Executive pay bandwagon and corporate innovation

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A R T I C L E   I N F O

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A B S T R A C T

Based on social comparison theory and principal-agent theory, we examine the influence of the executive pay bandwagon on corporate innovation. Our findings suggest that a greater propensity of the executive pay bandwagon is associated with lower level of corporate research and development spending, and fewer high-quality patents, leading to a lower level of total factor productivity. Additionally, our analysis shows that executives with a strong comparing mentality exhibit less risk-taking but more myopic behaviors, thereby reducing their incentive to engage in innovation. We further find that corporate governance has moderating effects on the relationship between the executive pay bandwagon and corporate innovation. Overall, we find that executive pay bandwagon triggered by external pay inequality is a type of intrinsic motivation that affects firms’ innovation strategy and innovation efficiency.

1. Introduction

As corporate innovation contributes significantly to the enhancement of the core competitiveness of enterprises, it directly affects their economic efficiency and the sustainable development of the economy. Exploration of the key factors driving innovation has emerged as a topic of considerable importance among academics and practitioners. Upper echelons theory suggests that top executives’ individual-level attributes affect firm strategy and performance (Hambrick and Mason, 1984; Chatterjee and Hambrick, 2007). Numerous subsequent studies have confirmed the important influence of internal and external executives' characteristics on firms' innovation activities (Barker and Mueller, 2002; Sauermann and Cohen, 2010; Hirschleifer et al., 2012; Sunder et al., 2017; Custodio et al., 2019; Huo and Li, 2022). Given that the effectiveness of corporate compensation also depends on financial incentives to some extent, effective compensation contracts affect the innovation efficiency by influencing the management's innovation strategy (Xue, 2007; Lerner and Wulf, 2007; Manso, 2011). Therefore, this study attempts to combine extrinsic incentives with executives’ personal traits, focusing on whether and how changes in executives’ intrinsic psychological perceptions triggered by extrinsic incentives affect corporate innovation.

Previous experimental and theoretical studies have shown that human behavior can be influenced by psychological factors. Experimental economics research has demonstrated that people have a preference for fairness in most cases. In other words, people care not only about their absolute income, but also about their income relative to others (Akerlof and Yellen, 1990; Luttmer, 2005), and they judge the fairness of the income distribution by comparing their income with that of others (Fehr and Schmidt, 1999; Gächter and Fehr, 2002). If individuals have a sense of injustice, they will experience a negative emotion due to fairness-related tension, that is, the comparing mentality in psychology. Driven by such a perception of unfairness, individuals may either change their thoughts or take action to seek justice (Adams, 1963). The introduction of fairness preference has greatly enriched the study of executive compensation. Bizjak et al. (2008) found that the use of benchmarking is widespread and that the practice of competitive benchmarking affects CEO compensation. Follow-up studies have shown that peer groups are constructed in a manner that biases compensation upward (Faulkender and Yang, 2010; Bizjak et al., 2011), leading to the “Lake Wobegon effect” (Hayes and Schaefer, 2009). These findings suggest that there exists a bandwagon effect in the executive compensation setting process.

China offers a good setting for our study because of: (1) the widespread phenomenon of social comparison, (2) the common concern of inequality aversion, and (3) the disclosure of relative performance and executive compensation information of listed companies. Thus, managers have access to information about the pay levels of their peers in other companies, and obtain the cognition of fairness by comparing their pay
with that of their peers. Jiang (2010, 2011) verified that Chinese listed companies refer to industry benchmarks when setting executive compensation. Gao and Du (2013) argued that executives not only pay attention to their absolute compensation, but also attach great importance to their relative compensation: thus, when the relative compensation of executives is lower, a pay-comparing mentality will arise. Thus, it can be said that the phenomenon of the executive pay bandwagon does exist in Chinese listed companies. Although some studies have found that the external fairness of compensation is an important factor influencing the behavior of the top management (Luo et al., 2016, 2021; Shi et al., 2017), how the executive pay bandwagon affects corporate innovation remains underexplored. As corporate innovation is characterized by high investment, high risk, great uncertainty of returns, and a long investment cycle, it is necessary to examine whether the executive pay bandwagon triggered by external pay inequity will change executives’ attitudes toward investments in risky projects and reduce their motivation and effort to invest in innovation activities, which in turn will impinge on firms’ innovation investment decisions and innovation efficiency.

This study examines the effects of the psychological characteristics of the executive pay bandwagon on corporate innovation. Specifically, based on social comparison theory and principal-agent theory, we use the ratio of executive pay to the median pay level of executives in firms of similar size and industry, termed as the comparing coefficient (Li and Liu, 1986), as an alternative variable of the executive pay bandwagon (Luo et al., 2016, 2021), and we conduct a theoretical and empirical analysis of the impact of the executive pay bandwagon on corporate innovation input, innovation output regarding both quantity and quality, and innovation efficiency. We argue that executive pay bandwagon not only reduces innovation inputs (research and development spending), but also inhibits the transformation of innovation inputs into innovation outputs, remains underexplored. As corporate innovation is characterized by high investment, high risk, great uncertainty of returns, and a long investment cycle, it is necessary to examine whether the executive pay bandwagon triggered by external pay inequity will change executives’ attitudes toward investments in risky projects and reduce their motivation and effort to invest in innovation activities, which in turn will impinge on firms’ innovation investment decisions and innovation efficiency. We argue that executive pay bandwagon not only reduces innovation inputs (research and development spending), but also inhibits the transformation of innovation inputs into innovation outputs, resulting in a decrease in the number of patents, especially for high-quality patents, measured by invention patents and patent citations. This finding indicates that pay bandwagon leads to executives strategically reducing their investments in substantial innovation, thus reducing the overall quality of corporate innovation outputs. We also find that the executive pay bandwagon is significantly and negatively related to the total factor productivity of firms, which to a certain extent indicates the efficiency of corporate innovation. These results are robust across methods. Further analysis shows that reduced risk-taking and increased managerial myopic behaviors are the main paths through which the executive pay bandwagon affects corporate innovation. Our study also demonstrates that the negative impact of the executive pay bandwagon on corporate innovation is mitigated when combined with stronger corporate governance mechanisms.

This study contributes to the literature mainly in two ways: first, our study expands the strand of literature that examines the economic consequences of executive compensation incentives based on social comparison theory and fairness preference theory (Faulkender and Yang, 2010; Bizjak et al., 2008, 2011; Liao et al., 2016, 2021; Lee et al., 2019). Although the economic consequences of pay gap between executives and employees has received considerable attention (Xu et al., 2017; Zhao and Wang, 2018), how the dispersion in top executives’ pay among firms in similar size and industry affects the executives’ decision making is largely unknown. We contribute to the literature by documenting evidence on the effect of the executive pay bandwagon triggered by external pay inequality on corporate innovation activities. Thus, top executives’ perception of pay inequity vis-à-vis external refers is a key driving force behind decision making at the firm level.

Second, the evidence in the effects of personal characteristics on corporate innovation is vast (Barker and Mueller, 2002; Sauermann and Cohen, 2010; Custodio et al., 2019; Sunder et al., 2017). However, there is little evidence on whether psychological biases generate unintentional effects on corporate innovation. From the psychological motivation of executives that affects their decision-making, this study considers corporate innovation activities as a dynamic process, and systematically examines whether and how the executive pay bandwagon affects corporate innovation input, innovation outcomes, and innovation efficiency, enabling us to better understand the mechanism through which executives’ psychological attributes affect their innovation strategies. Our results add to the growing literature on the determinants of corporate innovation.

Moreover, it has important theoretical reference value and policy implications for the improvement of the enterprise compensation incentive schemes and the effectiveness of executive compensation contracts, which will be ultimately helpful in enhancing the enthusiasm of executives for corporate innovation, optimizing strategic decisions, and realizing the long-term development of enterprises. Our research also highlights the significance of considering corporate governance mechanisms to explain the link between the executive pay bandwagon and corporate innovation in the context of emerging economies.

The remainder of the paper is organized as follows: Section 2 is a literature review. Section 3 provides a theoretical analysis and develops our hypotheses. Section 4 introduces the research method. Section 5 presents the main empirical results and robustness tests; Section 6 provides further analyses. Finally, Section 7 concludes.

2. Literature review

2.1. Social comparison based on executive compensation

The standard principal-agent analysis framework assumes that the agents react only to their absolute income and do not consider the income gap with others (Jensen and Murphy, 1990). However, this is at odds with the real economic life. Many experimental and theoretical studies have shown that individual behavior is influenced by psychological factors. Therefore, it is necessary to analyze the influence of psychological factors on the incentive effect of compensation. As early as in the 1960s, social comparison theory postulated that individuals have an innate drive to evaluate their own pay or status by comparing themselves with similar others (Festinger, 1954). On this basis, Adams (1963) proposed a theory of social inequity, that argues that individuals will pay attention to the fairness of distributive outcomes in the process of social comparison. If individuals have a sense of inequity, they will experience a negative emotion due to fairness-related tension, and the tension is proportional to the magnitude of inequity present. Driven by this unfair perception, individuals may change their mind or take actions to promote social justice. With the development of behavioral and experimental economics, many experimental and empirical studies have shown the widespread existence of individual fairness preferences (Forsythe et al., 1994; Fehr and Gacher, 2000; Fahr and Irlenbusch, 2000). Englmaier and Wambach (2010) introduced social preferences into principal-agent models, and found that individual inequity aversion may impact optimal compensation contracts.

