score was obtained

The propensity score is the conditional probability of an enterprise implementing equity incentive, namely:

$$p(X) = pr[D = 1 | X] = E[D | X] \quad (1)$$

Where, D indicates whether equity incentive is implemented and if it is implemented. D=1, otherwise D=0; P is the implementation probability of equity incentive, that is, the propensity score value; X is the factor affecting the implementation of equity incentive, that is, the matching variable. Because propensity score is not easy to observe, this paper uses logit binary regression model to estimate.

(2) Select the matching method

When matching the excitation group and the control group, PS is a continuous variable, it is difficult to find two samples with exactly the same propensity score, so it is necessary to adopt pairing methods, which usually include nearest neighbor matching, radius matching and kernel matching.

(3) Calculate the average treatment effect

Average treatment effect is the difference between incentive group and control group in firm performance. To wit:

$$\begin{aligned} ATT &= E[Y_{1i} - Y_{0i} | D_i = 1] \\ &= E\{E[Y_{1i} - Y_{0i} | D_i = 1, p(X_i)]\} \\ &= E\{E[Y_{1i} | D_i = 1, p(X_i)] \\ &\quad - E[Y_{0i} | D_i = 0, p(X_i)] | D_i = 1\} \end{aligned} \quad (2)$$

Where, Y is the result variable, and is the result variable obtained by the implementation and non-implementation of equity incentives in the same enterprise respectively.

4. Empirical Analysis

4.1 Descriptive Statistics

Table 2 presents the descriptive statistics of

variables. It can be seen that the return on assets, return on equity, and growth rate of total assets are all higher than that of the control group, the asset-liability ratio incentive group is lower than that of the control group, and the Tobin Q value, sales profit rate, and executive compensation incentive group are all higher than that of the control group.

Table 2. Descriptive Statistics

Variable	Full sample		control	treated
	N=28634		N=25765	N=2869
	mean	sd	mean	mean
Roa	0.04	0.05	0.04	0.06
Roe	0.07	0.10	0.06	0.09
Ac	0.08	0.06	0.08	0.08
Tagr	0.16	0.22	0.15	0.21
Incentive	0.10	0.30	0.00	1.00
Sub	0.003	0.005	0.003	0.002
Size	22.24	1.30	22.26	22.08
Tobin	1.95	1.14	1.92	2.24
Prof	0.09	0.15	0.09	0.12
Gpay	2,546,990	2,131,525	2,475,729	3,186,947
Dual	0.29	0.45	0.27	0.42
Hhi5	54.22	15.11	54.24	54.06
Zindex	0.72	0.59	0.71	0.86
Growth	0.14	0.28	0.13	0.25
Board	8.53	1.68	8.57	8.19
Indr	37.63	5.34	37.55	38.31

4.2 Sample Matching Result Test

In this paper, 1:1 nearest neighbor matching method is used to carry out common support test and balance test.

(1) Jointly support the test.

As shown in Figure 1, The left side of Figure 1 shows the kernel density function diagram before matching. Before nearest neighbor matching, the peak value of the control group is about 0.05, while that of the excitation group is about 0.1, with certain differences. The right side of Figure 1 shows the kernel density function after matching. After nearest neighbor matching, it is found that the peaks of both the excitation group and the control group are about 0.1, and the two curves basically coincide, reducing the difference between the control group and the excitation group. The PS values of the two groups of samples are very close, and the common support test is satisfied.

(2) Balance test.

The balance test was carried out to check whether the dimensions of the excitation group were similar after matching with the control

group. The balance test between the incentive group and the control group is shown in Table 3. Before there is no match, except for ownership concentration, the remaining variables are all significant at the 1% level, indicating the interference of many factors. After matching, other variables are not significant except enterprise size and board size, indicating that there is almost no other difference between the incentive group and the control group after

matching, except equity incentive. Moreover, it can be seen from the data that the deviations after matching are all less than 10%, and the absolute value of standard errors is also relatively high, most of which are above 80%, indicating that the samples of the incentive group and the control group are basically the same in all dimensions after matching. The balance test is satisfied.

