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The Impact of Executive Equity Incentives on Corporate Digital Transformation: Facilitating or Inhibiting

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Abstract: From the perspective of executive equity incentives, this paper utilizes the data of A-share listed companies in Shanghai and Shenzhen from 2007 to 2021 to explore the impact of executive equity incentives on the digital transformation of enterprises. It is found that, firstly, executive equity incentives have an inverted "U" shape impact on enterprise digital transformation, with an inflection point value of 35.17%, and the conclusion still holds after a series of tests. Second, the mechanism test shows that executive equity incentives affect the digital transformation of enterprises through two paths: financing ability and risk-taking ability. Third, the heterogeneity test finds that the effect of executive equity incentives on enterprise digital transformation is more significant in state-owned enterprises and enterprises with dispersed equity. The findings of this paper not only provide empirical evidence for the promotion of enterprise digital transformation, but also provide useful insights for the improvement of enterprise equity incentive mechanism.

Keywords: Executive equity incentives; digital transformation; inverted "U" shape.

1. Introduce

Since the 21st century, a new generation of digital technology represented by big data and artificial intelligence has driven human society to accelerate into the digital era. The deep integration of the new generation of digital technology and the real economy has promoted the conversion of the global economic development momentum from the traditional economy to the digital economy [1]. The Party Central Committee and the State Council have attached great importance to the cultivation and development of the digital economy in recent years. General Secretary Xi Jinping has repeatedly emphasized that "it is necessary to accelerate the development of the digital economy and promote the deep integration of the digital economy and the real economy" "to develop the digital economy, accelerate the promotion of digital industrialization, rely on information technology innovation to drive, and constantly give rise to new industries, new business forms and new modes, and to promote the new development with new kinetic energy ".In 2021, the scale of China's digital economy reached 45.5 trillion, of which the total amount of industrial digitization was 372,000,000 yuan, a year-on-year increase of 17.2%, accounting for 81.7% of the digital economy . The digital economy has become the main engine for the high-quality development of China's economy and an important support for the transformation of traditional industries [2]. For the main body of the high-quality development of the economy, digital transformation is a new source for enterprises to forge future competitive advantages[3]. Digital transformation will change the boundaries of the enterprise as well as the traditional innovation model, optimize the organization and management of innovation activities and the way of work, so as to achieve cost reduction and efficiency, profit maximization and innovation ability [3]. Only by firmly grasping the initiative of digital transformation can enterprises continuously maintain their core competitiveness and stand in the tide of profound changes in technology and market environment in the new era [4]. However, the "digital transformation" of domestic enterprises is generally faced with the "reluctance to turn" due to the high cost of transformation, "not dare to turn" due to the long duration of the transformation investment time, and "not turn" due to the weak transformation ability. The three major dilemmas of "will not turn" [1]. As of 2018, China's industrial digitization process in only four subsectors more than the average level [5], the proportion of enterprises with significant digital transformation is only 17%, and in 2022, the average score of enterprise digital transformation is only 52, compared to 2021 there is also a decline. At present, China's enterprise digital transformation is in its infancy, and generally lacks the determination and motivation to deeply promote digital transformation [6]. Therefore, how to drive enterprise digital transformation has become the focus of common concern of the three sessions of the political and academic sectors.

Digital transformation is an organizational change characterized by disruptive innovation, which determines the difficulty of its strategy development and implementation, which puts high demands on the strategic planning, management and implementation of enterprise management. The top management team is a core group that determines the development of the organization and plays an important role in digital transformation strategy decision making and implementation [7]. The manager's personal cognition and ability affects his perception of the future direction of the enterprise, which in turn determines his decision-making behavior and ultimately plays a role in the enterprise's goals, actions and results [8]. Digital transformation, as an important strategic decision of the enterprise, is inevitably affected by the personal characteristics of the executives [9]. Established studies have focused on the impact of normative characteristics such as executive team characteristics [10], experience [11], and background [12] on corporate digital behavioral decision-making, but have neglected the impact of the serious agency problem between executives and owners on corporate digital transformation in the context of the separation of powers in modern enterprises. Faced with the characteristics of digital transformation, such as high initial investment and long "pain period", executives are often "reluctant" to digital transformation due to their own career

planning, salary and compensation, and reputation [13]. Therefore, it is particularly important to solve the agency conflict to promote the digital transformation of enterprises. As an important mechanism to coordinate the principal-agent relationship between shareholders and executives [14], executive equity incentives are the key to resolving the agency conflict and promoting the digital transformation of enterprises. Equity incentives link executives' interests to the uncertainty of long-term corporate earnings by granting executives a portion of their shares [15], prompting executives to develop valuable long-term strategies for the company, effectively reducing executives' short-term behavior, and thus realizing the long-term development of the enterprise. Enterprise digital transformation is not a quick fix, it is a long-term systematic project [16], requiring executives to uphold long-termism. It can be seen that equity incentives are long-term incentives, digital transformation is the embodiment of the long-term behavior of the enterprise, examining the equity incentives on the digital transformation of the enterprise has important practical significance. Existing studies have mainly focused on the impact of equity incentives on corporate innovation [17], total factor productivity [18], transformation and upgrading [19], and some scholars have explored the key role played by managerial characteristics [20], organizational characteristics [21] and other influencing factors in the digital transformation of enterprises. Unfortunately, however, little literature has placed equity incentives and enterprise digital transformation under the same framework and explored their relationship. In view of this, this paper explores the role of equity incentives in the development of enterprise digital transformation through empirical research to provide empirical evidence for promoting enterprise digital transformation and improving equity incentive mechanism.

