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The impact of employee welfare on innovation performance: Evidence from China's manufacturing corporations

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ABSTRACT

A large amount of literature has addressed the significant effects of some internal and external factors on corporate innovation performance. However, no research in the field of production economics focuses on the plausible impact of employee welfare on innovation performance of manufacturing corporations. Using a large sample data from Chinese listed manufacturing corporations over the period of 2010–2017, this study investigates whether and how employee welfare affects corporate innovation performance. We find that manufacturing corporations with higher employee welfare have better innovation performances measured by three categories of patent applications and this positive relationship is mainly reflected in the level of quality of innovation but not in the quantity of it. Then, various robustness checks further show that our results are not biased by alternative measures of innovation performance or employee welfare through different regression methods. In addition, the channel tests show that the positive impacts of employee welfare on innovation performances in China's manufacturing corporations are mainly achieved by retaining outstanding employees, attracting positive media reports and increasing inventor (R&D) efficiency. Finally, we test the validity of three impact channels by using mediating effect analysis and further confirm our conclusions.

1. Introduction

Innovation performance and its influence factors in manufacturing corporations are very important issues in the field of production economics (Zeng et al., 2017; Escrig-Tena et al., 2018). As the "engine of driving revenue growth" (Patterson, 1998) and "the cornerstone of organizational survival" (Hurley and Hult, 1998), innovation is also a hot practical topic for policy makers and corporation managers. For the reason that manufacturing corporations are the core and main body of the national innovation system, it is extremely important to promote innovation performance in manufacturing corporations to achieve and maintain significant economic growth and development. Many external and internal factors that can affect corporate innovation have discussed in recent researches. For example, on the one hand, analyst pressure (Guo et al., 2019), national policies (Gu and Zhang, 2017), competitive environment (Aghion and Howitt, 2005; Lunn, 1986), litigation risk (Yue et al., 2015) are well recognized external factors related to corporate innovation performance. On the other hand, corporate size (Scherer, 1965), equity incentives (Chang et al., 2015), internal pay dispersion (Ederer and Manso, 2013), and management characteristics (Song et al., 2010), are also taken as important internal drivers for innovation performance. Specifically, in the field of production economics, the effects of hard and soft quality management (SQM and HQM) as well as human capital development on innovation performance are well addressed in recent years (see Zeng et al., 2017; Escrig-Tena et al., 2018; Hong et al., 2019; Ma et al., 2019 and among others). However, among all the internal or external influence factors, corporate employee is a primary determinant to directly handle all the issues that are possibly related to the innovation performance of a corporation (Edmans, 2011; Mao and Weathers, 2015; Ben-Nasr and Ghouma, 2018). Thus the main motivation of this paper is to investigate whether and how the employee welfare impacts on the innovation performance of manufacturing corporations.

As a market unit formed by human capital and non-human capital, human capital plays an indispensable role in corporation production and value creation. Employees, as direct participants in corporation production activities, play a more important role in promoting corporate value than that of non-human capital (Black and Lynch, 1996). But prior

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researches have yielded conflicting results on how employee welfare can benefit production and value creation in corporations. Started with Frederick Taylor in early years of the 20th century, the traditional motivational theory assumes that money is the main, if not the only, incentive for better performance. In this context, employees are considered as inputs, just like other raw materials, who are required to perform unskilled tasks. Corporations use employees as inputs in their productions and focus only on cost efficiency which can be attained by extracting the maximum possible productivity while minimizing costs. Any attempt to increase the satisfaction of the workers could only be done through higher salaries or lower working hours which, in both cases, is synonym of less efficiency, i.e. less profitability. At the same time, similar to these views, some studies suggest that what makes employees satisfied may not, in some cases, enhance shareholders wealth. Employee welfare is a costly investment which might not yield its expected marginal return. For instance, investments to improve working conditions can be a downer if mediocre employees stay because they are satisfied with such environment. In this case, the marginal return of those investments is offset by the marginal cost due to opportunistic unskilled employees. An article entitled "Costco's dilemma: be kind to its workers, or Wall Street?" in Wall Street Journal, shows how corporations can be accused of paying too much to their workers. This article presents frustrations of some investors and financial analysts who expressed their disappointments about the overly generous welfare of Costco.

In contrast, the modern management theory gives more values to employees, who are considered as strategic asset that can provide additional value to the corporation, particularly in knowledge-based industries such as technology and manufacturing corporations. How to increase the enthusiasm of employees to participate in corporate innovation activities has become a topic of interest to more and more scholars and corporations, especially in manufacturing corporations. According to these theories, employee welfare is particularly crucial to drive employee engagement which ultimately translates into higher performance and enhanced shareholders' values. Consistent with this view, some scholars point out that corporations that offer better welfare measures to their employees generate higher returns for shareholders (Edmans, 2011) and a corporate environment conducive to work can enhance corporate value creation, profitability, and productivity (Faleye and Trahan, 2011). By implementing policies that are beneficial to employees, corporations can improve their enthusiasm, strengthen their employee relations, and increase their trust in managers, thus offsetting the negative effect of high-risk innovation activities on employees. In turn, this motivates them to overcome difficulties and failures in the innovation process.

The above-mentioned findings show that there are different perceptions on the role of employee welfare in corporation value. While job welfare increases the utility of the work force, it is not evident that it would create wealth to shareholders. In addition to this unclear impact of job satisfaction on corporation's performance, it is also noticeable that prior studies haven't devoted enough attention to other dimensions of corporate performance. Beyond the potential impact of employee welfare on the accounting performance (Meyer et al., 2001) or market performance (Filbeck, 2001; Gorton and Schmid, 2004; Edmans, 2011, 2012), however, there are no researches focusing on the effect of employee welfare on other dimensions of corporate value, especially on the innovation performance in manufacturing corporations.

This paper tries to fill this gap by investigating whether corporations providing their employees with good welfare mitigate or contribute to their innovation performance. Two competing hypotheses are tested: on the one hand, the incentive theory holds that higher employee welfare will result in better corporate innovation. On the other hand, the agency theory acknowledges the opposite relationship. We use data from China's manufacturing corporations listed in the Shanghai and Shenzhen Stock Exchanges from 2010 to 2017 to test the relationship between employee welfare and corporate innovation performance. The empirical results show that better employee welfare can significantly improve the innovation outputs of manufacturing corporations in China, especially in the total number of patents and invention patents, but not in non-invention patent applications. These findings remain valid by adopting a series of robustness tests, such as, regressions with alternative measurements of employee welfare, Heckman's two-step regression, instrumental variable, lagged independent variables, regression without samples from first-tier cities in China, regression by using variables in difference forms, Poisson counting and Fama-MacBeth regressions. Next, this study analyzes the possible channels through which employee welfare can affect corporate innovation outputs. The results show that improving employee welfare can retain more outstanding employees, attract positive media reports and create harmonious working environment for corporate innovation, thus promoting the innovation outputs in manufacturing corporations. Finally, we test the robustness of the three affecting channels of employ welfare on corporate innovation using mediating effect analysis.

This paper makes several contributions to the literature: first, it enriches the researches on the factors influencing innovation performance in manufacturing corporations. Most extant literature mainly focuses on the relationship between various macro-level or corporation-level factors and innovation performance. Few studies, however, pay attention to whether and how employee welfare can promote corporate innovation, especially in manufacturing corporations. We provide evidence that better employee welfare is an incentive approach helping to retain talented employees, attract positive media reports and promote inventor efficiency. To the best of our knowledge, this is the first study that investigates the linkage between China's manufacturing listed corporations and employee welfare. Previous studies mainly analyze the impact of employee welfare on corporate accounting performance or market value. By focusing on corporate innovation, this paper can broaden our understanding of the implications of employee welfare on corporate innovation performance. Second, this paper finds that employee welfare is an effective method that can be used by corporation managers to promote the quality (e.g., invention patents), instead of quantity (e.g., non-invention patents), of corporate innovation. Previous researches mainly pay attention to the impacts of internal and external factors on the overall innovation performances in a corporation, without classifying them into innovation quality and innovation quantity (Tan et al., 2015). However, distinguishing the different effects of employee welfare on innovation quality and quantity is very important for managers to make articles of association to seek core innovation capability of a corporation, which is exactly the key topic of this paper. Third, most studies use ASSET4 or KLD databases to create a measurement of employee welfare (Bae et al., 2011; Ghaly et al., 2015; Landier et al., 2007). However, there are some problems in utilizing these two databases in our empirical studies. For instance, although the ASSET4 database contains data of China's corporations, there are only 42 Chinese corporations available (Ben-Nasr and Ghouma, 2018), which cannot meet the requirement of this paper. Regarding to KLD database, it contains only data for US listed corporations, which is also not suitable for the research topic for the Chinese manufacturing corporations. Thus, this study is the first to adopt the database of China-Hexun listed corporation social responsibility report (CHSRR) to build the employee welfare index. The advantages of CHSRR over ASSET4 and KLD are that it is designed specifically for China's listed corporations and offers more data categories than ASSET4 and KLD to make it possible to explore the channels analysis through which employee welfare can affect innovation performance in China's manufacturing corporations. Finally, we use various methods, such as regressions with alternative measurements of employee welfare, Heckman's two-step regression, instrumental variable, lagged independent variables, regression without samples from first-tier cities in China, regression by using variables in difference forms, Poisson counting and Fama-MacBeth regressions, to ensure the robustness of our conclusions. We also figure out three impacting channels, i.e., retaining outstanding employees, getting more positive media reports and increasing inventor efficiency, through which the employee welfare can positively affect the innovation quality in China's manufacturing corporations. All of these findings have important economic implications for policy makers and corporate managers.