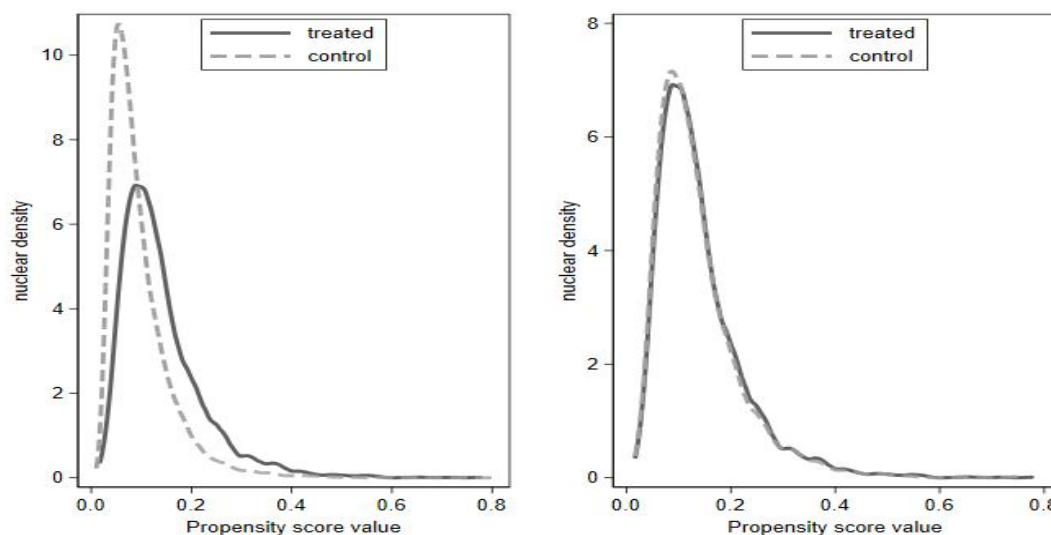


Figure 1. Nuclear Density Map before and after Variable Matching

Table 3. Balance Test

Variable	sample	mean		%bias	%reduct	t
		treated	control			
Size	U	22.082	22.260	-13.9		-6.95
	M	22.082	22.022	4.8	65.7	1.88
Tobin	U	2.241	1.922	26.4		14.26
	M	2.241	2.230	0.8	96.8	0.29
Prof	U	0.116	0.894	18.3		8.94
Variable	sample	mean		%bias	%reduct	t
		treated	control			
	M	0.116	0.115	0.9	95.3	0.33
Gpay	U	3200000	2500000	30.9		17.04
	M	3200000	3100000	4.4	85.8	1.47
Dual	U	0.418	0.274	30.7		16.26
	M	0.418	0.433	-3.3	89.4	-1.17
Hhi5	U	54.070	54.240	-1.2		-0.58
	M	54.070	54.51	-3.1	-161.9	-1.18
Zindex	U	0.856	0.707	25.0		12.85
	M	0.856	0.871	-2.5	90.1	-0.89
Growth	U	0.247	0.132	40.5		20.86
	M	0.247	0.238	3.5	91.5	1.20
Board	U	8.190	8.570	-23.5		-11.55
	M	8.190	8.099	5.6	76.1	2.26
Indr	U	38.311	37.552	14.1		7.24
	M	38.311	38.357	-0.8	94.0	-0.32

4.3 Analysis of the Relationship between Equity Incentive and Enterprise Performance

When studying the impact of equity incentive on enterprise performance, considering the large sample size, the nearest neighbor matching method of 1:3 is adopted for research. The results obtained are shown in Table 4. It can be found that the return on total assets before matching is 0.056 for the incentive group and 0.041 for the control group, and the difference is 0.016, which is not significant. After matching, the difference is 0.056 in the incentive group and 0.053 in the control group, and the difference is 0.004, which decreases somewhat and is outstanding at the level of 1%, manifesting that the implementation of equity incentive improves the return on total assets. The return on equity before matching was 0.089 in the incentive group and 0.064 in the control group, and the difference was 0.024, which was not significant. After matching, the incentive group is 0.089, the control group is 0.081, the difference is 0.007, the difference is reduced, and is outstanding at the level of 1%, manifesting that the implementation of equity incentive can improve the return on equity assets. From the perspective

of total return on assets and return on equity, it shows that equity incentive can promote enterprise performance. Let's say H1 is supported.

