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Research article

Relationship analysis between executive motivation and digital transformation in Chinese A-Share companies: An empirical study

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ABSTRACT

In the expanding global digital economy, the digital transformation of businesses has become a critical component of modern operations. This study investigates the relationship between executive incentives and the digital transformation in A-share-listed Chinese companies from 2011 to 2020. Using multi-period DID and linear regression models, we analyzed how equity and compensation incentives influence this transformation. We discovered an inverse U-shaped correlation between executive incentive intensity and corporate digital transformation. Additionally, the relationship between compensation incentives and digital transformation is initially non-positive but transitions to a non-linear positive association beyond a certain threshold. Our research also reveals that digital process innovation and digital business expansion mediate the relationship between executive motivation and digital transformation. These findings highlight the importance of appropriate executive rewards in fostering innovative thinking and advancing digital transformation. This study contributes to the understanding of the drivers and effects of digital transformation and the role of equity incentives in governance. It offers valuable insights for companies aiming to accelerate digital transformation, optimize industrial structure, and promote economic development. Based on this study, further research on this issue can be conducted in the future by refining the personality traits, educational background, and cognitive differences of executives.

1. Introduction

With the advancement of the new technological revolution and industrial change, digital transformation has become a major trend in global economic development. As the second largest economy in the world, the development of the digital economy in China has become one of the critical driving forces supporting the sustainable and healthy development of the economy and society and has shown an increasingly in-depth development. According to the data, by 2020, the value added of China's digital economy core industries will reach 7.8 % of GDP. In 2021, the State issued the "14th Five-Year Plan" for the development of the digital economy, in which it is proposed to adhere to digital products as the guide to guide the digital transformation and upgrading of enterprises. To this end, companies must strengthen digital thinking, improve employees' digital skills and data management capabilities, and promote digital transformation comprehensively and systematically. It needs to implement digitalization in business processes such as R&D and design, production and processing, operation and management, sales and service, and accelerate integrating the digital economy with the real economy. Digital innovation has also greatly impacted the manufacturing industry, changing traditional manufacturing

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methods and business models. Digital innovation has also had a tremendous impact on manufacturing, changing traditional manufacturing and business models, unleashing enterprises' vital innovation energy and growth potential, and transforming digital into a new engine for high-quality economic development.

Digital transformation is necessary for companies to achieve survival and sustainable growth. During the transformation process, enterprises can adopt advanced technology tools [1,2] such as artificial intelligence, cloud computing, big data, 5G, Internet of Things, blockchain, etc., and integrate them closely with the strategy, business, organization and management of the enterprise. Technological innovation and business expansion have accelerated the economic development of enterprises, but on the other hand, they have also increased the difficulty of corporate governance. In the context of digitalization, how to reduce the difficulty of corporate governance, realize the sharing and linkage of the interests of agents and enterprises [3], help enterprises continue to promote digital process innovation, expand digital business [4,5], and accelerate the pace of digital transformation of corporations has become a hot issue [6]. Since Jensen proposed the principal-agent theory [7], scholars in China and abroad have conducted extensive research on how to reconcile the conflicting interests of executives and shareholders [8]. A fair, effective and reasonable incentive system can closely link the interests of management with those of shareholders [9], effectively prevent moral hazard, and stimulate executives' sense of responsibility and motivation to work for the company [10]. It plays an indispensable role in optimizing the internal governance structure, improving the quality of internal control, expanding business and promoting the overall upgrading of the enterprise [11]. Digital transformation is the upgrading of technology and software, and it is also the integration of enterprise strategy change, business model innovation, business process reengineering and other important behaviors. Company management focuses on the team and individual level within the company, and people are the most active element in the company's business activities. Executives play a central role in the selection and implementation of an organization's digital strategy, and a digital transformation strategy that is supported by executives will be executed with less resistance. Leadership and agile management capabilities of executives can significantly influence the change of organizational structure and culture during the digital transformation process. Most of the relevant literature on executive incentives and corporate strategy development at this stage focuses on tax planning [12,13], executive shareholding [14,15], R&D investment [16,17], technological innovation [18,19]. Few discussions involve executive incentives and corporate digital transformation. Therefore, it is significant to explore the relationship between executive motivation and corporate digital transformation.

The innovations of this study are: first, in terms of research perspective, it considers the role of management in the digital transformation of corporations, analyzes the impact of different forms of executive incentives in terms of managerial traits, and provides a new perspective to promote the digital transformation of corporations. Second, the executive incentives are divided into two parts: equity incentives and compensation incentives. It breaks down the impact of the behavior that executives may exhibit in different situations on the corporate's digital transformation. Third, this paper explores the relationship between executive motivation and incentive intensity and corporate digital transformation and examines digital processes and business expansion as transmission paths. This study fills the gap in exploring the mechanisms of executive motivation and digital transformation at this stage. It provides a reference for subsequent related research and a theoretical basis for China's listed companies to practice digital transformation.

This study uses the data of listed companies in China's A-share market from 2011 to 2020 as the sample. It performs a two-way panel fixed effects regression with executive incentives of the sample companies as explanatory variables. It considers the impact of incentive intensity on digital transformation on this basis. Here, we used parallel trend test, placebo test, and GMM for robustness testing. Finally, the article summarizes the empirical results and points out the value of this study to provide theoretical references for different listed companies in developing incentive contracts.

2. Theoretical analysis and research hypothesis

2.1. Theoretical analysis

2.1.1. Equity incentives and corporate digital transformation

With the emergence of artificial intelligence, cloud computing, blockchain, big data and other technologies, digitalization is becoming an important breakthrough point for innovation and change in global enterprises. While digital technology continues to achieve innovative breakthroughs of its own, it also deeply integrates with traditional manufacturing industries, showing a strong trend of digital transformation and innovation. Executives play a critical role in digital transformation, as they must create and implement a digital transformation plan that is tailored to the company's needs [20]. Companies often use restricted stock or stock options to incentivize corporate executives to solve principal-agent problems. Several studies have confirmed that executives have an impact on the digital orientation [21], digital efficiency [22–24], and digital innovation capabilities of a company [25]. Zhang examined the heterogeneity within the executive team on firms' engagement in digitally related technology acquisitions [26]. Focusing on executive branding characteristics, he finds that skill-based and institutional branding differences significantly influence firms to engage in digitally related technology acquisitions; whereas, experience-based branding does not play a significant role in M&A decisions. Mao examined the influencing factors of corporate digital transformation based on the perspective of executive composite functional backgrounds and concluded that CEO composite functional backgrounds can enhance the value of the company by increasing the degree of corporate digital transformation and thus the value of the company [27]. Wang pointed out that executives in the context of information technology promote digital transformation mainly by reducing management myopia and increasing the digital patent output of the enterprise [28]. Joshua compared the relationship between equity incentives and managerial risk-taking, and his study showed that equity incentives have different motivational effects on managers in different contexts [29]. The above research demonstrates the critical role of executives in driving digital transformation in the enterprise. The characteristics of the equity

incentive system include the involvement and motivation of interests, which make the company's executives tied to the interests of the company. From the perspective of executives, digital transformation of companies is a strategy that responds to the times. The digital transformation strategy enables companies to take the initiative to innovate their businesses, deepen their reform programs, and promote maximum corporate benefits. As a result, executives become more actively engaged in their work, pursuing outstanding performance and effectively contributing to the corporate's digital transformation drive. Enterprises set up scientific elements of equity incentive contracts, which can realize the integration of executive interests and corporate interests. Through the granting of equity to establish a mechanism of incentive compatibility between the interests of incentive recipients and shareholders, the executives are driven to accelerate the implementation of the corporate's digital transformation strategy, promote the enterprise's economic development and thus maximize the interests of the enterprise. This is precisely the interest-driven logic of equity incentives to promote enterprise upgrading (see Fig. 1).

2.1.2. Compensation incentives and corporate digital transformation

The research on the relationship between executive compensation incentives and enterprise development can be roughly divided into two categories, namely ' promotion theory ' and ' inhibition theory ' [30–32]. According to the "disincentive theory", executive compensation incentives are mainly short-term salaries and bonuses, encouraging executives to focus on short-term performance and abandon investment in longer-term projects [33,34]. This paper favors the " promotion theory", which argues that executive compensation incentives can facilitate the digital transformation of companies. The reasons are as follows: First, as a typical material incentive, compensation incentives can meet the basic living needs and wealth needs of executives, and it still plays a vital role in stimulating executives' enthusiasm for innovation. In addition, considering the institutional background and reality, the management system of Chinese listed companies is in the process of continuous optimization, and companies often have specific requirements for academic background and management experience when selecting executives. This mitigates the short-sightedness of executives to a certain extent. In addition, in the digital economy, executive compensation incentives are likely to promote the implementation of digital innovation projects and thus accelerate the digital transformation of companies due to the potential high benefits of digital transformation. Secondly, executive compensation is the external embodiment of the executives' value [35]. Some studies pointto the existence of pay creep among executives [36]. Therefore, giving executives a higher salary than their peers can satisfy their "sense of value" and also help to enhance their sense of identification with the company. Combining these factors can increase the motivation of executives and make them more focused on the company's long-term development, thus accelerating the corporate's digital transformation [20]. Third, because of the long strategic cycle of digital transformation, it may threaten executive compensation, which is mainly determined and evaluated by short-term performance. Executives avoid long-term projects based on risk aversion and short-term benefits [37]. However, the inherent short-term characteristics of executive compensation incentives can eliminate executives' worries to a certain extent and produce a timely' long-term compensation effect' [38]. This allows them to devote more time and energy to digital transformation work [39] (see Fig. 2).