The remainder of this paper is organized as follows: Section 2 reviews the literature and develops the hypotheses. Section 3 describes the data and methodology used. Section 4 discusses the empirical results and makes robustness checks, channel tests and the mediating effect analysis. Finally, Section 5 concludes.

2. Literature review and hypothesis development

Studies focus on the impact of employee welfare on business performance or value. The main goal of this paper is to expand the literature by exploring the impact of employee welfare on corporate innovation. Trends in the employee welfare and corporate innovation literature are briefly discussed before further hypothesis development.

2.1. Employee welfare

Two main perspectives exist regarding why corporations conduct employee welfare management research, namely incentive theory and agency theory.

According to incentive theory, providing employees with better welfare can motivate them to work hard and ultimately create higher corporate value. In modern management theories, employees are considered strategic asset that can provide additional value to the corporation, particularly in knowledge-based industries, such as manufacturing and pharmaceutical corporations. According to these theories, employee welfare is particularly crucial to drive employee engagement which ultimately translates into higher performance and enhanced shareholders' values. Consistent with this view, Levine (1992) and Wadhwani and Wall (1991) find that high levels of wages lead to enhanced productivity. Moreover, Perry-Smith and Blum (2000) document that family-friendly policies within corporations lead to increasing market share, and larger corporate profits. More recently, Edmans (2011) utilizes a value-weighted portfolio of the "100 Best Corporations to Work for in America" to investigate the relationship between employee satisfaction and long-run stock returns. The results show that this portfolio earned an annual four-factor alpha of 2.1% above industry benchmarks during the period from 1984 to 2009. The author concludes that corporations with high levels of employee satisfaction generate superior long-term stock returns. The author attributes these findings to the failure of the stock markets to incorporate intangible assets (such as employee well-being) fully into stock valuations. Affected by incentive theory, some corporations strive to provide welfare for their employees in all aspects, making them satisfied and happy, as happy employees are often more efficient than unhappy employees (Oswald et al., 2015). Increasing remuneration (Mas, 2006) can increase employees' enthusiasm for work and create higher corporate value. Other corporations enhance their value creation, profitability and productivity by providing employees with more comfortable working environment (Faleye and Trahan, 2011). Negative incentives, such as layoffs and pay cuts, dampen employee enthusiasm and lead to low productivity and a loss of corporate value (Ghaly et al., 2015).

Contrary to the incentive theory, the agency theory's view suggests that higher levels of employee welfare might lead to a damage for corporations. In fact, improved working conditions can be seen as a maneuver by the management to cover up corporate misbehavior (Hemingway and Maclagan, 2004; Friedman, 2007; Petrovits, 2006; Prior et al., 2008). This might lead news to accumulate until a certain tipping point when bad news come out to the public and consequently equity prices crash, damage to the value of corporation. So, corporate executives may improve employee welfare to pursue personal prestige and status, conceal management faults. Additionally, overly generous employee welfare can be seen as a tool used by managers to make the employees less likely to act as potential whistleblowers (Dyck et al., 2010). It is reasonably realistic to believe that employees enjoying generous welfare would be more reluctant to blow the whistle on frauds or misconducts in their corporations. On the contrary, poor welfare and mediocre work conditions often motivate employees to bring frauds and management misbehavior to light (Rothschild and Miethe, 1999; Bowen et al., 2010; Miceli and Near, 1994). Employees' sense of ownership and responsibility is growing stronger. When they find that managers demonstrate fraudulent and inappropriate management behavior, they tend to expose the latter's misconduct (Rothschild and Miethe, 1999). Therefore, some managers tend to provide employees with better welfare. Better employee welfare can establish a good relationship between managers and employees and develop a friendly image that enhances the former's personal prestige and status (Prior et al., 2008). However, generous employee welfare may serve as a tool for managers to divert employees' attention and conceal their negligence (Hemingway and Maclagan, 2004), reducing the likelihood of employee reporting (Ben-Nasr and Ghouma, 2018).

Based on the above analyses, we can see that there is not a unified conclusion on the effect of employee welfare on the innovation performance of corporations. Beyond the potential impacts of employee welfare on the accounting performance (Meyer et al., 2001) and the stock market performance (Filbeck, 2001; Gorton and Schmid, 2004; Edmans, 2011, 2012), there are no studies focusing on the effect of employee welfare on innovation performance in manufacturing corporations, especially in Chinese manufacturing corporations. Thus, the motivation of this paper is trying to fill this gap in extant researches in this field.

2.2. Corporate innovation performance

Research on corporate innovation mainly focuses on its influencing factors, addressing two key aspects: external factors and internal factors.

Research on the external factors influencing corporate innovation mainly addresses political, legal, humanities, administrative supervision, industry and media supervision factors. In terms of the political environment, central anti-corruption actions increase the cost of seeking political connection behavior, prompting corporations to abandon their search for political connections and to seek development by increasing their innovative research and development (R&D) expenditures instead (Song et al., 2015). Policy uncertainty has led to hesitation and swayed business management decisions, either delaying or shelving corporate innovation (Bhattacharya et al., 2017). In terms of the legal system, the introduction of the Labor Contract Law can enhance labor protection, making corporations face stronger operational risks and lower operational flexibility. The competitive environment of 'survival of the fittest' encourages corporations to increase their investment in R&D (Acharya et al., 2013a, b). The promulgation of the Intellectual Property Protection Law can stimulate corporations to create enthusiasm, stimulate R&D investment and promote the improvement of innovation level (Kafouros et al., 2015). Furthermore, the implementation of the Sarbanes-Oxley Act can strengthen the supervision of independent directors of the management of the corporation. Improving corporate governance, increasing R&D investment and promoting innovation are important steps (Gu and Zhang, 2017). In terms of the human environment, a corporation established in a region or country with a strong creative culture is well equipped to cultivate employees' creative thinking and improve corporate innovation output (Ucar, 2018). In areas with higher individualism, the confidence of corporate employees is high. Confidence helps overcome obstacles to innovation and promotes corporate innovation (Chen et al., 2017). In terms of administrative supervision, establishing an administrative examination and approval center can simplify the associated procedures, decrease institutional transaction costs and promote corporate R&D and innovation (Anton et al., 2006). At the industrial level, the unfair competition behavior of illegal corporations in the industry, such as evading government regulations and plagiarism, damages the enthusiasm of corporate innovation. This reduces corporations' innovation ability. The resulting intensification of inter-bank competition and the relaxation of supervision on the banking industry make it easier for corporations to obtain R&D funding from banks and improve their innovation capabilities (Amore et al., 2013). In terms of media supervision, the increase in negative media reports exerts great psychological pressure on managers. Managers may reduce investment in corporate innovation because they fear that performance declines or innovation failure will lead to more negative media coverage and investor dissatisfaction (Dai et al., 2015).

Research on the internal factors of corporate innovation mainly addresses human capital, equity structure and option incentives. First, human capital is a key factor in creating value and driving business growth. At the executive level, a chief information officer (Song et al., 2010), and executives with overseas life or learning experiences (Yuan and Wen, 2018) bring more invention knowledge to corporations, pay more attention to innovation investment and thus significantly improve innovation output. CEOs with flight licenses tend to have higher risk tolerance and enjoy trying new things, usually in the process of business management. This increases R&D investment and the level of corporate innovation (Sunder et al., 2017). In addition, as a carrier of resource flow and knowledge dissemination, the social network of corporate directors is better able to provide financing and patent knowledge support for innovation and increase corporations' R&D investment and innovation capability (Faleye et al., 2014; Fang et al., 2012; Helmers et al., 2013). At the employee level, improving employee satisfaction can significantly increase corporate innovation by increasing employee motivation (Mao and Weathers, 2015; Mayer et al., 2016). Furthermore, in terms of shareholding structure, foreign institutional investors act as supervisors and information exchange media for corporations, bringing more capital investment and creativity and improving corporate innovation output (Luong et al., 2017). After a merger and acquisition is implemented, foreign shareholders help the corporations carry out innovation activities by providing technical support, and the proportion of foreign equity is significantly positively correlated with risk commitment in the corporation investment decision (Boubakri et al., 2013; Guadalupe et al., 2012). Finally, in terms of option incentives, management incentive stock option incentives protect managers from the pressure of falling stock prices and motivate management to take risks and invest in long-term innovative R&D. Furthermore, employee stock option incentives increase employee risk tolerance levels, inspire employees' adventurous spirit and improve corporate innovation (Chang et al., 2015).