The introduction of social comparison theory and fairness preference theory has greatly enriched the field of research on executive compensation. On the one hand, scholars attest to the existence of pay-based social comparisons, that is, the pay bandwagon. For instance, Fehr et al. (2009) and Fehr et al. (2011) respectively confirmed through theoretical models and experimental studies that firms’ compensation contracts provide reference points for competitors in the same industry. Bizjak et al. (2008), Bizjak et al. (2011), Faulkender and Yang (2010), and Albuquerque et al. (2013) analyzed the voluntary disclosure of executive compensation practices, and argued that the prevailing interpretation of the sustained growth of executive compensation in American listed companies is that the Compensation Committee uses the median pay level of executives at a peer group of similar companies as a benchmark, and tends to target pay above the peer group median when determining executives’ compensation; this leads to an increase in the pay benchmarking of the industry, and in turn leads to a Lake Wobegon effect that imparts an upward bias on compensation (Hayes and Schaefer, 2009; Elson and Ferrere, 2013).
On the other hand, since personal motivation and behaviors are often closely related to fairness preferences (Fehr and Schmidt, 1999), the cognition of fairness obtained through social comparison may have an important impact on executives’ behavioral choices. Goel and Thakor (2005) assumed that agents in a corporate setting experience a decline in utility when their payoff is lower than that of a reference group; the presence of envy or inequity aversion may cause investment distortions. Li and Hu (2012) pointed out that with mandated increased disclosure of executive compensation, pay comparisons between executives and peer groups in the same industry have become widespread. By comparing with their peers, executives have a new cognition of their pay inequity, and adjust their behaviors accordingly (Wu et al., 2010). As executives appear to make blind and negative comparisons with those having higher compensation in the same industry or company (Liu et al., 2014), once an unfair cognition after comparing with others is acquired, executives will take measures to eliminate the negative utility caused by fairness-related tension. Luo et al. (2016) showed that if executive compensation is lower than the median executive compensation of comparable firms in the same industry, the greater the intensity of the executive pay bandwagon, the more likely it is that compensation will be manipulated in the future through earnings management. Luo et al. (2021) further showed that the executive pay bandwagon is positively associated with crash risk in Chinese listed companies. Lee et al. (2019) extended previous research on the influence of CEO pay inequity on CEOs’ decision-making by examining the relationship in the acquisition context. It can be seen that the impact of external pay inequity on executives’ cognitive and behavioral choices has received increasing attention. However, whether the executive pay bandwagon triggered by external pay inequality affects corporate innovation is an open question.

2.2. Determinants of corporate innovation

The significance of innovation in the long-run development of enterprises and society cannot be overstated. Previous studies have extensively examined the factors influencing corporate innovation. At the macro level, national import and export policies, laws and regulations, innovation subsidy policies, and financial market development have different degrees of influence on innovation; at the meso level, industrial policies and industry competition are the main factors affecting corporate innovation; at the micro level, firm size, corporate financial status, and corporate governance have a significant impact on firms’ innovation activities. It is worth noting that for firms in the developmental and mature stages, the macro- and meso-level factors of innovation are not controllable; therefore, it is necessary to explore the factors that affect their innovation dynamics at the micro level. Based on upper echelons theory proposed by Hambrick and Mason (1984), scholars have conducted extensive research on the executive characteristics that influence corporate innovation. In addition to examining the effects of executive extrinsic characteristics such as executive age, education, career experience (Barker and Mueller, 2002), management comprehensive competence (Custodio et al., 2019), and heterosexual leadership structure (Huo and Li, 2022) on corporate R&D inputs and outputs, existing studies have also focused on effects of executive intrinsic motivations on firm innovation, including executive overconfidence (Hirshleifer et al., 2012), management motivation for pecuniary and non-pecuniary gains (Sauermann and Cohen, 2010), latent but not observable manager characteristics (Cho et al., 2016), dynamic entrepreneurship (Pham and Nguyen, 2021), risk-taking ability, and the desire to new experiences (Sunder et al., 2017). Overall, previous research has explored relatively few executive psychological characteristics that influence corporate innovation.

Additionally, regarding the impact of executive compensation incentives on corporate innovation, the existing literature has confirmed that equity incentives in compensation packages can give managers risky returns, thus motivating them to take risks, reducing their myopic behaviors, and promoting corporate innovation. However, an increasing number of scholars are studying the relationship between compensation incentives and firm innovation based on specific contexts; for example, Xue (2007) argued that performance-based compensation contracts motivate CEOs to innovate through mergers and acquisitions, while equity incentive-based compensation contracts motivate CEOs to innovate through internal R&D investment. Baranchuk et al. (2014) found that for newly listed companies, granting stock options to management can motivate innovation. However, some studies also pointed out that the pressure on executives to meet short-term performance targets reduces their willingness to innovate; thus, performance-based financial incentives can inhibit creativity and innovation (Dan et al., 2009; Ederer and Manso, 2013).

Over all, these studies suggest that the effect of executive compensation incentives on corporate innovation cannot be ignored. With the increase in research on the economic consequences of pay-based social comparison, it is important to examine in depth how the changes in executives’ psychological perceptions of pay inequity affect corporate innovation activities.

3. Theoretical analysis and research hypothesis

Psychological studies have shown that individuals are concerned with the fairness of distributional outcomes in the process of social comparison (Adams, 1963), Kahneman and Tversky (1979) also suggested that people’s judgments of gain and loss come from comparison, and people’s efforts to improve their income are mostly motivated by peer envy and comparison. Mandatory disclosure of executive compensation information provides conditions for executive pay comparison, and executives often appear to engage in blind, negative comparisons with people in the same industry or with higher-income groups within the company. As people tend to underestimate the efforts of others while exaggerating their own efforts, they increasingly believe that they should be better compensated and become discontented (Gao et al., 2013). When finding out that their compensation is lower than that of their peers, executives may develop perceptions of inequity caused by underpayment. Thus, this may lead to actions restoring inequity, such as reducing diligent competence, changing inputs, or taking other measures (Luo et al., 2016).

R&D investments are critical for developing a firm’s competitive advantage (Porter, 1992), and its future survival (Eisdorfer and Hsu, 2011). However, R&D investments are riskier than fixed asset investments (Bhagat and Welch, 1995; Kothari et al., 2002), and risk-averse executives are often reluctant to invest in high-risk R&D projects. Additionally, the cost of R&D investment is high, the investment cycle is long, and returns are slow to materialize; thus, executives may cut back on R&D investments to improve short-term reported performance (Dechow and Sloan, 1991; Bushue, 1998; Ali and Zhang, 2015). Executive incentives, due to their being linked to shareholder wealth, can align the interests of shareholders and executives and encourage risk-averse executives to take risks. Studies have confirmed the important role of executive compensation incentives in increasing R&D investments (Cheng, 2004; Coles et al., 2006). However, some studies have also found that performance-based compensation inhibits innovation (Dan et al., 2009; Ederer and Manso, 2013) because the pressure on executives to meet short-term performance targets can reduce their willingness to innovate. Moreover, once the R&D investments result in failure, enterprises will suffer great losses, and the reputation of the management will be affected accordingly. Therefore, the optimal compensation package for innovation incentives should demonstrate tolerance for early failures and rewards for long-term success (Manso, 2011).

If executives are underpaid relative to referent groups of other executives, the lack of incentives triggers a pay comparison that may reduce their satisfaction with their compensation. Underpaid executives are likely to frame their situation as losses (Lee et al., 2019), and thus be willing to take less risky actions to reduce their perceived pay inequity. Furthermore, underpaid executives tend to be short-sighted, they are more eager to gain current benefits than to consider the present and future gains rationally. Orhangazi (2008) found that increased financial
investment and increased financial profit opportunities may have impeded real investment by decreasing available internal funds, shortening the planning horizons of the firm management. Therefore, when executives form equity-related tensions in the pay comparison process, on the one hand, they tend to be negatively engaged and their aversion to risk may contribute to a reduction in their motivation to invest in R&D; on the other hand, pay bandwagon may lead to managerial myopia, such as engaging in certain types of financial investments to seek short-term capital gains, which may have a crowding-out effect on corporate innovation by directing funds away from R&D spending. As a result, executives with a pay comparing mentality have incentives to opportunistically reduce R&D investments, and/or bias it towards short-term projects. Thus, we propose the following hypothesis:

**H1.** The greater the propensity of the executive pay bandwagon, the lower is the future investment in innovation.

R&D investment merely reflects the overall innovation investment of a firm; it does not reflect the selection of specific innovation projects and the effectiveness of innovative output, nor does it mean that after the innovation investment, executives will necessarily work hard for the success of the project. Instead, executives may take advantage of inside information to change the company's R&D budget and innovative strategy, and R&D expenditures may even become a means for insiders to gain private benefits (Abodoo and Lev, 2000; Bereskin et al., 2018). Innovation output, as represented by various types of patents, may be a better measure of executives' effort toward corporate innovation than R&D expenditures.