2.1.3. Equity incentive strength and corporate digital transformation

Theoretically, a corporate's digital transformation process is lengthy, thus requiring executives to expend much time and effort. Executives will be more mindful of the company's long-term objectives. They will no longer opt for surplus management to fulfill the exercise requirements, thus attaining the desired outcome of long-term incentives. However, if the incentive scale is too large, the equity incentives will affect the judgment of executives and restrict them from making decisions at this time due to the existence of interest bundling characteristics. Zhou discovered that CEO equity incentives considerably dampen R&D investment in general, though this effect is only seen in restricted stock incentives, not stock options [40]. Li argued that equity incentive intensity positively affects both firm value and return on net assets [41]. This effect is different in the sample of firms of different natures, and the impact of equity incentives intensity on return on net assets is significantly and negatively related to the selection of state-owned enterprises. An empirical study by Chang found that management equity incentive intensity is significantly and positively related to firm performance [42]. This is because as the intensity of management equity incentives increases, management is more focused on the long-term development of the firm and more motivated to increase R&D investment, thus improving corporate performance. Chen et al. used

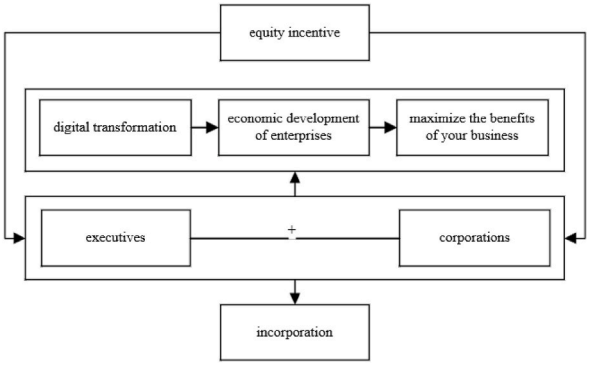

Fig. 1. It indicates the impact of equity incentives for executives on the digital transformation of corporates.

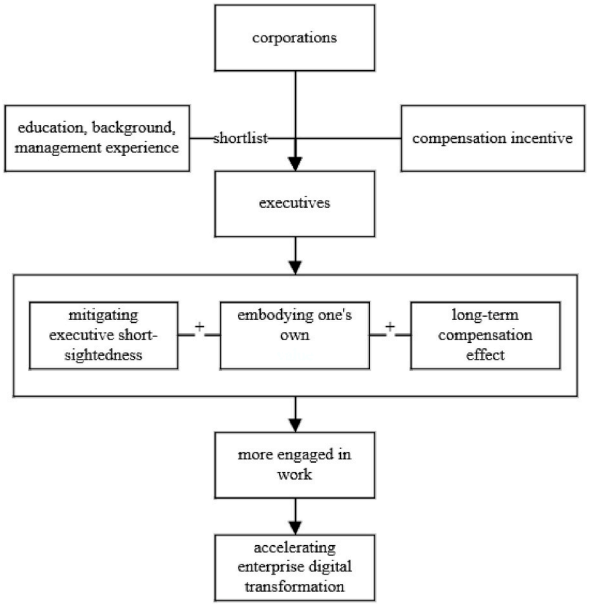

Fig. 2. It indicates the impact of compensation incentives for executives on the digital transformation of corporates.

the difference between the return on total assets three years after the implementation of equity incentives and the return on total assets three years before the implementation as a measure of firm performance, and the study showed that the intensity of equity incentives was positively associated with firm performance until it reached 18 % [43]. Morck conducted a real-world validation analysis using a long-term performance effect of equity incentives [44]. The analysis results concluded that there is a non-linear relationship between equity incentives and the long-term performance of listed firms. Moreover, the study pointed out that there are thresholds between equity incentives and long-term performance of firms, which are 5 % and 25 %, respectively, and they are negatively correlated when the intensity of equity incentives exceeds 5 %. In comparison, they are positively correlated when the intensity of equity incentives exceeds 25 %. McConnell, Servaes reached a similar conclusion as Morck, Shleifer, and Vishny through their studies [45]. They concluded that equity incentives are positively related to long-term firm performance when the intensity is below 50 %, and negatively related when the intensity is above 50 %. Domestic researchers such as Zhang and Fan [46], Wu and Yu [47], have mainly studied SMEs with equity incentives for a certain number of years, and they have used comparative analysis to analyze the changes in the business performance of companies after implementing equity incentives. These studies point out the inverted U-shape of firm performance during the equity incentives period and find that the intensity of equity incentives is non-linearly related to the long-term performance of listed companies.

2.1.4. Compensation incentive intensity and corporate digital transformation

Several studies have shown that firms adjust executive incentives to their own circumstances and that different incentives for executives may have different effects. Compensation incentives are short-term incentives given to management for basic labor, while equity incentives are long-term incentives. The results of Yan showed that the effect of firm age on pay for performance and incentive intensity differed, with growth-stage firms preferring pay-for-performance incentive policies and mature firms preferring bonus incentive policies [48]. Chai believed that companies need to choose executive compensation incentives that match their different competitive strategies and pay more attention to the rationality of selecting executive incentives [49]. Wang indicated that the inverted U-shaped relationship between corporate financialization and innovation is transmitted through its inverted U-shaped relationship with executive compensation incentives [50]. This paper argues that when the intensity of compensation incentives is lower than the industry average, executives may feel inequity, which can decrease their motivation for their jobs and organization. At the same time, lower remuneration levels may negatively impact executives' self-esteem and value recognition. They may feel that the value of their work is not fully recognized, thus reducing their enthusiasm for their work. In addition, there is often an attenuation effect on the effectiveness of the compensation incentives. Once executives become accustomed to lower compensation levels, the incentive effect of payment on them may gradually diminish, leading to declining incentive effects. In other words, lower-intensity compensation incentives do not significantly boost executives' efforts to drive the digital transformation of their companies, and even their incentive effects will continue to diminish. Comparatively, suppose an executive receives a pay incentive greater than the industry average after receiving the incentive. In that case, they will be tempted to receive a higher pay incentive. At this point, the compensation incentive approach is a disguised long-term incentive that positively impacts the organization's digital transformation.

After the above analysis, it can be seen that equity incentives can better realize the integration of executive interests and corporate interests. The two have a specific synchronization in the time dimension. Therefore, this paper analyzes the following text based on matching cycles.

2.1.5. Equity incentives, process innovation and corporate digital transformation

Digital process innovation is an innovative way for companies to use digital technology to optimize, supplement, or replace existing business processes to achieve goals such as improving operational efficiency, meeting customer needs, and visualizing capital, cash, and logistics. Process innovation involves the application of digital technologies in multiple areas, including but not limited to artificial intelligence, big data, cloud computing, Internet of Things, and blockchain, to integrate with existing business processes to achieve the goal of digital transformation of corporations [51]. To realize the digital process in the process of transformation, enterprises need to consider the characteristics and advantages of these factors in an all-aroun wayand formulate corresponding strategies and implementation paths based on them.

First, the continuous opening of process digitization platforms and systems can break through time and space constraints, reduce information search, verification, exchange, and processing costs, and effectively reduce coordination costs [52]. The open nature of these platforms and systems enables enterprises to share resources and optimize processes more efficiently, thereby increasing productivity and creativity, shortening order execution cycles and delivery times, thereby increasing market competitiveness and economic benefits [53]. In addition, the openness of the digital process platform can also promote collaboration between industries. Through data interfaces and common standards, various forms of cooperation, such as resource sharing, and knowledge sharing can be achieved to achieve a win-win strategy for the corresponding industry [54].

Second, the digital process can effectively reduce the problem of information asymmetry between the parties to the transaction, making it easier to monitor the performance of the other party to the trade while reducing the operational risks caused by concealing information [55]. Digital process platform through effective data collection, transmission, storage, and analysis. This allows each participant to understand each other 's needs, willingness, and behavior more profoundly compare and evaluate the advantages and disadvantages of different trading schemes, monitor risk factors in real time, and take corresponding measures. The digital process can also help enterprises achieve the goals of policy compliance, risk prevention, and internal control, strengthen the values and product image of enterprises, and enhance the goodwill and credibility of enterprise brands.

Third, it enables the modularization of technology and products, making products and services independent modules that can easily be inserted into different value chains while reinforcing corresponding standards. This modular feature reduces the investment relationship's specific requirements and the enterprise's opportunity risk. In the systems provided by the digital process platform, different technology and product components can be exchanged, assembled, and deployed through standardized interfaces [22]. In this way, companies can more flexibly combine and arrange product modules with different functions and quality levels, respond quickly to customer needs, and update and expand at any time to meet the vagaries of the market and the challenges of competition. Combining multiple modular products and services can improve productivity and resource utilization, optimize corporate management and decision-making, increase the speed of innovation and profitability, and thus enhance the company's position and influence in the marketplace. In the above process, executives are essential decision-makers and executors in the company and play a key role in implementing digital processes. In addition, equity incentives can break the boundaries between departments within the company to a certain extent, promote internal resource sharing, build an Internet + platform, and achieve digital strategic integration while improving the integrity and landing ability of the corporate's digital transformation strategy (see Fig. 3).