The incremental contributions of this paper are as follows: first, it expands the study of the drivers of digital transformation from the perspective of incentives in corporate governance. Established literature has focused on the impact of the corporate governance level on digital transformation, such as the market competition mechanism and the short selling mechanism, etc., but all of them are centered on the external governance perspective, ignoring the role of internal governance, especially the incentive mechanism, in driving digital transformation. Equity incentives, as an important part of the incentive mechanism, are a powerful tool for solving the principal-agent problem and realizing the convergence of the interests of executives and the company, which can break the dilemma of the enterprise's lack of willingness to digitally transform from the root. Second, the study of the economic consequences of executive equity incentives is enriched from the perspective of digital transformation. Equity incentives are an important part of the corporate governance mechanism, which is also the focus of scholars' research. Existing studies have mainly explored the effects of equity incentives on enterprise development from the perspectives of enterprise performance, enterprise value and enterprise innovation, and neglected the effects of equity incentives on enterprise transformation and upgrading. In the context of the rapid development of digital economy, enterprise digital transformation has been given high attention, but existing studies have not expanded the research field of equity incentives to digital transformation. Based on this, this paper takes the enterprise digital transformation as the landing point and breakthrough point, explores the impact of executive equity incentives on enterprise digital transformation, and extends and broadens the economic consequences of equity incentives. Finally, the mechanism black box of executive equity incentives acting on enterprise digital transformation is opened. On the one hand, the specific path of executive equity incentives affecting enterprise digital transformation is analyzed in depth, i.e., the mediating role of financing constraints and risk-taking ability; on the other hand, considering that the influence effect of equity incentives in different scenarios may differ, the effect of executive equity incentives on enterprise digital transformation under different property rights properties and majority shareholder control scenarios is further compared to confirm the influence effect of executive equity incentives on the digital transformation of enterprises. digital transformation of enterprises, confirming the path dependence and mechanism of executive equity incentives on the digital transformation of enterprises.

2. Theoretical Analysis

2.1. Executive equity incentives and corporate digital transformation

Digital transformation is not only a sharp tool to cope with the dramatic impact of the new crown epidemic as well as to promote the high-quality development of the economy [22], but also an important strategic decision about the future development of enterprises [9]. As the makers and practitioners of strategic decisions, executives play a crucial role in promoting enterprise digital transformation. However, affected by executives' own cognition, ability and other factors, most executives lack the motivation to carry out digital transformation activities. From the cognitive aspect, the risk-averse characteristics and short-sighted concepts of executives are in conflict with the high risk, high cost, and long cycle of enterprise digital transformation. From the aspect of capability, digital transformation, as an emerging strategic change, lacks mature theoretical guidelines and real-world experience, making it difficult for executives to rely on their existing knowledge reserves to drive strategy implementation. Therefore, executives need to continuously improve their management skills to reduce the uncertainty in the process of enterprise digital transformation, which significantly increases the learning cost [23]. Under the trade-off between benefits and costs, executives will rationally ignore digital transformation, resulting in insufficient endogenous motivation for enterprise digital transformation. Therefore, appropriate incentive mechanisms are needed to alleviate the above problems and promote digital transformation. As an important incentive mechanism for executives, equity incentives have received extensive attention from scholars. Existing studies have found that appropriate equity incentives can alleviate the agency conflict between executives and owners, inhibit risk aversion and short-sighted behavior of executives to a certain extent, and encourage executives to pay more attention to the long-term development of the enterprise [24]. However, excessive equity incentives will exacerbate the agency problem of the enterprise and induce rent-seeking behavior of executives, which is not conducive to the long-term development of the enterprise [25]. Based on this, this paper argues that there may be differences in the effects of different equity incentive intensities on executives' attitudes toward digital transformation.

Based on the optimal contract theory, executive equity

incentives can coordinate the conflict of interests between executives and shareholders, realize the sharing of interests and risks between them, produce the convergence effect of interests, and promote the digital transformation of enterprises through the incentive mechanism to play the role of governance. On the one hand, executive equity incentives can alleviate the agency conflict in the process of digital transformation, coordinate and balance the short-term costs and long-term benefits of digital transformation by increasing the convergence of the interests of shareholders and executives, weakening the short-sightedness of executives, and enhancing their willingness to carry out digital transformation. On the other hand, the convexity feature of executive equity incentives can tolerate the risk of short-term innovation failure as well as give executives lucrative returns in the long term [26]. It helps to increase their risk-taking level, weaken their short-term behavior, and actively carry out digital transformation. Meanwhile, tournament theory suggests that when a sufficiently rich tournament prize is set, participants will try to win the tournament. Equity incentives provide the possibility for executives to obtain high returns, and they will try to engage in high-value business activities (e.g., digital transformation) in order to win the tournament [27]. In addition, prospect theory suggests that executives' decisions are based on a trade-off between benefits and costs; if the expected benefits of an investment are higher than the costs, executives are inclined to take risks; otherwise, they will try to avoid the investment [28]. Equity incentives give executives partial equity to compensate for the private costs of digital transformation activities and increase the expected benefits; at the same time, equity incentives also have the effect of risk underwriting and reduce the expected costs, which strengthens the willingness of executives to carry out digital transformation.

Managerial power theory suggests that executives' control over the enterprise is increasing with the increase of equity incentives, which may weaken the constraints of the internal governance mechanism on executives, exacerbate the opportunistic behavior of executives who use their power for personal gain, and produce the trench defense effect, i.e., executives, in order to seek more private interests, tend to choose low-risk investment projects that are beneficial to them personally, which is detrimental to the advancement of the digital transformation of the enterprise. When executive equity incentives exceed a specific threshold, the board of directors' supervisory function is weakened, exacerbating rent-seeking behavior and insider control problems, which in turn affects corporate digital transformation. Specifically, first, compared with digital transformation, which is a high-risk and long-cycle project, executives prefer to seize private profits through on-the-job consumption, connected transactions and transfer of benefits [17]. Second, excessive equity incentives may increase risk aversion and laziness among executives [17], which, coupled with the high risk and uncertainty of digital transformation projects, may lead to an upsurge in short-sightedness among executives and reduce their willingness to carry out digital transformation. Finally, granting too much equity to executives will exacerbate the employee income gap [29], weakening the work motivation of core and junior employees, intensifying internal conflicts, increasing the difficulty of enterprise management, and hindering the digital transformation of enterprises.