Generally speaking, R&D investment forms new knowledge and technology, which in turn increases innovation output. However, executives' lack of willingness to innovate is not conducive to the effective accumulation of new knowledge and technology, and may even put corporate R&D activities in a state of high input and low output. Firstly, as we mentioned above, the executive pay bandwagon may inhibit firm's innovation investment, and this reduction of R&D spending will directly affect the innovation output of enterprises. Therefore, considering other factors being unchanged, the negative impact of the executive pay bandwagon on R&D spending will be further reflected in the low level of firms' future innovation output.

Second, since the process of innovation requires executives to bear the depletion of human resources, whether material, psychological, or spiritual, the success of a firm's R&D activities requires, to a certain extent, great resource inputs of executives as a guarantee. High-quality innovation, in particular, requires more financial and human capital, and more risk-taking from executives. Adams (1963) argued that when faced with an unfair situation, individuals may adjust the perceived inequity by changing their output. For example, employees who are paid piece-rate wages increase their wages by increasing low-quality output. Similarly, even if the company's R&D expenditure is predetermined, the executives' perception of pay inequity will make them reluctant to spend significant time and energy to prove the feasibility of innovation decisions, and to organize and carry out relevant innovation projects in a timely manner to ensure that the company's innovation investment is effectively converted into innovation output. In the process of implementing specific projects, inequality-averse executives have the incentives and ability to maximize their utility by investing in projects that are relatively less risky and beneficial to the firm. Furthermore, even if the R&D project decisions are preset, negative utility caused by executive pay bandwagon tends to lead executives to reduce their efforts to promote corporate innovation and lower their work efficiency. The reduction of human capital invested by executives in the R&D process will reduce the probability of success of substantial innovations, thus reducing the number of patents applications and citations, which are widely used proxies for quantity and quality of innovation outcomes, respectively.

Third, Lee et al. (2020) found that as conditions of managerial myopia worsen in line with deepening financialization, economic entities direct technological innovation strategy toward incremental innovation at the expense of radical innovation that involves high-risk and long-term investment, reflecting growing short-termism in technological innovation strategy. Thus, as executives with a pay-comparing mentality are more inclined to be short-sighted, they are less likely to invest in R&D for substantial innovations like invent patents. Instead, they tend to make more R&D investments in strategic innovation such as utility and design patents, or even use existing funds to make short-term financial investments, and thereby reducing the overall quality of corporate innovation. Therefore, we propose the following hypothesis:

**H2.** The greater the propensity of executive pay bandwagon, the lower is the quantity and quality of future innovation output.

The ultimate goal of corporate innovation is to improve productivity and save production costs to improve business performance. Most studies measure corporate innovation through R&D spending or the number of patent applications and citations (Firshleifer et al., 2012; Bena and Kai, 2014; Sunder et al., 2017); however, these indicators cannot accurately reflect the impact of innovation investment on corporate efficiency. Firms that value technological innovation and R&D investment generally have higher productivity. Studies in the field of macroeconomics use total factor productivity to measure the level of technology employed (e.g., Park and Weber, 2006). Some firm-level studies also showed that firms' innovation output increases with the strengthening of R&D investment and that innovation output significantly improves firms' productivity (e.g., Wu, 2006). Therefore, the total factor productivity can be used as an alternative measure of innovation productivity (Custodio et al., 2019).

From the aforementioned analysis, it is clear that pay bandwagon reduces executives' willingness to take risks but increases managerial short-termism, which in turn directly and negatively affects corporate innovation inputs and innovation outcomes. Moreover, with the given amount of innovation spending, executive pay bandwagon is not conducive for the effective conversion of innovation inputs into innovation outputs. In other words, executives' opportunistic choice of innovation projects and the reduction of executive human capital investment due to the executive pay bandwagon will also reduce the quality of firms' innovation outcomes. Thus, the imbalance in the ratios of corporate innovation inputs and innovation outputs caused by the executive pay bandwagon will reduce the efficiency of corporate innovation activities, which manifests as low total factor productivity of firms. Therefore, we propose the following hypothesis:

**H3.** The greater the propensity of the executive pay bandwagon, the lower is the total factor productivity of the firm.

4. Research method

4.1. Data and sample selection

Our sample consists of all firms listed on the A-share market of the Shanghai and Shenzhen Stock Exchanges, which cater primarily to domestic investors, for the period 2007–2020; the final sample does not include financial and insurance firms, financially distressed firms, and firms with missing financial data. Continuous variables are winsorized at the 1% and 99% levels.

Firm-level data for R&D expenditures and patent applications are obtained from the Chinese Research Data Services Platform System (CNRDS). Executive compensation and firm-level financial data, such as ROA, sales, leverage, cash balance, and all control variables, are collected from the China Stock Market & Accounting Research Database (CSMAR).
4.2. Method

Patent count and citation count are all counted data expressed in log form. We use OLS regression to estimate Eqs. (1) and (5); and we use Tobit regression to estimate Eqs. (2), (3), and (4). We also used negative binomial regression as a robustness test.

\[
R&D_{it+1} = \beta_0 + \beta_1 PB_{it} + \sum \beta_j Controls_{it} + \sum Year + \sum Industry + \epsilon_{it} \\
(1)
\]

\[
Patent_{it+1} = \beta_0 + \beta_1 PB_{it} + \sum \beta_j Controls_{it} + \sum Year + \sum Industry + \epsilon_{it} \\
(2)
\]

\[
Citation_{it+1} = \beta_0 + \beta_1 PB_{it} + \sum \beta_j Controls_{it} + \sum Year + \sum Industry + \epsilon_{it} \\
(3)
\]

\[
Patent_{it+1} = \beta_0 + \beta_1 PB_{it} + \sum \beta_j Controls_{it} + \sum Year + \sum Industry + \epsilon_{it} \\
+ \sum Area + \epsilon_{it} \\
(4)
\]

\[
TFP_{it+1} = \beta_0 + \beta_1 PB_{it} + \sum \beta_j Controls_{it} + \sum Year + \sum Industry \\
+ \sum Area + \epsilon_{it} \\
(5)
\]

The explanatory variable is Pay bandwagon (PB). We use the ratio of executive compensation to the median pay level of executives in firms of similar size and industry (comparing coefficient) as an alternative variable of PB. Following Bizjak et al. (2008) and Luo et al. (2016, 2021), we first rank all firms according to the prior year’s sales by industry and year. We classify firms as being in the large (small) firm group if they have sales above (below) the median sales in the industry. Second, we obtain the comparing coefficient by calculating the ratio of executive pay to the median pay level of executives in firms of similar size and industry (peer group), where executive pay is the average compensation of the firms’ top three executives. According to Li and Liu (1986), the comparing coefficient and the propensity or intensity of the executive pay bandwagon are inversely related, that is, the smaller the comparing coefficient, the greater is the propensity of the executive pay bandwagon. Therefore, we used the inverse of the comparing coefficient as the independent variable PB.

The independent variable in Eq. (1) is R&D, which is the R&D spending over total assets at the beginning of the period (Sunder et al., 2017). We also use R&D spending over total revenue as a robustness test.

We measure the dependent variable (innovation output) in Eqs. (2) and (3) as follows: The patent (Invention, utility, and design patents) applications for company i in year t as follows: The patent (Invention, utility, and design patents) applications for company i in year t.

In Eq. (4), the interaction term between R&D spending and the executive pay bandwagon is introduced into the baseline model to examine whether the executive pay bandwagon affects the conversion of R&D input into innovation output and the choice of specific innovation projects under the given amount of R&D spending.

In Eq. (5), firm-level total factor productivity (TFP) is the dependent variable. Shen and Sun (2009) used TFP to measure the degree of technological progress of a firm, and Custodio et al. (2019) directly used TFP as a proxy for corporate innovation productivity. Following Schoar (2002) and Giannetti et al. (2015), we estimate the following OLS regression by industry and year to form our estimate of TFP, and use it as a measure of corporate innovation efficiency.

\[
LnS_{it} = \beta_0 + \beta_1 LnK_{it} + \beta_2 LnL_{it} + \beta_3 LnM_{it} + \epsilon_{it} \\
(6)
\]

where S denotes the sales of firm i in year t; K and L are the size of fixed assets and employees of the firm, respectively; M is the cash paid for purchasing goods and receiving services; and, the residuals from the estimation are the total factor productivity of enterprises (TFP_OLS). Additionally, we use the LP method to estimate another measure of total factor productivity of enterprises (TFP_LP).