As discussed above, we can find that a lot of literature has begun to focus on the role of employees in the process of corporate innovation, but it is mainly based on the analysis of the US market and the conclusions are also inconsistent. Chang et al. (2015) find that the implementation of employee equity incentives can promote corporate innovation. Acharya et al. (2013a) and Chen et al. (2016b) point out that improving employee working conditions and treatment, and providing better care for employees can significantly increase corporate innovation. However, Bradley et al. (2017) found that over-protection of employees is not conducive to corporate innovation, on the contrary, it encourages employees to slacken and leads to tricks in works. Based on these works, we know that although employee welfare is one of the important factors affecting corporate innovation, does it promote or hinder innovation? The conclusions are inconsistent and need further testing.

2.3. Why might employee welfare increase corporate innovation? An incentive theory perspective

As innovation requires the active participation of every employee in the corporation (Dougherty, 1992; Van de Ven, 1986), it is important to increase employee participation in innovation activities. Implementing a series of employee-friendly policies, such as improving employee compensation (Mas, 2006), providing employees with a more comfortable working environment (Faleye and Trahan, 2011), and offering work-family benefits (Meyer et al., 2001), can alleviate employees' worries, improve their recognition by the corporation, reduce the employee turnover rate and help retain outstanding talents. Therefore, employee welfare may enhance corporate innovation by helping the corporation to retain outstanding talents.

Taylor (1911) points out that if employees are regarded as unskilled labor without special status, then employee welfare is a wasteful expenditure. However, with the development of technology and the corporations, the role of employees has also undergone tremendous changes. Highly competitive business environment and human capital-intensive corporation form force corporations to pay more attention to innovation capability (Edmans, 2011). At the same time, technological progress has also increased the demand for highly motivated and well-educated labors to meet the requirements of new technologies. Therefore, it is becoming more and more important to rely on a series of employee welfare policies, such as improving the working environment and enhancing employee treatment, to retain employees and stimulate their enthusiasm and creativity. As we all know, innovation is characterized by long-term and high risks (Holmstrom, 1989), which requires the long-term and stable participation of talented employees. The corporations can increase employee loyalty and productivity by improving employee benefits, such as generous salary, comfortable and safe working environment, good employee care and protection, and attractive retirement protection (Bloom et al., 2011), so as to retain talents for the corporation and attract excellent employees to join (Chen et al., 2016a). At the same time, employees who have solved their worries can increase their risk tolerance and be more willing to improve efficiency (Tian and Wang, 2011; Chen et al., 2016b). Therefore, employee welfare may enhance corporate innovation by improving the inventor efficiency.

Innovation requires not only the long-term investment of corporates and the active participation of employees, but also a good external ecological environment. The attention and active publicity of news media will also have a significant impact on the innovation investment of corporates. Corporates with good employee welfare often enjoy good social reputation, which can attract more and better talents to join in and promote innovation efficiency. At the same time, they can also get more positive reports from the media (Ben-Nasr and Ghouma, 2018), creating a relaxed and harmonious external environment for corporates, leading to the improvement of corporates innovation level.

Based on the above discussion, one can infer that generous investment in employee welfare will probably enhance corporate innovation performance, as it tends to retain outstanding talents and increase positive media coverage. Hence, the first hypothesis is as follows:

H1. Higher levels of employee welfare are associated with higher levels of corporate innovation.

2.4. Why might employee welfare decrease corporate innovation? An agency theory perspective

Agency theory can be found in the traditional principal-agent framework developed by Jensen and Meckling (1976) and in the free cash flow argument of Jensen (1986). They point out that corporations with higher free cash flow and higher internal reserves may spend more resources on employee welfare. In this typical agency theory framework, managers are not the perfect agents of the principal shareholders. They tend to use their information advantage to serve their agenda and increase their utilities at the expense of the principal's interests. Therefore, to improve their image, some managers may treat their employees more generously even if better employee welfare does not create value for their shareholders. Generous working conditions can be seen as a maneuver by the management to cover up corporate misbehavior. That is, if managers believe that improving employee welfare is beneficial to them, e.g., by helping cover up their own faults (Hemingway and Maclagan, 2004; Prior et al., 2008), they may treat employees better. This statement will be even more pronounced for over-generous employee welfare. Indeed, managers can use the work environment to divert shareholder attention and focus market attention on important issues. This kind of speculation is hidden in misleading working conditions and possibly other corporate social responsibility activities, which will lead to the accumulation of news until bad news reaches a critical point in the market and causes the stock price to plummet, so that the value of corporation will be damaged. Consistent with this view, Hemingway and Maclagan (2004) claim that one reason corporations adopt corporate social responsibility is to hide management misconduct. This view supports Friedman (2007) that corporate social responsibility can be viewed as an agency problem.

Opportunistic managers are likely to engage in doubtful accounting practices resulting in opaque financial reporting and disclosure. Recent studies on CSR suggest that providing good employee welfare practices are associated with earnings management. For instance, Petrovits (2006) finds evidence that corporations manipulate their earnings by using corporate philanthropy programs to achieve their earnings targets. Moreover, Prior et al. (2008) test the hypothesis that managers who manipulate the corporation's income tend to build a socially friendly image by increasing their socially responsible investments. The empirical findings support their conjecture suggesting a positive relationship between good employee welfare practices and earnings management. The underlying notion of these studies is that managers might be inclined to use the high-quality work environment in order to hide those practices. Financial markets, as myopic as they might be, tend to embrace the idea that corporations with apparent solid reputation are better managed and well governed. For instance, Enron, World Com., Arthur Andurson, and more recently VolksWagen have enjoyed for long-time excellent images in the markets, partially due to their good work environments. Nevertheless, they face issues relating to fraudulent behaviors by their managements. When corporations use good employee welfare practices (with employment quality being in the top) to hide bad news, one would expect a positive relationship between employment quality and the value of the corporations. Managers may have incentive to withhold bad news from investors and hide misconducts to pursue their personal agenda. Generous employee welfare would help them achieving their goals by diverting the employees focus on important issues. Accumulated undisclosed information over time leads to opaque and less transparent financial reporting. At a certain point of time, hidden bad news would come to light, causing stock price crash (Kim et al., 2011a, 2011b, 2014; Wang et al., 2009), funding constraints due to damaged corporate value, financing constraints in postpone investment (Hirth and Viswanatha, 2011) and even disrupting R & D projects (Li, 2011).

Overly generous employee welfare can be seen as a tool to reduce the likelihood that employees uncover potential managers' wrongdoings and blow the whistle on their fraudulent behaviors. More satisfied employees would be more reluctant to reveal wrongdoings of their management. Put differently, being unsatisfied with the working conditions may make the employees more inclined toward bringing the mistakes of their management to light. This behavior is being encouraged in many countries particularly after the recent wave of frauds. Many regulators have proposed legal protections and monetary rewards to employees uncovering frauds and misconducts. The Sarbanes-Oxley Act of 2002 is an example of how the US regulators dealt with the issue of accounting frauds after the scandal of Enron. To protect "whistle-blowers", SOX made it unlawful for firms to take punitive actions against employees uncovering doubtful accounting or auditing practices in their firms. The act also requires public corporations to set up a hotline enabling whistle-blowers to talk anonymously to the board of directors about suspicious practices. The US regulator also financially encourages employees, especially in the public sector, to uncover fraudulent practices. For instance, the Federal Civil False Claims Act (also known as the qui tam statute), offers a reward that ranges from 15 to 30% of the covered damage to individuals who bring forward relevant information to uncover a fraud committed against the government. Dyck et al. (2010) try to identify the most effective actors in blowing the whistle on corporate frauds. An analysis of all reported fraud cases in large U.S. corporations between 1996 and 2004 shows that the investors, the SEC, and the auditors are not effective in discovering and reporting corporate frauds. Surprisingly, a non-traditional player, namely the employees, has been more effective in fulfilling that monitoring task. Employees are found to be the most important fraud detectors as the authors report that around 17% of studied frauds are brought to light by employees. The percentage reaches 41% in some key industries such as the health care sector. This is mainly due to the employees' easy and costless access to information in addition to the monetary rewards following the uncovering of frauds. In a related study, Rothschild and Miethe (1999) analyze the characteristics of firms where whistle-blowing frauds are more frequent. Their findings suggest that in corporations with more bureaucratic and undemocratic work environments, employees have more tendency to reveal management wrongdoings. Other studies also argue that higher layoffs and downsizings (Dyck et al., 2010; Bowen et al., 2010) as well as unclear internal communication channels (Miceli and Near, 1994; Bowen et al., 2010) can contribute to employee whistle blowing. Seen from this angle, it is in the interest of the management to be closer to their employees and provides them with generous employment conditions. Overly generous employee welfare program can thus be opportunistically used by managers in order to withhold (hoard) more bad news as long as possible. Studies by Graham et al. (2005) and Kothari et al. (2009) who find that managers tend to delay disclosure of bad news more than those of good news support this idea. Building on all of these results, an agency theory perspective is adopted. The second competing hypothesis is as follows:

H2. Higher levels of employee welfare are associated with reduced levels of corporate innovation when managers use employee welfare to advance their opportunistic agendas.