Therefore, appropriate equity incentives are conducive to digital transformation, and if equity incentives are excessive, instead of facilitating the digital transformation of enterprises, they may become a tool for executives to implement opportunistic behaviors. In view of this, this paper proposes the following hypotheses:

H1: Executive equity incentives have an inverted “U”-shaped impact on enterprise digital transformation.

2.2. Mechanism analysis

2.2.1. Financing constraint mechanism analysis

Enterprise digital transformation is a transformative activity that requires sustained capital investment in technology, manpower and other aspects. However, the high degree of uncertainty about the success or failure of digital transformation leads to the low value of collateral security of the relevant projects, which makes enterprises face high financing constraints due to the lack of effective collateral [30]. At this time, equity incentives can alleviate the financing constraints of enterprise digital transformation. On the one hand, based on the signaling theory, the implementation of executive equity incentives can release positive signals to the market that the enterprise has a perfect governance mechanism and invests in excellent projects, improve the expectations of external investors for the future development prospects of the enterprise, bring “investor attention effect”, and attract social capital [31]; on the other hand, based on the asymmetric information, equity incentives can ease the conflict of interest between shareholders and executives, prompting the disclosure preferences of executives and shareholders to converge, which can improve the transparency of corporate information [32], enhance the possibility of obtaining external financing support for the enterprise, and make up for the capital needs of digital transformation. In addition, equity incentives can replace part of the cash compensation, reduce cash outflow, and improve the financial status of the enterprise by generating a large amount of cash inflow and enjoying relevant tax benefits during the exercise period [17]. A good financial position provides a more relaxed environment for enterprise development, prompting executives to focus on high-risk, high-investment activities (e.g., digital transformation) for the long-term development of the enterprise.

However, the welfare and financial whitewash effects of equity incentives may also exacerbate corporate financing constraints. As the shareholding ratio of executives granted by equity incentives continues to increase, the voice of executives in the enterprise also increases, which enhances the motivation of executives to use their power for private opportunistic behavior, resulting in equity incentives becoming a tool for executives to seek benefits. According to statistics, nearly 1/3 of the listed enterprises in China implemented equity incentive programs have welfare effects [33]. If external investors or creditors determine that an enterprise's equity incentive program has a significant welfare effect, it will question or worry about the company's development prospects and solvency, in order to reduce their own credit risk, their investment willingness to be inhibited, exacerbating the corporate financing constraints [34]. At the same time, after carrying out the equity incentive plan, if the listed company's earnings growth fails to meet the exercise conditions, the executives may actively carry out surplus management operations or whitewash the financial statements in order to unlock the stock options or restricted shares on schedule [34]. Equity incentives have been shown to be a direct trigger for executives' surplus management

operations, and managerial power is a catalyst for such financial manipulation behavior [35]. The above behaviors will undoubtedly increase the difficulty for external investors and creditors to discern the true financial status of the enterprise, and reduce the creditors' trust in the enterprise's financial reports, which will make them more cautious when facing the financing needs of the company's digital transformation.

It can be seen that there is a non-linear relationship between executive equity incentives and financing constraints, and financing constraints negatively affect the digital transformation of enterprises. In view of this, this paper proposes research hypothesis 2:

H2: Executive equity incentives affect corporate digital transformation through the financing constraint path.

2.2.2. Analysis of risk-taking mechanisms

Agency theory suggests that executives are unable to reduce risk through diversification. According to McKinsey research data, the failure rate of digital transformation is as high as 80%. Failure of transformation will cause huge losses to executives, who may give up such activities for the consideration of salary compensation, career development and industry reputation ("quiet life" theory hypothesis). In the context of traditional compensation incentives, executives are not incentivized to choose high-risk investments such as digital transformation because they have to bear the risk of investment failure but cannot share the returns from risky investments. However, executive equity incentives combine the tolerance of short-term failures with long-term rewards, and its many provisions (especially stock options) allow executives to suffer limited losses due to the decline in share price, while enjoying the gains due to the success of the digital transformation and the rise in share price [36], which improves the risk-return match for executives. At the same time, equity incentives make executives and shareholders a community of interest by granting executives partial residual claim rights, internalizing shareholders' external monitoring into executives' self-motivation, and improving managers' willingness to take risks from the root [37]. Therefore, we believe that equity incentives can enhance executives' risk-taking ability, which in turn increases the willingness of digital transformation.

However, according to behavioral agency theory, excessive equity incentives may also exacerbate executive risk aversion and inhibit digital transformation. First, when equity incentives grant executives a portion of stock options, executives will regard them as existing wealth, and the fluctuation of this portion of wealth will exacerbate executives' loss aversion, and the stronger the incentive, the more sensitive executives show to losses, and the lower their willingness and ability to take risks [38]. Therefore, when the equity incentive exceeds the threshold, it will cause executives to pay excessive attention to the enterprise's share price and short-term business performance, and the stronger the incentive to adopt surplus management behavior to increase the short-term share price. Facing the high-risk digital transformation, executives prefer to choose "short, medium and fast" projects to prevent the loss of wealth caused by the short-term performance and stock price decline. Second, equity incentives give executives more power, and with increased control, executives are more inclined to use their power for personal gain rather than investing in risky projects to gain uncertain future returns [39]. Finally, executives are unable to diversify risk through portfolio investment, and once the investment fails, they will suffer a huge loss of wealth, and the loss increases with the increase of the proportion of shareholding, which leads to their fear and unwillingness to take risks when making decisions [40]. Therefore, the greater the intensity of equity incentives, the worse the risk-taking ability of executives, the more reluctant to engage in high-risk digital transformation.