We include several control variables in Eqs. (1), (2), (3), (4), and (5).

| Variable | Definition |
|----------|------------|
| Size | The logarithm of total assets |
| LEV | The firm’s leverage ratio (total debt/total assets) |
| ROA | Return on assets |
| SALES_G | The growth of sales as a percentage |
| AGE | The logarithm of the number of years listed on the exchange |
| PPE/EMP | Capital intensity, which is the book value of fixed assets (property, plant, and equipment) per employee in thousands |
| CFO | The net cash flow from operating activities divided by the book value of total assets |
| MTB | The ratio of total market capitalization to total assets |
| SOEs | Equals 1 if the enterprise is state owned, and 0 otherwise |
| InstHold | The ratio of shares held by institutional investors to the total shares |
| Msh | The Percentage ownership of the management |
| TOP1 | The percentage ownership of top1 shareholder |
| HHl | The Herfindahl index of the sales revenue |
| Dual | Coded 1 if the CEO and chairperson are the same individual, and 0 otherwise |
| Indir | The percentage of independent directors on the board |

Table 1. Variable definitions.
4.3. Empirical results

4.4. Summary statistics and correlation coefficients

Table 2 presents the summary statistics of the sample. The mean and median of the executive pay bandwagon (PB) are 1.140 and 0.978, respectively; the mean is larger than the median, the maximum is 4.186, and the minimum is 0.179, which indicates that the external pay gap of executives in the same industry among listed companies in China is large; this implies that executives may have incentives to compare with their peers. In terms of innovation input (R&D), the mean of R&D expenditure totals to assets is 2.3%, and the maximum and minimum of R&D are 0 and 10.8%, respectively, with a standard deviation of 0.020, indicating that the amount of R&D spending of listed companies in China is generally low and needs to be further increased.

In terms of innovation outcomes, the mean and median of total patent applications (Patent) are 27.93 and 6, respectively, with the maximum and minimum of 548 and 0, respectively, and a standard deviation of 73.88; regarding the number of invention patents (Substantial) and non-invention patents (Strategy), both have a minimum value of 0 and a maximum value of 270 and 322, respectively, with large standard deviations. The large variations in patent metrics reflect that some firms do not engage in corporate innovation at all. In terms of the quality of invention patents, the mean and median of citation counts (Citation) is 11.94 (2), while the mean (median) of non-invention patents is 15.73 (2), which is higher than the average of invention patent count. Objectively, substantial patent is more difficult to develop and has a lower success rate; subjectively, the existence of agency problems may lead to a preference for “more and faster” innovation activities among listed companies in China. The mean (median) of citation counts (Citation) is 14.75 (1). To a certain extent, this also indicates that there exists a problem of more but not better patents in China, and that corporate innovation efficiency needs to be further improved. From the maximum and minimum of total factor productivity (TFP), we can see that total factor productivity varies across firms.

Table 3 shows that the correlations between corporate innovation (R&D, Inpatent, Lnsubstantial, Lnsstrategy, Lncitation, and TFP) and the executive pay bandwagon (PB) are negative and significant, with p < 0.001. The correlation results provide preliminary evidence to support our hypotheses that there is a significant negative association between pay bandwagon and corporate innovation input, corporate innovation outcomes, and corporate innovation efficiency.

4.5. Effects of pay bandwagon on corporate innovation

Table 4 presents the regression results for PB on corporate innovation. We use 1-year ahead innovation input, R&D, innovation outcomes, Lnsstrategy, Lncitation, and TFP to explore how the executive pay bandwagon affects corporate innovation outcomes. It can be seen that the executive pay bandwagon (PB) is significantly and negatively related to the total number of patents (Inpatent). Further results for patent types reveal that the executive pay bandwagon (PB) shows a negative correlation with the number of invention patents (Instrategy), non-invention patents (Lncitation), and citation counts (Lncitation), all of which are significant at the 1% significance level. These results indicate that the executive pay bandwagon significantly reduces the number of patents and citations, suggesting that inequalityaverse executives choose to avoid high-risk investment projects, leading to lower quality of innovation outcomes. These results support H1, and partially support H2.

The executive pay bandwagon leads to lower innovation outputs of firms, which may be the result of reduced innovation input. To further examine the direct effect of the executive pay bandwagon on firms’ innovation investment choices, we estimate Eq. (4) to explore how the executive pay bandwagon affects corporate innovation output at a given amount of R&D spending. The empirical results are presented in Table 5.

Table 2. Summary statistics.

| variable     | N  | mean | sd  | min | p25 | p50   | P75   | max  |
|--------------|----|------|-----|-----|-----|-------|-------|------|
| PB           | 17885 | 1.140 | 0.720 | 0.179 | 0.664 | 0.978 | 1.403 | 4.186 |
| R&D          | 17885 | 0.023 | 0.020 | 0 | 0.008 | 0.019 | 0.032 | 0.108 |
| Patent       | 17885 | 27.930 | 73.880 | 0 | 0 | 6 | 21 | 548 |
| Substantial  | 17885 | 11.940 | 34.410 | 0 | 0 | 2 | 9 | 270 |
| Strategy     | 17885 | 15.730 | 43.850 | 0 | 0 | 2 | 11 | 322 |
| Citation     | 17885 | 14.75 | 47.95 | 0 | 0 | 1 | 8 | 370 |
| TFP OLS      | 17885 | 0.003 | 0.280 | -0.648 | -0.179 | -0.019 | 0.159 | 0.891 |
| TFP LP       | 17885 | 0.450 | 0.584 | 0.038 | 0.139 | 0.243 | 0.469 | 3.309 |
| Size         | 17885 | 22.090 | 1.236 | 19.970 | 21.190 | 21.900 | 22.780 | 25.970 |
| ROA          | 17885 | 0.057 | 0.059 | -0.187 | 0.030 | 0.053 | 0.084 | 0.234 |
| LEV          | 17885 | 0.419 | 0.200 | 0.055 | 0.260 | 0.412 | 0.569 | 0.883 |
| PPE EMP      | 17885 | 48.000 | 64.000 | 2.300 | 16.000 | 28.000 | 51.000 | 440.000 |
| CFO          | 17885 | 0.048 | 0.066 | -0.138 | 0.009 | 0.046 | 0.086 | 0.231 |
| MTB          | 17885 | 0.614 | 0.235 | 0.135 | 0.434 | 0.613 | 0.792 | 1.131 |
| SALES,G      | 17885 | 0.175 | 0.351 | -0.455 | -0.005 | 0.119 | 0.274 | 2.100 |
| AGE          | 17885 | 2.194 | 0.672 | 0.693 | 1.609 | 2.197 | 2.773 | 3.296 |
| TOP1         | 17885 | 0.350 | 0.145 | 0.088 | 0.236 | 0.333 | 0.448 | 0.733 |
| Inhold       | 17885 | 0.375 | 0.236 | 0.001 | 0.169 | 0.379 | 0.561 | 0.877 |
| Msh          | 17885 | 0.079 | 0.148 | 0.000 | 0.000 | 0.001 | 0.079 | 0.625 |
| HHI          | 17885 | 0.037 | 0.062 | 0.008 | 0.014 | 0.016 | 0.024 | 0.355 |
| SOEs         | 17885 | 0.374 | 0.484 | 0.000 | 0.000 | 0.000 | 1.000 | 1.000 |
| Dual         | 17885 | 0.268 | 0.443 | 0 | 0 | 0 | 1 | 1 |
| Indir        | 17885 | 0.373 | 0.053 | 0.333 | 0.333 | 0.333 | 0.429 | 0.571 |
Table 3. Correlation coefficients.

|         | PB | R&D | Lpatent | Lnsubstantial | Lnstrategy | Lincitation | TFP_OLS | TFP_LP |
|---------|----|-----|---------|---------------|------------|-------------|---------|--------|
| PB      | 1.00 | -0.158*** | -0.134*** | -0.148*** | -0.091*** | -0.153*** | -0.130*** | -0.130*** |
| R&D     | -0.155*** | 1.000 | 0.362*** | 0.370*** | 0.281*** | 0.269*** | 0.086*** | -0.038*** |
| Lpatent | -0.140*** | 0.313*** | 1.000 | 0.889*** | 0.898*** | 0.735*** | 0.031*** | 0.101*** |
| Lnsubstantial | -0.162*** | 0.332*** | 0.895*** | 1.000 | 0.664*** | 0.812*** | 0.053*** | 0.115*** |
| Lnstrategy | -0.108*** | 0.235*** | 0.908*** | 0.695*** | 1.000 | 0.568*** | 0.003 | 0.081*** |
| Lincitation | -0.161*** | 0.247*** | 0.735*** | 0.817*** | 0.589*** | 1.000 | 0.047*** | 0.075*** |
| TFP_OLS | -0.111*** | 0.107*** | 0.035*** | 0.055*** | 0.012 | 0.053*** | 1.000 | 0.347*** |
| TFP_LP | -0.119*** | -0.038*** | 0.116*** | 0.164*** | 0.118*** | 0.151*** | 0.230*** | 1.000 |

Reports correlation coefficients among the firm-level variables. The correlations in the lower triangle reflect Pearson’s correlation coefficients. The upper triangle coefficients indicate Spearman’s rank correlation coefficients. ***, **, and * indicate at the 1%, 5%, or 10% significance level, respectively.

Table 4. Relation between the executive pay bandwagon and corporate innovation input and output We use OLS regression to estimate Models (1) and the Tobit regression to estimate Models (2)–(4). Standard errors clustered by firms are in parentheses. ***, **, and * denote significance at the 10%, 5%, and 1% level, respectively. The number of observations is 17,885.