2.1.6. Equity incentives, business innovation and corporate digital transformation

Digital transformation of an enterprise is a multi-dimensional and complex process in which many new business and commercial models emerge [56]. For example, with the rise of the sharing economy, new business models such as shared travel, shared accommodation, and shared offices have emerged, allowing consumers to share resources, improve efficiency, and synergy through Internet platforms, creating more business opportunities for companies [57]. In addition, digital technology has also promoted the development of smart homes, smart cities, industrial Internet, and other fields, which allows companies to be supported by technologies such as big data and artificial intelligence. Technological innovations have led to increased investment in this business area, bringing

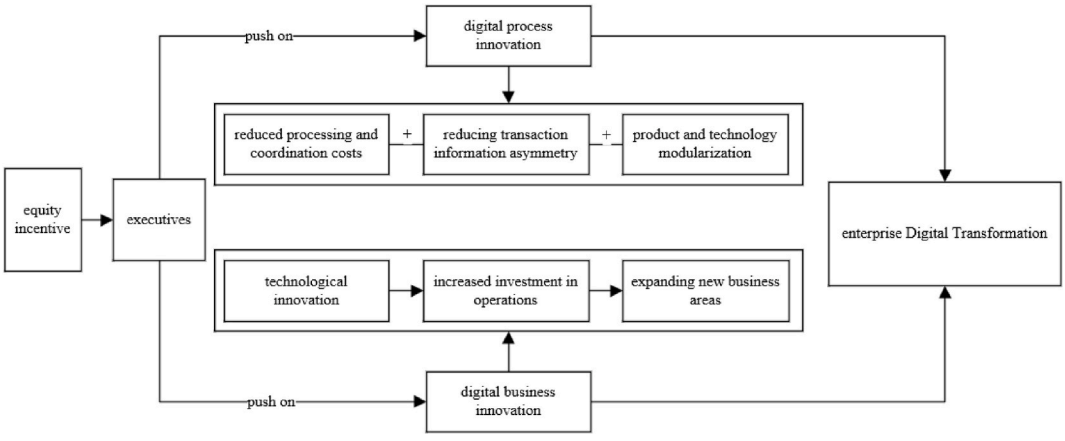

Fig. 3. It represents the mechanical transmission diagram of equity incentives and corporate digital transformation.

endless opportunities for companies to develop domestic and overseas markets [58]. At the same time, the digital economy also brings unlimited possibilities for enterprises to develop domestic and overseas markets. For example, through e-commerce and cross-border e-commerce, enterprises can more easily communicate and cooperate with global consumers, promote international trade and investment, improve the competitiveness of the industry and value chain, and continue to promote business development [59]. As a way of managers' incentive motivation, equity incentives encourage managers to pay attention to and boost product innovation activities that are beneficial to the sustainable development and core competitiveness of enterprises by linking management compensation with the long-term value of enterprises to lay a solid foundation for enterprises to realize product upgrading and open up new business areas. On the one hand, through technical means such as data analysis and artificial intelligence, executives can more accurately grasp market demand and consumer behavior, predict market trends and customer preferences, and improve product and service quality. On the other hand, digital technology represented by the industrial Internet constantly promotes enterprises to achieve advanced production and green manufacturing. The managers of listed companies can use big data, cloud computing, the Internet of things, and other technologies to develop product life cycle management, intelligent quality monitoring, independent innovation design, and so on [60]. The equity incentives system motivates executives to optimize the organizational structure, adjust strategic decisions, and accelerate resource integration in the above process, which provides a more profound and global planning proposal for digital transformation to achieve overall organizational change (see Fig. 3).

2.2. Research hypothesis

The research objective of this paper is to determine whether executive incentives accelerate corporates' digital transformation. The digital economy has exacerbated the conflict of interest and information asymmetry between principals and agents, giving rise to severe principal-agent problems. As key players in solving the principal-agent problem, executives have an essential impact on implementing corporate digital strategies. Therefore, to explore how to motivate the endogenous motivation of executives so that they continuously promote the digital transformation of corporates, this paper proposes the following research questions.

H1. The implementation of executive equity incentives can accelerate the digital transformation of corporations.

H2. Companies implementing executive compensation incentives can accelerate the digital transformation of their corporates.

However, differences in motivational intensity also produce different motivational effects. Based on the above analysis, this paper proposes the following two hypotheses for the relationship between incentive intensity on the digital transformation of corporates.

H3. An inverted U-shaped relationship between equity incentives intensity and corporate digital transformation.

H4. There is a positive U-shaped relationship between compensation incentives intensity and the digital transformation of corporations.

In addition, since most of the equity incentives have a longer term and integrate executives with corporate interests, it creates long-term incentives. Th corporate's digital transformation in the process also requires a longer cycle than according to the matching of the two bikes. This paper suggests that digital process and business innovation may be transmitted between equity incentives and digital transformation. Accordingly, the following hypotheses are proposed.

H5. Digital process innovation mediates between equity incentives and corporate digital transformation.

H6. Digital business innovation mediates between equity incentives and corporate digital transformation.

3. Research design

3.1. Sample selection and data sources

This paper divides executive incentives in two parts: equity incentives and compensation incentives. The equity incentive system was introduced into China in 2006, and the incentive period is usually 3–5 years. Before 2011, fewer listed firms implemented the equity incentive system, which was expected to lead to a severe multicollinearity problem in the model. And after 2020, the new crown epidemic affected the Chinese economy, which led to inaccurate experimental results. Therefore, this paper uses the data of all listed Chinese A-share companies from 2011 to 2020 as the sample. At the same time, to ensure the accuracy and validity of the data, the termination of listing and the period of delisting of enterprises are excluded. This paper's data source is mainly the CSMAR database, and some of the missing data was obtained from Python's big data crawler. Excel processed the data, and then regression analysis was performed by Stata.

3.2. Variable definitions

3.2.1. Explained variables

Corporate digital transformation (*dt*): In recent years, there have been abundant academic studies on digital transformation, but the standards for measuring the digital transformation of corporations have not been unified. Wu et al. [61], Yuan et al. [62], and others extracted the digital keywords in the annual report by constructing the digital transformation lexicon of listed companies and used the text analysis method to obtain indicators to measure the digital transformation of corporations. According to the document '

evaluation indicators ' issued by the State Council in 2022, enterprises should comprehensively evaluate the digital development level of small and medium-sized enterprises from the four dimensions of digital foundation, operation, management, and effectiveness according to the characteristics of the industry. Therefore, this paper constructs the evaluation system of corporate digital transformation from the strategic guidance, technology drive, organizational empowerment at the level of listed companies, enterprise digital achievements and applications, and environmental support at the macro level (See Fig. 4).

We calculate the e corporate digital transformation index according to the six first-level indicators of strategic leadership, technology drive, organizational empowerment, environmental support, digital results, and digital application. The proportion of each indicator is 34.72 %, 16.20 %, 9.69 %, 3.42 %, 27.13 %, 8.84 %. Each first-level indicator is composed of secondary indicators in each enterprise document.

The calculation process is as follows:

After standardizing each secondary index, it is mapped to 0–100 to obtain the score of each primary index. Then, the product of the score and the weight of the primary index is obtained, the corporate digital transformation index.

3.2.1.1. Standardization

$$y_{it} = \frac{x_{it} - mean(x)}{AD} \tag{1}$$

Where x_{it} is the index value, *mean(x)* is the index mean value, *AD* is the average deviation between the index value and the mean value, and the formula is:

$$AD = \frac{1}{N}\sum_{i,t}|x_{it} - u(x)| \tag{2}$$

3.2.1.2. Indicators are mapped to 0–100

$$z_{it} = \Phi(y_{it}) * 100 \tag{3}$$

Here, z_{it} is the indicator mapping value, $\Phi(y_{it})$ is the cumulative distribution function of the standard normal distribution, the formula is:

$$\Phi(y_{it}) = \int_{-\infty}^{y_{it}} \frac{1}{\sqrt{2\pi}} e^{\frac{x^2}{2}} dx \tag{4}$$

In this paper, the corporate digital transformation index is calculated based on the weighted calculation of six indicators, namely, strategic leadership, technology-driven, organizational empowerment, environmental support, digital results, and digital application, and the detailed indicators and weights are as follows (Table 1), and the relevant data are the latest data from CSMAR.

3.2.2. Explanatory variables

Equity incentives(*incentive*): This paper selects the full sample data of listed companies and sets virtual variables: the value of equity incentives is 1, and the value of non-implementation is 0.

Fig. 4. It is used to measure corporates' digital transformation degree, and the digital transformation indicators are derived from the evaluation system.

Equity incentives intensity (*strength*): It refers to the implementation of the equity incentives system of listed companies; equity incentives plan in the incentive stock shares accounted for the percentage of total equity; the closer to 1, the greater the equity incentives intensity.

Compensation incentives (*lnsalary3*): In this paper, the total compensation of the top three listed senior executives is selected as a measure of the compensation incentives of executives.

Compensation incentives intensity (*lnsalary_t*): The total compensation of one or a few executives is selected to measure compensation incentives intensity by chance. Therefore, this paper sets the full compensation of senior executives of the listed companies to measure the incentive intensity of compensation.

Process innovation (*proin*), business innovation (*busin*): Based on the frequency of the following numerical process words appearing in the annual reports of listed companies, the corresponding scores are calculated and measured as point mapping, and the related terms are explained in Table 2.

