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## Industry salary gap incentive and enterprise innovation

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## ABSTRACT

The impact of an industry salary gap on corporate innovation is a topic that has attracted great interest. To enrich and expand research on this topic, this research aims to measure this impact from the perspective of the governance effect. The results show that a salary gap across industries significantly drives enterprise innovation at firms with higher agency costs. According to this result, reducing agency costs is the potential mechanism that drives this effect. In this way, this salary gap can drive enterprise innovation. Also, the results provide further evidence that the industry salary gap drives enterprise innovation. In addition, the driving effect of the industry salary gap on enterprise innovation is more significant in industries experiencing a recession and in enterprises with higher financial issues.

## 1. Introduction

In recent years, the issue of the salary gap within enterprises has attracted considerable attention from the public, media, and researchers (Kong et al., 2017; Li & Hu, 2012; Liang, Jimbo et al., 2019). Also, government departments have repeatedly issued policies and measures aimed at restricting the compensation of senior executives at state-owned enterprises (SOEs). For example, a compensation reform plan that was issued in 2015 and directly affects the heads of SOEs managed by the central government limits the compensation gap between senior executives and ordinary employees to a factor of less than eight (i.e., the former can be no higher than eight times that of the latter).

Although research in this field mainly focuses on the impact of salary gap within a firm, namely the internal salary gap (Kong et al., 2017; Li & Hu, 2012; Liang, Jimbo et al., 2019; Main et al., 1993), research on salary gap within an industry, namely external or industry salary gap is still in its infancy. For instance, Coles, Li, & Wang (2018) and Huang et al. (2019) studied the impact of salary gap on corporate performance and corporate cash holdings, respectively. However, a research gap is how an industry salary gap at the macro level affects the behavior of enterprises at the micro level, specifically innovation behavior.

Enterprises are the main locus of innovation which has increasingly become the cornerstone of national competitiveness due to the continuous development of economic globalization (Shirazi et al., 2020; Nodehi et al., 2022). Scientific and technological innovation is an effective way for enterprises not only to gain a competitive advantage but also to promote sustainable economic development (Nasrollahi et al., 2020; Solow, 1957). This analysis shows the great significance of cultivating and encouraging enterprises to

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innovate. However, the innovation process in enterprises faces serious risks including high uncertainty, a high investment failure rate, and the long investment cycle of enterprise innovation investment (Chu et al., 2021; Holmstrom, 1989; Yu et al., 2022). The enterprise's management is more reluctant to carry out high-risk innovation activities for risk avoidance. Therefore, a critical issue is the effective motivation of enterprise management to get more willing to take risks. A crucial way for this motivation is compensation which is also an important mechanism of corporate governance. Therefore, studying the impact of the industry salary gap on enterprise innovation behavior not only expands and improves the relevant theories on the enterprise salary gap but also provides new support for the practice of enterprise innovation and improvement in government innovation policies. Moreover, such investigation can contribute to the literature on corporate governance, offering valuable insights for future research.

This study investigates the governance effect of the industry salary gap incentive on enterprise innovation behavior, using a sample consisting of China's 2005–2018 Shanghai and Shenzhen A-share<sup>1</sup> listed companies. For this investigation, this study proposes the following three questions. First, does the industry salary gap affect enterprise innovation? Second, what is the mechanism of this effect? Third, if the industry salary gap affects enterprise innovation, under what circumstances is its impact more significant? This research tries to answer these questions by constructing variables to measure the industry salary gap and enterprise innovation. Following Coles, Li, & Wang (2018) and Huang et al. (2019), this study measures the industry salary gap at an enterprise using the gap in salary between an enterprise's CEO and that of the second-highest enterprise in the same industry. In addition, this research employs the number of invention patents, cited, granted, and applied by enterprises to measure the innovation level of enterprises. Then, regression analysis indicates that the industry salary gap of CEOs has a significant and positive impact on enterprise innovation, confirming the tournament theory.<sup>2</sup> The results of the mechanism test show that the CEO industry salary gap incentive has a more significant and greater positive effect on enterprise innovation when the enterprise agency cost is relatively high. This result indicates that the reduction in agency cost is the potential mechanism in which the CEO's industry salary gap affects enterprise innovation. Further research shows that the industry and the micro characteristics of the enterprise are other factors affecting the impact of the CEO's industry salary gap on enterprise innovation. This effect is more significant when the industry is in a recession and the enterprise has financial difficulties and fewer opportunities for external development.

The paper makes a marginal contribution to the literature as follows. First, this paper enriches and expands the literature on the enterprise and corporate salary gap which has attracted increasing attention from the media, public, and relevant government departments in recent years. Existing studies mainly focus on the economic consequences of the internal salary gap, including its impact on enterprise performance (Banker et al., 2016; Kale et al., 2009; Li & Hu, 2012; Li et al., 2014; Liang, Jimbo et al., 2019; Liu & Sun, 2010), labor productivity (Dai et al., 2017; Faley et al., 2013), and enterprise innovation (Jiang et al., 2018; Kong et al., 2017). From the perspective of the industry salary gap, the impact on enterprise micro behavior mainly focuses on enterprise violations, audit fees, enterprise performance, and cash holdings (Coles, Li, & Wang, 2018; Jia, 2017; Huang et al., 2019). At present, few studies have explored the impact of industry salary gap on enterprise innovation and the specific impact mechanism. Therefore, this paper fills a gap in the existing research by exploring the impact of industry salary gap on enterprise innovation.

Second, this paper enriches the research on enterprise innovation by focusing on the innovation behavior and innovation performance of enterprises, which offers new evidence that improves enterprises' innovation practices and government innovation policies. Innovation has increasingly become the cornerstone of national competitiveness due to the in-depth development of economic globalization. Enterprises are the main sites of innovation. Scientific and technological innovation is not only an important source of competitive advantage for enterprises (Zhao & Meng, 2016) but also a key factor in sustainable economic development (Taghvaei et al., 2023; Parsa et al., 2019). Therefore, a practically significant issue is the exploration of how to cultivate and encourage enterprises to innovate, which has also become an important issue of academic concern (Tian & Tracy, 2014). The existing research on enterprise innovation mainly focuses on the factors that influence enterprise innovation, in terms of behavior and performance, such as how corporate governance, financing constraints, the legal system, and social culture (Aghion et al., 2013; Amore et al., 2013; Ang et al., 2015; Balsmeier et al., 2017; Chemmanur & Tian, 2018; Ni & Zhu, 2016). From the perspective of corporate governance, this paper explores the innovation behavior and performance of enterprises regarding the industry salary gap, which expands and deepens research on enterprise innovation.

## 2. Theoretical analysis and research assumptions

In the modern enterprise system, the separation of ownership and management rights often gives rise to agency conflicts between the company's executives and shareholders (Jensen & Meckling, 1976; Liu et al., 2006). To incentivize the company's executives to operate the enterprise in a manner that maximizes shareholders' interests and reduces agency costs, shareholders need to provide appropriate incentives to these executives. The compensation incentives for executives include not only absolute compensation incentives but also the use of a compensation gap. This paper specifically examines CEO compensation from the perspective of the industry compensation gap, and discusses the potential governance effect of this gap on enterprise innovation behavior. This paper

<sup>1</sup> A-share index refers to the stock index reflecting the trend of A-share. There are dozens of A-share indexes used in China, including Shanghai Stock Exchange Index. The A-share index is almost synchronized with the changes in the stock market, which is an indispensable reference for Chinese investors and securities practitioners to study and judge the trend of stock price changes.

<sup>2</sup> The tournament theory was jointly proposed by Lazear and Rosen. According to the championship theory, the wage increase rate associated with the established promotion will affect the employees' enthusiasm below the job level. As long as the result of promotion is unclear, employees have the motivation to work hard for promotion. Therefore, the theory advocates that enterprises should motivate employees through promotion.

argues that the industry salary gap can have both positive and negative impacts on enterprise innovation.

On one hand, the industry pay gap might drive enterprise innovation. Tournament theory considers the pay gap among various levels of an enterprise as a reward for winning the tournament and advancing to a higher level [Chen et al. \(2011\)](#). Based on this theory, a differentiated payment system motivates employees to exert more effort in the tournament, promoting winning employees with higher pay. This internal competition model remains applicable to enterprises because the enterprise's CEO not only holds a pivotal role as the main decision-maker and implementer of innovation within the enterprise, but also ranks among the highest-paid individuals within the enterprise. Hence, the salary level of an enterprise's CEO is comparable with that of the other CEOs in the industry. Due to the cohort effect, a CEO compares his/her own salary with that of the other CEOs with similar scales in the industry. According to the championship theory, CEO's incentive depends on the gap between a CEO's salary and the highest CEO's salary in the industry. A sufficiently large gap motivates CEOs to strive to improve their own operational efficiency, management skills, and productivity, leading to a reduction in the enterprises' agency costs and an increase in innovation level. The salary gap can encourage employees to make greater efforts in the tournament, with the prospect of winning leading to promotions and higher salaries for successful employees ([Lazear & Rosen, 1981](#)). Many studies analyzed the incentive effect of the tournament mechanism on enterprise employees from the perspective of a multistage continuous game ([Kale et al., 2009](#); [Li & Hu, 2012](#); [Liang, Yu, et al., 2019](#); [Main et al., 1993](#); [Rosen, 1986](#)). [Rosen \(1986\)](#) confirmed the positive impact of a salary gap on corporate performance. Such analysis can consider the tournament theory within both enterprises and industries. In general, the CEO is not only the most important maker and implementer of innovation decisions at an enterprise, but also among the highest-paid individuals within the organization. Therefore, the salary gap among an enterprise's CEOs is likely to be comparable to that of CEOs at other enterprises. In addition to the comparison with a specific enterprise, CEOs compare their salaries with other CEOs at enterprises of similar size in the same industry because of the influence of the same group effect.

Therefore, the tournament theory shows that a wide gap in salary between CEOs at two firms in the same industry can motivate the less-paid CEOs to improve their management and to engage in activities with higher risk to enhance the enterprise's performance. For example, [Coles, Li, & Wang \(2018\)](#) studied the CEO salary gap in an industry, and found that the tournament incentive effect caused by the salary gap has a significant and promotional effect on enterprise performance. Innovation and new technologies are not only the most fundamental driving force in promoting economic transformation ([Mohamad Taghvaei et al., 2022](#)) but also the most important way to improve the competitive advantage of enterprises. Innovation can enhance enterprise performance ([Atanassov, 2013](#); [Ciftci & Cready, 2011](#); [Pandit et al., 2011](#); [Wu & Tang, 2016](#)). Therefore, this analysis infers when an industry salary gap is sufficiently wide, the tournament effect generated by the salary gap will motivate a CEO in that industry to improve company performance by raising the enterprise's innovation level. According to this analysis, this research proposes the following hypothesis.

**Hypothesis 1.** A salary gap between CEOs in an industry will motivate those CEOs to increase enterprise innovation.

However, another competition theory—the fair and relative comparison theory, first articulated by [Adams \(1965\)](#)—also analyzes the impact of the governance effect on enterprise innovation due to the salary gap in the industry. According to the fairness theory, unfair treatment dissatisfies individuals since they expect payment in proportion to their contribution. [Alesina et al. \(2004\)](#) found that individuals are less likely to show a tendency to report happiness in case of high inequality, even after controlling the influencing factors of country, year, and a large number of personal characteristics. This result confirms the negative impact of inequality on individual utility. Therefore, employees feel inequality if income gap is wide, leading to mood swings and low morale ([Chen & Sandino, 2012](#)). In addition, this sense of unfairness motivates employees to find alternative ways to compensate for the unfairness of salaries, so as to inhibit employees' labor output or drive an increase in the employee turnover rate ([Cowherd & Levine, 1992](#)). Relative comparison theory holds that in the absence of objective evaluation criteria or external benchmarks, people evaluate themselves in comparison to others and develop perceptions of fairness in the process. Therefore, employees compare their salaries in a horizontal comparison. When employees find that their own salary level is lower than that of others, they will easily find it unfair. This feeling dampens their work enthusiasm and leads them to reduce their work effort ([Akerlof & Yellen, 1990](#); [Martin & Murnighan, 1981](#)). For example, enterprise management will be more reluctant to perform innovation activities with higher risk.