It can be seen that there is a non-linear relationship between executive equity incentives and risk-taking, and risk-taking positively affects corporate digital transformation. In view of this, this paper proposes research hypothesis 3:

H3: Executive equity incentives affect corporate digital transformation through the risk-taking path.

3. Research Design

3.1. Data Source and Sample Selection

In order to explore the impact of executive equity incentives on the digital transformation of enterprises, the A-share listed companies in Shanghai and Shenzhen from 2007 to 2021 are selected as the initial sample of the study. The reasons mainly include the following two points: first, in 2006, the Securities and Futures Commission issued the "Management Methods of Equity Incentives for Listed Companies (for Trial Implementation)" to regulate the implementation of equity incentive plans, and the number of listed companies choosing equity incentives gradually increased. Second, the Ministry of Finance updated the Enterprise Accounting Standards in 2007, and the caliber of enterprise financial data statistics was unified. Meanwhile, with reference to the practice of previous studies, the initial samples are processed as follows: (1) the samples of financial companies are excluded; (2) the samples of companies with special treatments (e.g., ST, ST*, and PT, etc.) are excluded; (3) the data of the samples that are insolvent are excluded; (4) the data of the samples that have missing values are excluded; and (5) in order to minimize bias of the regression results caused by the extreme values, the upper and lower 1% shrinkage treatment is performed on all the continuous variables. 1% shrinkage treatment. Among them, the data of digital transformation are manually organized in the annual reports of enterprises, and Python is used to identify the keywords of digital technology in the annual reports (including ABCD technology, digital technology application, etc.), and aggregate the corresponding word frequency to pair with enterprise data to construct the measurement index of digital transformation, while other financial data are from the database of Cathay Pacific (CSMAR).

3.2. Definition of Variables

(1) Executive equity incentives. Referring to the study of Zhao Shifang et al. (2020) [17], the ratio of the number of shares held by executives to the total number of shares at the end of the period of the enterprise is selected to be measured.

(2) Enterprise digital transformation. Referring to Wu Fei et al. (2021) [41], text analysis is used. The details are as follows: firstly, we download the annual reports of the sample companies from Juchao Information Network from 2007 to 2021, and then we use Python to identify the keywords of digital technology in the annual reports (including ABCD technology, digital technology application, etc.), and summarize the corresponding word frequency to match with the enterprise data to construct the basic index system of digital transformation. To address the right skewness of the

indicators, the indicators are logarithmized to form the final digital transformation measurement indicators.

(3) Control variables. In order to avoid the interference of factors outside the research object on the regression results, referring to the practice of Zeng Hao (2022) and Zhao Shifang et al. (2020) [13, 17], enterprise size (SIZE), return on assets (ROA), gearing ratio (LEV), enterprise growth (GROWTH), enterprise value (TOBINQ), the first largest shareholder's ownership (TOP1), independent director ratio (ID), board size (BOARD), and dual position (DUAL) are the control variables.

3.3. Empirical model construction

(1) Benchmark regression test model

Drawing on Haans et al.'s (2016) study on the relationship between U-shape and inverted U-shape [42], this paper constructs equation (1) to test the relationship between executive equity incentives and digital transformation:

$$DT_{it}=\partial+\partial_1 EI_{it}+\partial_2 EI\_2_{it}+\partial_3 CV_{it}+\sum Industry+\sum Year+\varepsilon_{it} \quad (1)$$

(2) Mediated effects validation model

In this paper, drawing on the research of Wang Lu et al. (2020) [43] and combining the three-step method, we construct the following mediated effect model to verify the indirect effect:

$$M_{ij}=\beta+\beta_1 EI_{it}+\beta_2 EI\_2_{it}+\beta_3 CV_{it}+\sum Industry+\sum Year+\varepsilon_{it} \quad (2)$$

$$DT_{it}=\theta+\theta_1 EI_{it}+\theta_2 EI\_2_{it}+\theta_3 FC_{ij}+\theta_4 CV_{it}+\sum Industry+\sum Year+\varepsilon_{it} \quad (3)$$

If the sign of the coefficients of the primary term (EI) and secondary term (EI_2) of executive equity incentives in Eq. (1), Eq. (2) and Eq. (3) are both positive and negative and pass the test of significance, as well as the estimated coefficients of the mediating variables in Eq. (2) are significant as well, then it means that the mediating variables play a mediating role in the inverted "U" shaped relationship between executive equity incentives and digital transformation of the enterprise. hypotheses 2 and 3 are proved.

3.4. Descriptive Statistics Characteristics

The results of descriptive statistics are shown in table 1, the mean value of the explanatory variable DT is 1.195, the median is 0.693 and much smaller than the mean, indicating that the overall level of digital transformation of enterprises is still relatively low. at the same time, the difference between the maximum value of the degree of digital transformation and the minimum value in the sample is large, reflecting that there is a large difference in the distribution of transformation among the sample enterprises, which is basically the same as the results of Wu Fei et al. (2021). The median of the explanatory variable EI is 0.001, which means that there are still a large number of enterprises in China that have not carried out equity incentives, indicating that the long-term incentives for executives in China's listed enterprises are insufficient, and there is a large difference between the maximum value and the minimum value of the equity incentives for executives, which indicates that there is a large discrepancy in equity incentives among the sample enterprises. In addition, the control variables are not significantly different from the existing literature.