3.2.3. Control variables

The digital transformation of firms is also disrupted by other factors. We refer to the related literature [63–65] to select capital intensity (capin), gearing ratio (lev), return on investment (return), firm cashflow (cashflow), firm growth capacity (growth), state-owned enterprises (soe), shareholder1, institutional shareholding (inst), and auditor (big4) as control variables.

3.3. Construction of the model

In order to explore the impact of executive incentives on the digital transformation of corporations, this paper sets model (5)(6) to explore, in which model (5) is a multi-period DID model.

The impact of equity incentives on the digital transformation of corporations:

$$\mathrm{dt} = \alpha_{11} + \alpha_{12}\mathrm{incentive} + \sum_{i=2}^{10} \alpha_i controls + \lambda_i + \mu_t + \varepsilon_{i,t} \tag{5}$$

The impact of compensation incentives on digital transformation of corporations:

Table 1
Breakdown of digitization indicators.

Level 1 indicators	Level 1 indicator weights	Level 2 indicators	Level 2 indicator weights
strategic leadership	34.72 %	Management digital job creation	23.82 %
		Management is digitally innovation-oriented and forward-looking	27.88 %
		Management Digital Innovation Orientation Continuity	18.79 %
		Breadth of management's digital innovation orientation	12.83 %
		Strength of management's digital innovation orientation	16.68 %
technology drive	16.20 %	AI technology	55.04 %
		blockchain technology	12.98 %
		Cloud Computing Technology	18.32 %
		big data technology	13.66 %
organizational empowerment	9.69 %	Digital Capital Investment Program	50.22 %
		Digital Workforce Input Program	25.53 %
		Digital infrastructure development	12.06 %
		Science and technology innovation base construction	12.19 %
environmental support	3.42 %	Number of patents for inventions in the industry	19.23 %
		R&D activities in the industry	17.79 %
		New product development and sales in your industry	14.98 %
		Intensity of digitization technology in your industry	11.57 %
		Intensity of digital capital investment in your industry	11.4 %
		Intensity of human capital investment in the industry	7.89 %
		Density of fiber optic cables in the city	4.77 %
		Mobile switch capacity in your city	4.03 %
		Scale of Internet broadband access users in your city	4.00 %
		Size of mobile Internet users in your city	4.34 %
digital results	27.13 %	Digital Innovation Standards	36.68 %
		Digital Innovation Essay	11.74 %
		Patents for digital inventions	23.54 %
		Digital Innovation Qualification	14.73 %
		Digital National Awards	13.31 %
digital application	8.84 %	Technological innovation	63.42 %
		Process Innovation	23.78 %
		Business Innovation	12.8 %

Note: Digital transformation indicators comprise six first-level indicators: strategic leadership, technology-driven, organizational empowerment, environmental support, digital outcomes, and digital applications. Each tier-1 indicator is, in turn, composed of multiple tier-2 indicators. The Tier 2 indicators are normalized and mapped to 0–100. The score of each level 1 indicator is then derived according to its weight, and the multiplication with the level 1 indicator's importance of the level 1 indicator is the corporate digital transformation indicator.

Table 2
Definition and description of variables.

Variable Category	Variable Name	Variable Symbols	Variable Definition
Explained variables	Corporate digital transformation	*dt*	corporate digital transformation index
Explanatory variables	Equity incentives	*incentive*	the value of equity incentives is 1, and the value of non-implementation is 0.
	Compensation incentives	*lnsalary3*	top three senior managers pay total logarithm
	Equity incentives intensity	*strength*	total incentive/total equity
	Compensation incentives intensity	*lnsalary_t*	logarithm of total remuneration of senior managers
Mediator variables	Digital process	*proin*	Intelligent manufacturing, intelligent customer service, intelligent marketing, digital marketing, unmanned retail, unmanned factory, mobile payment, third-party payment, NFC payment, human-computer interaction, social network corresponding word frequency proportion score.
	Digital business	*busin*	Intelligent agriculture, intelligent transportation, intelligent medical care, smart home, intelligent investment advisor, intelligent cultural tourism, intelligent environmental protection, smart grid, intelligent energy, Internet medical care, Internet finance, digital finance, Fintech, financial technology, quantitative finance, open banking, Internet, Internet + corresponding word frequency ratio score.
Control variables	Capital intensity	*capin*	total assets/operating income
	Gearing ratio	*lev*	liabilities at the end of the period/total assets at the end of the period
	ROI	*return*	current investment income/investment cost
	Corporate cash flow	*cashflow*	operating income - cash cost - income tax
	Business growth capability	*growth*	total assets change/initial value of total assets period
	State-owned enterprises	*soe*	the value of state-owned enterprises is 1, and the value of non-state-owned enterprises is 0.
	Shareholder shareholding ratio	*shareholder1*	shareholding ratio of the largest shareholder
	Institutional holdings	*inst*	institutional investors hold shares/total shares of listed companies
	audit Institution	*big4*	the value of the four major audit institutions is 1, otherwise 0.

Note : The above table explains each variable in the model, which includes explanatory variables, mediating variables, and control variables. The range of values of each variable is given below: $dt \in [0,100]$, $proin \in [0,100]$, $busin \in [0,100]$, $lnsalary\_t \in (0,+\infty)$, $cashflow \in (0,+\infty)$, $lnsalary3 \in (0,+\infty)$, $growth \in (0,+\infty)$, $capin \in (0,+\infty)$, $lev \in [0,1]$, $return \in (-\infty,+\infty)$, $shareholder1 \in (0,1]$, $inst \in (0,1]$, $strength \in (0,1)$, $incentive = 0$ or 1, $soe = 0$ or 1, $big4 = 0$ or 1.

$$\mathrm{dt} = \alpha_{21} + \alpha_{22}\, lnsalary3 + \sum_{i=2}^{10} \alpha_i controls + \lambda_i + \mu_t + \varepsilon_{i,t} \tag{6}$$

The impact of equity incentives intensity on the digital transformation of corporates:

$$\mathrm{dt} = \alpha_{31} + \alpha_{32} strength + \alpha_{33} strength^2 + \sum_{i=2}^{10} \alpha_i controls + \lambda_i + \mu_t + \varepsilon_{i,t} \tag{7}$$

The impact of compensation incentives intensity on the digital transformation of corporations:

Table 3
Statistical description.

VarName	Obs	Mean	SD	Min	Median	Max
dt	30484	34.77	11.476	0	32.13335	80.0403
incentive	30484	0.18	0.384	0	0	1
lnsalary3	29150	14.41	0.753	11.00874	14.37727	18.04904
capin	30453	60.91	2468.015	0	8.502673	309719.5
lev	30463	0.44	0.656	−.22719	.405238	66.68997
return	30463	5.44	869.959	−69.56332	0	151819.4
cashflow	30463	−5.55e+07	1.54e+10	−4.10e+11	−3.72e+07	1.61e+12
growth	30222	0.02	3.303	−494.745	.0512925	98.69378
soe	30484	0.34	0.475	0	0	1
shareholder1	29704	34.58	15.248	0	32.26	100
inst	29699	40.92	25.703	0	41.98	146.67
big4	29704	1.93	0.251	1	2	2

Note: Obs: number of samples; Mean: sample mean; SD: standard deviation; Min: minimum; Median: median; Max: maximum.

$$dt = \alpha_{41} + \alpha_{42} \ln salary\_t + \alpha_{43} \ln salary\_t^2 + \sum_{i=2}^{10} \alpha_i controls + \lambda_i + \mu_t + \varepsilon_{i,t} \quad (8)$$

4. Empirical results and analysis

4.1. Descriptive statistical analysis

Table 3 is the descriptive statistical results of the main variables. The mean value of corporate digital transformation (*dt*) is 34.77, the standard deviation is 11.476, the median is 32.13335, the maximum and minimum values are 80.0403 and 0, respectively. Its mean and median converge, indicating that only a few companies are at a high level of digital transformation. The mean value of equity incentives (*incentive*) is 0.18 and the median value is 0. This reflects that although the equity incentives system has been welcomed by listed companies since its introduction, most companies still have a wait-and-see attitude toward the system. The standard deviation of compensation incentives (*lnsalary3*) is 0.753, which shows that listed companies are not biased toward compensation incentives for their companies.

After obtaining the above descriptive statistics, this paper plots two charts to compare the digital transformation levels of both the full sample of listed companies (see Fig. 5) and the listed companies that implemented the equity incentive system (see Fig. 6). The points in the charts show the distribution of listed companies with a digital transformation index greater than 50. The distribution of these two charts shows that they are broadly similar. This finding suggests that equity incentive systems and digital transformation are likely to be related to some extent. In addition, the data samples selected in this paper are large-sample data, which are too sensitive to the judgment of normality, and a slight deviation from a little bit will be considered non-normal. The digital transformation indicators constructed in this paper belong to non-negative indicators, whose values are all greater than 0. Therefore, this paper drew the histogram of the selected samples, to judge whether the selected samples obey the normal distribution. The histogram shows that under the condition of greater than 0, the sample conforms to the normal distribution (see Fig. 7).

4.2. Analysis of correlation

When Pearson correlation coefficient tests were performed, the correlation coefficients were all significant at the 1 % level and the tests passed (Table 4). Preliminary conclusions can be drawn from the correlation coefficients that both compensation incentives and equity incentives for executives accelerate the degree of digital transformation of companies.