Furthermore, in Chinese traditional culture, the feeling of suffering more because of inequality than oligopoly is based on the concept of fairness. Therefore, under the same-group effect, CEOs can easily compare their salary levels with those of CEOs at other enterprises in the same industry. According to the theory of fairness and relative comparison, CEOs perceive unfairness if a large gap exists between their salary levels and those of CEOs at other enterprises in the same industry. This feeling dampens their enthusiasm and tamps down their efforts, especially in innovation activities. Innovation is an investment process of intangible assets in long-term, unlike the enterprises' investment behavior of general fixed assets. Also, the process of innovation is accompanied by a high degree of uncertainty and a high failure rate ([Holmstrom, 1989](#)), which engenders great risks for an enterprise in the process of innovation and creates the need for CEOs to make greater efforts toward driving enterprise innovation and take higher innovation risk ([Kothari et al., 2002](#)). Therefore, when the salary gap is wide between CEOs in the same industry, CEOs will find the situation unfair and hold back on their work effort. In this environment, they become more reluctant to undertake high-risk investment activities, which reduces the innovation investment by enterprises. This analysis proposes the second hypothesis.

**Hypothesis 2.** A salary gap between CEOs in an industry inhibits enterprise innovation.

### 3. Research design

#### 3.1. Samples and data sources

This study measures the governance effect of an industry salary gap on enterprise innovation behavior using China's A-share listed companies from 2005 to 2018 as the initial research sample. This research screens the original sample data based on the following principles. The data process omits sample data on financial listed companies, on ST and PT<sup>3</sup> companies, and the missing data of the main variables. After screening, the final sample of this paper totals annual observations on 24,476 enterprises. In order to reduce the influence of extreme values on the regression results, all continuous variables were treated with winsorized at 1 %. The enterprise patent application and patent reference data are from the China Research Data Service (CNRDS) platform, CEO salary data come from the Wind database, and the main financial data on other companies come from the CSMAR database.

#### 3.2. Variable definition

##### 3.2.1. Enterprise innovation

Number of invention patents (*Ln (Patent)*):

This variable is the number of invention patents applied by company  $i$  and granted in year  $t + 1$  in natural logarithm, used to measure the number of enterprise innovations. The quantity of patents applied by enterprises reflects the efficiency of their investment in research and development (R&D) as well as the capability of their technological innovation (Ernst, 2001; Fang et al., 2014; Kong et al., 2017; Wang et al., 2018). This research measures the innovation level of enterprises by the number of patents granted and applied by enterprises. This measurement truncates the number of patents due to the time interval between the year of filing a patent application and the year of its actual granting. This approach uses the method of Hall et al. (2001, 2005) and data on patent applications and grants within 2005 and 2010 to calculate the proportion of patents granted every year after patent applications and obtained the time distribution of patent grants. Then, this method uses the equation  $P_{adj} = P_{raw} / \sum_{s=0}^{2018-t} W_s$  to adjust the number of patents from 2016 to 2018, where  $P_{adj}$  is the number of patents granted and applied by the company after adjustment in year  $t$ ,  $P_{raw}$  is the number of patents granted and applied without adjustment in year  $t$ , and  $W_s$  is the proportion of patents granted in year  $s$  since the application year,  $\sum_{s=0}^{2016-t} W_s$  is the sum of the proportion of patents granted since the application year.

Number of invention patents cited (*Ln (Citation)*):

This variable is the average number of citations of each invention patent of the company in year  $t$  after adjusting the application year and the technical field of the company, plus the natural logarithm of 1. This index measures the quality of enterprise innovation. Specifically, this research first calculates the average number of citations of all invention patents applied and granted in a certain application year  $t$  and a certain technical field  $j$ . Then, this study divides the number of citations of each patent by its corresponding application year and the average number of citations of patents in the same technical field to calculate the adjusted number of citations of each patent. Furthermore, this data process averages the adjusted patent citations at the company level to obtain the average number of citations of each patent adjusted by the application year and the technical field at the company level. Finally, this process adds the resulted values to 1 to take their natural logarithm.

##### 3.2.2. Industry salary gap

Following Coles et al. (2018) and Huang et al. (2019), this research measures the salary gap between enterprises in the same industry, using the gap in salary between the CEOs at enterprises and the second-highest enterprises in the same industry and the same scale. The compensation of CEO, rather than other executives, is a proper index for measurement because CEO is the most important person who makes and implements enterprise innovation decisions. In addition, the gap between the compensation level of a CEO and that of other CEOs in the industry can have a direct impact on the CEO's business decisions, which in turn can affect the performance of the enterprise (Coles et al., 2018). Specifically, this paper defines the CEO industry salary gap as the natural logarithm of the difference between the CEO salary of a target enterprise and the CEO salary of the second-highest enterprise within the same scale of the same industry plus 1. When this difference is greater, so is the gap in CEO salary between enterprises in the same industry. Generally, the following steps construct the variables. The first step sorts listed companies into different groups based on the industry classification standard of the China Securities Regulatory Commission (CSRC) in 2012, in which manufacturing uses a three-quantile classification while non-manufacturing uses a one-quantile classification. The second step considers the impact of the enterprise scale on the CEO compensation level in an industry to divide enterprises in an industry into large- and small-scale based on the industry-year median operating income at an enterprise. The next step reduces the possible extreme influence of the highest CEO compensation level in an industry using the second-highest CEO compensation level in an industry in a year as the benchmark value for CEO compensation in the corresponding year-industry scale enterprises. This benchmark value is then subtracted from the CEO compensation level of the

<sup>3</sup> If a listed company has suffered losses for two consecutive years, has suffered losses for one year and its net assets have fallen below the par value, or has committed major illegal activities during the operation, the stock exchange will deal with the company's shares in a special way, known as the ST system. For ST companies, if further issues arise, such as continuing to lose money in the next year and thus reaching the limit of loss for three consecutive years in the company law, PT treatment shall be carried out. The PT system is a special arrangement adopted by the stock exchange for the stock circulation of companies whose listing is suspended. The purpose is to enhance the market liquidity and effectively protect the interests of the majority of small and medium investors.

corresponding enterprise, which permits a more reliable analysis of CEO compensation levels within the industry while minimizing the impact of extreme values.<sup>4</sup> The final step constructs the indicator for the CEO industry salary gap (Gap) by adding 1 to this value and taking the logarithm. The robustness analysis applies several other measurements of an industry salary gap and found that the results are still robust.

### 3.2.3. Other control variables

Following the practice in relevant research on enterprise innovation (Fang et al., 2014; He & Tian, 2013; Kong et al., 2017; Wu & Tang, 2016), the multiple regression analysis control for a series of other company characteristics that affect enterprise innovation, including enterprise size (*Size*), enterprise age (*Age*), financial leverage (*Lev*), cashflow from operating activities (*CFO*), enterprise performance (*ROA*), firm ownership (*SOE*), enterprise development opportunities (*Q*), scale of intangible assets (*Intangible*), board size (*Director*), independent directors and shareholdings of major shareholders (*Independent*), and the shareholding ratio of major shareholders (*Shareholdings*). Also, the multiple regression model adds firm and year effects to control for the individual enterprise characteristics that are constant over time and the impact of annual impact factors. Table 1 represents the symbols, definitions, and measurements of the variables.

### 3.3. Descriptive statistical results

Table 2 reports the descriptive statistical results of the main variables. According to Table 2, enterprises have applied for and obtained 17.6 invention patent licenses on average every year, but a large gap exists in the number of invention patent applications between different enterprises, with a standard deviation of 41.401. The results are similar for citations of invention patents (*Citation*). The average number of citations for each invention patent is 0.627 per year but with a substantial variation in citation counts among different invention patents, as evidenced by a standard deviation of 0.641. The results are also similar to the descriptive statistical results of utility model patents (*Model*), with a standard deviation of 42.712. In the descriptive statistical results of the explanatory variable industry salary gap, the mean in natural logarithm is 13.313, the maximum is 16.078, and the standard deviation is 2.966. The natural logarithm of the average total asset (*Size*) size of the enterprises in the sample is 21.835, but the gap in scale is relatively large between different enterprises, and its standard deviation reaches 1.221. About 39.6 % of the observed values in the sample are SOEs, and the average shareholding of the largest shareholder is 34.9 %. In the subsequent stage, a more rigorous multiple regression analysis empirically tests the impact of the industry pay gap incentive on enterprise innovation.

## 4. Empirical results and analysis

### 4.1. Basic regression analysis

The following regression estimates the impact of an industry salary gap on enterprise innovation.

$$\text{Innovation}_{i,t} = \alpha + \beta \text{Gap}_{i,t} + \gamma X_{i,t} + \text{Firm Fixed Effects} + \text{Year Fixed Effects} + \varepsilon_{i,t} \quad (1)$$

where  $\text{Innovation}_{i,t}$  is the innovation level of enterprise  $i$  in year  $t$ , measured by the number of invention patents applied by the enterprise and granted each year plus the natural logarithm of 1 ( $\ln(\text{Patent})$ ) and the average number of citations of each invention patent after adjustment of the technology category and application year plus the natural logarithm of 1 ( $\ln(\text{Citation})$ );  $\text{Gap}_{i,t}$  shows the industry salary gap at enterprise  $i$  in year  $t$ , measured by the natural logarithm of the difference in CEO salaries between two enterprises at a similar scale in the same industry in the same year plus 1;  $X_{i,t}$  is a series of control variables that affect enterprise innovation, as defined above; Firm Fixed Effects and Year Fixed Effects are to control the individual characteristics that remain constant over time and at the enterprise level, respectively;  $\varepsilon_{i,t}$  denotes error term;  $\alpha$  indicates intercept; and  $\beta$  and  $\gamma$  are coefficients of the variables. All the regressions use robust standard errors to obtain more accurate  $t$ -statistics.

Table 3 reports the regression results of model (1). The dependent variables in Columns (1) and (2) are the number of invention patents applied by the enterprise and granted in the year plus the natural logarithm of 1 ( $\ln(\text{Patent})$ ). The dependent variables in Columns (3) and (4) are the average number of citations of each invention patent after adjusting the application year and technical category plus the natural logarithm of 1 ( $\ln(\text{Citation})$ ). Columns (1) and (3) exclude any control variables, and Columns (2) and (4) add a series of enterprise-level control variables, defined above. The regression results show that the estimated coefficients of the industry salary gap variables (*Gap*) are positive and statistically significant at least at 5 % level. This result implies that the industry salary gap incentives of enterprise CEOs significantly promote enterprise innovation, which confirms the tournament theory and H1.

The results in Columns (2) and (4) of Table 3 have economic significance. For example, for each increase in the industry salary gap by a standard deviation of 2.966, the number of enterprise invention patent applications increases by 0.033 ( $2.966 \times 0.011$ ). Also, the number of invention patents cited increases by 0.006 ( $2.966 \times 0.002$ ). These results are equivalent to an average number of enterprise invention patent applications of 2.04 % ( $0.033/1.600$ ) and an average number of cited invention patents of 1.45 % ( $0.006/0.413$ ). According to the results, larger (*Size*) and older (*Age*) enterprises with a higher proportion of intangible assets (*Intangible*) tend to show

<sup>4</sup> In order to make the analysis more stable, this section will delete the highest CEO salary of the same level in the same industry in the same year. The robustness test shows that the conclusion remains stable even if the highest CEO salary is used.