3. Sample selection and methodology design

3.1. Sample selection

The data used in this paper are collected in the following ways: first the data belonging to corporate innovation, financial indictor and corporate governance are from CSMAR database. Then employee welfare data are recorded from the China-Hexun listed corporation social responsibility report database (CHSRR). The quantity and quality of R&D personnel come from WIND database. The data of media reports is collected from China Economic News database in INFOBANK database. As the data disclosure date of the listed corporation social responsibility report is 2010, all A-share listed corporations on the Shanghai and Shenzhen stock markets from 2010 to 2017 are selected for the initial research sample. Strictly according to the industry classifications of CSMAR database, the initial sample is screened and the following corporations are excluded: 1) listed corporations in the financial industry, 2) listed corporations subject to ST, *ST, suspension of listing and delisting, 3) real estate investment corporations as well as other non-manufacturing corporations. After the above screening, the final sample contains 9689 observations. In addition, considering the right-bias problem of patent application data in the regression, logarithmic processing is used to three kinds of innovation measurements, i.e., *PATENT*, *PATENT1* and *PATENT2_3*. To eliminate the effects of extreme values, all of the continuous variables are winsorised at the 1% and 99% levels. The descriptions for all the dependent and independent variables are reported in Table 1A of Appendix in this paper.

3.2. Methodology designs

3.2.1. Measuring innovation performance

The innovation literature rarely discusses the types of corporate innovation behavior from the perspective of motivation. Generally, corporations invest resources in R&D activities by default, which in turn leads to technological progress and competitive advantages and is characterized by high-quality innovation behavior. However, some studies based on patent perspectives find that corporate innovations measured by patent applications sometimes appear to be strategic (Dosi et al., 2006; Hall and Harhoff, 2012; Tong et al., 2014). This means that the innovation of a corporation is only a management strategy. Its purpose is not to substantially improve its technological competitiveness, but to obtain certain benefits, which are often expressed as government policies and regulations. For example, Tong et al. (2014) find that China's second revised patent law encourages state-owned corporations to apply for patents. As a result, the utility model and design patents of state-owned corporations has increased significantly, whereas their invention patents have not. The innovation strategy of state-owned corporations shows that the government needs state-owned corporations to achieve a certain amount of patent output, while ignoring the quality of actual patent output. Based on the above discussion and the research purpose of this paper, corporate innovation behavior is divided into two kinds from the perspective of motivation. One involves high-quality innovation behavior and is undertaken to promote a corporate technological progress and obtain a competitive advantage. It is called substantial innovation. The other involves the pursuit of innovation quantity and speed and is undertaken to cater to the regulatory and government innovation strategy. It is called strategic innovation.

Following the literature of (Ben-Nasr and Ghouma, 2018; Chen et al., 2016a, 2016b), this paper focuses on the number of patent applications of corporations as a measure of corporate innovation. Specifically, the number of patent applications representing innovative outputs can better reflect corporations' innovation ability (Tan et al., 2015).

According to China's Patent Law, patents are divided into three types: invention patents, utility model patents and design patents. Invention patents are new technical schemes proposed by the production of new products, with the highest technical content and the strongest novelty. Utility model patents are new technical schemes proposed for product structure, with high technical content and strong novelty. Design patents are design schemes proposed for the shape and pattern of a product, with low technical content and low novelty. Based on the definition of China's Patent Law and the discussion in the literature (Dosi et al., 2006; Hall and Harhoff, 2012; Tong et al., 2014), this paper identifies a corporation's application for a highly innovative invention patent as a substantial innovation, with the number of applications representing the quality of innovation. Furthermore, it identifies the application for a relatively innovative utility model patent and design patent as a strategic innovation. The number of applications represents the number of innovations. Specifically, the number of invention patent applications (*PATENT1*) is considered as representative of the quality of innovation. The sum of the number of utility model patent and design patent applications (*PATENT2_3*) represents the number of innovations (Dosi et al., 2006; Hall and Harhoff, 2012; Tong et al., 2014). Substantial innovation promotes technological progress and high-level innovation. Strategic innovation only caters to government policies. Generally, only minor innovations are needed.

3.2.2. Measuring employee welfare

The literature on measuring employee welfare is extensive (Ben-Nasr and Ghouma, 2018; Ghaly et al., 2015; Bae et al., 2011), in which two main methods exist: one is based on the ASSET4 database. It contains indicators on various aspects of employee welfare, such as employee satisfaction, compensation, employee rewards, presence of union representatives, presence or absence employee turnover, which are commonly used to build a comprehensive index to measure employee welfare (Ben-Nasr and Ghouma, 2018); the other is based on the social responsibility assessment database (KLD STATS). The major index in this database are unions, retirement welfare, employee safety and health, and life care. Mao and Weathers (2015), Bae et al. (2011) and Ghaly et al. (2015) measure employee welfare by developing an employee welfare index based on KLD database. However, there are some problems in utilizing these two databases in our empirical studies. For instance, although the ASSET4 database contains data of Chinese coroporations, there are only 42 Chinese samples available (Ben-Nasr and Ghouma, 2018), which cannot meet the research aim in this paper. Regarding to KLD database, it contains only data for US listed corporations, which is also not suitable for the research topic for the Chinese manufacturing corporations. Therefore, this paper will adopt a database developed specifically for China's listed corporations to construct the measurement for employee welfare, namely China-Hexun listed corporation social responsibility report database (CHSRR). The data relevant to employee sector in this database include: employee income per capita, employee training, safety inspections, safety training, evaluations for awareness of condolences, total condolences and numbers of employees received condolences, which are every similar to the data categories of KLD database. The weight of employee segment in the overall China-Hexun listed corporation social responsibility index is 15% and the sub-weights for each items are employee income per capita (4%), employee training (1%), safety inspections (2%), safety training (3%), evaluations for awareness of condolences (1%), total condolences (2%) and numbers of employees received condolences (2%). Thus, following Bae et al. (2011), Ghaly et al. (2015) and Ben-Nasr and Ghouma (2018), this paper also utilizes the sum of the above-mentioned weighted data scores as a composite measurement index of employee welfare.

3.2.3. Control variable selections

Following previous studies (Ben-Nasr and Ghouma, 2018; Chen et al., 2016a, 2016b; Tian and Wang, 2011), this paper controls a series of corporate characteristics that may affect innovation performance in manufacturing corporations. First, Scherer (1965) and Cohen et al. (1987) argue that the larger a corporation is, the more innovation opportunities and resources it has. Similarly, some recent studies, such as He and Tian (2013), find that the larger the corporation is, the more frequent R&D activities it has. Therefore, we choose firm size (*SIZE*) as the first control variable. Second, as Brown et al. (2012) point out, the more profitable of a corporation, the stronger motivation for innovation it has. Then we control the return on assets (*ROA*). Third, according to Bhagat and Welch (1995), it is difficult for high leveraged corporations to have sufficient funds to support their R&D activities due to financial risks. The level of financial leverage of corporations can reflect the degree of risk appetite of the corporations and may also have an impact on the innovation performance of the organization. Therefore, this paper uses the ratio of total debt to total assets (*LEV*) as another control variable (Blair, 2010). Fourth, the age of the corporation is controlled for two reasons: on the one hand, mature corporations have sufficient cash flow to support R&D and production of new products. The rich experience in innovative activities accumulated during the long-term production and operation process makes them have stronger demand for technological development. Better analysis and adaptability in mature corporation make it easier to reduce innovation costs and uncertainty of innovation activities (Coad et al., 2016). On the other hand, however, mature corporations are easily satisfied with the status quo, lacking the motivation for innovation, change and development, hindering corporate innovation (Huergo, 2006; He and Tian, 2013). So we control the firm age (*AGE*) accordingly. Fifth, regarding to the research of Ryan and Wiggins (2002), TobinQ is equal to the sum of the market value of the corporation's current stock and the book value of its liabilities divided by the book value of the corporation's total assets. This indicator is used to measure the growth of the corporation, so we control corporation TobinQ (*TQ*). Sixth, corporate innovation activities require long-term capital investment, and the abundance of corporate capital has a significant impact on innovation. The higher the capital intensity, the higher the per capita capital level of the corporation. Under the circumstances of limited external financing, the corporation can use its comparative advantage of capital intensiveness to carry out innovation activities. Therefore, the corporations with high capital intensity are more inclined to independent research and development activities. According to the research of Chen et al. (2016b), we control capital intensity (*PPE*). Seventh, the free cash flow demonstration conducted by Jensen (1986) mentions that corporations with higher free cash flow and internal reserves may waste more resources, and the abuse of resources will reduce the value of the corporation (Masulis and Reza, 2014), and delay the pace of innovation, so cash holdings (*CASH*) is controlled in this paper. Eighth, we further control the R&D investment as a percentage of total assets (*RDA*), because corporations with low intensity of R&D are difficult to maintain ideal innovation output (Chen et al., 2016a). Ninth, to account for the potential impact of corporate governance on the level of innovative activity (O'Connor and Rafferty, 2012; Sapra et al., 2014), we control the fraction of independent directors on the board (*BI*). Tenth, according to the research of Kim and Lu (2013), the concurrent appointment of CEO can significantly promote corporate performance and there will be sufficient funds for R&D and production. Thus we control the CEO duality (*DUALITY*). Eleventh, under the background of China, state-owned corporations have more financial support than non-state-owned corporations, which will be more conducive to corporate innovation (He and Tian, 2013), so we control the corporation's ultimate controller (*STATE*). Twelfth, we control the equity concentration (*TOP1*) according to Chen et al. (2016a). Thirteenth, the quantity and quality of R&D personnel are also key factors affecting corporate innovation, so this paper controls the number of R&D personnel (*R&D_SUM*) and the ratio of R&D personnel to total number of employees (*R&D_RATIO*).[1] Besides, to control the industry-fixed and year-fixed effects as usual, this paper also adds year and industry dummy variables, as shown in Table 1A of Appendix in this paper.