In columns (1)–(2), it can be seen that the higher the propensity of the executive pay bandwagon, the lower is the number of patent applications (total patents or invention patents) by firms, while the coefficient on the interaction term R&D_{it1} × PB_{it} also being significantly negative. In other words, under the given amount of R&D spending, the executive pay bandwagon reduces the conversion of R&D input into innovation output, indicating that to alleviate the equity-related tensions triggered by the pay bandwagon, executives will reduce the level of effort in the innovation process without being able to change the innovation input, thus reducing the number of corporate innovation outputs. Additionally, innovation input (R&D_{it1}) is significantly and positively correlated with the number of innovation outputs (Lpatent_{it1}), suggesting that the more the innovation inputs, the more are the innovation outputs, and vice versa.

In column (3), when the number of non-invention patents is the explanatory variable, the coefficient on the interaction term R&D_{it1} × PB_{it} is negative but insignificant, indicating that while the pay bandwagon reduces the conversion of corporate innovation inputs into substantial patents, it does not have a significant effect on strategic patents. This evidence suggests that the executive pay bandwagon may reduce investment in innovation projects that involves high-risk and long-term investment, and it inhibits innovation input to successfully translate into substantial innovation outputs, leading to a reduction in the overall quality of a firm’s innovation outcomes. These results support H2.

Table 6 reports the relationship between the executive pay bandwagon and firm total factor productivity. We use the OLS method and LP method to estimate total factor productivity to measure corporate innovation efficiency. The results show that executive pay bandwagon (PB_{it}) is significantly and negatively related to firm TFP (TFP_{it1}), which suggests that, all else being equal, the executive pay bandwagon reduces corporate innovation efficiency. The reason for this is that when executives are at a disadvantage in pay comparison, they are prone to develop a perception of unfair income distribution; thus, to alleviate fairness-related tensions, executives may take measures to reduce their own inputs or change their outputs. Specifically, executives are likely to reduce their innovation inputs, reduce their own efforts, strategically invest in innovation efficiency.
Table 5. Executive pay bandwagon and the transformation of corporate innovation output We use the Tobit regression to estimate Models (1)–(3). Standard errors clustered by firms are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively. The number of observations is 17,885.

| (1) | (2) | (3) |
|-----|-----|-----|
| Lipatent, t | Lnsubstantial, t | Lnstrategy, t |
| PBt | -0.027 (0.052) | -0.020 (0.047) | -0.035 (0.059) |
| R&Dt | 26.070*** (2.520) | 29.539*** (2.326) | 17.167*** (2.843) |
| PBt×R&Dt | -4.887*** (1.804) | -6.431*** (1.628) | -2.541 (2.055) |
| Siɛt | 0.519*** (0.050) | 0.567*** (0.044) | 0.452*** (0.055) |
| ROAt | 1.578*** (0.476) | 0.955** (0.425) | 1.933*** (0.538) |
| LΕVt | -0.249 (0.194) | -0.177 (0.176) | -0.146 (0.211) |
| PFEMPt | -0.002*** (0.001) | -0.001** (0.001) | -0.003*** (0.001) |
| CFOt | 1.450*** (0.340) | 0.738*** (0.315) | 2.184*** (0.370) |
| MTBt | 0.250 (0.188) | -0.124 (0.166) | 0.593*** (0.299) |
| SALES,Gt | -0.318*** (0.052) | -0.239*** (0.048) | -0.334*** (0.055) |
| AGEt | -0.702*** (0.065) | -0.610*** (0.057) | -0.628*** (0.070) |
| TOPt | -0.660*** (0.231) | -0.813*** (0.211) | -0.338 (0.258) |
| Insholdt | 0.378*** (0.136) | 0.161 (0.124) | 0.478*** (0.153) |
| Msht | 0.561*** (0.209) | 0.362* (0.187) | 0.545*** (0.239) |
| HHIt | -0.161 (0.787) | -0.086 (0.703) | -0.042 (0.911) |
| SOEst | 0.135 (0.086) | 0.265*** (0.079) | -0.003 (0.095) |
| Dualt | 0.098 (0.067) | 0.062 (0.061) | 0.116 (0.074) |
| Indrt | 0.018 (0.532) | -0.114 (0.501) | 0.319 (0.581) |
| ccons | -10.459*** (1.014) | -11.740*** (0.907) | -10.700*** (1.125) |
| N | 17885 | 17885 | 17885 |
| pseudo R² | 0.098 | 0.101 | 0.099 |

Table 6. Relation between the executive pay bandwagon and corporate innovation efficiency We use OLS regression to estimate Models (1)–(2). Standard errors clustered by firms are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively. The number of observations is 17,885.

| (1) | (2) |
|-----|-----|
| TPPOLS,t | TPPLP,t |
| PBt | -0.011** (0.005) | -0.019*** (0.008) |
| Siɛt | 0.044*** (0.006) | 0.342*** (0.013) |
| ROAt | 0.928*** (0.068) | 0.139 (0.108) |
| LΕVt | -0.079*** (0.025) | 0.162*** (0.037) |
| PFEMPt | 0.000*** (0.000) | -0.001*** (0.000) |
| CFOt | 0.201*** (0.049) | 0.181*** (0.075) |
| MTBt | -0.124*** (0.023) | -0.201*** (0.038) |
| SALES,Gt | 0.054*** (0.007) | 0.076*** (0.011) |
| AGEt | 0.005 (0.008) | -0.037*** (0.014) |
| TOPt | 0.033 (0.031) | 0.233*** (0.054) |
| Insholdt | 0.011 (0.019) | -0.042 (0.030) |
| Msht | 0.047* (0.029) | 0.024 (0.034) |
| HHIt | -0.077 (0.115) | -0.016 (0.149) |
| SOEst | 0.013 (0.011) | 0.055*** (0.019) |
| Dualt | 0.015* (0.099) | -0.002 (0.013) |
| Indrt | -0.146** (0.064) | 0.402*** (0.123) |
| ccons | -0.834*** (0.111) | -7.226*** (0.260) |
| N | 17885 | 17885 |
| adj. R² | 0.116 | 0.579 |

4.6. Robustness analyses of the impact of the executive pay bandwagon on innovation activities

4.6.1. Alternative estimation methods

Two-stage least squares analysis. Although we control for corporate governance and firm performance variables in the baseline models, the relationship between the executive pay bandwagon and corporate innovation may still be endogenous. One possible explanation is that firms with poorer corporate governance and performance have lower levels of executive compensation, thus making it easier to trigger executive pay comparison, along with a corresponding reduction in firms’ investment in innovation. To mitigate endogeneity, we perform a two-stage least squares instrument variable (IV) analysis. We use the religious environment in the location of listed companies as an IV for the executive pay bandwagon. Since religious beliefs can help people to avoid or reduce the effects of stress and negative emotions, and the pursuit of forgiveness can motivate individuals to replace negative emotions arising from unfair treatment with positive emotions, people with religious beliefs are more internally peaceful and less likely to engage in pay comparison. Listed companies are influenced by the religious environment in their locations (Chen et al., 2013), and thus there are differences in their executives’ pay-comparing mentality. However, there exists no discernible relationship between religious beliefs and corporate innovation. We calculate the median number of provincial key temples in the location of companies in the same industry; Religion equals 1 when the number of provincial key temples in the location of listed companies is less than its median, and 0 otherwise. We expect religion to be negatively related to the executive pay bandwagon.

The results are presented in Table 7. The coefficient on IV (Religion) has the expected sign and is statistically significant. More importantly, the coefficients associated with PB IV are negative and significant in column (2), column (4) and columns (6)–(7), but not significant in column (3) and column (5) of Table 7, suggesting that the executive pay bandwagon decreases both corporate innovation inputs and innovation outputs (especially for high-quality patents), and exhibits a significant negative effect on firm’s total factor productivity after controlling for possible endogeneity.

Fixed effects model. Endogeneity may arise due to the omission of unobservable firm-level controls in the regression. We adopt the fixed effects approach to mitigate this issue. Panel A of Table 8 displays the results. The estimated coefficient of the executive pay bandwagon (PB) is negative as expected.

Negative binomial method. The negative binomial method is attractive when the dependent variable uses count data and there is evidence of wide dispersion (Zhang et al., 2019). The negative binomial regression results in Panels B of Table 8 show that the executive pay bandwagon is negatively associated with total patents (Patentt), invention patents (Inventiont), and citation counts (Citationt), while it has an insignificant negative effect on the non-invention patent counts (Strategyt), confirming H2.