**Table 1**  
Variable definitions and measures.

| Variable   | Label                | Definition   |
|--|----------------------|--|
| Natural logarithm of invention patents                   | <i>Ln (Patent)</i>   | Natural logarithm of the number of invention patents applied by the enterprise and granted annually plus 1   |
| Number of invention patents                              | <i>Patent</i>        | Original value of the number of invention patents applied by the enterprise in a year  |
| Natural logarithm of times the invention patent is cited | <i>Ln (Citation)</i> | Natural logarithm of the number of citations of each invention patent of the company after adjustment of application year and technical category plus 1  |
| Times of cited invention patents                         | <i>Citation</i>      | Original value of the average number of citations of each invention patent of the company after adjustment of application year and technical category  |
| Natural logarithm of utility model patents               | <i>Ln (Model)</i>    | Natural logarithm of the number of utility model patents applied by the enterprise in a year plus 1  |
| Number of utility model patents                          | <i>Model</i>         | Original value of annual number of utility model patents applied by the enterprise   |
| Natural logarithm of design patents                      | <i>Ln (Design)</i>   | Natural logarithm of the number of design patents applied by the enterprise in a year plus 1   |
| Number of design patents                                 | <i>Design</i>        | Original value of the number of design patents applied by the enterprise in the year   |
| Industry salary gap                                      | <i>Gap</i>           | Natural logarithm of the gap between CEO's salary and that of the second highest CEO in the same industry and the same scale plus 1  |
| Enterprise size  | <i>Size</i>          | Natural logarithm of total assets of the enterprise at the end of the year (in RMB)  |
| Enterprise age   | <i>Age</i>           | Natural logarithm of the difference between the year of establishment and the year of observation plus 1   |
| financial leverage                                       | <i>Lev</i>           | Ratio of total liabilities to total assets at the end of the period  |
| Cash flow from operating activities                      | <i>CFO</i>           | Ratio of net cash flow from operating activities at the end of the period to total assets at the end of the period   |
| Enterprise performance                                   | <i>ROA</i>           | Ratio of net profit to total assets at the end of the period   |
| Ownership of enterprise                                  | <i>SOE</i>           | Ownership of the equity of the actual controller of the enterprise. If the owner of the equity of the actual controller is a government or state-owned enterprise, it is 1; otherwise, it is 0 |
| Enterprise growth  | <i>Q</i>             | Ratio of the sum of equity market value and net debt market value at the end of the period to the total assets at the end of the period  |
| Enterprise intangible assets                             | <i>Intangible</i>    | Ratio of net intangible assets to total assets at the end of the period  |
| Board size   | <i>Director</i>      | Natural logarithm of the number of directors at the end of the year plus 1   |
| Proportion of independent directors                      | <i>Independent</i>   | Ratio of the number of independent directors to the number of directors at the end of the period   |
| Shareholding ratio of major shareholders                 | <i>Shareholdings</i> | Shareholding ratio of the largest shareholder at the end of the period   |
| Annual fixed effect                                      | <i>Year</i>          | Sample period of 2005–2019 with 14 dummy variables   |
| Industry fixed effect                                    | <i>Industry</i>      | 17 industries and 16 dummy variables according to the industry classification guidelines of the CSRC in 2012   |
| Provincial fixed effect                                  | <i>Province</i>      | 31 provinces, autonomous regions, and municipalities directly under the central government, comprising 30 dummy variables  |

**Table 2**  
Descriptive statistics of the main variables (N = 24,476).

| Variable             | Mean   | P25    | P50    | P75    | SD     | Min    | Max    |
|----------------------|--------|--------|--------|--------|--------|--------|--------|
| <i>Ln (Patent)</i>   | 1.600  | 0.000  | 1.386  | 2.708  | 1.531  | 0.000  | 5.455  |
| <i>Patent</i>        | 17.601 | 0.000  | 3.000  | 14.000 | 41.401 | 0.000  | 233.00 |
| <i>Ln (Citation)</i> | 0.413  | 0.000  | 0.454  | 0.705  | 0.378  | 0.000  | 1.242  |
| <i>Citation</i>      | 0.627  | 0.000  | 0.574  | 1.025  | 0.641  | 0.000  | 2.462  |
| <i>Ln (Model)</i>    | 1.479  | 0.000  | 1.099  | 2.708  | 1.571  | 0.000  | 5.727  |
| <i>Model</i>         | 16.75  | 0.000  | 2.000  | 14.000 | 42.712 | 0.000  | 306    |
| <i>Gap</i>           | 13.313 | 13.133 | 13.897 | 14.590 | 2.966  | 0.000  | 16.078 |
| <i>Size</i>          | 21.835 | 20.938 | 21.690 | 22.537 | 1.221  | 19.496 | 25.675 |
| <i>Age</i>           | 2.767  | 2.565  | 2.773  | 2.996  | 0.342  | 1.946  | 3.526  |
| <i>Leverage</i>      | 0.438  | 0.265  | 0.432  | 0.599  | 0.217  | 0.0500 | 0.976  |
| <i>CFO</i>           | 0.043  | 0.003  | 0.043  | 0.085  | 0.073  | -0.177 | 0.246  |
| <i>ROA</i>           | 0.036  | 0.014  | 0.037  | 0.065  | 0.065  | -0.322 | 0.192  |
| <i>SOE</i>           | 0.396  | 0.000  | 0.000  | 1.000  | 0.489  | 0.000  | 1.000  |
| <i>Q</i>             | 2.655  | 1.403  | 2.024  | 3.189  | 1.916  | 0.873  | 11.46  |
| <i>Intangible</i>    | 0.047  | 0.016  | 0.033  | 0.058  | 0.052  | 0.000  | 0.321  |
| <i>Director</i>      | 2.299  | 2.197  | 2.303  | 2.485  | 0.245  | 1.609  | 2.944  |
| <i>Independent</i>   | 0.385  | 0.333  | 0.375  | 0.429  | 0.098  | 0.000  | 0.636  |
| <i>Shareholdings</i> | 0.349  | 0.233  | 0.329  | 0.450  | 0.147  | 0.088  | 0.730  |

Notes: P25, P50, and P75 denote the 25th, 50th, and 75th percentile means, respectively. SD signifies the standard deviation value.

**Table 3**  
Industry salary gap and enterprise innovation.

| Variables                 | (1)<br><i>Ln (Patent)</i> | (2)<br><i>Ln (Patent)</i> | (3)<br><i>Ln (Citation)</i> | (4)<br><i>Ln (Citation)</i> | (5)<br><i>Ln (Model)</i> | (6)<br><i>Ln (Design)</i> |
|---------------------------|---------------------------|---------------------------|-----------------------------|-----------------------------|--------------------------|---------------------------|
| <i>Gap</i>                | 0.013***<br>(4.85)        | 0.011***<br>(4.26)        | 0.002**<br>(2.48)           | 0.002**<br>(2.42)           | 0.003<br>(1.21)          | -0.00005<br>(-0.02)       |
| <i>Size</i>               |                           | 0.204***<br>(7.54)        |                             | 0.042***<br>(6.50)          | 0.345***<br>(12.11)      | 0.165***<br>(8.46)        |
| <i>Age</i>                |                           | 1.504***<br>(7.56)        |                             | 0.197***<br>(4.08)          | 0.855***<br>(4.77)       | 0.135<br>(1.06)           |
| <i>Leverage</i>           |                           | 0.129<br>(1.58)           |                             | -0.025<br>(-1.10)           | 0.057<br>(0.65)          | 0.051<br>(0.88)           |
| <i>CFO</i>                |                           | 0.242***<br>(2.85)        |                             | 0.003<br>(0.09)             | 0.037<br>(0.37)          | -0.268***<br>(-3.59)      |
| <i>ROA</i>                |                           | -0.436***<br>(-3.78)      |                             | 0.002<br>(0.06)             | 0.205<br>(1.46)          | 0.180*<br>(1.83)          |
| <i>SOE</i>                |                           | 0.036<br>(0.55)           |                             | 0.006<br>(0.35)             | -0.012<br>(-0.20)        | -0.095**<br>(-2.38)       |
| <i>Q</i>                  |                           | -0.002<br>(-0.32)         |                             | 0.004**<br>(2.03)           | -0.010<br>(-1.59)        | -0.000<br>(-0.05)         |
| <i>Intangible</i>         |                           | 0.845***<br>(3.07)        |                             | 0.168**<br>(2.36)           | 0.853***<br>(3.19)       | 0.309*<br>(1.72)          |
| <i>Director</i>           |                           | -0.019<br>(-0.60)         |                             | -0.002<br>(-0.16)           | 0.011<br>(0.28)          | -0.022<br>(-0.77)         |
| <i>Independent</i>        |                           | 0.066<br>(0.99)           |                             | 0.010<br>(0.36)             | 0.115<br>(1.30)          | -0.008<br>(-0.11)         |
| <i>Shareholdings</i>      |                           | -0.005***<br>(-3.03)      |                             | -0.000<br>(-1.11)           | -0.003**<br>(-2.09)      | -0.004***<br>(-2.92)      |
| Constant                  | 1.432***<br>(41.48)       | -7.076***<br>(-9.55)      | 0.384***<br>(32.25)         | -1.074***<br>(-5.66)        | -8.464***<br>(-11.11)    | -3.232***<br>(-6.06)      |
| <i>N</i>                  | 24476                     | 24476                     | 24476                       | 24476                       | 24476                    | 24476                     |
| <i>Firm Fixed Effects</i> | YES                       | YES                       | YES                         | YES                         | YES                      | YES                       |
| <i>Year Fixed Effects</i> | YES                       | YES                       | YES                         | YES                         | YES                      | YES                       |
| <i>R</i> <sup>2</sup>     | 0.871                     | 0.879                     | 0.571                       | 0.574                       | 0.783                    | 0.696                     |

Notes: \*, \*\*, and \*\*\* indicate statistical significance at 10 %, 5 %, and 1 % levels, respectively. Robust standard errors are clustered at the enterprise level. t-statistics are in parentheses.

a relatively higher level of innovation output and quality.<sup>5</sup>

The results in Column (5) of Table 3 show the impact of gap (*Gap*) on the number of utility model patents (*Ln (Model)*) with a low technological level. According to Column (5), the coefficients of gap (*Gap*) are statistically insignificant, rejecting its effect on the number of utility model patents (*Ln (Model)*). The results in Column (6) indicate the impact of gap (*Gap*) on (*Ln (design)*) at a lower technical level. Similarly, the estimated coefficients of the gap (*Gap*) variables are near zero and statistically insignificant, refusing its effect. This result shows that the promotional effect of the industry salary gap on enterprise innovation is reflected only in invention patents with the highest technical level and citation numbers, without any obvious promotional effect on utility model patents and design patents with a lower technical level.

To address the impact of the pay gap among employees within a company on its innovation, the following two approaches adjust the industry pay gap metrics. These approaches specifically capture the potential concern about the impact of employee pay gaps within companies on innovation.

First, this research directly tests the potential impact of employee pay gaps within firms on innovation. Following Faleye et al. (2013) and Banker et al. (2016), the employee pay gap (*Internal\_Gap*) within the enterprise refers to the ratio of average management compensation (*AMP*) to average employee compensation (*AEP*). The management includes all officers, directors (except independent directors), and supervisors, while employees refer to all ordinary employees. Specifically, *AMP* is equal to "total annual remuneration of directors, supervisors, and officers" divided by the size of management. In this definition, management size is defined as the sum of "number of directors", "number of officers" and "number of supervisors" minus "number of independent directors" and "number of directors, supervisors, or officers who have not received compensation". In addition, the *AEP* equals the change in "total remuneration payable to employees" plus "cash paid to and for employees" minus "total annual salary of directors, supervisors, and officers" divided by the number of employees. This research re-estimates the regressions by replacing *Gap* as an independent variable with the intra-firm pay gap variable (*Internal\_Gap*). The results are in Columns (1) and (2) in Table 4. According to the results, the estimated coefficient of the intra-firm pay gap variable (*Internal\_Gap*) is statistically insignificant, rejecting the effect of the intra-firm pay gap on innovation.

<sup>5</sup> According to China's Patent Law, patents have three categories: invention patents, utility model patents, and design patents. Invention patents have the largest technical content, followed by utility model patents. Design patents are for new designs regarding the shape, pattern, or a combination of products, as well as combinations of colors, shapes, and patterns. Their technical content is far lower than that of invention and utility model patents.