4.3. Regression analysis

The independent variables for the regression in column (1) of Table 5 contain only incentive, year-fixed effects, and firm-fixed effects. Column (2) adds other control variables to column (1). The adjusted *R2* is further improved by adding control variables, and the regression equation is better fitted. According to the results of the study, the regression coefficient of the equity incentives system is significantly greater than zero at the 1 % level, regardless of whether the control variables are considered. This shows that companies that have adopted an equity incentives system have an advantage over those that have not implemented it when it comes to digital transformation. Similarly, Table 6 reports the regression results for executive compensation incentives, which are also significantly greater than zero at the 1 % level, meaning that compensation incentives also accelerate the digital transformation of the firm. H1 and H2 hypotheses hold. The findings of Hayes [20], Joshua [29], and Liang [39] are further corroborated.

The test results in Table 7 show that strength and strength 2 are significant and opposite in sign at the 1 % level, and the coefficient

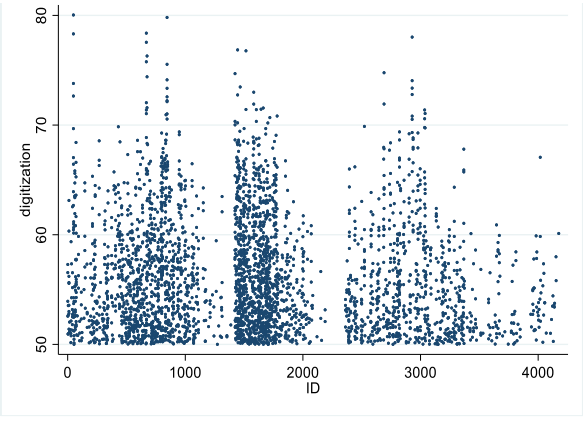

Fig. 5. It represents the distribution of the degree of digital transformation of all samples, *ID* denotes the number of listed enterprises; *digitization* denotes the degree of digital transformation of corporates.

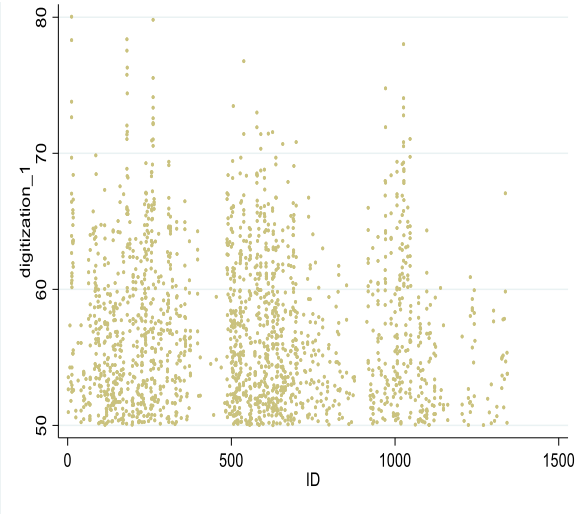

Fig. 6. It represents the distribution of digital transformation degree of corporates implementing the system, *ID* denotes the number of listed enterprises; *digitization_t* denotes the degree of digital transformation of corporates implementing equity incentives.

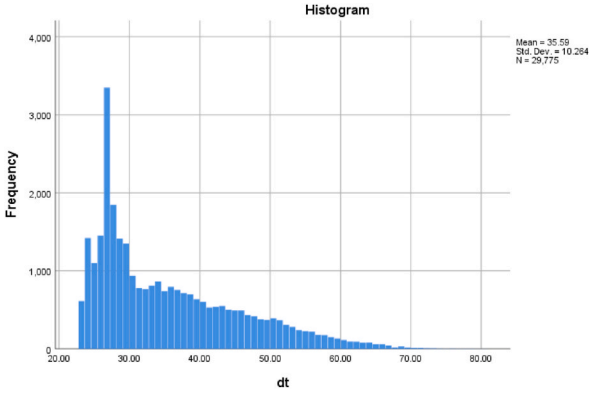

Fig. 7. This figure is used to determine the histogram of the selected sample, with the horizontal axis being the degree of digital transformation of the corporate and the vertical axis being the frequency of occurrence.

of the quadratic term is negative. This indicates an inverted U-shaped relationship between equity incentives intensity and corporate digital transformation, i.e., the degree of corporate digital transformation tends to increase and then decrease with the increase of equity incentives intensity. Adjusting *R2* to increase after adding control variables, the significance of the coefficients and the direction of the sign were the same as the original. H3 was verified. The results of Table 6 are the traditional inverted U-shaped model, but in the traditional inverted U-shaped relationship test method, the peak point of the inverted U-shaped relationship is simply regarded as the threshold point, but this treatment does not guarantee that the peak point is the threshold point, nor can it judge whether the threshold effect exists [66]. In order to further improve the accuracy of the experiment, the *utest* test is carried out and the regression results are illustrated (Fig. 8). The confidence interval of the extreme point is [2.149,3.5842], and the extreme point is 2.5368. The range of excitation intensity of the sample is [0,8.75], including the confidence interval of the extreme point. When the equity incentives intensity is [0,2.5368], the equity incentives have an upward trend in the digital transformation of the enterprise and begin to decline at [2.5368,8.75]. This proves again that there is indeed an inverted U-shaped relationship between equity incentives intensity and corporate digital transformation. The results confirm the findings of the relevant literature [44–47].

Table 8 reports the relationship between salary incentive intensity and corporate digital transformation. The square of salary incentive intensity (*lnsalary_t2*) is significantly positively correlated with the digital transformation of corporations, which means that there is a positive U-shaped relationship between salary incentive and digital transformation of corporations. Fig. 9 shows the test results of *utest*. The confidence interval of the extreme point is [5.7989,11.3844], and the extreme point is 9.6340. The range of excitation intensity of the sample is [11.0087,18.7722], 95.16 % of the samples may not contain extreme points, and the threshold effect does not exist. The results of this experiment indicate that the compensation incentives intensity of Chinese listed firms is likely to lie to the right of the threshold, and there is a non-linear upward trend between compensation incentives intensity and the digital transformation of firms. From the research results, this paper is more supportive of Liu 's view [36].

Table 4
Table of Pearson correlation coefficients.

	dt	dt_application	incentive	lnsalary3	capin	lev	return	cashflow	growth	soe	shareholder1	inst	big4
dt	1												
dt_application	0.633***	1											
incentive	0.212***	0.148***	1										
lnsalary3	0.204***	0.126***	0.167***	1									
capin	−0.004	−0.004	−0.010	−0.007	1								
lev	−0.045***	−0.029***	−0.051***	−0.008	0.011*	1							
return	−0.005	−0.001	−0.003	−0.002	−0.000	−0.001	1						
cashflow	0.006	0.002	−0.009	−0.007	0.000	0.004	−0.000	1					
growth	−0.003	−0.003	0.007	0.014**	−0.001	−0.011*	0.000	0.000	1				
soe	−0.108***	−0.096***	−0.231***	0.030***	0.004	0.096***	−0.005	−0.010*	0.004	1			
shareholder1	−0.141***	−0.105***	−0.085***	−0.003	−0.008	−0.014**	0.006	0.010*	0.004	0.209***	1		
inst	−0.068***	−0.067***	−0.098***	0.237***	0.012**	0.061***	−0.008	0.018***	−0.001	0.372***	0.401***	1	
big4	−0.015**	0.015**	0.033***	−0.283***	0.001	−0.055***	0.001	−0.025***	−0.005	−0.143***	−0.107***	−0.252***	1

Note: ***, **, * indicate significant at the 1 %, 5 %, 10 % levels; same as below.

Table 5
Equity incentives regression analysis.

	dt		dt	
	Coefficient	t	Coefficient	t
incentive	0.9258***	(6.3067)	0.8893***	(6.0489)
capin			0.0000*	(1.6236)
lev			−0.0703	(-1.4441)
return			0.0000***	(28.6514)
cashflow			−0.0000	(-0.3291)
growth			0.0114**	(2.0543)
soe			0.2316	(0.6398)
shareholder1			−0.0500***	(-5.6915)
inst			0.0009	(0.2659)
big4			−0.5046	(-1.1612)
_cons	29.8675***	(237.8101)	33.5461***	(36.0230)
TE	Yes		Yes	
FE	Yes		Yes	
N	30484		29671	
R^2	0.3265		0.3378	
Adj. R^2	0.3263		0.3374	

Table 6
Compensation incentives regression analysis.

	dt		dt	
	Coefficient	t	Coefficient	t
lnsalary3	0.7593***	(5.4284)	0.7559***	(5.5054)
capin			0.0000*	(1.6535)
lev			−0.0391	(-0.7041)
return			0.0000***	(25.6768)
cashflow			−0.0000	(-0.3625)
growth			0.0105*	(1.9068)
soe			0.1782	(0.4915)
shareholder1			−0.0517***	(-5.7971)
inst			−0.0002	(-0.0597)
big4			−0.4863	(-1.0978)
_cons	20.2129***	(10.2535)	23.1133***	(10.6381)
TE	Yes		Yes	
FE	Yes		Yes	
N	29150		29119	
R^2	0.3365		0.3404	
Adj. R^2	0.3362		0.3399	

Table 7
Regression analysis of equity incentives intensity.