4.6.2. Including executives’ characteristics

Another possible explanation for the fact that the executive pay bandwagon triggered by insufficient extrinsic incentives can inhibit corporate innovation is that relatively low levels of compensation are matched by lower executive ability, which has an important impact on corporate innovation (Custodio et al., 2019). To exclude the influence of the omitted variable of managerial ability, on the results of this study, we control for managerial ability indicators in Eqs. (1), (2), and (3) and Eq. (5), where managerial ability is estimated according to Demerjian et al.’s (2012) method. We first estimate firm efficiency by industry using Data Envelopment Analysis (DEA). Subsequently, we estimate the following Tobit regression (7) by industry. Variables in Eq. (7) include firm efficiency measured by using DEA (Efficiency), firm size (Size), market share as the percentage of revenues earned by the firm within its industry in year t (MS); free cash flow indicator projects, resulting in a negative impact on both the quantity and quality of innovation outputs, and consequently, a reduction in innovation efficiency. Thus, these results support H3.
Table 7. Two-stage least squares analysis presents the results for the impact of executive pay bandwagon on corporate innovation using a two-stage least squares analysis. The instrumental variable is the religious environment in the location of the listed companies (Religion). T-statistics are based on standard errors clustered at the firm level and are in parentheses. ***, **, and * indicate 1%, 5%, or 10% significance, respectively.

| 1st-Stage | 2nd-Stage |
|-----------|-----------|
| (1)       | (2)       | (3)       | (4)       | (5)       | (6)       | (7)       |
| Religion  |           |           |           |           |           |           |
|           | 0.062***  | (0.010)   |           |           |           |           |
| PB_IV     | -0.014*** (0.005) | -0.215 (0.461) | -1.022*** (0.456) | 0.940 (1.263) | -1.016* (0.600) | -0.122** (0.066) |
| Size      | -0.227*** (0.007) | -0.002** (0.001) | 0.525*** (0.107) | 0.401*** (0.106) | 0.702** (0.290) | 0.627*** (0.139) |
| ROA       | -0.924*** (0.109) | 0.008 (0.005) | 1.952*** (0.533) | 0.638 (0.527) | 3.202** (1.336) | 1.116 (0.710) |
| LEV       | 0.640*** (0.033) | 0.007** (0.003) | -0.229 (0.313) | 0.347 (0.309) | -0.832 (0.837) | 0.232 (0.404) |
| PPE_EMP   | 0.001*** (0.000) | -0.319*** (0.043) | -0.003*** (0.000) | -0.002*** (0.000) | -0.004*** (0.000) | -22.574*** (6.564) |
| CFO       | -0.504*** (0.089) | 0.012*** (0.004) | 1.855*** (0.349) | 0.801*** (0.346) | 3.022*** (0.747) | 0.732 (0.459) |
| MTB       | 0.544*** (0.033) | -0.011*** (0.003) | -0.122 (0.267) | -0.130 (0.264) | -0.250 (0.709) | -0.472 (0.350) |
| SALES_G   | 0.061*** (0.015) | 0.004*** (0.001) | -0.250*** (0.053) | -0.117** (0.053) | -0.353*** (0.098) | -0.098 (0.071) |
| Industry  | Yes       | Yes       | Yes       | Yes       | Yes       | Yes       |
| Year      | Yes       | Yes       | Yes       | Yes       | Yes       | Yes       |
| TopI       | 0.451*** (0.040) | 0.002 (0.002) | -0.731*** (0.233) | -0.560*** (0.230) | -0.857 (0.607) | -0.916*** (0.303) |
| Inhabit    | -0.136*** (0.029) | 0.001 (0.001) | 0.436** (0.104) | 0.121 (0.103) | 0.666*** (0.233) | 0.221 (0.135) |
| Mktb       | -0.096** (0.044) | 0.006** (0.001) | 0.715** (0.131) | 0.460*** (0.130) | 0.756*** (0.292) | 0.672*** (0.163) |
| HHI       | 0.533*** (0.238) | -0.001 (0.008) | -0.293 (0.737) | 0.160 (0.733) | -0.662 (1.184) | 0.611 (0.965) |
| SOEs      | 0.024* (0.013) | 0.001*** (0.000) | 0.162** (0.041) | 0.319*** (0.040) | -0.016 (0.109) | 0.318*** (0.054) |
| Dual       | 0.106*** (0.013) | -0.001 (0.001) | 0.099 (0.661) | 0.146*** (0.060) | 0.001 (0.157) | 0.153* (0.080) |
| Indd       | -0.025 (0.098) | 0.004 (0.003) | 0.079 (0.275) | -0.059 (0.272) | 0.370 (0.618) | -0.256 (0.371) |
| Year       | Yes       | Yes       | Yes       | Yes       | Yes       | Yes       |
| Industry  | Yes       | Yes       | Yes       | Yes       | Yes       | Yes       |
| _cons     | 4.608*** (0.152) | 0.071*** (0.023) | -10.060*** (2.178) | -7.779*** (2.154) | -15.509*** (5.920) | 4.602*** (0.154) |
| N         | 17885     | 17885     | 17885     | 17885     | 17885     | 17885     |
| adj. R²    | 0.125     | 0.142     |           |           |           |           |
| Wald chi²  | 5638.06   | 4306.28   | 3436.97   | 5857.67   |           |           |

Table 8. Robustness check with alternative methods. We use fixed effects regression models to estimate Models (1)-(6) in Panel A. Standard errors are in parentheses. We also estimate Models (1)-(4) in Panel B with the negative binomial regression method with standard errors clustered by firms in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

| Panel A: Using fixed effects regression |
|--------------------------------------|
| (1)        | (2)        | (3)        | (4)        | (5)        | (6)        |
| PB         | -0.001** (0.000) | -0.021 (0.023) | -0.027** (0.014) | -0.030** (0.015) | -0.069*** (0.020) | -0.011*** (0.004) |
| Controls   | Yes        | Yes        | Yes        | Yes        | Yes        | Yes        |
| Firm       | Yes        | Yes        | Yes        | Yes        | Yes        | Yes        |
| _cons      | 0.138*** (0.011) | 0.932 (0.861) | 0.037 (0.387) | 0.705 (0.429) | -3.125*** (0.651) | -4.079*** (0.105) |
| N          | 17885    | 17885    | 17885    | 17885    | 17885    | 17885    |
| adj. R²    | 0.125    | 0.085    | 0.037    | 0.048    | 0.245    | 0.162    |

| Panel B: Using the negative binomial regression |
|--------------------------------------|
| (1)        | (2)        | (3)        | (4)        |
| PB         | -0.105** (0.043) | -0.244*** (0.039) | -0.027 (0.054) |
| Controls   | Yes        | Yes        | Yes        |
| Year       | Yes        | Yes        | Yes        |
| Industry  | Yes        | Yes        | Yes        |
| _cons     | -12.909*** (0.959) | -14.802*** (0.858) | -12.766*** (1.172) |
| N         | 17885     | 17885     | 17885     |
| pseudo R² | 0.050     | 0.064     | 0.048     |

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coded to 1 when a firm has nonnegative free cash flow (FCF); business segment concentration as the ratio of individual business segment sales to total sales, summed across all business segments for year t (BSC); and, firm age as the number of years the firm has been listed at the end of year t (Age). The residual of the estimation is managerial ability (Mability).
Efficiency_{it} = \alpha_0 + \beta_1 \text{Size}_{it} + \beta_2 \text{M}S_{it} + \beta_3 \text{FC}_{it} + \beta_4 \text{Age}_{it} + \beta_5 \text{BSC}_{it} + \sum \text{Year} + \epsilon_{it} \tag{7}

As shown in Table 9 (Panel A), managerial ability has a marginal incremental effect on firms’ R&D expenditures, innovation outcomes, and total factor productivity, while the executive pay bandwagon is significantly negatively related to all of these innovation measures. Thus, the results of this study remain robust after controlling for managerial ability.

Since CEO age, tenure, educational background, etc., also impact corporate innovation (Barker and Mueller, 2002; Lin et al., 2011; Chen, 2013), we also include extra executives’ individual-level controls, such as CEO age (CEOAge), tenure (Tenure), educational background (Education), and overseas background (Oversea) in the regressions to alleviate the problem of omitted variables. In Panel B of Table 9, the findings consistently show that the coefficients on PB are negatively significant at the 1% or 10% level, with the statistical significance being slightly lower for the non-invention patents (Instrategy) results.

4.6.4. Alternative subsamples

In the final set of tests, we reexamine our results in the state-owned enterprises (SOEs) and non-state-owned enterprises (Non-SOEs), respectively. Given that SOEs have other goals beyond shareholder wealth maximization, the incentive structure of managements in SOEs differs from that of non-SOEs. Executives of the state-owned enterprises may have a greater preference for implicit incentives like political promotions and perquisites. Thus, non-SOEs are more likely to experience a greater propensity of the executive pay bandwagon than SOEs. Table 11 reports the results, we find slightly stronger results in the non-SOEs as expected.

5. Further analyses

5.1. Transmission mechanism

5.1.1. Risk taking

According to principal-agent theory, executives tend to abandon risky but NPV-positive investment projects out of their own interests, and appropriate compensation incentives can help encourage risk-taking (Low, 2009) and stimulate the innovation spirit of executives. The high-risk characteristic of corporate innovation determines the intrinsic link between entrepreneurs’ risk-taking and innovation spirit. The executive pay bandwagon triggered by external pay inequality makes executives eager to achieve short-term performance goals to reduce the current pay gap, while abandoning risky projects that are beneficial to the company’s long-term development, thus showing a lack of motivation to innovate. Therefore, risk-taking, which acts as a direct motivation and necessary condition for influencing firms’ innovative behavior, is affected year-end × 0.01), and use it as a measure of executives’ equity-based incentives. On this basis, we adopt the sum of the executives’ cash compensation and equity incentives to recalculate the comparing coefficient to test the hypotheses; the results in Panel C of Table 10 remain unchanged.