**Table 4**  
Internal\_Gap and enterprise innovation.

| Variables                 | (1)<br><i>Ln (Patent)</i> | (2)<br><i>Ln (Citation)</i> | (3)<br><i>Ln (Patent)</i> | (4)<br><i>Ln (Citation)</i> |
|---------------------------|---------------------------|-----------------------------|---------------------------|-----------------------------|
| <i>Internal_Gap</i>       | 0.002<br>(0.20)           | 0.009<br>(0.74)             |                           |                             |
| <i>Gap</i>                |                           |                             | 0.012***<br>(4.52)        | 0.002**<br>(2.49)           |
| <i>Size</i>               | -0.143***<br>(-10.54)     | 0.070***<br>(6.24)          | 0.199***<br>(7.30)        | 0.041***<br>(6.30)          |
| <i>Age</i>                | 0.575***<br>(5.14)        | 0.230***<br>(2.86)          | 1.505***<br>(7.76)        | 0.181***<br>(3.86)          |
| <i>Leverage</i>           | 0.046<br>(1.07)           | -0.049<br>(-1.24)           | 0.118<br>(1.45)           | -0.024<br>(-1.09)           |
| <i>CFO</i>                | 0.089*<br>(1.86)          | -0.007<br>(-0.13)           | 0.243***<br>(2.85)        | 0.008<br>(0.26)             |
| <i>ROA</i>                | -0.152**<br>(-2.02)       | 0.023<br>(0.36)             | -0.440***<br>(-3.88)      | -0.003<br>(-0.09)           |
| <i>SOE</i>                | 0.010<br>(0.25)           | -0.008<br>(-0.27)           | 0.040<br>(0.58)           | -0.005<br>(-0.29)           |
| <i>Q</i>                  | 0.014***<br>(3.82)        | 0.005<br>(1.36)             | -0.002<br>(-0.43)         | 0.003<br>(1.62)             |
| <i>Intangible</i>         | 0.294**<br>(2.06)         | 0.287**<br>(2.33)           | 0.827***<br>(3.01)        | 0.182**<br>(2.55)           |
| <i>Director</i>           | 0.000<br>(0.02)           | -0.003<br>(-0.13)           | -0.018<br>(-0.59)         | -0.002<br>(-0.16)           |
| <i>Independent</i>        | 0.005<br>(0.12)           | 0.023<br>(0.47)             | 0.064<br>(0.96)           | 0.017<br>(0.62)             |
| <i>Shareholdings</i>      | 0.000<br>(0.05)           | -0.001<br>(-0.94)           | -0.005***<br>(-3.01)      | -0.001<br>(-1.25)           |
| <i>Internal_Gap</i>       |                           |                             | 0.026<br>(1.09)           | 0.007<br>(0.95)             |
| Constant                  | 1.861***<br>(4.61)        | -1.541***<br>(-4.74)        | -7.008***<br>(-9.59)      | -1.008***<br>(-5.40)        |
| <i>N</i>                  | 24476                     | 24476                       | 24476                     | 24476                       |
| <i>Firm Fixed Effects</i> | YES                       | YES                         | YES                       | YES                         |
| <i>Year Fixed Effects</i> | YES                       | YES                         | YES                       | YES                         |
| <i>R</i> <sup>2</sup>     | 0.809                     | 0.522                       | 0.879                     | 0.575                       |

Notes: \*, \*\*, and \*\*\* indicate statistical significance at 10 %, 5 %, and 1 % levels, respectively. Robust standard errors are clustered at the enterprise level. t-statistics are in parentheses.

Secondly, this paper adds the intra-firm pay gap variable as a control variable to the benchmark regression results. Table 4 represents the results in Columns (3) and (4). According to Table 4, the industry pay gap variable (*Gap*) is still positive and statistically significant at 1 % level, implying the robustness and stability of the resulted estimation.

In summary, the results show that the industry pay gap index constructed in this paper does not only reflect the impact of the pay gap among employees within the enterprise on innovation, but also captures the impact of some other unobservable characteristics of the enterprise.

#### 4.2. Endogeneity problems

Table 3 demonstrates reverse causality and missing variables in the results of the impact of the industry salary gap on enterprise innovation. Regarding Table 3, a large gap might exist at the CEO salary level in the industry due to improvement at the enterprise innovation level, or a pseudo correlation might exist between them because of omitting the other control variables. Therefore, this section reduces the endogeneity problems in the model by controlling for potential missing variables and instrumental variables.

##### 4.2.1. Controlling for potential missing variables

Previous studies have shown that an important factor effective in the enterprise innovation is the characteristics of the province where the company headquarters are located, such as banking industry reform, financial development level, legal protection, and enforcement of intellectual property rights (Chava et al., 2013; Chemmanur & Tian, 2018; Fang et al., 2017; Hsu et al., 2014). In addition, macro-level policy factors might also affect the CEO's salary and the enterprise's innovation. For example, the reform plan for the remuneration of people in charge of centrally managed SOEs, implemented on January 1, 2015, has limited executive compensation at centrally managed enterprises. Since then, all provinces have successively introduced similar policies to cap executive compensation at local SOEs. Therefore, this section adds a (*Province* × *Year*) fixed effect to control the impact of these factors at provincial-level on enterprise innovation over time. The results are in the first two columns of Table 5. Column (1) reports the test results of the dependent variable, which is the number of patent applications (*Ln (Patent)*). Column (2) reports the test results of the dependent variable, which is the number of patent citations (*Ln (Citation)*). The test results still support the tournament theory, that is,

**Table 5**  
Endogeneity test results.

| Variable                  | (1)                  | (2)                  | (3)                   | (4)                           |                      |
|---------------------------|----------------------|----------------------|-----------------------|-------------------------------|----------------------|
|                           | <i>Ln (Patent)</i>   | <i>Ln (Citation)</i> | Phase 1<br><i>Gap</i> | Phase 2<br><i>Ln (Patent)</i> | <i>Ln (Citation)</i> |
| <i>Gap</i>                | 0.010***<br>(3.78)   | 0.002**<br>(2.20)    |                       |                               |                      |
| <i>Sum_pay</i>            |                      |                      | 0.923***<br>(10.52)   |                               |                      |
| <i>Mean_pay</i>           |                      |                      | -0.178***<br>(-6.75)  |                               |                      |
| <i>EGap</i>               |                      |                      |                       | 0.176***<br>(6.15)            | 0.015***<br>(2.63)   |
| <i>Size</i>               | 0.204***<br>(7.92)   | 0.041***<br>(6.33)   | -0.036<br>(-0.74)     | 0.203***<br>(7.17)            | 0.042***<br>(6.49)   |
| <i>Age</i>                | 1.495***<br>(7.28)   | 0.168***<br>(3.24)   | 0.253<br>(0.70)       | 1.452***<br>(7.10)            | 0.193***<br>(3.98)   |
| <i>Leverage</i>           | 0.093<br>(1.17)      | -0.028<br>(-1.25)    | 0.394**<br>(2.55)     | 0.080<br>(0.93)               | -0.028<br>(-1.27)    |
| <i>CFO</i>                | 0.193**<br>(2.32)    | 0.004<br>(0.11)      | -0.158<br>(-0.60)     | 0.254***<br>(2.65)            | 0.004<br>(0.12)      |
| <i>ROA</i>                | -0.450***<br>(-3.94) | 0.002<br>(0.04)      | -0.862***<br>(-2.84)  | -0.206<br>(-1.55)             | 0.020<br>(0.53)      |
| <i>SOE</i>                | 0.027<br>(0.41)      | 0.008<br>(0.48)      | 0.265*<br>(1.90)      | 0.009<br>(0.13)               | 0.004<br>(0.22)      |
| <i>Q</i>                  | -0.001<br>(-0.26)    | 0.004*<br>(1.88)     | -0.053***<br>(-3.11)  | 0.004<br>(0.65)               | 0.004**<br>(2.23)    |
| <i>Intangible</i>         | 0.847***<br>(3.08)   | 0.163**<br>(2.29)    | -0.006<br>(-0.01)     | 0.877***<br>(3.19)            | 0.171**<br>(2.40)    |
| <i>Director</i>           | -0.008<br>(-0.25)    | -0.004<br>(-0.35)    | -0.036<br>(-0.43)     | -0.004<br>(-0.11)             | -0.001<br>(-0.06)    |
| <i>Independent</i>        | 0.039<br>(0.59)      | 0.011<br>(0.41)      | -0.117<br>(-0.59)     | 0.077<br>(1.03)               | 0.011<br>(0.39)      |
| <i>Shareholdings</i>      | -0.004***<br>(-2.67) | -0.0003<br>(-1.17)   | 0.002<br>(0.57)       | -0.005***<br>(-2.79)          | -0.0002<br>(-1.09)   |
| Constant                  | -6.999***<br>(-9.21) | -0.952***<br>(-4.50) | -7.560***<br>(-1.22)  | -8.658***<br>(-11.70)         | -6.550***<br>(-1.29) |
| <i>N</i>                  | 24476                | 24476                | 24476                 | 24476                         | 24476                |
| <i>Firm Fixed Effects</i> | YES                  | YES                  | YES                   | YES                           | YES                  |
| <i>Year Fixed Effects</i> | NO                   | NO                   | YES                   | YES                           | YES                  |
| <i>Province × Year</i>    | YES                  | YES                  | NO                    | NO                            | NO                   |
| <i>R<sup>2</sup></i>      | 0.886                | 0.585                | 0.506                 |                               |                      |
| <i>IV F statistics</i>    |                      |                      | 408.77                |                               |                      |

Notes: \*, \*\*, and \*\*\* indicate statistical significance at 10 %, 5 %, and 1 % levels, respectively. Robust standard errors are clustered at the enterprise level. t-statistics are in parentheses.

the incentive of industry salary gap drives enterprise innovation.

#### 4.2.2. Instrumental variables

This section addresses the problem of endogeneity and potential reverse causality using two instrumental variables (IVs) as explanatory variables for the CEO industry salary gap, according to Coles, Li, & Wang (2018), Huang et al. (2019), and Kubick et al. (2018). The first IV is the total pay level of CEOs in the industry, excluding the sample enterprises (*Sum\_pay*). Previous studies show that the salary level of employees depends on the payment ability of the enterprise, implying that the total salary of the industry reflects the payment ability in the industry (Kahneman et al., 1986; Dickens & Katz, 1986). If an industry has a high payment ability, enterprises within the industry are more likely to offer higher salaries to their CEOs, resulting in a higher industry salary. Coles, Li, & Wang (2018) also found a positive relationship between the industry's ability to pay and the CEO salary gap in the industry, without any direct impacts on the innovation level of individual enterprises. The second IV is the average salary level of CEOs in their cities (*Mean\_pay*), excluding the sample enterprises. Coles, Li, & Wang (2018) advocated that the average salary level of regional CEOs affects the salary gap of industry CEOs by affecting the salary level of specific CEOs in the industry. A high average salary of regional CEOs entails the relatively high salary of their local CEOs, which may narrow the salary gap between industry CEOs. However, it is unlikely that the average salary level of regional CEOs directly affects the innovation level of enterprises, which meets the requirement of exogeneity.

Columns (3) and (4) of Table 5 report the two-stage regression results of the IVs. In the first-stage regression, the regression coefficients of the two IVs are statistically significant at 1 % level, indicating the strong correlations of IVs with *Gap*. Specifically, the estimated coefficient of the total salary level of CEOs in an industry is positive and statistically significant. In contrast, the estimated coefficient of the average salary level of regional CEOs is negative and statistically significant. This result indicates that a wide industry