Table 1. Descriptive statistics

Variable name	Observation	Mean	S.D	Median	Min	Max
DT	36731	1.195	1.365	0.693	0.000	4.963
EI	36731	0.074	0.141	0.001	0.000	0.611
SIZE	36731	22.070	1.274	21.880	19.770	26.060
AGE	36731	2.766	0.397	2.833	1.386	3.466
ROA	36731	0.039	0.061	0.039	-0.247	0.195
LEV	36731	0.421	0.206	0.415	0.050	0.881
GROWTH	36731	0.184	0.408	0.120	-0.563	2.579
TOBINQ	36731	2.042	1.291	1.627	0.870	8.523
TOP1	36731	0.345	0.148	0.323	0.086	0.742
ID	36731	0.374	0.053	0.333	0.308	0.571
BOARD	36731	2.132	0.200	2.197	1.609	2.708
DUAL	36731	0.282	0.450	0.000	0.000	1.000

4. Empirical Analysis

4.1. Benchmark regression analysis

The results of the benchmark regression of executive equity incentives on corporate digital transformation are shown in the table 2. Column (1) shows the univariate regression results, and the results show that the regression coefficients of the primary term (EI) and secondary term (EI_2) of executive equity incentives are 4.415 and -6.972 respectively, which are significant at 1% level; Column (2) after adding control variables and two-way fixed effects, the estimated coefficients of the primary term (EI) and secondary term (EI_2) of executive equity incentives are 1.259 and - 1.790, which still pass the 1% significance test. In summary, executive equity incentives have an inverted "U"-shaped impact on corporate digital transformation, hypothesis 1 is verified. At the same time, the inflection point value is calculated to be about 35.17%, when the executive equity incentive reaches 35.17%, it has the greatest effect on the promotion of enterprise digital transformation. The reason for this is that with the increase in the intensity of equity incentives, the control of executives over the enterprise is also increased, which not only improves the ability of executives to resist external pressure, but also strengthens their tendency to seek personal gain and risk aversion, which in turn weakens the supervision and constraints of the internal governance mechanism on the executives, exacerbates the principal-agent problem, and results in the executives' preference for low-risk, certainty of short-term investment decision-making, which has a negative impact on the digital transformation of the enterprise. This has a negative impact on the digital transformation of enterprises.

Table 2. Benchmark regression results

Variable	(1)	(2)
	DT	DT
EI	4.415***	1.259***
	(26.339)	(8.505)
EI_2	-6.972***	-1.790***
	(-19.883)	(-6.148)
SIZE		0.155***
		(25.190)
AGE		-0.109***
		(-6.332)
ROA		-0.414***
		(-3.606)
LEV		-0.192***
		(-5.201)
GROWTH		0.055***
		(3.735)
TOBINQ		0.051***
		(9.779)
TOP1		-0.291***
		(-7.405)
ID		0.576***
		(4.620)
BOARD		-0.030
		(-0.881)
DUAL		0.067***
		(4.578)
_cons	1.045***	-3.234***
	(132.716)	(-21.080)
Year	No	Yes
Industry	No	Yes
N	36731	36731
r2	0.030	0.416

Table 3. Endogeneity test

Variable	(1)	(2)	(3)	(4)
	2SLS	A phase lag	Two phase lag	Heckman two-stage model
	DT	DT	DT	DT
EI	19.879***			1.282***
	(7.842)			(7.568)
EI_2	-36.829***			-1.871***
	(-5.704)			(-5.542)
L.EI		1.349***		
		(8.305)		
L.EI_2		-1.813***		
		(-5.665)		
L2.EI			1.415***	
			(8.013)	
L2.EI_2			-1.740***	
			(-4.975)	
IMR				-0.413***
				(-9.262)
Controls	Yes	Yes	Yes	Yes
_cons	-5.924***	-3.209***	-3.251***	-2.750***
	(-22.739)	(-18.694)	(-16.924)	(-15.483)
Year	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
N	36706	30546	26530	30538
r2	0.120	0.414	0.405	0.415

4.2. Endogeneity test

4.2.1. Instrumental variable test

In view of the possible interference of endogeneity issues such as mutual causality between executive equity incentives and enterprise digital transformation, this paper draws on the study of Liu Baohua et al. (2018) [44] and selects the average value of executive equity incentives of other enterprises in the industry in the province where the enterprise belongs to (AVEI) as an instrumental variable. The reason for this is that, firstly, in order to attract outstanding executives, listed firms in the same province need to take into account the retained earnings of executives, the compensation that competitors may give to executives, when formulating their compensation system. Therefore, the equity incentives of other listed firms in the same province will affect the equity incentive plan of this firm and satisfy the correlation requirement of the instrumental variable. Second, the equity incentive plans implemented by competitors will not have a direct impact on the firm's digital transformation, satisfying the exogeneity condition of the instrumental variables. Instrumental variable tests are conducted using 2SLS and the results are reported in column (1) of table3. The results show that after controlling for the endogeneity issue of mutual causality, the regression results of the primary and secondary terms of executive equity incentives remain significant and the sign direction remains consistent with the benchmark regression., the benchmark regression results of this paper still hold.

4.2.2. Lagged explanatory variables test

In order to further control the bias of research conclusions due to mutual causation, lagged N-period explanatory variables are used for regression. Specifically, this paper lags executive equity incentives by 1~2 periods for the regression test, and the regression results are reported in Table 3. columns (2) and (3) are the regression results of lagged explanatory variables. The results show that the regression coefficients of the primary term (L.EI) and the quadratic term (L.EI_2) for executive equity incentives lagged one period are 1.349 and -1.813, respectively, with t-values of 8.305 and -5.665, while the estimated coefficients of the primary term (L2.EI) and the quadratic term (L2.EI_2) for the lagged two period are 1.415 and -1.740, respectively, with t-values of 8.013 and -4.975, and passed the 1% significance test, indicating that executive equity incentives still have an inverted “U” shape impact on enterprise digital transformation, consistent with the findings of the previous study.