4. Empirical results and robustness checks

4.1. Descriptive statistics

Table 1 reports the descriptive statistics of the variables used in this paper. For the main variables, the means of *PATENT*, *PATENT1* and *PATENT2_3* are 3.057, 2.160 and 2.441, respectively. Thus, the listed manufacturing corporations in China make an average of 2.160 invention patent applications and 2.441 non-invention patent applications per year. The mean, median and standard deviation of *EW* are 2.706, 1.510 and 3.220, respectively, indicating that more than half of the corporations' employee welfare are lower than the average and employee welfare varies widely across corporations. For the other control variables, the manufacturing corporations have asset-liability ratio average of 38.4%, the capital intensity average of 23.6%, the cash holding ratio average of 16.9% and the independent directors ratio average of 37.3%. China's manufacturing corporations with the same general manager account for 30.2% and corporations controlled by state-owned figures account for 29.3%.

4.2. Correlation analysis

Table 2 shows the Pearson correlation coefficients between some major variables. The correlation coefficients between employee welfare (*EW*) and corporate innovation (*PATENT*, *PATENT1* and *PATENT2_3*) are 0.023, 0.039 and 0.010, respectively. Among them, the correlation coefficients of *PATENT* and *PATENT1* are significantly positive at 1% level, but the one for *PATENT2_3* is not. Thus, employee welfare is significantly positively correlated with corporate innovation without considering the influence of other factors. The higher the employee welfare level, the greater the corporate innovation, which is consistent with H1. Furthermore, the correlation coefficient of *PATENT1* and *EW* is larger than that of *PATENT2_3* and *EW*, indicating that the quality of innovation may have more tight relationship with employee welfare than the quantity of innovation (*PATENT2_3*). From the perspective of the control variables, corporate size (*SIZE*) and profitability (*ROA*) are significantly positively correlated with corporate innovation. Corporate age (*AGE*) and corporate growth (*TQ*), however, are significantly negatively correlated with corporate innovation. These findings are consistent with previous research results.

Table 1
Descriptive statistics.

Variables	Obs.	Mean	Median	P25	P75	SD
PATENT	9689	3.057	3.091	2.079	4.025	1.499
PATENT1	9689	2.160	2.079	1.099	3.091	1.420
PATENT2_3	9689	2.441	2.485	1.386	3.526	1.575
EW	9689	2.706	1.510	0.810	3.000	3.220
SIZE	9689	21.918	21.756	21.085	22.566	4.146
ROA	9689	0.045	0.041	0.016	0.072	0.049
LEV	9689	0.384	0.370	0.224	0.529	0.197
AGE	9689	1.965	2.010	1.369	2.709	0.811
TQ	9689	2.137	1.740	1.339	2.473	1.259
PPE	9689	0.236	0.210	0.133	0.314	0.136
CASH	9689	0.169	0.129	0.074	0.224	0.134
RDA	9689	0.019	0.018	0.009	0.027	0.015
BI	9689	0.373	0.333	0.333	0.429	0.053
DUALITY	9689	0.302	0.000	0.000	1.000	0.459
STATE	9689	0.293	0.000	0.000	1.000	0.455
TOP1	9689	34.963	33.350	24.090	43.848	14.051
R&D_SUM	9689	5.739	5.638	4.942	6.454	1.161
R&D_RATIO	9689	2.694	2.687	2.352	3.077	0.599

Note: This table presents the descriptive statistics of the main variables. The sample includes corporation-year observations from 2010 to 2017. P25 and P75 are the 0.25 and 0.75 quantiles of the variable, respectively. SD is the standard deviation of the variable. All of the variables are defined in Appendix A.

4.3. Basic results

To estimate the impact of employee welfare on corporate innovation, different dimensions are evaluated, as shown in model (1).

$$Innovation_{i,t} = \beta_0 + \beta_1 EW_{i,t} + \beta_i Controls_{i,t} + Fixed \quad effects + \varepsilon_{i,t}, \tag{1}$$

where the dependent variable *Innovation* represents corporate innovation, specifically defined as *PATENT*, *PATENT1* and *PATENT2_3*; *EW* is the measurement of employee welfare; *Controls* represents the control variables, consisting of a series of corporate and industry characteristic variables that may affect corporate innovation; and *Fixed effects* are the industry-fixed effects and year-fixed effects.

Before massive panel regression analyses in next steps, we first perform Hausman test (Hausman, 1978) to judge whether fixed effect or random effect regression should be adopted. Table 3 reports the results of basic regression with Hausman tests for the impact of employee welfare on corporate innovation performance. Among them, columns (1), (3), and (5) report the results of panel regression with fixed effects, and columns (2), (4), and (6) show the results with random effects. In panel fixed effect regression, the regression coefficients of columns (1) and (3) are 0.016 and 0.024, respectively, and are both significant at 1% level, while the regression coefficient of column (5) is 0.008 and is not significant. In random effects regression, the regression coefficients in columns (2) and (4) are 0.013 and 0.014, respectively, and are significant at the 5% level, while the regression coefficient of column (6) is −0.002 with no significance. Furthermore, all Hausman tests reject the null hypothesis of "difference in coefficients is not systematic" at 1%

[1] We control the quantity and quality of R&D personnel according to the valuable suggestion of one reviewer.

Table 2
Correlation analysis.

	PATENT	*PATENT1*	*PATENT2*$_3$	*EW*	*SIZE*	*ROA*	*LEV*	*AGE*	*TQ*	*PPE*	*CASH*	*RDA*	*BI*	*DUALITY*	*STATE*	*TOP1*	*R&D*$_S$*UM*	*R&D*$_R$*ATIO*
PATENT	1.000																	
PATENT1	0.868***	1.000																
PATENT2_3	0.903***	0.647***	1.000															
EW	0.023***	0.039***	0.010	1.000														
SIZE	0.465***	0.481***	0.414***	0.285***	1.000													
ROA	0.061***	0.057***	0.026***	0.062***	−0.079***	1.000												
LEV	0.217***	0.216***	0.221**	0.121***	0.551***	−0.432***	1.000											
AGE	−0.018***	−0.076***	−0.053***	0.153***	0.394***	−0.262***	0.445***	1.000										
TQ	−0.147***	−0.109***	−0.154***	−0.072***	−0.351***	0.159***	−0.247***	0.071***	1.000									
PPE	−0.091***	−0.055**	−0.098***	0.049***	0.154***	−0.243***	0.235***	0.210***	−0.099***	1.000								
CASH	−0.064***	−0.082***	−0.055***	−0.030***	−0.259***	0.323***	−0.466***	−0.331***	0.071***	−0.391***	1.000							
RDA	0.242***	0.256***	0.178***	0.011	−0.160***	0.204***	−0.180***	−0.188***	0.155***	−0.121***	0.093***	1.000						
BI	0.021***	0.022***	0.020***	0.010	0.013*	−0.023***	−0.015*	−0.027***	0.055***	−0.051***	0.012*	0.028***	1.000					
DUALITY	0.026***	0.033***	0.042***	−0.103***	−0.183***	0.070***	−0.165***	−0.255***	0.052***	−0.092***	0.110***	0.135***	0.100***	1.000				
STATE	0.124***	0.159***	0.104***	0.221***	0.366***	−0.200***	0.356***	0.491***	−0.094***	0.183***	−0.132***	−0.123***	−0.053***	−0.276***	1.000			
TOP1	0.052***	0.041***	0.058***	0.072***	0.140***	0.116***	0.015	−0.131***	−0.080***	0.020**	0.060***	0.002	0.061***	0.001	0.101***	1.000		
R&D_SUM	0.555***	0.559***	0.497***	0.236***	0.749***	0.004	0.407***	0.361***	−0.252***	0.123***	−0.182***	0.119***	−0.029***	−0.131***	0.326***	0.109***	1.000	
R&D_RATIO	0.146***	0.193***	0.090***	0.040***	−0.099***	0.071***	−0.153***	−0.103***	0.083***	−0.186***	0.132***	0.297***	−0.008	0.040***	−0.031***	−0.075***	0.331	1.000

Note: This table presents the correlations of the main variables. The sample includes corporation-year observations from 2010 to 2017. *PATENT*, *PATENT1* and *PATENT2_3* are the corporate innovation measures. *EW* is the employee welfare measure. The variables such as *SIZE* are the corporation-level control variables. All of the other variables are defined in Appendix A. *** and ** denote statistical significance at the 1% and 5% levels, respectively.

significance level, indicating the acceptance of panel fixed effect model. Therefore, in the following regressions, we uniformly utilize panel fixed effect models for regression analyses. The regression results of panel fixed effects show that employee welfare (*EW*) has significantly positive impacts on *PATENT* and *PATENT1*, but not on *PATENT2_3*, indicating that employee welfare can promote the overall innovation output in China's manufacturing corporations (*PATENT*), and this impact is mainly effective on the quality of innovation, i.e., output of the invention patent (*PATENT1*), but not on the quantity of innovation, i.e., non-invention patents (*PATENT2_3*). These findings are in line with the hypothesis H1 is initially verified.