4.6.3. Alternative measures of the executive pay bandwagon

In some firms the CEO makes all the major decisions (Adams et al., 2005). Because CEOs are able to exert direct influence on the firm’s innovation activities, we calculate the comparing coefficient based on CEO pay. Table 10 (Panel A) shows the results. The coefficients on the CEO pay bandwagon (CEO PB) are negative and significant in all of the regressions. To verify robustness, we also calculate the comparing coefficient based on the average compensation of the top three managements (M PB), which includes members of the board of directors, supervisory committee and senior executive officers. The results in Panel B of Table 10 remain similar.

The composition of executive compensation is not just cash. It also includes equity-based incentives. Following Balsam et al. (2014), we calculate the market value of executives’ stock at fiscal year-end (i.e., the number of shares executives hold × the closing price of the stock at fiscal
Table 10. Alternative measures of the executive pay bandwagon We use OLS regression to estimate Models (1) and (6) and the Tobit regression to estimate Models (2)-(5). Standard errors clustered by firms are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

|                  | (1) R²D,t | (2) Lpatent,t | (3) Lsubstantial,t | (4) Lstrategy,t | (5) Lincitation,t | (6) TFP,t |
|------------------|-----------|---------------|-------------------|----------------|-------------------|----------|
| Panel A: CEO pay bandwagon |           |               |                   |                |                   |          |
| CEO_PBP,t        | -0.01***  | -0.044***     | -0.051***         | -0.031***      | -0.080***        | -0.003*** |
| Controls         | Yes       | Yes           | Yes               | Yes            | Yes               | Yes      |
| Year             | Yes       | Yes           | Yes               | Yes            | Yes               | Yes      |
| Industry         | Yes       | Yes           | Yes               | Yes            | Yes               | Yes      |
| _cons            | 0.010     | -10.129***    | -11.299***        | -10.508***     | -13.964***       | -1.154*** |
| N                | 13524     | 13524         | 13524             | 13524          | 13524             | 13524    |
| adj. R²          | 0.274     | 0.083         | 0.076             | 0.092          | 0.152             | 0.119    |

Panel B: Management pay bandwagon

|                  | (1) R²D,t | (2) Lpatent,t | (3) Lsubstantial,t | (4) Lstrategy,t | (5) Lincitation,t | (6) TFP,t |
|------------------|-----------|---------------|-------------------|----------------|-------------------|----------|
| M_PBP,t          | -0.003*** | -0.154***     | -0.189***         | -0.101***      | -0.277***        | -0.008*** |
| Controls         | Yes       | Yes           | Yes               | Yes            | Yes               | Yes      |
| Year             | Yes       | Yes           | Yes               | Yes            | Yes               | Yes      |
| Industry         | Yes       | Yes           | Yes               | Yes            | Yes               | Yes      |
| _cons            | 0.016*    | -10.181***    | -11.553***        | -10.486***     | -14.238***       | -0.815*** |
| N                | 17896     | 17896         | 17896             | 17896          | 17896             | 17896    |
| adj. R²          | 0.287     | 0.088         | 0.085             | 0.094          | 0.116             | 0.121    |

Panel C: Considering equity-based incentives

|                  | (1) R²D,t | (2) Lpatent,t | (3) Lsubstantial,t | (4) Lstrategy,t | (5) Lincitation,t | (6) TFP,t |
|------------------|-----------|---------------|-------------------|----------------|-------------------|----------|
| PB,t             | -0.001*** | -0.024***     | -0.025***         | -0.019***      | -0.046***        | -0.002*** |
| Controls         | Yes       | Yes           | Yes               | Yes            | Yes               | Yes      |
| Year             | Yes       | Yes           | Yes               | Yes            | Yes               | Yes      |
| Industry         | Yes       | Yes           | Yes               | Yes            | Yes               | Yes      |
| _cons            | 0.013     | -10.194***    | -11.466***        | -10.448***     | -13.636***       | -1.900*** |
| N                | 13530     | 13530         | 13530             | 13530          | 13530             | 13530    |
| adj. R²          | 0.275     | 0.082         | 0.076             | 0.092          | 0.119             | 0.121    |

Table 11. Alternative subsamples We use OLS regression to estimate Models (1) and (6) and the Tobit regression to estimate Models (2)-(5). If the firm is a non-state-owned enterprise, the value of Non_SOEs is 1 and 0 otherwise. If the firm is a state-owned enterprise, the value of SOEs is 1 and 0 otherwise. Standard errors clustered by firms are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

|                  | (1) R²D,t | (2) Lpatent,t | (3) Lsubstantial,t | (4) Lstrategy,t | (5) Lincitation,t | (6) TFP,t |
|------------------|-----------|---------------|-------------------|----------------|-------------------|----------|
| Non_SOExPBP,t    | -0.003*** | -0.219***     | -0.282***         | -0.127***      | -0.390***        | -0.014*** |
| SOExPBP,t        | -0.003*** | -0.134***     | -0.120***         | -0.136***      | -0.208***        | -0.005*** |
| Size             | 0.000     | 0.534***      | 0.588***          | 0.459***       | 0.739***         | 0.044***  |
| ROA,t            | 0.018***  | 1.974***      | 1.383***          | 2.196***       | 1.867***         | 0.929***  |
| LEV,t            | -0.001    | -0.259        | -0.193            | -0.137         | -0.212           | -0.081*** |
| PPE,EMP,t        | -0.466*** | -30.047***    | -24.809***        | -34.776***     | -26.088***       | 1.969***  |
| CFO,t            | 0.018***  | 1.840***      | 1.162***          | 2.467***       | 0.990***         | 0.199***  |
| MTB,t            | -0.017*** | -0.128        | -0.547***         | 0.323          | -0.779***        | -0.124*** |
| SALES,t          | 0.003***  | -0.254        | -0.171            | -0.287         | -0.144           | 0.065***  |
| AGE,t            | -0.004*** | -0.770        | -0.678            | -0.676         | -0.830***        | 0.036***  |
| TOPF,t           | -0.003    | -0.720        | -0.875            | -0.373         | -1.140***        | 0.033***  |
| Inhold,t         | 0.003**   | 0.455**       | 0.258**           | 0.525**        | 0.334**          | 0.011    |
| (0.001)          | (0.141)   | (0.131)       | (0.155)           | (0.166)        | (0.166)          | (0.011)  |
| Msh,t            | 0.007***  | 0.703         | 0.513             | 0.644***       | 0.683***         | 0.046***  |
| HHI,t            | -0.006    | -0.309        | -0.265            | -0.115         | 0.269            | -0.076*** |
| SOEs,t           | 0.000     | -0.105        | -0.077            | -0.117         | -0.092           | -0.015*** |
| Dual,t           | 0.004     | 0.081         | 0.056             | 0.366          | -0.211           | -0.145*** |
| Year             | Yes       | Yes           | Yes               | Yes            | Yes               | Yes      |
| Industry         | Yes       | Yes           | Yes               | Yes            | Yes               | Yes      |
| _cons            | 0.016*    | -10.020***    | -11.401***        | -10.335***     | -14.000***       | -0.805*** |
| N                | 17885     | 17885         | 17885             | 17885          | 17885             | 17885    |
| adj. R²          | 0.287     | 0.088         | 0.085             | 0.095          | 0.116             | 0.122    |

p-value of the F-statistic is 0.057.
by executive pay bandwagon, consequently inhibiting corporate innovation.

We apply the successive tests in Barron and Kenny (1986) to validate whether risk-taking mediates the impact of the executive pay bandwagon on corporate innovation. We follow Lee et al. (2018) in using beta from the capital asset pricing model as a proxy for a firm’s risk-taking behavior.

The results are presented in Table 12. In column (1), we regress Risk-taking on PB. The coefficients of PB are negatively significant at the 5% level, suggesting that the executive pay bandwagon translates into fewer risk-taking behaviors. In columns (2)–(5), we use R&D, Inpatent, Incitation, and TPP,OLS as the dependent variables, and Risk taking and PB as the explanatory variables, respectively. The findings show that the

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coefficients on Risk taking are significant at the conventional level, with the expected signs in column (2) and column (5). Hence, risk-taking is a mediating variable for the impact of the executive pay bandwagon on corporate R&D expenditures and TFP.

5.1.2. Short-sighted managerial behavior

We argue that pay bandwagon may exacerbate management short-termism, such as engaging in certain types of short-term investments, which can discourage corporate innovation since technological innovation is a long-term process fraught with unknown risks. Thus, we apply the successive tests to validate whether short-sighted managerial behavior mediates the impact of the executive pay bandwagon on corporate innovation. Based on extant studies on managerial myopia, we use net short-term investments (Shortinv_ratio) as explanatory variables. The findings show that the coefficients of Shortinv_ratio and PB are all negative and significant at the conventional level, with the expected signs in column (2)–(4). Hence, Shortinv_ratio is one of the mechanisms through which the executive pay bandwagon affects corporate innovation inputs and outputs. These results provide further evidence that the executive pay bandwagon is detrimental to corporate innovation.