4.2.3. Heckman two-stage model test

Whether listed companies implement executive equity incentives is not arbitrary, and may be affected by certain corporate characteristics, while enterprise digital transformation will also be affected by these corporate characteristics. Therefore, the results of the benchmark regression in this paper may not be the effect of executive equity incentives, but the results generated by the influence of corporate characteristics, thus generating the problem of selectivity bias. Therefore, in order to control the selectivity bias problem, this paper refers to the existing studies to select the Heckman two-stage model for validation. First, the Probit model is used to estimate the inverse Mills ratio (IMR) to test whether the firm characteristic variables (control variables in the previous section) in the lagged period will affect the implementation of executive equity incentives by firms. The reason for choosing one-period lagged firm characteristics variables is that the extent of firms' implementation of executive equity incentives is closely related to indicators such as firm size, earnings and governance structure. At the same time, there should be at least one exclusivity constraint variable in Heckman's first stage. In this paper, we select the mean value of executive equity incentives of other enterprises in the industry province to which the enterprise belongs, for the same reason as the selection of instrumental variables. The IMR is calculated and incorporated into the benchmark regression model to control the selection bias problem. Specifically, the Probit model is constructed as follows:

$$EI_{it} = \beta_0 + \beta_1 LagCV_{it} + \beta_2 \mathrm{AV}EI_{it} + \sum Indutry + \sum Year + \varepsilon_{it} \quad (4)$$

The empirical results are reported in column (4) of Table 3, where the inverse Mills ratio (IMR) passes the test of significance at the 1% level, indicating that there is indeed a bias in the distribution of executive equity incentives and that there is a need to control for the problem of selectivity bias. Further, after adding IMR as a control variable to the baseline regression model, the estimated coefficients of the regression coefficients of the primary term (EI) and the secondary term (EI_2) of executive equity incentives are 1.282 and -1.871, respectively, and both of them are significant at the 1% level, which suggests that after controlling for selectivity bias by using the Heckman two-stage model, the findings of this paper are still robust.

4.3. Robustness Tests

4.3.1. Replacement of explanatory variables

Drawing on Du Jinmin et al.'s (2022) study [45], the digital transformation indicators in the previous section are further decomposed into two dimensions of “ABCD technology” and “digital technology application” for regression. After regression, the results are reported in columns (1) and (2) of Table 4. The primary (EI) and secondary (EI_2) terms of executive incentives have inverted“U”shaped effects on both ‘ABCD technology’ and ‘digital technology adoption’, indicating that the regression results of this paper are still robust to changing the measurement of the explanatory variables.

4.3.2. Changing the sample period

The design of corporate executives' equity incentive programs and whether or not to carry out digital transformation are greatly influenced by the overall economic environment. To ensure the scientific validity of the data, such influencing factors need to be eliminated. In the selected sample period of 2007~2021, there are three more special time points: first, the global financial crisis in 2008; second, the change of bulls and bears in China's stock market in 2015; and third, the outbreak of the new crown epidemic in 2020. In practice, such factors are more difficult to be absorbed through variable construction. Therefore, in this paper, the samples of global financial crisis (2008), Chinese stock market turmoil (2015) and new crown epidemic outbreak (2020) are excluded from the regression. The results are reported in column (4) of Table 4. The regression coefficients of the primary term (EI) and the secondary term (EI_2) of executive equity incentives are 1.203 and -1.694, respectively, and the t-values are 7.325 and -5.271, respectively, which all pass the test of significance at at the 1% level, suggesting that

this paper's core conclusion of the existence of the inverted "U" effect has not changed.

Table 4. Robustness test

Variable	Substitution of explanatory variables		Changing the sample period	Remove internal interference
	(1)	(2)	(3)	(4)
	DT_T	DT_A	DT	DT
EI	1.125***	0.814***	1.203***	1.049***
	(8.394)	(6.164)	(7.325)	(7.613)
EI_2	-1.823***	-1.103***	-1.694***	-1.445***
	(-6.859)	(-4.267)	(-5.271)	(-5.656)
Apay				0.141***
				(11.801)
Rpay				0.136***
				(3.449)
Mpay				-0.000
				(-0.823)
Controls	Yes	Yes	Yes	Yes
_cons	-2.341***	-2.689***	-3.154***	-3.891***
	(-17.611)	(-19.746)	(-18.425)	(-17.635)
Year	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
N	36583	36583	29455	36649
r2	0.419	0.287	0.411	0.419

4.3.3. Excluding internal interference

Executive compensation incentives are mainly divided into monetary compensation incentives in the form of bonuses or allowances and other forms of monetary compensation incentives and equity incentives to corporate stock as the underlying executive compensation, executive equity incentives to corporate digital transformation effect may be affected by monetary compensation incentives of interference, especially in the form of short-term performance evaluation criteria for bonuses, allowances may also be the design of equity incentive covenants. Therefore, in order to exclude the interference of monetary compensation incentives on the conclusions of this paper, absolute monetary compensation of executives (natural logarithm of total executive compensation, Apay), relative monetary compensation of executives (total compensation of top three executives/total executive compensation, Rpay), and average monetary compensation of executives (total compensation of executives/total number of executives, Mpay) are added into Models 3-4 to be re-regressed, and the results are reported in Table 4, column (5). It can be seen that after adding the effect of other forms of compensation, the primary term (EI) and secondary term (EI) of executive equity incentives pass the significance test, with the regression coefficients of 1.049 and -1.445, and the results of this paper's baseline regression are still robust, there exists an inverted U-shaped.