**Table 6**  
Mechanism test results.

| Panel A: Shareholding ratio of management |                                  |                                   |                                    |                                     |
|---|----------------------------------|-----------------------------------|------------------------------------|-------------------------------------|
| Ratio Variable                            | (1)<br>Low<br><i>Ln (Patent)</i> | (2)<br>High<br><i>Ln (Patent)</i> | (3)<br>Low<br><i>Ln (Citation)</i> | (4)<br>High<br><i>Ln (Citation)</i> |
| <i>Gap</i>                                | 0.012***<br>(4.14)               | -0.001<br>(-0.20)                 | 0.004***<br>(3.38)                 | -0.0002<br>(-0.13)                  |
| <i>Size</i>                               | 0.114***<br>(3.70)               | 0.257***<br>(8.52)                | 0.044***<br>(5.21)                 | 0.045***<br>(4.50)                  |
| <i>Age</i>                                | 1.583***<br>(5.82)               | 1.036***<br>(4.40)                | 0.233***<br>(3.62)                 | 0.164**<br>(2.06)                   |
| <i>Leverage</i>                           | 0.131<br>(1.33)                  | -0.020<br>(-0.20)                 | -0.029<br>(-0.94)                  | -0.050<br>(-1.40)                   |
| <i>CFO</i>                                | 0.053<br>(0.53)                  | 0.215**<br>(2.07)                 | 0.045<br>(1.14)                    | -0.074<br>(-1.35)                   |
| <i>ROA</i>                                | -0.256*<br>(-1.79)               | -0.205<br>(-1.53)                 | 0.033<br>(0.63)                    | -0.043<br>(-0.76)                   |
| <i>SOE</i>                                | 0.047<br>(0.60)                  | 0.134<br>(1.54)                   | -0.019<br>(-0.96)                  | 0.014<br>(0.42)                     |
| <i>Q</i>                                  | -0.012<br>(-1.50)                | -0.006<br>(-1.03)                 | 0.002<br>(0.56)                    | 0.002<br>(0.57)                     |
| <i>Intangible</i>                         | 0.747**<br>(2.29)                | 0.955***<br>(2.90)                | 0.237**<br>(2.45)                  | 0.153<br>(1.39)                     |
| <i>Director</i>                           | 0.005<br>(0.13)                  | -0.021<br>(-0.58)                 | -0.010<br>(-0.61)                  | 0.007<br>(0.40)                     |
| <i>Independent</i>                        | 0.049<br>(0.57)                  | 0.124*<br>(1.70)                  | 0.001<br>(0.04)                    | 0.038<br>(0.96)                     |
| <i>Shareholdings</i>                      | -0.004**<br>(-2.01)              | 0.001<br>(0.38)                   | -0.001*<br>(-1.87)                 | -0.0002<br>(-0.35)                  |
| Constant                                  | -5.771***<br>(-6.12)             | -6.526***<br>(-7.32)              | -1.252***<br>(-4.95)               | -0.954***<br>(-3.07)                |
| <i>N</i>                                  | 12775                            | 10988                             | 12775                              | 10988                               |
| <i>Firm Fixed Effects</i>                 | YES                              | YES                               | YES                                | YES                                 |
| <i>Year Fixed Effects</i>                 | YES                              | YES                               | YES                                | YES                                 |
| <i>R</i> <sup>2</sup>                     | 0.888                            | 0.930                             | 0.611                              | 0.591                               |
| Panel B: Total asset turnover             |                                  |                                   |                                    |                                     |
| Turnover                                  | (1)<br>Low<br><i>Ln (Patent)</i> | (2)<br>High<br><i>Ln (Patent)</i> | (3)<br>Low<br><i>Ln(Citation)</i>  | (4)<br>High<br><i>Ln (Citation)</i> |
| <i>Gap</i>                                | 0.014***<br>(3.50)               | 0.006*<br>(1.85)                  | 0.003***<br>(2.59)                 | 0.001<br>(1.21)                     |
| <i>Size</i>                               | 0.145***<br>(4.10)               | 0.264***<br>(7.09)                | 0.039***<br>(4.21)                 | 0.049***<br>(5.31)                  |
| <i>Age</i>                                | 1.589***<br>(5.98)               | 1.295***<br>(4.87)                | 0.102<br>(1.45)                    | 0.255***<br>(3.99)                  |
| <i>Leverage</i>                           | 0.044<br>(0.42)                  | 0.093<br>(0.81)                   | 0.003<br>(0.11)                    | -0.067**<br>(-2.04)                 |
| <i>CFO</i>                                | 0.096<br>(0.87)                  | 0.418***<br>(3.35)                | -0.021<br>(-0.47)                  | 0.077*<br>(1.66)                    |
| <i>ROA</i>                                | -0.443***<br>(-2.95)             | -0.372**<br>(-2.31)               | 0.095*<br>(1.84)                   | -0.099*<br>(-1.70)                  |
| <i>SOE</i>                                | -0.058<br>(-0.67)                | 0.176*<br>(1.75)                  | -0.011<br>(-0.45)                  | 0.009<br>(0.42)                     |
| <i>Q</i>                                  | 0.005<br>(0.73)                  | -0.020**<br>(-2.45)               | 0.005*<br>(1.89)                   | 0.002<br>(0.55)                     |
| <i>Intangible</i>                         | 0.689**<br>(2.10)                | 0.863**<br>(2.10)                 | 0.236***<br>(2.74)                 | 0.050<br>(0.42)                     |
| <i>Director</i>                           | -0.035<br>(-0.85)                | -0.017<br>(-0.41)                 | 0.001<br>(0.09)                    | -0.004<br>(-0.22)                   |
| <i>Independent</i>                        | 0.110<br>(1.23)                  | 0.081<br>(0.87)                   | 0.021<br>(0.54)                    | 0.031<br>(0.76)                     |
| <i>Shareholdings</i>                      | -0.005**<br>(-2.27)              | -0.004*<br>(-1.84)                | -0.001<br>(-1.05)                  | -0.001<br>(-1.15)                   |
| Constant                                  | -6.075***<br>(-5.97)             | -7.684***<br>(-7.75)              | -1.785***<br>(-2.86)               | -1.326***<br>(-5.19)                |
| <i>N</i>                                  | 12542                            | 11443                             | 12542                              | 11443                               |
| <i>Firm Fixed Effects</i>                 | YES                              | YES                               | YES                                | YES                                 |
| <i>Year Fixed Effects</i>                 | YES                              | YES                               | YES                                | YES                                 |
| <i>R</i> <sup>2</sup>                     | 0.884                            | 0.898                             | 0.604                              | 0.593                               |

Notes: \*, \*\*, and \*\*\* indicate statistical significance at 10 %, 5 %, and 1 % levels, respectively. Robust standard errors are clustered at the enterprise level. t-statistics are in parentheses.

salary gap exists between CEOs at enterprises with a high salary level and those of regional CEOs in the same industry with a low average salary. The *F* statistic of the IV is 61.85, much larger than 408.77, i.e., the critical value found by Stock et al. (2002), rejecting the original assumption that the IV is weak. Based on the estimates of *Ln (Patent)* and *Ln (Citation)* as dependent variables in the second-stage regression, the estimated coefficients of *Gap* are positive and statistically significant at 1 % level. This result is consistent with the benchmark regression results, indicating that the industry salary gap still has a positive and significant impact on enterprise innovation, even after controlling the potential endogeneity problems.

#### 4.3. Mechanism analysis

The regression results presented above confirm the positive relationship between the industry salary gap and enterprise innovation, suggesting a synergistic effect. Then, this section further discusses the underlying mechanism through which the industry salary gap affects enterprise innovation. One possible mechanism is through executive governance, as the industry salary gap incentive encourages the management to work harder, which reduces the agency costs of the enterprise. Therefore, the analysis below considers a hypothesis with another potential impact, based on which the industry salary gap incentive drives enterprise innovation by reducing agency costs of an enterprise.

Innovation differs from general fixed asset investment by enterprises due to substantial risk, high information asymmetry, and a long investment cycle. These characteristics make the innovation investment riskier for enterprises, which in turn makes them unwilling to engage in such activities, specifically the management. For this reason, an important way for promoting the enterprise innovation is to motivate enterprise managers, including the CEOs. The tournament effect caused by the industry salary gap is conducive to the CEO's efforts to improve the enterprise's operation and management mode and reduce the enterprise's agency cost. Moreover, existing studies show that a reduction in agency costs significantly drives enterprise innovation (Luong et al., 2017). Based on this analysis, the tournament effect of the industry salary gap drives the innovation activities by enterprises through the mechanism of reducing agency costs. If this mechanism holds, the industry salary gap must play a stronger role in driving enterprise innovation at enterprises with higher agency costs. Following Ang et al. (2000) and Miller et al. (2007), the two subsequent indicators measure an enterprise's agency cost: management shareholdings and total asset turnover. These indicators have a positive association with each

**Table 7**  
Impact of the industry pay gap on the agency cost of enterprises.

| Variable           | (1)<br>Charge          | (2)<br>Ratio          |
|--------------------|------------------------|-----------------------|
| Gap                | -0.0003 *<br>(-1.69)   | 0.004 ***<br>(4.71)   |
| Size               | -0.020 ***<br>(-8.87)  | -0.070 ***<br>(-6.82) |
| Age                | 0.019 *<br>(1.81)      | 0.170 ***<br>(3.14)   |
| Leverage           | 0.008<br>(0.99)        | 0.195 ***<br>(6.62)   |
| CFO                | -0.050 ***<br>(-5.56)  | 0.369 ***<br>(11.75)  |
| ROA                | -0.297 ***<br>(-16.16) | 0.674 ***<br>(12.01)  |
| SOE                | -0.011 *<br>(-1.85)    | 0.002<br>(0.12)       |
| Q                  | 0.005 ***<br>(8.60)    | 0.006 ***<br>(3.11)   |
| Intangible         | 0.153 ***<br>(5.95)    | -0.313 ***<br>(-3.16) |
| Director           | 0.001<br>(0.24)        | 0.025 **<br>(2.28)    |
| Independent        | -0.010 *<br>(-1.87)    | -0.059 ***<br>(-2.70) |
| Shareholdings      | -0.0004 ***<br>(-4.10) | 0.001<br>(1.24)       |
| Constant           | 0.488 ***<br>(9.83)    | 1.446 ***<br>(5.55)   |
| N                  | 24476                  | 24476                 |
| Firm Fixed Effects | YES                    | YES                   |
| Year Fixed Effects | YES                    | YES                   |
| R2                 | 0.709                  | 0.818                 |

Notes: \*, \*\*, and \*\*\* indicate statistical significance at 10 %, 5 %, and 1 % levels, respectively. Robust standard errors are clustered at the enterprise level. t-statistics are in parentheses.

other, and a negative connection with total agency cost. Based on the median value of the industry agency cost variable in the sample, we divide the sample into two groups: the first with high agency costs and the second with low agency costs. Panels A and B in Table 6 represent the estimation results of Model (1). Regardless of the size or significance of the coefficients, the industry salary gap incentive variable (*Gap*) has a higher coefficient in the high agency cost group. This result suggests that the reduction in agency costs is a potential mechanism that affects enterprise innovation.

This research examines the direct impact of the industry's pay gap on corporate agency costs Referring to Ang et al. (2000), this examination uses two indicators to measure the agency cost of enterprises. The first indicator is the management expense ratio of enterprises (*Charge*), measured by the ratio of enterprise management expenses to total operating income. The second indicator is the turnover ratio of total assets of enterprises (*Ratio*), calculated as the ratio of total operating income to total assets at the end of the period. Generally, the higher the management expense ratio and the total asset turnover rate, the lower the agency cost in the enterprise. If the industry pay gap can promote business innovation by reducing the cost of corporate agency, then the industry pay gap will expectedly reduce the management expense ratio of enterprises and increase their total asset turnover. Table 7 reports the test results. The estimated coefficient of the industry gap variable (*Gap*) is negative and statistically significant at 10 % level, in case of (*Change*) as the dependent variable (*Charge*), while it is positive and statistically significant at 1 % level, in case of (*Ratio*) as the dependent variable. These two conflicting signs determine the total asset turnover ratio of the enterprise (*Ratio*). This result indicates the reducing effect of the industry pay gap variable on agency costs.

#### 4.4. Heterogeneous impact of industry salary gap on enterprise innovation

The regression results represented above confirm the positive impact of the industry salary gap on enterprise innovation. According to these results, the industry salary gap incentive drives enterprise innovation by strengthening the risk-seeking character of enterprises. Also, these results mean that a reduction in agency costs is another potential mechanism through which the industry pay gap affects enterprise innovation.

Then, this research theoretically predicts under what circumstances an industry salary gap has a greater impact on enterprise innovation and empirically tests the results of the theoretical prediction. This approach can confirm the causal relationship and its mechanism in the industry salary gap incentive and enterprise innovation. If the empirical evidence does not support the theoretical prediction, then their causal relationship is open to question. Specifically, this paper examines the following three aspects.

##### 4.4.1. Industry growth

The impact of a salary gap in an industry on enterprise innovation can also be affected by growth in the industry. When an industry is in recession and experiences a low level of growth, enterprises have fewer opportunities for external development, which increases business risk. If management is risk-averse, it is unlikely to carry out high-risk innovation and investment activities during the recession period of the industry. In this environment, the industry salary gap can be an alternative for motivating the enterprise managers to accept riskier investments and activities. For this reason, industry salary gap can catalyze enterprise innovation during economic downturns in the business cycles. Following Benmelech and Frydman (2015), we measure industry growth as *ROA\_Industry* weighted by the total assets of all listed companies in the industry in different years. Then, we divide the firms based on the median value of industry growth. If the growth of the sample industry is higher than the median, the period is defined as a high industry growth; otherwise, it is a low industry growth.<sup>6</sup> Table 8 represents the estimation results of Model (1). Columns (1) and (3) report the results for the period of low industry growth, and Columns (2) and (4) report the results for the period of high industry growth. In the period of low industry growth, the coefficients of the salary gap variables are positive and statistically significant at 1 % level. In the period of high industry growth, however, the coefficients are either statistically insignificant or significant at a lower level. This result shows that the industry salary gap of the CEO of the enterprise plays a more significant role in promoting the innovation of the enterprise during a recession period in industry.