5.2. The moderating role of corporate governance

Managers are subject to psychological biases and exhibit less than fully rational behavior. Good corporate governance mechanisms are helpful in mitigating the effects of these biases by monitoring managerial activities and limit undesirable managerial behavior. However, top executives in firms with poor corporate governance may have greater discretionary power. Thus, we argue that weak corporate governance structures may exacerbate the negative relationship between the executive pay bandwagon and corporate innovation.

Since corporate governance has multiple dimensions and interaction effects are possible, we construct a measure of the quality of firm-level corporate governance (CG) using principal component analysis. According to Dey (2008), we consider 8 governance variables: the percentage ownership of top1 shareholder, the percentage of independent directors on the board, whether the chairman and CEO are the same individual, the size of the board of directors, the percentage ownership by top executives, the percentage ownership held by top2 shareholder to top10 shareholder, whether the enterprise is state owned, and the ratio of shares held by institutional investors to total shares. Then, we divide the full sample into strong and weak corporate governance sample groups based on the median of the CG. GCG takes a value of 1 if the quality of firm-level corporate governance is above the sample median, and 0 otherwise. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

### Table 14. The moderating effect of corporate governance. We use OLS regression to estimate Models (1) and (6) and the Tobit regression to estimate Models (2)–(5). GCG takes a value of 1 if the quality of firm-level corporate governance is above the sample median, and 0 otherwise. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

|        | (1)                  | (2)              | (3)              | (4)               | (5)              | (6)              |
|--------|----------------------|------------------|------------------|-------------------|------------------|------------------|
|        | R&Dt                 | Lnpatentt        | Lnsubstantialt   | LnstrategyYt      | Lncitationt      | TFPtr            |
| PB     | -0.004*** (0.000)    | -0.250*** (0.038) | -0.278*** (0.036) | -0.208*** (0.044) | -0.358*** (0.049) | -0.007 (0.005)   |
| GCG    | -0.002*** (0.001)    | -0.103 (0.073)   | -0.104 (0.068)   | -0.136* (0.080)   | -0.234*** (0.086) | -0.006 (0.010)   |
| GCG×PB | 0.002*** (0.000)     | 0.074 (0.055)    | 0.099* (0.052)   | 0.116* (0.062)    | 0.141** (0.067)  | 0.003 (0.007)    |
| Size   | 0.001*** (0.000)     | 0.535*** (0.029) | 0.561*** (0.027) | 0.488*** (0.031)  | 0.713*** (0.032)  | 0.404*** (0.004) |
| ROA_t  | 0.012*** (0.004)     | 1.997*** (0.432) | 1.263*** (0.395) | 2.271*** (0.477)  | 1.450*** (0.498)  | 0.935*** (0.066) |
| LEV_t  | 0.002* (0.001)       | -0.042 (0.136)   | 0.023 (0.128)    | -0.059 (0.147)    | 0.102 (0.158)    | -0.078*** (0.019) |
| PPE_EMP_t | -0.475*** (0.027) | -32.021*** (4.565) | -25.107*** (4.296) | -39.792*** (4.805) | -24.660*** (5.306) | 2.901*** (0.568) |
| CFO_t  | 0.020*** (0.003)     | 2.020*** (0.359) | 1.125*** (0.335) | 2.915*** (0.392)  | 1.187*** (0.417)  | 0.220*** (0.050) |
| MTB_t  | -0.020*** (0.001)    | -0.020 (0.120)   | -0.359*** (0.113) | 0.375*** (0.132)  | -0.621*** (0.144) | -0.120*** (0.017) |
| SALES_t | 0.003*** (0.001)    | -0.319*** (0.061) | -0.236*** (0.057) | -0.353*** (0.065) | -0.176*** (0.068) | 0.064*** (0.008) |
| AGE_t  | -0.003*** (0.000)    | -0.727*** (0.036) | -0.590*** (0.033) | -0.707*** (0.039) | -0.652*** (0.041) | 0.017*** (0.005) |
| HHI_t  | -0.008 (0.014)       | -1.632 (1.287)   | -1.782 (1.191)   | -0.368 (1.418)    | -1.171 (1.549)    | 0.043 (0.197)    |
| Year   | Yes                   | Yes               | Yes               | Yes                | Yes               | Yes               |
| Industry | Yes                   | Yes               | Yes               | Yes                | Yes               | Yes               |
| cons   | 0.020*** (0.005)     | -0.158*** (0.611) | -10.264*** (0.569) | -9.691*** (0.674) | -13.539*** (0.714) | -0.895*** (0.079) |
| N     | 10818               | 10818             | 10818             | 10818              | 10818             | 10818             |
| adj. R² | 0.293             | 0.087             | 0.081             | 0.096              | 0.138             | 0.114             |

6. Conclusions

We examine the effects of executive psychological motivations on corporate operating strategies, specifically, the pursuit of corporate innovation. Taking the social comparison triggered by the external pay inequality as an opportunity, this study systematically examines the specific effects of the psychological characteristics of executives' inequality aversion on corporate innovation inputs, innovation outputs, and innovation efficiency.

Using a sample of Chinese firms and a novel corporate innovation metric, we present several findings. First, our results provide robust support for the hypothesized relationship between the executive pay bandwagon and corporate R&D spending. Second, we document a negative and significant impact of the executive pay bandwagon on innovation outcomes measured by both patent count and citation count. We show that executives with a pay-comparing mentality are more inclined to reduce investment in substantial innovation, thus inhibiting the
transformation of innovation inputs into innovation outcomes, especially for invention patents of relatively higher quality. Third, the executive pay bandwagon reduces innovation efficiency, which is reflected in the lower total factor productivity. Finally, we report that managers’ risk aversion and short-termism are two channels through which executive pay bandwagon negatively affects corporate innovation activities, and good corporate governance can mitigate the negative impact of the executive pay bandwagon on corporate innovation. Thus, based on these results, this study has the following implications.

First, while firms in China have entered an active innovation period, compared with innovative countries, there continue to exist problems of insufficient R&D investment intensity and innovation efficiency in the country. Therefore, while further strengthening the guiding and pulling effect of governmental financial support on corporate innovation, appropriate incentive mechanisms should be designed to reduce the influence of executives’ irrational behavior on corporate innovation. On the one hand, since the innovation results are highly uncertain, the risk they pose to executive compensation should not be borne by executives alone; enterprises should also give executives sufficient incentives before the innovation pays off, and encourage them to take appropriate risks by optimizing the incentive structure of executive compensation to give full play to the positive role of their human capital on corporate innovation. On the other hand, to motivate executives to engage in original innovation activities of substantial value, they should be rewarded at different levels according to the corporate benefits (e.g., revenue from sales of new products or services) and social benefits (e.g., number of patent citations) generated by different innovation outputs.

Second, there is a large gap in peer compensation among the listed companies in China. Although listed companies are required to disclose mandatory information on executive compensation, the disclosure of executive compensation of listed companies suffers from overly simple disclosure of compensation composition items, a formal basis for compensation decisions, and a lack of transparency in compensation decision-making procedures; therefore, the phenomenon of blind comparison by executives occurs. Consequently, in the process of compensation system reform, the higher peer pay gap should be limited to ensure fairness in the income distribution. At the same time, the disclosure of executive pay information should be strengthened, particularly the basis for pay setting and its reasons, so as to ensure that the pay obtained by executives is justified; this will promote a state of healthy competition, and will facilitate avoiding the negative effects of the executive pay bandwagon.

Third, from the perspective of innovation disclosure, the degree of information asymmetry between insiders and external investors of listed companies in China continues to be large. Relevant regulatory authorities should improve the corporate innovation disclosure system to make the disclosure of listed companies’ innovation activities more timely and complete, providing better protection for corporate innovation and shareholders’ investment. At the same time, listed companies should strengthen the construction of corporate governance mechanisms, especially for the supervision mechanism, to effectively restrain the power of executives and “negative idle” behavior, optimize the allocation of R&D resources, and achieve long-term development of enterprises.

We have three limitations. First, the major challenge in analyzing the effect of the executive pay comparing mentality is the lack of an appropriate empirical measure, this issue can be addressed in future studies by combining experimental and inquiry methods. Second, it is difficult to include different compensation components in the same research framework. Interesting and testable hypotheses for future research can be developed from other forms of executive compensation incentives (such as non-monetary or implicit compensation) based on a psychological perspective. Third, our findings are based on China. Future studies can be extended to other markets.

Declarations

Author contribution statement

Yongliang Zeng: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Mengyao Zhou: Performed the experiments; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Hong Luo: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper.

Wei Zhou: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data.

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Data availability statement

Data associated with this study is available online from the Chinese Research Data Services Platform System (CNRDS), and the China Stock Market & Accounting Research Database (CSMAR).

Declaration of interest’s statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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