	dt		dt	
	Coefficient	t	Coefficient	t
strength	0.7346***	(4.7553)	0.7024***	(4.5676)
strength 2	−0.1448***	(-3.5380)	−0.1391***	(-3.4139)
capin			0.0000	(1.6278)
lev			−0.0698	(-1.4312)
return			0.0000***	(28.5177)
cashflow			−0.0000	(-0.3405)
growth			0.0114**	(2.0577)
soe			0.2181	(0.6022)
shareholder1			−0.0502***	(-5.6992)
inst			0.0011	(0.3132)
big4			−0.5152	(-1.1849)
_cons	29.8820***	(237.9249)	33.5893***	(36.0193)
TE	Yes		Yes	
FE	Yes		Yes	
N	30484		29671	
R^2	0.3259		0.3371	
Adj. R^2	0.3256		0.3367	

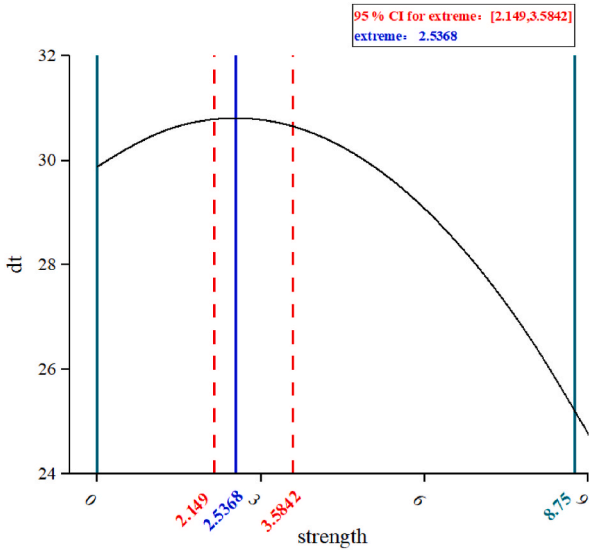

Fig. 8. It represents the relationship between equity incentive strength and the corporate's digital transformation, *dt* denotes the corporate's digital transformation; *strength* denotes equity incentive strength.

Table 8
Regression analysis of compensation incentives intensity.

	dt		dt	
	Coefficient	t	Coefficient	t
lnsalary_t	−1.5521***	(-2.9736)	−1.4407***	(-2.7485)
lnsalary_t2	0.0806***	(4.3277)	0.0766***	(4.0929)
capin			0.0000	(1.6400)
lev			−0.0454	(-0.8375)
return			0.0000***	(25.3900)
cashflow			−0.0000	(-0.3364)
growth			0.0107**	(1.9791)
soe			0.1401	(0.3917)
shareholder1			−0.0516***	(-5.8021)
inst			−0.0001	(-0.0332)
big4			−0.4720	(-1.0600)
_cons	36.3103***	(9.4653)	38.3639***	(9.8322)
TE	Yes		Yes	
FE	Yes		Yes	
N	29150		29119	
R^2	0.3381		0.3419	
Adj. R^2	0.3378		0.3415	

4.4. Robustness tests

4.4.1. Substituting the explanatory variables

In order to avoid the error brought by a single explanatory variable to the experimental conclusion, the explanatory variable (*digitization*) is replaced by the digital_application score in this paper. Tables 9 and 10 show that the regression coefficients of incentive remain significantly positive after replacing the explanatory variables, which is generally consistent with the baseline regression results and does not change the experimental results of this paper.

4.4.2. Parallel trend test and placebo test

4.4.2.1. (1) parallel trend test. The above paper uses a multi-period DID model on whether equity incentives accelerate the digital transformation of firms. If the parallel trend hypothesis holds, it implies that the degree of digital transformation in the treatment and control groups is parallel in time trend if the listed firms do not implement the equity incentives system. To test whether the multi-period DID model in this paper satisfies the parallel trend assumption, we construct 14 dummy variables: pre7, pre6, pre5, pre4, pre3, pre2, pre1, current, post1, post2, post3, post4, post5, and post6, using the last period as the benchmark group, and replace incentive with them in the regression model. These dummy variables are intervals of 7 years before, 6 years before, 5 years before, 4

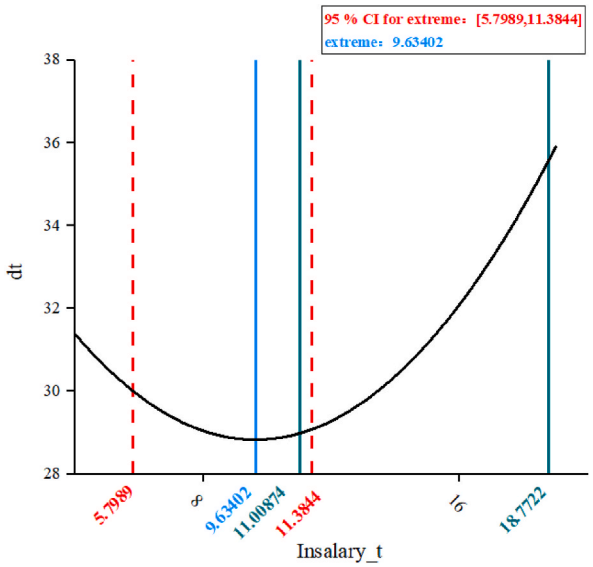

Fig. 9. It represents the relationship between compensation incentive intensity and corporate's digital transformation. *dt* denotes corporate's digital transformation; *Lnsalary_t* denotes equity incentive intensity.

Table 9
Equity incentives Replacement Variables.

	dt_application		dt_application	
	Coefficient	t	Coefficient	t
incentive	1.3414***	(3.4189)	1.3005***	(3.3067)
capin			0.0000	(1.6422)
lev			0.1361*	(1.7339)
return			0.0001***	(34.3289)
cashflow			−0.0000	(-0.5080)
growth			−0.0070	(-0.8720)
soe			1.0231	(1.3687)
shareholder1			−0.1012***	(-4.9584)
inst			−0.0070	(-0.9592)
big4			1.3826*	(1.8502)
_cons	31.3526***	(136.0623)	33.1062***	(19.2030)
TE	Yes		Yes	
FE	Yes		Yes	
N	30484		29671	
R^2	0.0318		0.0357	
Adj. R^2	0.0315		0.0351	

years before, 3 years before, 2 years before, 1 year before, the current year, 1 year after, 2 years after, 3 years after, 4 years after, 5 years after, and 6 years after the implementation of equity incentives, and take values of 0 or 1 to represent the sample at different time points. Where the dummy variable takes the value of 1 if the sample is in the corresponding interval, otherwise it takes the value of 0. According to the parallel trend hypothesis, this paper expects that the regression coefficients of pre7, pre6, pre5, pre4, pre3, pre2, and pre1 should not be significantly different from 0.

Table 11 reports the regression results of the parallel trend hypothesis test. Fig. 10 shows the graph of the parallel trend test, corresponding to the regression results in column (1) of Table 5, with the confidence interval set at the 95 % level. It is easy to see that the regression coefficients of pre7, pre6, pre5, pre4, pre3, pre2, are not significantly different from 0, and pre1 is at the margin of significance. This may be due to the role of shareholders needing to plan incentive covenants in advance before implementing the equity incentives system, and the role of corporate managers in getting relevant information leading to the advancement of incentive effects. Overall, the above results are consistent with the expectation of the parallel trend hypothesis; and, the regression coefficients of Current, post1, post2, post3, post4, and post5 are significantly greater than zero, which indicates that the parallel trend between the treatment and control groups before the implementation of the equity incentives system is broken. Although it is not significant in the 6th period after the implementation of the system, its p-value is close to 0.1. It proves that the equity incentives system still has a significant impact on the digital transformation of the company after the 6th year after the implementation of the system, but the degree of its impact is slightly weakened.

Table 10
Compensation incentives Replacement Variables.

	dt_application		dt_application	
	Coefficient	t	Coefficient	t
Lnsalary3	1.6262***	(5.5237)	1.7325***	(5.9101)
capin			0.0000*	(1.7076)
lev			0.1871**	(2.0159)
return			0.0000***	(30.4600)
cashflow			−0.0000	(-0.5542)
growth			−0.0092	(-1.1638)
soe			1.0211	(1.3721)
shareholder1			−0.1040***	(-5.0032)
inst			−0.0114	(-1.5482)
big4			1.8364**	(2.4139)
_cons	9.5879**	(2.3091)	8.3029*	(1.8233)
TE	Yes		Yes	
FE	Yes		Yes	
N	29150		29119	
R^2	0.0337		0.0383	
Adj. R^2	0.0334		0.0377	

Table 11
Parallel trend test.

	dt	
	Coefficient	t
pre7	−7.2134	(-1.4368)
pre6	−7.1186	(-1.5731)
pre5	−6.5721	(-1.5635)
pre4	−5.9606	(-1.5382)
pre3	−4.3551	(-1.2281)
pre2	−0.9921	(-0.3085)
pre1	5.2395*	(1.8143)
current	6.8126***	(2.6580)
post1	6.4854***	(2.8851)
post2	6.1332***	(3.1738)
post3	5.2893***	(3.2694)
post4	4.0148***	(3.0433)
post5	2.7180***	(2.6145)
post6	1.3138	(1.6223)
post 7	0.0000	(0.000)
_cons	22.4336***	(5.3452)
TE	Yes	
FE	Yes	
N	13490	
R^2	0.5535	
Adj. R^2	0.5030	

4.4.2.2. (2) placebo test. Parallel trend tests address the influence of other potentially realistic threats and confounding variables on causal inferences and randomize the experiment as much as possible, but the issue of omitted variables may have some impact on the baseline results of this paper. In order to test the impact of missing variables on the benchmark results of this paper, drawing on the practice of Casaburi [67], the method of random replacement of listed companies implementing equity incentives is used to generate random resampling distribution for placebo test. This is done as follows: first generate the interaction term did of treat and time, and then rerun the regression model (1) with 500 independent experiments randomly selected for the interaction term to see if the coefficients are significantly different from the baseline estimation results. Under this placebo test idea, if the baseline results of this paper are the result of the omitted variables, the regression coefficients of digitization obtained from the placebo test would not be clustered around 0, but would be significantly different from 0, similar to the results of this paper, and vice versa indicating that the omitted variable issue has little effect on the baseline results of this paper. Fig. 11 demonstrates the results of the placebo test. The test results show that the kernel density estimates and p-values of the coefficients in the random process are distributed around 0. Therefore, the implementation of the equity incentives system obeys a random distribution. This could indicate that our baseline regression results are not the result of other factors that we did not control for in this paper, but rather the effect of the implementation of the equity incentives system. The placebo test results further indicate the reliability of the core findings of this paper.