##### 4.4.2. Financial distress of the company

This research further examines the impact of a company's financial distress. Financial distress increases the operational and bankruptcy risks in an enterprise. Since bankruptcy increases the managers' expectations of losses in a company, they tend to adopt a stable operating mode and reduce the investment in high-risk innovation activities so as to risk avoidance. In this case, they need stronger incentives for engaging in risk-taking activities, which increases the incentive effect of the industry salary gap. Based on this analysis, the industry salary gap plays a stronger role in driving enterprise innovation, in the case of great financial issues in the company. According to Altman (1968) in terms of measuring financial distress, a firm with a z-score tends to face less financial distress. The annual median value of the z-score is a criterion to divide the sample into two groups: 1- with high financial distress and 2- with low financial distress. In Table 9, Columns (1) and (3) report the results of estimating Model (1) for the first group, and Columns (2) and (4) represent the corresponding results for the second group. With regard to the results in Table 8, the coefficients of the salary gap are positive and statistically significant at 1 % level in the first group, but insignificant in the second group. This result implies that the industry salary gap of the CEO plays a stronger role in driving enterprise innovation, when a company has great financial distress.

<sup>6</sup> We also set the first 25 % quantile in the sample interval as a period of high industry growth and the last 25 % quantile as a period of low industry growth. We retested and found that the results were still robust. This paper avoids reporting these results due to the word limitations.

**Table 8**  
Industry salary gap, industry growth, and enterprise innovation.

| Industry growth Variable | (1)<br>Low<br>Ln (Patent) | (2)<br>High<br>Ln (Patent) | (3)<br>Low<br>Ln (Citation) | (4)<br>High<br>Ln (Citation) |
|--------------------------|---------------------------|----------------------------|-----------------------------|------------------------------|
| Gap                      | 0.011***<br>(3.46)        | 0.006*<br>(1.78)           | 0.003***<br>(2.65)          | -0.0007<br>(-0.25)           |
| Size                     | 0.201***<br>(6.52)        | 0.190***<br>(6.16)         | 0.034***<br>(4.30)          | 0.050***<br>(5.17)           |
| Age                      | 1.313***<br>(5.57)        | 1.468***<br>(6.55)         | 0.131**<br>(2.18)           | 0.197***<br>(2.74)           |
| Leverage                 | 0.152<br>(1.55)           | 0.167*<br>(1.72)           | -0.015<br>(-0.51)           | -0.036<br>(-1.05)            |
| CFO                      | 0.131<br>(1.18)           | 0.159<br>(1.57)            | -0.040<br>(-0.88)           | 0.030<br>(0.63)              |
| ROA                      | -0.398***<br>(-2.72)      | -0.402***<br>(-2.65)       | 0.041<br>(0.81)             | -0.131*<br>(-1.86)           |
| SOE                      | 0.094<br>(1.18)           | 0.003<br>(0.04)            | 0.010<br>(0.50)             | 0.001<br>(0.02)              |
| Q                        | -0.003<br>(-0.46)         | -0.003<br>(-0.47)          | 0.002<br>(0.75)             | 0.005<br>(1.54)              |
| Intangible               | 0.654**<br>(2.00)         | 0.663**<br>(2.06)          | 0.183*<br>(1.85)            | 0.101<br>(1.02)              |
| Director                 | -0.036<br>(-0.99)         | 0.014<br>(0.32)            | 0.0004<br>(0.03)            | -0.005<br>(-0.25)            |
| Independent              | 0.111<br>(1.43)           | 0.050<br>(0.44)            | 0.048<br>(1.36)             | -0.020<br>(-0.39)            |
| Shareholdings            | -0.004**<br>(-2.10)       | -0.004**<br>(-2.03)        | -0.0004<br>(-0.31)          | -0.001<br>(-1.50)            |
| Constant                 | -6.457***<br>(-7.31)      | -6.797***<br>(-8.16)       | -0.752***<br>(-3.20)        | -1.172***<br>(-4.21)         |
| N                        | 12966                     | 10784                      | 12966                       | 10784                        |
| Firm Fixed Effects       | YES                       | YES                        | YES                         | YES                          |
| Year Fixed Effects       | YES                       | YES                        | YES                         | YES                          |
| R <sup>2</sup>           | 0.906                     | 0.900                      | 0.635                       | 0.618                        |

Notes: \*, \*\*, and \*\*\* indicate statistical significance at 10 %, 5 %, and 1 % levels, respectively. Robust standard errors are clustered at the enterprise level. t-statistics are in parentheses.

#### 4.4.3. Enterprise growth

This paper examines whether the impact of the industry pay gap on enterprise innovation is affected by the growth of enterprises. because innovation is an important way to improve the core competitiveness of enterprises and promote the growth of enterprises. This study investigates the relationship between industry pay gap and enterprise innovation in the context of enterprise growth due to the crucial role of innovation in enhancing the core competitiveness and growth of businesses. Enterprises experiencing lower growth have limited and inadequate development opportunities. Also, risk-avertter managers avoid investing in high-risk innovation activities. To tackle these issues, the board of directors should develop recovery policies like compensation schemes. Therefore, the promotional effect of the salary gap in the industry on the innovation level of enterprises is expected to be more significant in enterprises with lower growth. Following Hu (2021), Tobin’s Q measures the enterprise growth with a direct relationship. The annual median value of the variable for enterprise growth in the sample is a criterion for dividing the sample into two groups: 1- with high growth and 2- with low growth. In Table 10, Columns (1) and (3) present the results of Model (1) for the low-growth group, and Columns (2) and (4) show the corresponding results for the high-growth group. The results show that the coefficients of the salary gap are positive and statistically significant at 1 % level in the low-growth group, but insignificant in the high-growth group. This result shows that the industry salary gap of enterprise CEOs plays a more significant role in promoting the innovation level of low-growth enterprises than high-growth enterprises, which is consistent with our expectations.

#### 4.5. Consequences of the industry salary gap

This section employs the following model to investigate whether the improvement effect of the industry pay gap on the innovation level of enterprises has a positive effect on the future compensation of CEOs.

$$\ln(\text{Salary})_{i,t+1} = \beta_0 + \beta_1 \text{Innovation}_{i,t} + \beta_2 \text{Gap}_{i,t} + \beta_3 \text{Gap}_{i,t} * \text{Innovation}_{i,t} + \beta \mathbf{X}_{i,t} +$$

$$\text{Firm Fixed Effects} + \text{Year fixed effects} + e_{i,t}$$

where  $\mathbf{X}$  is the vector of explanatory variables,  $i$  and  $t$  are the company and year, respectively,  $B_s$  are the coefficients of the variables,  $e$  denotes error term, and the remaining symbols have been defined previously in Table 1. The focus is on  $\beta_3$ , the regression coefficient of the multiplication of the industry pay gap variable (*Gap*) and the enterprise innovation level variable. If this coefficient is positive, the

**Table 9**  
Intra-industry salary gap, corporate financial distress, and corporate innovation.

|                           | (1)                  | (2)                  | (3)                  | (4)                  |
|---------------------------|----------------------|----------------------|----------------------|----------------------|
| Financial distress        | High                 | Low                  | High                 | Low                  |
| Variable                  | <i>Ln (Patent)</i>   | <i>Ln (Patent)</i>   | <i>Ln (Citation)</i> | <i>Ln (Citation)</i> |
| <i>Gap</i>                | 0.015***<br>(4.67)   | 0.0006<br>(0.02)     | 0.003***<br>(2.78)   | 0.001<br>(0.64)      |
| <i>Size</i>               | 0.125***<br>(3.86)   | 0.323***<br>(8.99)   | 0.042***<br>(4.88)   | 0.037***<br>(3.31)   |
| <i>Age</i>                | 1.992***<br>(7.65)   | 0.831***<br>(3.07)   | 0.305***<br>(4.53)   | 0.116<br>(1.53)      |
| <i>Leverage</i>           | 0.001<br>(0.01)      | 0.184*<br>(1.68)     | -0.050*<br>(-1.65)   | 0.019<br>(0.54)      |
| <i>CFO</i>                | 0.144<br>(1.43)      | 0.194<br>(1.55)      | 0.059<br>(1.47)      | -0.089*<br>(-1.68)   |
| <i>ROA</i>                | -0.450***<br>(-3.22) | -0.336**<br>(-2.18)  | -0.033<br>(-0.64)    | 0.033<br>(0.58)      |
| <i>SOE</i>                | 0.093<br>(1.23)      | 0.071<br>(0.75)      | 0.009<br>(0.43)      | -0.013<br>(-0.51)    |
| <i>Q</i>                  | -0.003<br>(-0.42)    | -0.002<br>(-0.32)    | 0.004<br>(1.41)      | 0.003<br>(1.02)      |
| <i>Intangible</i>         | 1.010***<br>(3.05)   | 0.850**<br>(2.33)    | 0.308***<br>(3.17)   | 0.043<br>(0.41)      |
| <i>Director</i>           | 0.030<br>(0.71)      | -0.041<br>(-1.03)    | -0.002<br>(-0.14)    | -0.010<br>(-0.53)    |
| <i>Independent</i>        | -0.024<br>(-0.28)    | 0.090<br>(1.00)      | -0.004<br>(-0.10)    | 0.034<br>(0.82)      |
| <i>Shareholdings</i>      | -0.004**<br>(-2.36)  | -0.001<br>(-0.28)    | -0.0003<br>(-0.58)   | -0.0005<br>(-0.61)   |
| Constant                  | -7.117***<br>(-7.49) | -7.433***<br>(-7.30) | -1.446***<br>(-5.56) | -0.647**<br>(-2.06)  |
| <i>N</i>                  | 12628                | 11422                | 12628                | 11422                |
| <i>Firm Fixed Effects</i> | YES                  | YES                  | YES                  | YES                  |
| <i>Year Fixed Effects</i> | YES                  | YES                  | YES                  | YES                  |
| <i>R</i> <sup>2</sup>     | 0.888                | 0.915                | 0.611                | 0.581                |

Notes: \*, \*\*, and \*\*\* indicate statistical significance at 10 %, 5 %, and 1 % levels, respectively. Robust standard errors are clustered at the enterprise level. t-statistics are in parentheses.

effect of industry pay gap on the innovation level of enterprises can improve the future compensation of corporate CEOs. Table 11 represents the estimation results of the regression.

According to Column (1), the multiplication of industry pay gap variable (*Gap*) and firm innovation level variable, *Ln (Patent)*, has a positive coefficient which is significant at 5 % level. Based on column (2), the multiplication of industry pay gap variable (*Gap*) and citations per invention patent, *Ln (Citation)*, has a positive coefficient, which is statistically insignificant. An explanation for this insignificant relationship is that the citation of patents is a long-term process, and the impact on CEO compensation is not apparent in the short term. Therefore, this result shows that the role of industry pay gap on enterprise innovation can lead to higher salary levels for CEOs in the future, which further confirms the validity of the tournament theory.

Furthermore, this research tests whether the industry's salary gap can help the CEO achieve faster promotion. This investigation focuses on the perspective of promotion because the CEO of the company is already the highest position that the management can achieve in the company.

#### 4.6. Robustness test

This research conducts a series of tests to check the robustness of the results.

##### 4.6.1. Replacing explanatory variable

The robustness tests use the natural logarithm measurement of the gap between the salaries of the first and second chairmen of the board at the same scale in the same industry plus 1 as an alternative to the main explanatory variable. Table 12 represents the estimated results in Columns (1) and (2) of panel A. The estimated coefficient of the industry salary gap (*Gap*) is still positive and statistically significant at 1 % and 5 % levels. Another approach of this paper uses the natural logarithm of the gap in CEO salary between two enterprises at the same scale in the same industry plus 1 as an alternative to the main explanatory variable. According to Columns (3) and (4), the estimated coefficients of the salary gap variable are also positive and statistically significant at 1 % and % levels.