4.4. Mechanism testing

4.4.1. Financing constraint mechanism

To validate the financing constraint mechanism, referring to the study of Kaplan and Zingales (1997) [46], the KZ index is selected to measure corporate financing constraints, and the results are reported in columns (1), (2) and (3) of table 5. First, column (1) validates whether executive equity incentives affect digital transformation and is consistent with the previous regression results. Second, the results in columns (2) and (3) show that the estimated coefficients of the primary term (EI) and the secondary term (EI_2) of executive equity incentives have a positive sign and a negative sign, and they are both significant at the 1% level, which suggests that there is a non-linear relationship between executive equity incentives and financing constraints, appropriate equity incentives can help firms to solve the dilemmas of financing constraints, and equity incentives exceeding a threshold can aggravate the corporate financing difficulty. Meanwhile, the regression results of model (3) show that both the primary term (EI) and the secondary term (EI_2) of executive equity incentives pass the 1% significance test, with estimated coefficients of 1.467 and -2.045; and the estimated coefficient of financing constraints (FC) is -0.016, which is also significant at 1% level, indicating that financing constraints play a significant role in the inverse "U" shaped relationship between executive equity incentives and enterprise digital transformation. "U"-shaped relationship plays a partial mediating utility, Hypothesis 2 is proved.

4.4.2. Risk-taking mechanism

To test the risk-taking mechanism, drawing on Amihud's (2002) study [47], the illiquidity indicator is used as a proxy variable for stock liquidity, and the results are reported in columns (4), (5) and (6) of Table 5. First, column (4) validates whether executive equity incentives affect digital transformation, consistent with the previous regression results. Second, columns (5) and (6) show the regression test results of models (2) and (3). The regression results based on model (2) find that the estimated coefficients of the primary term (EI) and the secondary term (EI_2) of executive equity incentives have opposite signs and are both significant at the 1% level, indicating that there is a nonlinear relationship between executive equity incentives and corporate risk-taking capacity, appropriate equity incentives can improve corporate risk-taking capacity, while excessive equity incentives will instead trigger short-sighted behavior of executives and weaken the corporate risk-taking ability. Meanwhile, the regression results of model (3) show that the estimated coefficient of the primary term of executive equity incentives (EI) is 1.241, which passes the 1% significance test; the estimated coefficient of the secondary term of executive equity incentives (EI_2) is -1.775, which is significant at the 1% level. the estimated coefficient of the risk-taking (CRT) is 0.028, passes the 10% significance test, indicating that risk-taking plays a partial mediating role in the inverted "U" relationship between executive equity incentives and digital

transformation of enterprises, hypothesis 3 is proved.

Table 5. Mechanism test results

Variable	(1)	(2)	(3)	(4)	(5)	(6)
	DT	FC	DT	DT	CRT	DT
EI	1.502***	-2.100***	1.467***	1.256***	0.520***	1.241***
	(9.119)	(-9.273)	(8.909)	(8.448)	(9.822)	(8.323)
EI_2	-2.085***	2.403***	-2.045***	-1.792***	-0.616***	-1.775***
	(-6.285)	(5.106)	(-6.170)	(-6.130)	(-5.536)	(-6.062)
FC			-0.016***			
			(-4.065)			
CRT						0.028*
						(1.683)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
_cons	-3.115***	2.926***	-3.067***	-3.179***	-0.784***	-3.157***
	(-19.269)	(12.328)	(-18.926)	(-20.499)	(-14.707)	(-20.268)
Year	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes
N	33563	33563	33563	36463	36463	36463
r2	0.418	0.627	0.418	0.415	0.365	0.415

4.5. Tests for heterogeneity

4.5.1. Test based on differences in the nature of property rights

In China's capital market, the government's behavior affects the enterprise's resource allocation, in particular, many of China's listed enterprises are restructured from state-owned enterprises, and there are still some enterprises held by the state, in this special property rights nature of the background, the executive equity incentives of the governance of the effect of the existence of significant differences. Therefore, this section groups the sample enterprises according to the nature of property rights to explore whether there are differences in the impact of executive equity incentives on digital transformation. The grouping regression results are shown in Table 6. The estimated coefficients of the primary term (EI) and secondary term (EI_2) of executive equity incentives are 2.612 and -3.926 in SOEs, and the regression coefficients are 1.050 and -1.456 in non-SOEs, which pass the 1% significance test, indicating that there is an inverted “U This indicates that there is an inverted “U-shaped” relationship between executive equity incentives and digital transformation of enterprises under different ownership properties, and this relationship is more prominent in SOEs. The reasons for this may be: first of all, the phenomenon of disconnection between salary and performance in SOEs is common, executives can not realize more work and more pay in their work, and are prone to inertia and negative work mentality, and at the same time, there is a general lack of long-term incentive mechanism in SOEs, and all of these factors jointly constrain the transformation of SOEs executives in the transformation of the power of change. The implementation of equity incentives can improve the decision-making power of executives in SOEs, and tie the interests of executives to the enterprise's revenue, which will prompt executives to work harder in promoting digital transformation. Secondly, in SOEs, there are inherent defects such as “owner deficiency” and “insider control”, which makes the internal proxy chain more complicated and lengthy, with higher agency costs and inefficient resource allocation. Equity incentives can help solve the internal agency problem of SOEs, improve the efficiency of resource allocation and promote the digital transformation of enterprises. However, if the equity incentive is too high, it will further aggravate the problem of “insider control” and cause more serious agency problems, which will magnify the obstacles to the digital transformation of enterprises. In summary, the implementation of executive equity incentives in SOEs can produce stronger marginal effects.