4.4.3. GMM test

When we solve the endogenous problem of compensation incentives, we use the mean value of executive compensation

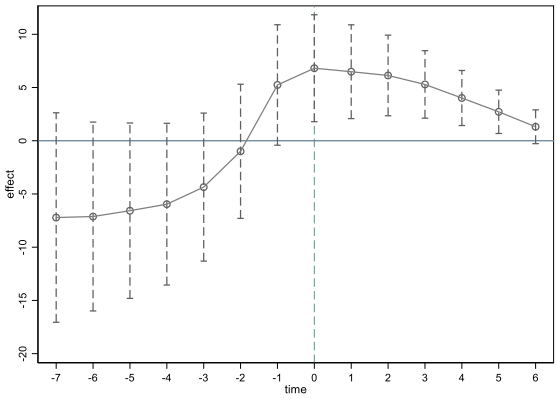

Fig. 10. It represents the parallel trend test chart of equity incentive and corporate digital transformation, in which the effect represents the regression coefficient of the sample digital transformation degree. If the regression coefficient contains 0, the result is not significant; if the regression coefficient does not contain 0, the result is significant. The horizontal coordinate indicates the time when the policy was implemented, with 0 being the period when the policy was implemented.

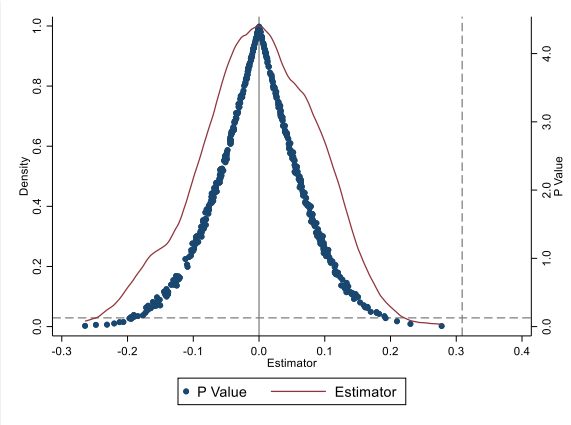

Fig. 11. The left vertical coordinate indicates the kernel density distribution. The higher the ' peak ' is, the more ' dense ' the data is here. The right vertical coordinate indicates the P value of the regression. The abscissa indicates that the random sampling coefficient is 0 as the mean.

Table 12
GMM endogeneity test for compensation incentives.

	dt	
	Coefficient	t
lnsalary3	3.1039***	(3.1629)
capin	−0.0013	(-0.8422)
lev	9.7082*	(1.8456)
return	−0.0036	(-0.6664)
cashflow	−0.0000	(-1.0542)
growth	−1.1952	(-0.7952)
soe	8.5675***	(2.8259)
shareholder1	−0.1743*	(-1.7112)
inst	−0.2296***	(-3.0832)
big4	−3.7811	(-0.5640)
TE	Yes	
FE	Yes	
N	29119	
AR(1)p	0.094	
AR(2)p	0.424	
Hansenp	0.334	

industrymean and the mean value of executive compensation provincemean as instrumental variables. At the same time, considering that any change in economic factors has certain inertia, the results of the previous period usually have an impact on the results of the latter period, and the corporate performance of listed companies has a lag effect. Therefore, we use systematic generalized moment estimation (GMM) to estimate a dynamic panel data model that is robust to potential endogeneity problems.

The regression results pass the stability test, and the coefficient symbol is consistent with the above. The P values of the Hansen test were 0.334, and the GMM test passed, so there was no endogenous problem in the model (See Table 12).

5. Further analysis

5.1. The mediating effect of business innovation

Based on the above research on executive incentive and corporate digital transformation, we use the mediating effect model summarized by Wen [68] to test whether executive incentive affects the digital transformation of corporations through business innovation. The first step is to test the impact of executive incentives on the digital transformation of corporations. The second step is to test the impact of executive incentives on digital business innovation. The third step is to take the digital transformation of corporations as the explanatory variable, executive incentive and business innovation as the explanatory variables. Following the above idea and combining with model (5)(6) above, we construct the mediating effect model set as follows. In the process of testing the influence mechanism, we construct the following models using stepwise regression, (9)(10) for testing the mediating effect of process innovation between equity incentives and digital transformation of corporations in the digital context, and (11)(12)for testing the mediating effect of business innovation between the two.

$$business\_innovation = \alpha_{51} + \alpha_{52}\text{incentive} + \sum_{i=2}^{10} \alpha_i controls + \lambda_i + \mu_t + \varepsilon_{i,t} \tag{9}$$

$$\text{dt} = \alpha_{61} + \alpha_{62}\text{incentive} + \alpha_{63} business\_innovation + \sum_{i=2}^{10} \alpha_i controls + \lambda_i + \mu_t + \varepsilon_{i,t} \tag{10}$$

$$business\_innovation = \alpha_{71} + \alpha_{72} lnsalary3 + \sum_{i=2}^{10} \alpha_i controls + \lambda_i + \mu_t + \varepsilon_{i,t} \tag{11}$$

$$\text{dt} = \alpha_{81} + \alpha_{82} lnsalary3 + \alpha_{83} business\_innovation + \sum_{i=2}^{10} \alpha_i controls + \lambda_i + \mu_t + \varepsilon_{i,t} \tag{12}$$

Tables 13 and 14 show the regression results of the mediated effects model. After controlling for time and individual effects, both equity incentives (*incentive*) and compensation incentives (*lnsalary3*) are significantly positive at the 1 % level. This means that business innovation is positively transmitted between executive incentives and the digital transformation of the corporate. In the digital context, companies incentivize executives, and executives will drive companies to initiate business innovation and develop business to complete digital transformation in order to achieve their goals. Hypothesis H5 is verified

Table 13
Analysis of the mechanism of business innovation in equity incentives.

	business_innovation		dt	
	Coefficient	t	Coefficient	t
incentive	1.5668***	(3.0266)	0.7711***	(5.5899)
capin	0.0001	(1.2684)	0.0000**	(1.9684)
lev	−0.0707	(-0.4722)	−0.0650	(-1.4403)
return	0.0000**	(2.2229)	0.0000***	(29.9535)
cashflow	0.0000	(1.2862)	−0.0000	(-0.9505)
growth	−0.0383***	(-3.4469)	0.0143***	(2.8787)
soe	−0.5879	(-0.5194)	0.2760	(0.8242)
shareholder1	−0.0749***	(-2.9319)	−0.0444***	(-5.4014)
inst	0.0133	(1.3219)	−0.0001	(-0.0253)
big4	−3.2162**	(-2.2195)	−0.2620	(-0.6338)
business_innovation			0.0754***	(26.0714)
_cons	41.5674***	(13.5936)	30.4098***	(34.0392)
TE	Yes		Yes	
FE	Yes		Yes	
N	29671		29671	
R^2	0.0185		0.3876	
Adj. R^2	0.0179		0.3872	

Table 14
Analysis of the mechanism of business innovation in compensation incentives.

	business_innovation		dt	
	Coefficient	t	Coefficient	t
lnsalary3	1.1721***	(2.8885)	0.6681***	(5.2351)
capin	0.0001	(1.2898)	0.0000**	(2.0485)
lev	−0.0546	(-0.3274)	−0.0350	(-0.6776)
return	0.0000	(1.3521)	0.0000***	(27.0104)
cashflow	0.0000	(1.2608)	−0.0000	(-0.9741)
growth	−0.0391***	(-3.6761)	0.0135***	(2.6887)
soe	−0.5488	(-0.4863)	0.2193	(0.6529)
shareholder1	−0.0786***	(-3.0116)	−0.0459***	(-5.4909)
inst	0.0126	(1.2316)	−0.0012	(-0.3472)
big4	−3.1174**	(-2.0999)	−0.2529	(-0.5999)
business_innovation			0.0749***	(25.6870)
_cons	25.2789***	(3.8285)	21.2205***	(10.4227)
TE	Yes		Yes	
FE	Yes		Yes	
N	29119		29119	
R^2	0.0187		0.3893	
Adj. R^2	0.0180		0.3888	

5.2. The mediating effect of process innovation

As above, we combine model (5)(6)and model the following model to explore whether process innovation in firms has a transmission mechanism between executive incentives and the digital transformation of corporates.

$$process\_innovation = \alpha_{91} + \alpha_{92}\text{incentive} + \sum_{i=2}^{10}\alpha_i controls + \lambda_i + \mu_t + \varepsilon_{i,t} \tag{13}$$

$$\text{dt} = \alpha_0 + \alpha_1\text{incentive} + \alpha_2 process\_innovation + \sum_{i=2}^{10}\alpha_i controls + \lambda_i + \mu_t + \varepsilon_{i,t} \tag{14}$$

$$process\_innovation = \alpha_3 + \alpha_4 lnsalary3 + \sum_{i=2}^{10}\alpha_i controls + \lambda_i + \mu_t + \varepsilon_{i,t} \tag{15}$$

$$\text{dt} = \alpha_5 + \alpha_6 lnsalary3 + \alpha_7 process\_innovation + \sum_{i=2}^{10}\alpha_i controls + \lambda_i + \mu_t + \varepsilon_{i,t} \tag{16}$$

Table 15 and Table 16 report the regression results of the mediating effect. It can be found that corporate process innovation plays a mediating effect between executive incentives and corporate digital transformation. Hypothesis H6 is tested.