##### 4.6.2. Replacing regression model

All the regression models employ the least squares technique. In the estimations, a Poisson and a negative binomial regression model consider the potential rightward bias of patents. Table 12 reports the estimation results in panel B. This panel adds fixed effects

**Table 10**  
Intra-industry salary gap, enterprise growth, and enterprise innovation.

| Growth Variables   | (1)                       | (2)                        | (3)                         | (4)                          |
|--------------------|---------------------------|----------------------------|-----------------------------|------------------------------|
|                    | Low<br><i>Ln (Patent)</i> | High<br><i>Ln (Patent)</i> | Low<br><i>Ln (Citation)</i> | High<br><i>Ln (Citation)</i> |
| Gap                | 0.015***<br>(4.36)        | 0.001<br>(0.17)            | 0.004***<br>(3.39)          | -0.001<br>(-0.40)            |
| Size               | 0.133***<br>(3.98)        | 0.284***<br>(8.46)         | 0.038***<br>(4.42)          | 0.047***<br>(4.68)           |
| Age                | 1.912***<br>(7.28)        | 0.802***<br>(3.17)         | 0.261***<br>(4.18)          | 0.085<br>(1.18)              |
| Leverage           | -0.014<br>(-0.12)         | 0.276***<br>(2.62)         | -0.047<br>(-1.54)           | 0.009<br>(0.28)              |
| CFO                | 0.163<br>(1.56)           | 0.114<br>(0.91)            | 0.053<br>(1.32)             | -0.093*<br>(-1.77)           |
| ROA                | -0.526***<br>(-3.38)      | -0.346**<br>(-2.26)        | -0.039<br>(-0.73)           | 0.008<br>(0.15)              |
| SOE                | 0.134<br>(1.59)           | 0.031<br>(0.33)            | 0.025<br>(1.15)             | -0.027<br>(-1.07)            |
| Q                  | -0.015*<br>(-1.85)        | -0.006<br>(-0.96)          | 0.001<br>(0.33)             | 0.003<br>(0.97)              |
| Intangible         | 1.208***<br>(3.21)        | 0.794**<br>(2.25)          | 0.291***<br>(2.89)          | 0.117<br>(1.12)              |
| Director           | 0.016<br>(0.39)           | -0.038<br>(-0.98)          | 0.003<br>(0.18)             | -0.001<br>(-0.05)            |
| Independent        | -0.021<br>(-0.25)         | 0.090<br>(1.02)            | -0.010<br>(-0.27)           | 0.019<br>(0.46)              |
| Shareholdings      | -0.004**<br>(-2.00)       | -0.001<br>(-0.24)          | -0.001<br>(-1.07)           | -0.0002<br>(-0.22)           |
| Constant           | -7.024***<br>(-7.31)      | -6.556***<br>(-6.86)       | -1.236***<br>(-4.88)        | -0.786***<br>(-2.70)         |
| N                  | 12793                     | 11203                      | 12793                       | 11203                        |
| Firm Fixed Effects | YES                       | YES                        | YES                         | YES                          |
| Year Fixed Effects | YES                       | YES                        | YES                         | YES                          |
| R <sup>2</sup>     | 0.879                     | 0.909                      | 0.607                       | 0.573                        |

Notes: \*, \*\*, and \*\*\* indicate statistical significance at 10 %, 5 %, and 1 % levels, respectively. Robust standard errors are clustered at the enterprise level. t-statistics are in parentheses.

for industries, provinces, and years, but not individual enterprises. Columns (1) and (2) report the test results of the Poisson regression model, and Columns (3) and (4) represent those of the negative binomial regression model, which confirm the robustness of the results.

#### 4.6.3. Impact of positive lag on innovation

Fang et al. (2014) believe that enterprise innovation may last for more than a year. Based on Fang et al. (2014), this research leads the dependent variable by one and two periods ( $Ln(Patent1)_{+1}$  and  $Ln(Patent1)_{+2}$ , respectively) to consider their positive lag values. In Table 12, panel C represents the estimation results of the adjusted Model (1) with each of the lead dependent variables, separately. The results remain stable for the industry salary gap variable (Gap).

#### 4.6.4. Using different empirical samples

The sample of this study covers both state-owned and private enterprises. The compensation for CEOs at SOEs, especially those run by the central government, might not be solely determined by the market. For example, the reform plan in 2015 set a ceiling on executive salaries to revamp the system of compensation for the heads of centrally managed SOEs. This plan the salaries to be no more than eight times that of an ordinary employee. After excluding the samples of SOEs, this study reruns Model (1). Table 12 reports the estimation results in Columns (1) and (2) of panel D, which accept the robustness of the estimated results. As this paper concentrates on enterprise innovation, non-innovative enterprises may lack the internal motivation for innovation, which reduce the incentive effect of the industry salary gap. To address this issue, Model (1) re-estimates the coefficients after excluding enterprises from the sample that did not apply for any patents during the sample period. Table 12 provides the results in Columns (3) and (4) of panel D, which affirm the robustness of the regression results.

#### 4.6.5. Replacing explained variable

Following Hall et al. (2005), this research measures the number of enterprise innovations using the ratio of the number of patents applied by the enterprise and granted to the enterprise's total assets ( $Patent/Asset$ ). Also, the measurement of enterprise innovation quality is the average number of citations of each invention patent ( $Citation/Patent$ ), without taking the natural logarithm of the enterprise. Model (1) re-estimates the coefficients after replacing the dependent variable. Table 12 represents the results in panel E, which support the stability of the results.

**Table 11**  
Impact of industry pay gaps on CEO future compensation.

| Variable                  | (1)<br><i>Ln (Salary)</i> | (2)<br><i>Ln (Salary)</i> |
|---------------------------|---------------------------|---------------------------|
| <i>Ln (Patent)</i>        | -0.113<br>(-0.93)         |                           |
| <i>Ln (Citation)</i>      |                           | 0.107<br>(0.33)           |
| <i>Ln (Patent)* Gap</i>   | 0.015**<br>(2.15)         |                           |
| <i>Ln (Citation)* Gap</i> |                           | 0.007<br>(0.28)           |
| <i>Gap</i>                | -0.068***<br>(-4.05)      | -0.050***<br>(-3.02)      |
| <i>Size</i>               | 0.395***<br>(3.52)        | 0.405***<br>(3.62)        |
| <i>Age</i>                | -0.798<br>(-1.02)         | -0.674<br>(-0.86)         |
| <i>Leverage</i>           | 0.357<br>(0.93)           | 0.377<br>(0.98)           |
| <i>CFO</i>                | 0.530<br>(1.13)           | 0.538<br>(1.15)           |
| <i>ROA</i>                | 1.747***<br>(2.66)        | 1.719***<br>(2.61)        |
| <i>SOE</i>                | -1.280***<br>(-3.69)      | -1.275***<br>(-3.67)      |
| <i>Q</i>                  | 0.004<br>(0.14)           | 0.002<br>(0.08)           |
| <i>Intangible</i>         | -2.300*<br>(-1.84)        | -2.264*<br>(-1.82)        |
| <i>Director</i>           | -0.329*<br>(-1.84)        | -0.332*<br>(-1.86)        |
| <i>Independent</i>        | 0.725*<br>(1.88)          | 0.733*<br>(1.89)          |
| <i>Shareholdings</i>      | -0.007<br>(-1.04)         | -0.008<br>(-1.10)         |
| <i>Constant</i>           | 6.295*<br>(1.95)          | 5.550*<br>(1.73)          |
| <i>N</i>                  | 24475                     | 24475                     |
| <i>Firm Fixed Effects</i> | YES                       | YES                       |
| <i>Year Fixed Effects</i> | YES                       | YES                       |
| <i>R<sup>2</sup></i>      | 0.564                     | 0.564                     |

Notes: \*, \*\*, and \*\*\* indicate statistical significance at 10 %, 5 %, and 1 % levels, respectively. Robust standard errors are clustered at the enterprise level. t-statistics are in parentheses.

## 5. Conclusion and implications

In recent years, the issue of a corporate salary gap has attracted greater attention from the public and the media in China, and government departments have repeatedly issued policies and measures to limit executive pay at SOEs. Accelerating the construction of an innovative country is a major strategic task in achieving high-quality economic development and building a modern economy. In this context, investigating the impact of a salary gap on enterprise innovation also has great practical significance. This study specifically tests the governance effect of an industry salary gap on enterprise innovation using a sample consisting of China's A-share listed companies from 2005 to 2018. This investigation focuses on the industry salary gap to empirically test the impact of a CEO industry salary gap on enterprise innovation.

The empirical results show that the industry salary gap plays a significant role in promoting enterprise innovation, which supports the tournament theory. The results of the mechanism test show that the promotional effect of an industry salary gap on enterprise innovation is more significant at firms that have higher agency costs. This finding indicates that the industry salary gap can drive enterprise innovation by encouraging CEOs to reduce agency costs. A series of cross-sectional tests identify the mechanism through which the industry salary gap affects enterprise innovation. The results show that the industry salary gap plays a more significant role in driving enterprise innovation during the recession period of industry and within enterprises with more financial distress and lower growth. The results are robust and valid since they remain robust even after replacing the, adjusting the regression models, or alternating the research samples.

This study has some theoretical and practical value. Theoretically, this paper tests the impact of an industry salary gap on enterprise innovation from the perspective of the governance effect, and further enriches and expands the research in the field of salary gaps and enterprise innovation. At the practical level, technological innovation plays an increasingly important role in its development because the domestic economy is in a new phase. This paper offers evidence that the industry salary gap promotes enterprise innovation,