In addition, the coefficient of the control variable shows that the estimated coefficients of *SIZE* and *ROA* are significantly positive. This indicates that the larger the corporations, the stronger its profitability and the higher its innovation output (Scherer, 1965). The coefficient of *CASH* is significantly negative. This indicates that excessive cash holdings in a corporation may result in idle and wasted resources, reducing innovation (Jensen, 1986). These results are in line with expectations and consistent with previous findings.

4.4. Robustness checks

From the interaction logic between employee benefits and corporate innovation activities, the seemingly exogenous impact of employee benefits has endogenous problems caused by selective bias. To avoid the estimation bias caused by a lack of information, it is customary to assign a value of 0 to corporations with no R&D expenditure in their annual reports, whereas the variable is processed according to the missing value for corporations that do not disclose their R&D expenditure. This allows R&D investment to be selected as the interpreting variable, automatically ignoring sampled corporations that have no R&D investment. Ultimately, this biases the estimates. Therefore, the regression analysis above may have endogenous problems caused by missing variables and sample selection bias. To eliminate the possible influences of endogeneity problem, seven methods are used for robustness analysis: 1) the replacement variable method, 2) Heckman two-step method, 3) the instrumental variable method, 4) regression analysis with lagged independent variables, 5) regression analysis without samples from first-tier cities in China, 6) regression analysis by using variables in difference forms and 7) Poisson counting and Fama-MacBeth regressions.

4.4.1. Alternative employee welfare definition

According to Waddock and Graves (1997) and McWilliams and Siegel (2001), the level of CSR may vary according to industry characteristics. Similarly, in a study by Srinidhi et al. (2011), whether other corporations in the same industry hire female directors is found to be able to influence whether a given corporation hires female directors. Therefore, the average employee welfare of other corporations in the same industry can be used as a substitute variable to the corporation's employee welfare. From a practical point of view, the welfare level of employees in other corporations in this industry indeed affects the welfare level of employees in this corporation, and then drive changes in the innovation output of corporations (Srinidhi et al., 2011). This is a typical industry aggregation phenomenon. So, this paper replaces the original independent variables (*EW*) with the mean of employee welfare of other corporations in the industry (*EW_M*) to estimate model (1). Table 4 reports the regression results. We find that the regression coefficients of both *PATENT* and *PATENT1* are significantly positive, but not for the one of *PATENT2_3*, indicating that employee welfare has significantly positive effects on corporate innovation. These outcomes are in line with those reported in Table 3.

4.4.2. Heckman's two-step method

When using Heckman's two-step method for robustness analysis, reference is made to Chen et al. (2016b) by making R&D input (*IFRD*) the dependent variable in the first-stage selection equation, introducing

Table 3
Baseline results-Employee welfare and corporate innovation.

	PATENT		PATENT1		PATENT2_3	
	(1)	(2)	(3)	(4)	(5)	(6)
	FE	RE	FE	RE	FE	RE
EW	0.016*** (2.67)	0.013** (1.97)	0.024*** (3.90)	0.014** (2.16)	0.008 (1.23)	−0.002 (−0.36)
SIZE	0.274*** (6.69)	0.369*** (6.15)	0.409*** (9.62)	0.464*** (8.71)	0.157*** (3.72)	0.270*** (7.82)
ROA	1.062** (2.30)	0.267 (0.58)	0.774* (1.74)	0.400 (0.90)	1.138** (2.36)	0.383 (1.18)
LEV	−0.209 (−1.48)	−0.318* (−1.83)	−0.132 (−0.94)	0.008 (0.04)	−0.092 (−0.63)	−0.176 (−1.54)
AGE	0.011 (0.31)	−0.031 (−0.62)	−0.022 (−0.63)	−0.024 (−0.46)	0.028 (0.76)	0.012 (0.35)
TQ	−0.010 (−0.55)	0.037* (1.79)	0.028 (1.63)	0.010 (0.50)	−0.012 (−0.69)	0.001 (0.11)
PPE	−1.058*** (−5.24)	−0.515*** (−2.73)	−0.899*** (−4.64)	0.002 (0.01)	−0.818*** (−3.98)	−0.100 (−0.67)
CASH	−0.144** (−2.28)	0.122** (2.12)	−0.264** (−2.07)	−0.326** (−2.23)	0.309** (2.26)	−0.368** (−2.42)
RDA	18.806*** (11.33)	11.319*** (6.77)	20.316*** (11.93)	12.323*** (7.17)	11.833*** (6.85)	7.602*** (6.83)
BI	0.137 (0.38)	0.618 (1.46)	0.193 (0.53)	0.308 (0.74)	0.276 (0.75)	−0.014 (−0.05)
DUALITY	0.056 (1.34)	−0.017 (−0.34)	0.037 (0.88)	0.057 (1.08)	0.026 (0.57)	0.057* (1.68)
STATE	−0.101* (−1.75)	−0.095 (−1.03)	−0.012 (−0.20)	0.093 (1.00)	−0.128** (−2.08)	−0.153** (−2.47)
TOP1	−0.003 (−1.54)	−0.003 (−1.27)	−0.004** (−2.16)	−0.008*** (−3.64)	−0.001 (−0.81)	−0.001 (−0.01)
R&D_SUM	0.536*** (13.39)	0.490*** (10.77)	0.351*** (8.65)	0.190*** (3.82)	0.591*** (14.12)	0.508*** (15.42)
R&D_RATIO	0.310*** (6.46)	0.325*** (5.39)	0.102** (2.07)	0.126** (2.07)	0.473** (9.25)	0.410*** (10.21)
Constant	−3.860*** (−4.36)	−5.571*** (−5.39)	−8.288*** (−8.76)	−8.288*** (−8.76)	−1.754* (−1.91)	−4.710*** (−4.42)
Year	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.451	0.400	0.410	0.373	0.443	0.400
Observations	9689	9689	9689	9689	9689	9689
Hausman	95.66 (<0.01)		55.56 (<0.01)		95.50 (<0.01)	

Note: This table presents the baseline results. Columns (1), (3) and (5) report the results of Panel fixed effect regression, and Columns (2), (4) and (6) report the results of Panel random effect regression. The sample includes corporation-year observations from 2010 to 2017. *PATENT*, *PATENT1* and *PATENT2_3* are the corporate innovation measures. *EW* is the employee welfare measure. The variables such as *SIZE* are the corporation-level control variables. All of the other variables are defined in Appendix A. Both the industry- and year-fixed effects are included in the model estimation. The numbers in parentheses are the *t*-statistics corrected for heteroscedasticity, as suggested by White (1980). ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

Table 4
Robustness check-Replace variable definition method.

	PATENT	PATENT1	PATENT2_3
	(1)	(2)	(3)
EW_M	0.017*** (2.77)	0.025*** (4.08)	0.008 (1.28)
SIZE	0.273*** (6.68)	0.408*** (9.60)	0.157*** (3.72)
ROA	1.056** (2.28)	0.763* (1.72)	1.134** (2.35)
LEV	−0.209 (−1.48)	−0.131 (−0.93)	−0.092 (−0.63)
AGE	0.011 (0.30)	−0.023 (−0.64)	0.028 (0.75)
TQ	−0.010 (−0.54)	0.028 (1.63)	−0.012 (−0.69)
PPE	−1.058*** (−5.24)	−0.900*** (−4.64)	−0.818*** (−3.99)
CASH	−0.045 (−0.28)	−0.165 (−1.07)	0.209 (1.26)
RDA	18.802*** (11.33)	20.308*** (11.93)	11.830*** (6.85)
BI	0.136 (0.38)	0.191 (0.52)	0.275 (0.74)
DUALITY	0.056 (1.34)	0.037 (0.88)	0.026 (0.57)
STATE	−0.102* (−1.76)	−0.013 (−0.22)	−0.129** (−2.09)
TOP1	−0.003 (−1.53)	−0.004** (−2.16)	−0.001 (−0.81)
R&D_SUM	0.536*** (13.40)	0.352*** (8.66)	0.592*** (14.12)
R&D_RATIO	0.310*** (6.47)	0.102** (2.08)	0.473*** (9.26)
Constant	−3.813*** (−4.30)	−8.215*** (−8.67)	−1.729* (−1.88)
Year	Yes	Yes	Yes
Industry	Yes	Yes	Yes
R-squared	0.451	0.410	0.443
Observations	9689	9689	9689

Note: This table presents the results of the first robustness check: the replace variable definition method. The sample includes corporation-year observations from 2010 to 2017. *PATENT*, *PATENT1* and *PATENT2_3* are the corporate innovation measures. *EW_M* is the corporation's employee welfare minus the industry's average employee welfare. The variables such as *SIZE* are the corporation -level control variables. All of the other variables are defined in Appendix A. Both the industry- and year-fixed effects are included in the model estimation. The numbers in parentheses are the *t*-statistics corrected for heteroscedasticity, as suggested by White (1980). ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

the logarithm of 1 plus the number of patents granted in the previous year (*PATENTSS*) as the selection variable in the selection equation and then returning to the first stage. The obtained inverse Mills ratio is substituted into the second-stage regression equation to obtain the regression results in Table 5. Column (1) reports the first-stage estimation results. The estimated coefficient of *PATENTSS* is significantly positive, which indicates that the number of patents granted in the previous period does affect the current R&D investment of the corporation. Columns (2), (3) and (4) report the second-stage regression results. The inverse Mills coefficient is significantly negative, which indicates that there is an endogenous problem in the original regression analysis. Furthermore, the estimation coefficients of *PATENT* and *PATENT1* are 0.021 and 0.030, respectively. Both are significant at the 1% level, which indicates that after considering the endogeneity problem caused by sample selection bias, the positive relationship between employee welfare and corporate innovation is upheld.