It can be seen from the agent cost that, before matching, the incentive group is 0.085 and the control group is 0.081, the difference is 0.007, which is not significant. After matching, the incentive group is 0.085, the control group is 0.084, the difference is 0.001, the difference is reduced, but still not significant, indicating that the implementation of equity incentive has no significant impact on agency costs. The growth rate of total assets is used to measure the investment level. Before matching, it is 0.213 in the incentive group and 0.149 in the control group, and the difference is 0.064, and it is not significant. After matching, the incentive group is 0.213, the control group is 0.198, the difference is 0.015, the difference is reduced, and is significant at the level of 1%, indicating that the implementation of equity incentive has improved the growth rate of total assets, indicating that the implementation of equity incentive has improved the investment level of enterprises.

Table 4. Average Incentive Effect of Sample Population (Nearest Neighbor Matching)

Variable	sample	treated	control	difference	S.E.	t
Roa	U	0.056	0.041	0.016	0.001	14.970
	ATT	0.056	0.053	0.004	0.001	2.830***
	ATU	0.041	0.041	0.000	.	.
	ATE			0.000	.	.
Roe	U	0.089	0.064	0.024	0.002	12.220
	ATT	0.089	0.081	0.007	0.002	3.260***
	ATU	0.064	0.066	0.002	.	.
	ATE			0.003	.	.
Ac	U	0.085	0.081	0.004	0.001	3.130
	ATT	0.085	0.084	0.001	0.001	0.710
	ATU	0.081	0.080	-0.001	.	.
	ATE			-0.001	.	.
Tagr	U	0.213	0.149	0.064	0.004	15.150
	ATT	0.213	0.198	0.015	0.005	2.960***
	ATU	0.149	0.158	0.009	.	.
	ATE			0.010	.	.

4.4 Robustness Test

In order to verify the robustness of hypothesis H1, radius matching with a radius of 0.01 and kernel function matching with a window width of 0.06 were carried out. The matching results are shown in Table 5 and Table 6. It can be found that the return on total assets before

matching with radius matching is 0.056 for the incentive group and 0.041 for the control group, and the difference is 0.016, which is not significant. After matching, the difference is 0.056 in the incentive group and 0.053 in the control group, and the difference is 0.004, which decreases somewhat and is outstanding, indicating that the implementation of equity

incentive improves the return on total assets. The return on equity before matching was 0.089 in the incentive group and 0.064 in the control group, and the difference was 0.024, which was not significant. After matching, the incentive group is 0.088, the control group is 0.082, the difference is 0.006, the difference is reduced, and is significant at 1% level. Observing the

kernel matching data, it is found that the data result is similar to the nearest neighbor matching result, both of which improve the total return on assets and return on equity, indicating that the implementation of equity incentive has improved enterprise performance. The results are robust.

Table 5. Average Excitation Effect of Sample Population (Radius Matching)

Variable	sample	treated	control	difference	S.E.	t
Roa	U	0.056	0.041	0.016	0.001	14.970
	ATT	0.056	0.053	0.003	0.001	3.130***
	ATU	0.041	0.042	0.001	.	.
	ATE			0.001	.	.
Variable	sample	treated	control	difference	S.E.	t
Roe	U	0.089	0.064	0.024	0.002	12.220
	ATT	0.088	0.082	0.006	0.002	3.100***
	ATU	0.064	0.068	0.004	.	.
	ATE			0.004	.	.
Ac	U	0.085	0.081	0.004	0.001	3.130
	ATT	0.085	0.084	0.001	0.001	1.210
	ATU	0.081	0.800	-0.001	.	.
	ATE			-0.001	.	.
Tagr	U	0.213	0.149	0.064	0.004	15.150
	ATT	0.213	0.193	0.020	0.004	4.400***
	ATU	0.149	0.162	0.013	.	.
	ATE			0.014	.	.