**Table 12**  
Robustness tests results.

| Panel A: Replacing explanatory variables |                                 |                                   |                                 |                                   |
|--|---------------------------------|-----------------------------------|---------------------------------|-----------------------------------|
|  | (1)                             | (2)                               | (3)                             | (4)                               |
|  | <i>Ln (Patent)</i>              | <i>Ln (Citation)</i>              | <i>Ln (Patent)</i>              | <i>Ln (Citation)</i>              |
| Gap                                      | 0.010***<br>(3.80)              | 0.001**<br>(2.25)                 | 0.012***<br>(4.45)              | 0.002**<br>(2.02)                 |
| Size                                     | 0.198***<br>(7.40)              | 0.041***<br>(6.27)                | 0.199***<br>(7.58)              | 0.042***<br>(6.49)                |
| Age                                      | 1.468***<br>(7.64)              | 0.163***<br>(3.50)                | 1.417***<br>(7.55)              | 0.167***<br>(3.65)                |
| Leverage                                 | 0.131<br>(1.60)                 | -0.027<br>(-1.18)                 | 0.138*<br>(1.70)                | -0.022<br>(-0.97)                 |
| CFO                                      | 0.210**<br>(2.49)               | -0.0002<br>(-0.003)               | 0.238***<br>(2.84)              | -0.018<br>(-0.55)                 |
| ROA                                      | -0.461***<br>(-3.75)            | 0.0002<br>(0.005)                 | -0.507***<br>(-4.19)            | 0.003<br>(0.08)                   |
| SOE                                      | 0.022<br>(0.34)                 | 0.008<br>(0.51)                   | 0.020<br>(0.32)                 | 0.006<br>(0.38)                   |
| Q  | -0.004<br>(-0.70)               | 0.004**<br>(2.05)                 | -0.004<br>(-0.81)               | 0.004**<br>(2.27)                 |
| Intangible                               | 0.863***<br>(3.15)              | 0.157**<br>(2.18)                 | 0.785***<br>(2.85)              | 0.147**<br>(2.03)                 |
| Director                                 | -0.007<br>(-0.24)               | 0.003<br>(0.22)                   | -0.017<br>(-0.56)               | 0.002<br>(0.16)                   |
| Independent                              | 0.043<br>(0.65)                 | 0.001<br>(0.03)                   | 0.062<br>(0.93)                 | 0.007<br>(0.24)                   |
| Shareholdings                            | -0.004***<br>(-2.92)            | -0.0003<br>(-0.95)                | -0.004***<br>(-2.82)            | -0.001<br>(-1.30)                 |
| Constant                                 | -6.846***<br>(-9.40)            | -0.955***<br>(-5.07)              | -6.748***<br>(-9.44)            | -1.003***<br>(-5.42)              |
| N  | 24466                           | 24466                             | 25548                           | 25548                             |
| Firm Fixed Effects                       | YES                             | YES                               | YES                             | YES                               |
| Year Fixed Effects                       | YES                             | YES                               | YES                             | YES                               |
| R <sup>2</sup>                           | 0.879                           | 0.568                             | 0.876                           | 0.566                             |
| Panel B: Replacing regression model      |                                 |                                   |                                 |                                   |
|  | (1)                             | (2)                               | (3)                             | (4)                               |
|  | <i>Ln (Patent)</i>              | <i>Ln (Citation)</i>              | <i>Ln (Patent)</i>              | <i>Ln (Citation)</i>              |
| Gap                                      | 0.018***<br>(5.73)              | 0.009***<br>(3.08)                | 0.020***<br>(6.23)              | 0.009***<br>(3.08)                |
| Size                                     | 0.296***<br>(24.73)             | 0.153***<br>(14.66)               | 0.322***<br>(29.45)             | 0.153***<br>(14.66)               |
| Age                                      | -0.022<br>(-0.57)               | -0.134***<br>(-4.07)              | -0.178***<br>(-5.06)            | -0.134***<br>(-4.07)              |
| Leverage                                 | -0.297***<br>(-4.61)            | -0.267***<br>(-4.74)              | -0.169***<br>(-2.73)            | -0.267***<br>(-4.74)              |
| CFO                                      | -0.188*<br>(-1.70)              | -0.417***<br>(-3.89)              | -0.450***<br>(-4.14)            | -0.417***<br>(-3.89)              |
| ROA                                      | -0.158<br>(-1.16)               | 0.453***<br>(3.25)                | 0.820***<br>(6.18)              | 0.453***<br>(3.25)                |
| SOE                                      | 0.038<br>(1.28)                 | -0.032<br>(-1.25)                 | -0.013<br>(-0.44)               | -0.032<br>(-1.25)                 |
| Q  | 0.019***<br>(3.38)              | 0.013**<br>(2.34)                 | 0.016***<br>(2.88)              | 0.013**<br>(2.34)                 |
| Intangible                               | 0.130<br>(0.58)                 | 0.096<br>(0.47)                   | 0.175<br>(0.82)                 | 0.096<br>(0.47)                   |
| Director                                 | 0.016<br>(0.49)                 | 0.033<br>(1.05)                   | 0.006<br>(0.18)                 | 0.033<br>(1.05)                   |
| Independent                              | 0.039<br>(0.55)                 | -0.098<br>(-1.47)                 | -0.034<br>(-0.49)               | -0.098<br>(-1.47)                 |
| Shareholdings                            | -0.003***<br>(-4.05)            | -0.001*<br>(-1.80)                | -0.002**<br>(-2.40)             | -0.001*<br>(-1.80)                |
| Constant                                 | -5.955***<br>(-15.24)           | -3.867***<br>(-10.87)             | -6.627***<br>(-15.99)           | -3.867***<br>(-10.87)             |
| N  | 24476                           | 24476                             | 24476                           | 24476                             |
| Industry Fixed Effects                   | YES                             | YES                               | YES                             | YES                               |
| Province Fixed Effects                   | YES                             | YES                               | YES                             | YES                               |
| Year Fixed Effects                       | YES                             | YES                               | YES                             | YES                               |
| Pseudo R2                                | 0.231                           | 0.075                             | 0.179                           | 0.075                             |
| Panel C: Positive lag in innovation      |                                 |                                   |                                 |                                   |
|  | (1)                             | (2)                               | (3)                             | (4)                               |
|  | <i>Ln (Patent)<sub>+1</sub></i> | <i>Ln (Citation)<sub>+1</sub></i> | <i>Ln (Patent)<sub>+2</sub></i> | <i>Ln (Citation)<sub>+2</sub></i> |

(continued on next page)

Table 12 (continued)

|                                       |                      |                       |                        |                        |
|---------------------------------------|----------------------|-----------------------|------------------------|------------------------|
| Gap                                   | 0.011***<br>(4.20)   | 0.002*<br>(1.71)      | 0.010***<br>(3.80)     | 0.007**<br>(2.33)      |
| Size                                  | 0.214***<br>(7.89)   | 0.040***<br>(6.19)    | 0.214***<br>(7.89)     | 0.279***<br>(11.16)    |
| Age                                   | 1.539***<br>(7.76)   | 0.203***<br>(4.17)    | 1.539***<br>(7.76)     | 0.741***<br>(4.24)     |
| Leverage                              | 0.099<br>(1.22)      | -0.020<br>(-0.89)     | 0.099<br>(1.22)        | -0.116<br>(-1.41)      |
| CFO                                   | 0.266***<br>(3.11)   | 0.048<br>(1.61)       | 0.266***<br>(3.11)     | 0.165*<br>(1.68)       |
| ROA                                   | -0.396***<br>(-3.41) | 0.036<br>(0.99)       | -0.396***<br>(-3.41)   | 0.474***<br>(3.41)     |
| SOE                                   | 0.037<br>(0.54)      | -0.004<br>(-0.23)     | 0.037<br>(0.54)        | 0.094<br>(1.61)        |
| Q                                     | 0.003<br>(0.56)      | 0.003<br>(1.45)       | 0.003<br>(0.56)        | 0.014**<br>(2.30)      |
| Intangible                            | 0.841***<br>(2.99)   | 0.162**<br>(2.40)     | 0.841***<br>(2.99)     | 0.722***<br>(2.85)     |
| Director                              | -0.006<br>(-0.21)    | -0.001<br>(-0.06)     | -0.006<br>(-0.21)      | 0.021<br>(0.58)        |
| Independent                           | 0.049<br>(0.73)      | 0.023<br>(0.90)       | 0.049<br>(0.73)        | -0.077<br>(-0.89)      |
| Shareholdings                         | -0.004***<br>(-2.84) | -0.001*<br>(-1.87)    | -0.004***<br>(-2.84)   | -0.001<br>(-0.90)      |
| Constant                              | -7.269***<br>(-9.81) | -1.050***<br>(-5.48)  | -7.269***<br>(-9.81)   | -6.653***<br>(-9.42)   |
| N                                     | 24476                | 24476                 | 24018                  | 24018                  |
| Firm Fixed Effects                    | YES                  | YES                   | YES                    | YES                    |
| Year Fixed Effects                    | YES                  | YES                   | YES                    | YES                    |
| R <sup>2</sup>                        | 0.886                | 0.614                 | 0.777                  | 0.784                  |
| Panel D: Different regression samples |                      |                       |                        |                        |
|                                       | (1)                  | (2)                   | (3)                    | (4)                    |
|                                       | <i>Ln (Patent)</i>   | <i>Ln (Citation)</i>  | <i>Ln (Patent)</i>     | <i>Ln (Citation)</i>   |
| Gap                                   | 0.010***<br>(3.75)   | 0.002*<br>(1.87)      | 0.007***<br>(2.59)     | 0.002*<br>(1.79)       |
| Size                                  | 0.193***<br>(6.74)   | 0.039***<br>(5.57)    | 0.193***<br>(7.20)     | 0.043***<br>(7.85)     |
| Age                                   | 1.427***<br>(6.85)   | 0.199***<br>(3.70)    | 0.897***<br>(4.91)     | 0.106***<br>(2.68)     |
| Leverage                              | 0.149*<br>(1.77)     | -0.021<br>(-0.89)     | 0.003<br>(0.03)        | -0.046**<br>(-2.18)    |
| CFO                                   | 0.304***<br>(3.35)   | 0.001<br>(0.04)       | 0.214**<br>(2.49)      | -0.005<br>(-0.12)      |
| ROA                                   | -0.426***<br>(-3.62) | 0.015<br>(0.38)       | -0.571***<br>(-4.76)   | 0.011<br>(0.23)        |
| SOE                                   | -0.028<br>(-0.40)    | -0.005<br>(-0.29)     | 0.026<br>(0.36)        | 0.007<br>(0.48)        |
| Q                                     | -0.004<br>(-0.74)    | 0.002<br>(1.25)       | -0.005<br>(-0.92)      | 0.004**<br>(2.08)      |
| Intangible                            | 0.812***<br>(2.98)   | 0.183**<br>(2.43)     | 0.249<br>(0.83)        | 0.091<br>(1.33)        |
| Director                              | -0.040<br>(-1.25)    | -0.001<br>(-0.06)     | 0.006<br>(0.19)        | 0.0002<br>(0.02)       |
| Independent                           | 0.078<br>(1.13)      | 0.007<br>(0.25)       | -0.0001<br>(-0.01)     | 0.003<br>(0.10)        |
| Shareholdings                         | -0.006***<br>(-3.95) | -0.000<br>(-0.70)     | -0.003**<br>(-2.15)    | -0.0003<br>(-0.60)     |
| Constant                              | -6.539***<br>(-8.45) | -1.016***<br>(-4.84)  | -4.771***<br>(-6.66)   | -0.750***<br>(-4.74)   |
| N                                     | 21765                | 21765                 | 20517                  | 20517                  |
| Firm Fixed Effects                    | YES                  | YES                   | YES                    | YES                    |
| Year Fixed Effects                    | YES                  | YES                   | YES                    | YES                    |
| R <sup>2</sup>                        | 0.880                | 0.576                 | 0.895                  | 0.467                  |
| Panel E: Replacing dependent variable |                      |                       |                        |                        |
|                                       | (1)                  | (2)                   | (3)                    | (4)                    |
|                                       | <i>Patent/Asset</i>  | <i>Patent/Asset</i>   | <i>Citation/Patent</i> | <i>Citation/Patent</i> |
| Gap                                   | 0.003**<br>(2.26)    | 0.003**<br>(2.34)     | 0.004**<br>(2.38)      | 0.004**<br>(2.36)      |
| Size                                  |                      | -0.143***<br>(-10.75) |                        | 0.072***<br>(6.43)     |
| Age                                   |                      | 0.576***              |                        | 0.257***               |

(continued on next page)

Table 12 (continued)

|                           |          |          |          |           |
|---------------------------|----------|----------|----------|-----------|
|                           |          | (5.01)   |          | (3.09)    |
| <i>Leverage</i>           |          | 0.048    |          | -0.051    |
|                           |          | (1.12)   |          | (-1.29)   |
| <i>CFO</i>                |          | 0.089*   |          | -0.018    |
|                           |          | (1.86)   |          | (-0.32)   |
| <i>ROA</i>                |          | -0.140*  |          | 0.042     |
|                           |          | (-1.83)  |          | (0.64)    |
| <i>SOE</i>                |          | 0.019    |          | 0.011     |
|                           |          | (0.54)   |          | (0.40)    |
| <i>Q</i>                  |          | 0.015*** |          | 0.006*    |
|                           |          | (3.89)   |          | (1.81)    |
| <i>Intangible</i>         |          | 0.299**  |          | 0.260**   |
|                           |          | (2.10)   |          | (2.12)    |
| <i>Director</i>           |          | 0.001    |          | -0.002    |
|                           |          | (0.08)   |          | (-0.08)   |
| <i>Independent</i>        |          | 0.003    |          | 0.009     |
|                           |          | (0.08)   |          | (0.19)    |
| <i>Shareholdings</i>      |          | 0.0002   |          | -0.001    |
|                           |          | (0.05)   |          | (-0.80)   |
| <i>Constant</i>           | 0.369*** | 1.804*** | 0.578*** | -1.696*** |
|                           | (19.59)  | (4.41)   | (28.07)  | (-5.14)   |
| <i>N</i>                  | 24476    | 24476    | 24476    | 24476     |
| <i>Firm Fixed Effects</i> | YES      | YES      | YES      | YES       |
| <i>Year Fixed Effects</i> | YES      | YES      | YES      | YES       |
| <i>R<sup>2</sup></i>      | 0.798    | 0.809    | 0.519    | 0.521     |

Notes: \*, \*\*, and \*\*\* indicate statistical significance at 10 %, 5 %, and 1 % levels, respectively. Robust standard errors are clustered at the enterprise level. t-statistics are in parentheses.

showing that doing so calls for designing reasonable pay policies to keep the industry salary gap at a relatively high level. Therefore, the government should carefully consider all the possible impacts of the policies issued to adjust the industry income gap.

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## Declaration of Competing Interest

The authors declare that they have no competing interests.

## Data Availability

Data will be made available on request.

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## Consent to participate

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## Consent for publication

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