4.4.3. *Instrumental variable method*

When using the instrumental variable method for robustness analysis, two variables, *LNWAGE_IND* and *LNWELFARE_IND*, are selected as instrumental variables. Specifically, *LNWAGE_IND* is the logarithm of 1 plus the corporation's wage minus the industry's average wage and *LNWELFARE_IND* is the logarithm of 1 plus the corporation's employee welfare minus the industry's average employee welfare. As both *LNWAGE_IND* and *LNWELFARE_IND* can directly affect the employee welfare level of corporations and have no direct impact on corporate innovation, they meet the correlation and exogenous conditions of instrumental variables. The first-stage estimation results are reported in column (1) of Table 6. The instrumental variables *LNWAGE_IND* and *LNWELFARE_IND* are both significant at the 1% level, indicating that the instrumental variables meet the correlation criteria. That is, the next stage of the regression analysis can be replaced by the independent variables. The regression results in columns (2), (3) and (4) show that the estimation coefficients of *PATENT* and *PATENT1* are both positive. This indicates that the positive relationship between employee welfare and corporate innovation remains valid after controlling endogeneity. In addition, the instrumental variable identification deficiency test significantly rejects the null hypothesis. This indicates that the model does not have the problem of insufficient recognition, but that the selected

Table 5
Robustness check-Heckman's two-step method.

	IFRD	PATENT	PATENT1	PATENT2_3
	First Stage	Second Stage	Second Stage	Second Stage
	(1)	(2)	(3)	(4)
EW		0.021*** (3.83)	0.030*** (4.93)	0.009 (1.49)
PATENTSS	0.056** (2.03)			
SIZE	−0.195*** (−3.77)	0.208*** (5.41)	0.306*** (7.00)	0.123*** (2.90)
ROA	0.631 (0.85)	1.735*** (3.94)	1.186*** (2.62)	1.589*** (3.18)
LEV	−0.231 (−1.06)	−0.036 (−0.25)	−0.061 (−0.38)	0.038 (0.24)
AGE	−0.828*** (−13.08)	0.019 (0.47)	−0.023 (−0.51)	0.057 (1.21)
TQ	−0.063* (−1.91)	0.031* (1.84)	0.058*** (3.16)	0.017 (0.87)
PPE	0.153 (0.60)	−0.950*** (−4.98)	−0.907*** (−4.32)	−0.735*** (−3.52)
CASH	0.423 (1.32)	−0.049 (−0.30)	−0.259 (−1.45)	0.172 (0.97)
BI	−0.473 (−0.86)	0.411 (1.18)	0.314 (0.79)	0.538 (1.41)
DUALITY	−0.044 (−0.60)	0.049 (1.18)	0.037 (0.80)	0.011 (0.23)
STATE	−0.009 (−0.12)	−0.079 (−1.43)	0.002 (0.03)	−0.109* (−1.73)
TOP1	0.004** (2.30)	−0.001 (−0.12)	−0.001 (−0.80)	0.001 (0.34)
R&D_SUM	0.121** (2.30)	0.532*** (14.39)	0.433*** (10.54)	0.582*** (13.85)
R&D_RATIO	0.079 (1.17)	0.310*** (6.57)	0.213*** (5.32)	0.493*** (9.17)
Inverse Mills Ratio		−0.471*** (−4.72)	−0.454*** (−4.33)	−0.473*** (−4.19)
Constant	2.611*** (4.08)	−3.374*** (−3.52)	−4.533*** (−3.99)	−2.209*** (−5.33)
Year	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
R-squared	0.488	0.448	0.394	0.440
Observations	7847	7847	7847	7847

Note: This table presents the results of the second robustness check: the Heckman two-step method. The sample includes corporation-year observations from 2010 to 2017. *PATENT*, *PATENT1* and *PATENT2_3* are the corporate innovation measures. *EW* is the employee welfare measure. *IFRD* measures whether the corporation has R&D investment in the previous year. The variables such as *SIZE* are the corporation -level control variables. All of the other variables are defined in Appendix A. Both the industry-and year-fixed effects are included in the model estimation. The numbers in parentheses are the *t*-statistics corrected for heteroscedasticity, as suggested by White (1980). ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

Table 6
Robustness check-Instrumental variable method.

	EW	PATENT	PATENT1	PATENT2_3
	First Stage	Second Stage	Second Stage	Second Stage
	(1)	(2)	(3)	(4)
EW		0.018* (1.68)	0.024** (2.23)	−0.001 (−0.01)
SIZE	0.162** (2.22)	0.207*** (2.93)	0.321*** (4.68)	0.103 (1.42)
ROA	0.762 (1.00)	1.565** (2.17)	0.884** (2.09)	1.395* (1.78)
LEV	−0.753*** (−2.79)	−0.270 (−1.15)	−0.272 (−1.20)	−0.039 (−0.17)
AGE	0.077 (1.16)	−0.006 (−0.10)	−0.083 (−1.42)	0.061 (1.01)
TQ	0.025 (0.90)	−0.020 (−0.68)	0.025 (0.98)	−0.015 (−0.51)
PPE	0.265 (0.73)	−0.896*** (−2.85)	−0.847*** (−2.71)	−0.598* (−1.84)
CASH	−0.320 (−1.04)	−0.069 (−0.28)	−0.307 (−1.23)	0.275 (1.07)
RDA	1.238 (0.42)	14.620*** (5.84)	16.094*** (6.05)	8.412*** (3.18)
BI	−0.138 (−0.23)	−0.115 (−0.18)	0.222 (0.33)	−0.412 (−0.70)
DUALITY	0.049 (0.59)	0.094 (1.34)	0.087 (1.27)	0.064 (0.80)
STATE	0.310*** (2.89)	−0.112 (−1.31)	−0.065 (−0.74)	−0.174* (−1.82)
TOP1	−0.003 (−1.31)	−0.004 (−1.50)	−0.005* (−1.81)	−0.001 (−0.50)
R&D_SUM	0.114* (1.68)	0.623*** (9.05)	0.503*** (7.48)	0.653*** (9.13)
R&D_RATIO	0.266*** (2.92)	0.322*** (4.06)	0.144* (1.82)	0.441*** (5.20)
LNWAGE_IND	−0.255*** (−9.28)			
LNWELFARE_IND	2.422*** (25.40)			
Constant	0.220 (0.14)	−2.768* (−1.92)	−6.813*** (−4.81)	−8.861*** (−6.80)
Year	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
R-squared	0.801	0.498	0.485	0.492
Observations	2903	2903	2903	2903
F (p-value)	323.80 (0.000)			
Anderson Canon. LM (p-value)		286.147 (0.000)	286.147 (0.000)	286.147 (0.000)
Cragg-Donadld Wald F		3428.816	3428.816	3428.816
Stock-Yogo Weak ID Test		19.93	19.93	19.93
Hansen J (p-value)		0.863 (0.436)	0.730 (0.536)	0.537 (0.321)

Note: This table presents the results of the third robustness test: the instrumental variable method. The sample includes corporation-year observations from 2010 to 2017. *PATENT*, *PATENT1* and *PATENT2_3* are the corporate innovation measures. *EW* is the employee welfare measure. The variables such as *SIZE* are the corporation-level control variables. All of the other variables are defined in Appendix A. Both the industry- and year-fixed effects are included in the model estimation. The numbers in parentheses are the *t*-statistics corrected for heteroscedasticity, as suggested by White (1980). ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

instrumental variable is related to the endogenous explanatory variable. The Cragg-Donald Wald F statistic is significantly larger than the threshold of the Stock-Yogo weak instrumental variable test, significantly rejecting the null hypothesis of weak instrumental variables. This indicates that the model does not have weak instrumental variables. The Hansen J test also indicates that the two selected instrumental variables are appropriate.

4.4.4. *Regression analysis with lagged independent variables*

Although instrumental variable method adopted in section 4.4.3 can facilitate the effects of endogenous problem, the reverse causality problem between independent and dependent variables may still exist. Then according to the methods proposed by Chen et al. (2016a) and Ben-Nasr and Ghouma (2018), we further utilize the lags of employee welfare instead of its present value to re-do the regression, which can be used to explain the relationship of past employee welfare and future corporation innovation performance, and avoid the possible problem of reverse causality (Hsu et al., 2015). The results are shown in Table 7.