Table 15
Analysis of the mechanism of process innovation in equity incentives.

	process_innovation		dt	
	Coefficient	t	Coefficient	t
incentive	2.4247***	(4.6420)	0.6946***	(5.0592)
capin	0.0000	(1.5598)	0.0000	(1.5999)
lev	0.2336**	(2.4191)	−0.0891**	(-1.9644)
return	0.0002***	(66.5907)	0.0000***	(5.4377)
cashflow	−0.0000	(-0.3425)	−0.0000	(-0.2511)
growth	0.0217**	(2.0834)	0.0096*	(1.9426)
soe	0.7442	(0.6912)	0.1719	(0.5063)
shareholder1	−0.0922***	(-3.5627)	−0.0426***	(-5.2370)
inst	−0.0237**	(-2.3077)	0.0028	(0.8758)
big4	1.1272	(0.8989)	−0.5951	(-1.4267)
process_innovation			0.0803***	(27.5061)
_cons	33.0681***	(12.1547)	30.8912***	(34.3654)
TE	Yes		Yes	
FE	Yes		Yes	
N	29671		29671	
R^2	0.0324		0.3940	
Adj. R^2	0.0318		0.3936	

5.3. Robustness tests of the mediating mechanism

In addition, the Sobel test was conducted on the regression results of the mediating effect. If the Sobel test is passed, the mediating effect is considered significant. The regression results in Table 17 show that the Aroia values are 12.571, 14.799, 19.273 and 11.258, respectively, and their p-values are 0, which indicates the existence of the mediating effect above. Executive incentive and compensation incentives promote executives to carry out digital transformation of the company by increasing the executives to carry out digital process innovation and develop digital business.

6. Conclusion and evaluation

Digital transformation is a crucial engine driving the shift from an industrial to a digital economy. With the rapid development of information technology and significant changes in market demand, digitalization has become deeply embedded in the real economy's development process. Corporate digital transformation is a strategic decision crucial for company development, and the implementation of any strategy is inseparable from the role of corporate executives. Stimulating executives' endogenous motivation to continually promote digital transformation is a long-standing issue in corporate governance. Our study empirically analyzes the relationship between executive incentives and corporate digital transformation. We conclude that: (1) Both equity and compensation incentives for executives accelerate the digital transformation of corporations. (2) The intensity of equity incentives has an inverted U-shaped relationship with corporate digital transformation, while the intensity of compensation incentives, beyond a certain threshold, displays a non-linear positive association with it. (3) Digital process innovation and digital business expansion play a mediating role between executive incentives and corporate digital transformation, implying that these incentives can contribute to digital transformation by accelerating such innovations and expansions. This paper enriches the research field on the antecedents of corporate digital transformation and the governance effects of executive incentives, providing a reference for Chinese listed companies in formulating executive incentive plans. This, in turn, can help alleviate agency conflict and maximize corporate interests.

In the context of digital transformation, this study examines two approaches to executive motivation, considering the impact of different motivational approaches on the advancement of digital transformation in enterprises. As an important aspect of corporate governance, executive incentives are indeed conducive to long-term enterprise development and can effectively accelerate digital transformation. However, due to differences among enterprises, it is essential to formulate appropriate executive incentive plans tailored to their specific needs. In terms of equity incentives, enterprises should adjust the intensity appropriately to fully enhance executives' enthusiasm and promote the implementation of corporate strategies. Regarding monetary compensation incentives, enterprises should quantify the level appropriately, avoiding undercompensation that might lead to employee turnover and overcompensation that could be counterproductive. These considerations are vital for the healthy development of enterprises.

This study, based on the perspective of executive incentives in listed companies, does not fully account for factors like the personal characteristics of executives, academic backgrounds, and organizational cognition, which can significantly influence the effectiveness of incentives. Additionally, China's capital market, though improving in efficiency, has not yet achieved semi-strong efficiency, and recent challenges like the COVID-19 pandemic have likely impacted digitalization processes. As enterprise digitalization deepens, future research could use methods like artificial neural networks to consider these factors and refine the impact of different incentive methods and characteristics on corporate digital transformation. Moreover, exploring non-material incentives such as positions, power, and honors could provide further insight into executive motivation and governance.

Table 16
Mechanism analysis of process innovation in compensation incentives.

	process_innovation		dt	
	Coefficient	t	Coefficient	t
lnsalary3	1.5093***	(3.7099)	0.6362***	(4.9712)
capin	0.0000*	(1.6929)	0.0000	(1.6175)
lev	0.2963**	(2.5172)	−0.0626	(-1.2180)
return	0.0002***	(63.7485)	0.0000***	(4.4322)
cashflow	−0.0000	(-0.3939)	−0.0000	(-0.2768)
growth	0.0202*	(1.7894)	0.0089*	(1.8275)
soe	0.6799	(0.6266)	0.1243	(0.3645)
shareholder1	−0.0960***	(-3.6217)	−0.0441***	(-5.3412)
inst	−0.0248**	(-2.3563)	0.0018	(0.5396)
big4	1.4261	(1.1224)	−0.5994	(-1.4093)
process_innovation			0.0793***	(27.1832)
_cons	11.6905*	(1.8791)	22.1864***	(10.8303)
TE	Yes		Yes	
FE	Yes		Yes	
N	29119		29119	
R^2	0.0325		0.3956	
Adj. R^2	0.0319		0.3952	

Table 17
Sobel teat.

	dt		dt		dt		dt	
	Coefficient	t	Coefficient	t	Coefficient	t	Coefficient	t
business_innovation	0.2101***	(88.1811)			0.2093***	(86.4495)		
incentive	3.4872***	(25.6071)	3.4923***	(24.6521)				
capin	−0.0000*	(-1.9341)	−0.0000	(-0.3564)	−0.0000*	(-1.9154)	−0.0000	(-0.2918)
lev	−0.4989***	(-6.4767)	−0.4845***	(-6.0538)	−0.5024***	(-6.2326)	−0.4861***	(-5.8282)
return	−0.0000	(-0.7366)	−0.0001	(-1.2795)	−0.0000	(-0.8243)	−0.0001	(-1.3655)
cashflow	0.0000	(0.6071)	0.0000	(1.1296)	0.0000	(0.7586)	0.0000	(1.3745)
growth	0.0089	(0.5891)	−0.0138	(-0.8776)	0.0065	(0.4279)	−0.0175	(-1.1091)
soe	−0.0095	(-0.0806)	−0.2380*	(-1.9391)	−0.4724***	(-4.0087)	−0.6770***	(-5.5566)
shareholder1	−0.0416***	(-11.2822)	−0.0544***	(-14.2154)	−0.0400***	(-10.6504)	−0.0517***	(-13.3267)
inst	−0.0184***	(-7.6352)	−0.0134***	(-5.3677)	−0.0285***	(-11.5099)	−0.0258***	(-10.0805)
big4	−0.3889*	(-1.8569)	−1.5425***	(-7.1078)	0.8834***	(4.0427)	−0.0040	(-0.0178)
process_innovation			0.1869***	(70.8054)			0.1885***	(71.1660)
lnsalary3					1.6804***	(21.7730)	2.0713***	(26.0539)
_cons	27.6508***	(55.9390)	31.2969***	(61.6299)	2.3182*	(1.8147)	−0.0727	(-0.0550)
TE	Yes		Yes		Yes		Yes	
FE	Yes		Yes		Yes		Yes	
N	29671		29671		29119		29119	
R^2	0.2808		0.2235		0.2780		0.2271	
Adj. R^2	0.2804		0.2230		0.2775		0.2266	
Sobel_Z	12.572		14.801		19.275		11.259	
Aroian_Z	12.571		**14.799**		19.273		11.258	
Goodman_Z	12.572		14.802		19.276		11.260	

Data availability statement

The data involves an extensive organizing process and is available upon request.

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CRediT authorship contribution statement

Jinrong Ma: Writing – review & editing, Writing – original draft, Supervision, Software, Conceptualization. **Hongbo Wang:** Validation, Methodology, Investigation, Funding acquisition.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Hongbo Wang reports a relationship with University of Science and Technology Liaoning that includes: funding grants. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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