Note: The radius of radius matching is set to 0.01

Table 6. Average Incentive Effect of Sample Population (Kernel Matching)

Variable	sample	treated	control	difference	S.E.	t
Roa	U	0.056	0.041	0.016	0.001	14.970
	ATT	0.056	0.051	0.006	0.001	5.210***
	ATU	0.041	0.046	0.005	.	.
	ATE			0.005	.	.
Roe	U	0.089	0.064	0.024	0.002	12.220
	ATT	0.089	0.079	0.009	0.002	4.850***
	ATU	0.064	0.074	0.009	.	.
	ATE			0.009	.	.
Ac	U	0.085	0.081	0.004	0.001	3.130
	ATT	0.085	0.083	0.002	0.001	1.610
	ATU	0.081	0.082	0.001	.	.
	ATE			0.001	.	.
Tagr	U	0.213	0.149	0.064	0.004	15.150
	ATT	0.213	0.185	0.028	0.004	6.310***
	ATU	0.149	0.176	0.027	.	.
	ATE			0.027	.	.

Note: The kernel window width for kernel matching is 0.06

4.5 Analysis of the regulatory effect of government subsidies

According to previous studies, it is found that government subsidies can promote enterprise

innovation and help enterprises better research and development. Then, do government subsidies have an impact on enterprise performance? Therefore, this paper adds the variable of government subsidy to study whether

it has a regulating effect on the relationship between equity incentive and firm performance, and formulates the following equations (3) and (4):

$$Ro_a = \alpha_0 + \alpha_1 Incentive + \alpha_2 Control + \sum Industry + \sum Year + \varepsilon \quad (3)$$

$$Ro_a = \alpha_{10} + \alpha_{11} Incentive + \alpha_{12} Sub + \alpha_{13} Incentive * Sub + \alpha_{14} Control + \sum Industry + \sum Year + \varepsilon \quad (4)$$

Wherein, Roa is selected as the explained variable, Incentive is the explanatory variable, government subsidy Sub is the regulating variable, Incentive*Sub is the interaction term of the two, and the above control variables are added to control the industry and year, ε is the residual of the model, and equation (3) is the impact of equity incentive on enterprise performance. Equation (4) is the impact of government subsidies as a regulating variable on equity incentive and firm performance.

The results obtained after linear regression are shown in Table 7. Model (1) shows the impact of equity Incentive on enterprise performance. It is found that incentive is significant at 1% level, indicating that equity incentive can significantly improve enterprise performance. In model (2), Incentive is outstanding, and Incentive*Sub is outstanding at the level of 5%, both of which are positive, indicating that government subsidies have a outstanding regulating role in the path of equity incentive and enterprise performance. H2 is assumed to be valid.

Table 7. Moderating Effects of Government Subsidies

Variable	(1)	(2)
	Roa	Roa
Incentive	0.005*** (0.001)	0.005*** (0.001)
Sub		1.010*** (0.097)
Incentive*Sub		0.334** (0.170)
Control	Yes	Yes
Industry	Yes	Yes
Year	Yes	Yes
Variable	(1)	(2)
	Roa	Roa

N	5738	5738
R-squared	0.777	0.782

Note: Standard errors in parentheses, * p < 0.1, ** p < 0.05, *** p < 0.01

5. Conclusions

This paper uses propensity score matching method to conduct empirical research, and draws conclusions: (1) Equity incentives can promote enterprise performance. (2) Government subsidies have a significant moderating role in the path of equity incentive and firm performance.

Based on the above conclusions, the following suggestions are given: (1) An enterprise should reasonably formulate an executive equity incentive plan based on its own situation and market changes, including the choice of equity incentive model, the choice of executive shareholding ratio, the setting of exercise price and the validity period of incentive. It is necessary to ensure the openness and transparency of equity incentive, safeguard the interests of executives and employees, and ensure the effectiveness and permanence of the implementation of equity incentive plan. (2) Relevant government departments can strengthen support for enterprises, encourage the development of enterprises through subsidies or various forms, promote the R&D investment and product innovation of enterprises, and enhance the value of enterprises.

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