Table 6. Results of heterogeneity test

Variable	(1) state enterprise	(2) non-state enterprise	(3) High equity concentration	(4) Low equity concentration
	DT	DT	DT	DT
EI	2.612***	1.050***	0.831***	1.750***
	(7.212)	(6.595)	(3.866)	(8.798)
EI_2	-3.926***	-1.456***	-1.100***	-2.843***
	(-4.901)	(-4.703)	(-2.768)	(-5.950)
Controls	Yes	Yes	Yes	Yes
_cons	-2.674***	-5.287***	-2.564***	-4.130***
	(-12.511)	(-21.041)	(-12.506)	(-16.252)
Year	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
N	14839	21892	18368	18363
r2	0.433	0.405	0.377	0.436
Difference in coefficients between groups	chi2(1)=10.45，Prob>chi2=0.0012***		chi2(1)=8.17，Prob>chi2=0.0043***	

4.5.2. Test based on the difference in control of large shareholders

Based on the governance bundle theory, the corporate governance mechanism is essentially a linked system, where governance elements interact with each other through complementary or agency effects, and the effectiveness of any governance mechanism depends on the synergy of other governance mechanisms. Ownership structure, as a key element of modern corporate governance, determines the distribution of organizational control as well as the underlying principal-agent relationship faced by the firm. Therefore, the degree of shareholders' control fundamentally determines the arrangement of other governance mechanisms and their ultimate governance effectiveness. In this paper, we use the median shareholding of the first largest shareholder as the cut-off point and divide the sample into two groups of high and low shareholding concentration to explore the relationship between executive equity incentives and firms' digital transformation. The results are reported in columns (3) and (4) of table 6. The estimated coefficients of the primary term (EI) and the secondary term (EI_2) of executive equity incentives are 0.831 and -1.100 for high equity concentration, and the regression coefficients of 1.750 and -2.843 for low equity concentration, both of which are significantly correlated at the 1% level, suggesting that there is an inverted "U" relationship between executive equity incentives and firms' digital transformation in different equity concentration levels. The regression coefficients of 1.750 and -2.843 are significantly correlated at the 1% level, indicating that executive equity incentives have an inverted U-shaped relationship on enterprise digitalization under different equity concentration levels, and this relationship is more significant in enterprises with lower equity concentration. The reason for this may be: when the enterprise equity concentration is high, the major shareholders, in order to maximize their own interests, actively perform the function of supervision and control, thus forming an effective supervision of the executives, which replaces part of the incentive effect of the executive equity incentives; while when the equity is more dispersed, it is easy to produce the phenomenon of "free-riding", the cost of supervision should be borne by the shareholders alone, while the benefits of the enterprise should be borne by all shareholders. When the equity is more dispersed, it is easy to produce the phenomenon of "free-rider", that is, the supervision cost needs to be borne by the company alone, while the enterprise income is shared by all shareholders, which results in the shareholders' lower willingness to supervise the executives, leading to the executives' self-interest opportunities and space, the enterprise faces more serious agency problems, and equity incentives are more effective.

5. Research Conclusions and Recommendations

This paper analyzes the effect of executive equity incentives on enterprise digital transformation with the data of A-share listed enterprises in Shanghai and Shenzhen from 2007 to 2021. The research results show that, firstly, executive equity incentives have an inverted "U"-shaped impact on enterprise digital transformation, with an inflection point value of 35.17%, and the conclusion is still valid after a series of endogeneity and robustness tests, such as instrumental variables, lagged explanatory variables, Heckman's two-stage model, replacement of the explanatory variables, and replacement of the sample period; secondly, exploring the mechanism of the effect, we find that executive equity incentives have an impact on enterprise digital transformation. Secondly, exploring the mechanism of action, it is found that executive equity incentives mainly work on enterprise digital transformation through two paths: financing constraints and risk-taking; thirdly, the heterogeneity results show that the impact effect of executive equity incentives on enterprise digital transformation is different in enterprises with different property rights and shareholding concentration, in other words, executive equity incentives have a more significant impact effect on digital transformation in state-owned enterprises and those with a lower shareholding concentration; in other words, the impact effect of executive equity incentives on digital transformation is more pronounced in state-owned enterprises and those with lower shareholding concentration. digital transformation is more significant.

Based on the above findings, this paper puts forward the following countermeasure suggestions:

(1) Optimize the enterprise equity incentive mechanism. As the strategic decision makers of enterprises, the behavior of executives is related to the future development of enterprises. Combined with the actual development of enterprises to develop appropriate equity incentives is to promote the implementation of micro-enterprise digital transformation decisions and the key to high-quality development of enterprises. When designing executive incentive contracts, enterprises should not only focus on short-term incentives such as salary incentives, but also strengthen long-term incentives such as equity incentives, so as to promote the convergence of the interests of executives with the long-term value of the enterprise, and avoid the short-sighted behavior of executives. However, it is also necessary to control the proportion of executive shareholding, if the executive shareholding is too high will cause trench effect, inhibiting the promotion of enterprise digital transformation. At the same time, the exercise conditions of previous equity incentives mainly contain financial indicators such as ROA, ROE, etc., which are less involved in the assessment of innovative behaviors such as digital technology research and development, digital transformation, etc. Patent applications, R&D investment, etc. can be appropriately introduced as the exercise conditions of executive equity incentives. In addition, empirical analysis found that there is a certain time lag in the effect of equity incentives, and the exercise period can be appropriately extended to urge executives to maintain enthusiasm for digital transformation and other high-quality long-term projects.

(2) Improve the corporate governance mechanism. Building an effective corporate governance mechanism can solve the principal-agent problem, promote the digital transformation of enterprises and realize high-quality development. A perfect corporate governance structure is the prerequisite and foundation for conducting and implementing the equity incentive program. On the one hand, it is necessary to strengthen the construction of the board of directors and the supervisory board, and standardize the formulation of the equity incentive program to solve the problem of insider control, which is particularly important in state-owned enterprises; on the other hand, it is necessary to build a

compensation committee, audit committee and other main bodies to supervise and constrain the behavior of the executives to curb the rent-seeking behavior of the executives, weaken the motivation and ability of the executives to carry out surplus management, and bring into full play the incentive of the equity incentive program.

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