When using the variable lag processing, the independent variable (*EW*) are set to have lags of two years ($EW_{t\text{-}2}$) and three years ($EW_{t\text{-}3}$), respectively. Columns (1) to (3) of Table 7 report the regression results of the $EW_{t\text{-}2}$ on corporate innovation. The estimation coefficients of $EW_{t\text{-}2}$ on *PATENT* and *PATENT1* are 0.019 and 0.020, both significant at the 1% levels. Moreover, columns (4) to (6) present the regression outcomes of $EW_{t\text{-}3}$ on corporate innovation. Similarly, the estimation coefficients

Table 7
Robustness check-Variable lag processing.

	PATENT	PATENT1	PATENT2_3	PATENT	PATENT1	PATENT2_3
	(1)	(2)	(3)	(4)	(5)	(6)
EW_{t-2}	0.019*** (2.92)	0.020*** (3.00)	0.011 (1.63)			
EW_{t-3}				0.017** (2.42)	0.020*** (2.84)	0.007 (0.97)
SIZE	0.280*** (6.10)	0.403*** (8.47)	0.144*** (3.02)	0.267*** (5.44)	0.392*** (7.60)	0.120** (2.34)
ROA	1.048** (2.00)	1.099** (2.08)	1.177** (2.16)	1.253** (2.23)	1.148** (2.10)	1.488** (2.55)
LEV	−0.184 (−1.17)	−0.215 (−1.34)	0.010 (0.06)	−0.188 (−1.15)	−0.197 (−1.16)	−0.009 (−0.05)
AGE	−0.076 (−1.42)	−0.075 (−1.40)	−0.057 (−1.02)	−0.075 (−1.20)	−0.081 (−1.29)	−0.058 (−0.88)
TQ	−0.012 (−0.62)	0.029 (1.55)	−0.018 (−0.93)	−0.020 (−0.96)	0.022 (1.13)	−0.028 (−1.35)
PPE	−1.112*** (−5.01)	−1.032*** (−4.77)	−0.898*** (−3.93)	−1.179*** (−5.12)	−1.073*** (−4.68)	−0.964*** (−4.03)
CASH	0.027 (0.14)	−0.219 (−1.10)	0.316 (1.51)	0.064 (0.28)	−0.145 (−0.64)	0.317 (1.36)
RDA	20.264*** (10.40)	21.697*** (10.59)	12.681*** (6.36)	19.581*** (9.64)	21.226*** (9.87)	11.724*** (5.55)
BI	−0.124 (−0.30)	0.032 (0.08)	0.033 (0.08)	−0.296 (−0.66)	0.013 (0.03)	−0.098 (−0.21)
DUALITY	0.061 (1.26)	0.038 (0.77)	0.028 (0.53)	0.053 (1.02)	0.037 (0.70)	0.005 (0.08)
STATE	−0.056 (−0.88)	0.010 (0.15)	−0.093 (−1.37)	−0.067 (−1.02)	0.010 (0.14)	−0.108 (−1.50)
TOP1	−0.003 (−1.36)	−0.003* (−1.72)	−0.002 (−0.74)	−0.002 (−1.11)	−0.003* (−1.67)	−0.001 (−0.50)
R&D_SUM	0.529*** (11.53)	0.394*** (8.55)	0.593*** (12.32)	0.536*** (11.05)	0.411*** (8.33)	0.608*** (11.95)
R&D_RATIO	0.348*** (6.24)	0.114** (2.01)	0.508*** (8.50)	0.359*** (6.04)	0.121** (1.99)	0.531*** (8.37)
Constant	−4.912*** (−5.25)	−8.821*** (−9.00)	−2.551*** (−2.60)	−4.408*** (−4.32)	−9.157*** (−8.08)	−2.533*** (−2.59)
Year	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.465	0.440	0.454	0.469	0.446	0.455
Observations	6835	6835	6835	5438	5438	5438

Note: This table presents the results of the second robustness check: Variable lag processing method. The sample includes corporation-year observations from 2010 to 2017. *PATENT*, *PATENT1* and *PATENT2_3* are the corporate innovation measures. EW_{t+2} and EW_{t+3} are the employee welfare measure, representing *EW* lag 2 periods and 3 periods respectively. The variables such as *SIZE* are the corporation-level control variables. All of the other variables are defined in Appendix A. Both the industry- and year-fixed effects are included in the model estimation. The numbers in parentheses are the *t*-statistics corrected for heteroscedasticity, as suggested by White (1980). ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

on *PATENT* and *PATENT1* are 0.017 and 0.020, which are significant at 5% and 1% levels, respectively. In summary, these results indicate that even using the lags of employ welfare as regressors, the positive impacts of employee welfare on corporate innovation still hold.

4.4.5. Regression analysis without samples from first-tier cities in China

According to Bostan and Mian (2019), there are more Inventor Chief Executive Officers (ICEO) in developed regions with higher innovation capability than those in under-developed regions. Thereby, regions with better geographical locations and higher resource endowments will attract more talents with better innovation performance, thus contributing better innovation environment and innovation output level for corporations in these areas. So using data sample without located in first-tier cities is useful to check the conclusion robustness in this paper. We conduct this robustness check in two ways: one is to exclude samples of corporations registered in first-tier cities and the other one is to omit data of corporations whose headquarters are located in first-tier cities of China (i.e., Beijing, Shanghai, Guangzhou and Shenzhen in this paper).

Table 8
Robustness check-Regression without samples from first-tier cities.

	PATENT	PATENT1	PATENT2_3	PATENT	PATENT1	PATENT2_3
	(1)	(2)	(3)	(4)	(5)	(6)
EW	0.021*** (3.10)	0.020*** (3.10)	0.009 (1.19)	0.020*** (2.93)	0.020*** (2.99)	0.010 (1.36)
SIZE	0.224*** (4.67)	0.336*** (7.02)	0.127*** (2.61)	0.242*** (5.11)	0.348*** (7.22)	0.132*** (2.69)
ROA	2.149*** (4.00)	1.007** (2.03)	1..003** (1.98)	1.068** (2.10)	1.232*** (2.55)	0.940* (1.77)
LEV	−0.184 (−1.13)	−0.099 (−0.64)	−0.147 (−0.90)	−0.160 (−0.99)	−0.081 (−0.52)	−0.128 (−0.77)
AGE	0.007 (0.18)	−0.018 (−0.46)	0.028 (0.67)	0.013 (0.32)	−0.008 (0.21)	0.031 (0.73)
TQ	−0.014 (−0.72)	0.015 (0.79)	−0.011 (−0.59)	−0.023 (−1.16)	0.010 (0.56)	−0.019 (−0.97)
PPE	−1.128*** (−5.00)	−0.966*** (−4.63)	−0.915*** (−3.98)	−1.083*** (−4.82)	−0.936*** (−4.43)	−0.880*** (−3.87)
CASH	0.025 (0.14)	−0.125 (−0.73)	0.264 (1.39)	0.032 (0.17)	−0.130 (−0.75)	0.239 (1.24)
RDA	19.812*** (10.02)	20.199*** (9.73)	13.163*** (6.77)	20.013*** (10.10)	20.190*** (9.64)	13.092*** (6.69)
BI	−0.007 (−0.02)	−0.155 (−0.39)	0.187 (0.44)	−0.094 (−0.23)	−0.207 (−0.52)	0.079 (0.18)
DUALITY	0.088* (1.86)	0.048 (1.05)	0.040 (0.78)	0.065 (1.38)	0.039 (0.86)	0.030 (0.58)
STATE	−0.152** (−2.39)	−0.058 (−0.90)	−0.179*** (−2.67)	−0.167*** (−2.60)	−0.083 (−1.26)	−0.184*** (−2.72)
TOP1	−0.002 (−1.22)	−0.003 (−1.57)	−0.001 (−0.21)	−0.003 (−1.43)	−0.003* (−1.67)	−0.001 (−0.37)
R&D_SUM	0.559*** (11.67)	0.394*** (8.38)	0.593*** (11.93)	0.533*** (11.17)	0.375*** (7.92)	0.579*** (11.56)
R&D_RATIO	0.340*** (5.88)	0.193* (1.97)	0.471*** (7.81)	0.321*** (5.57)	0.232** (2.32)	0.469*** (7.74)
Constant	−4.009*** (−4.27)	−7.510*** (−7.91)	−2.413** (−2.50)	−4.063*** (−4.19)	−7.912*** (−7.66)	−1.961** (−1.98)
Year	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.420	0.395	0.414	0.424	0.395	0.416
Observations	7827	7827	7827	7659	7659	7659

Note: This table presents the results of the third robustness test: Kick out of first-tier cities method. The sample includes corporation-year observations from 2010 to 2017 except for first-tier cities (Beijing, Shanghai, Guangzhou, Shenzhen). *PATENT*, *PATENT1* and *PATENT2_3* are the corporate innovation measures. *EW* is the employee welfare measure. The variables such as *SIZE* are the corporation -level control variables. All of the other variables are defined in Appendix A. Both the industry- and year-fixed effects are included in the model estimation. The numbers in parentheses are the *t*-statistics corrected for heteroscedasticity, as suggested by White (1980). ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

The estimation results in first way are reported in columns (1) to (3) of Table 8. The estimation coefficients of *EW* on *PATENT* and *PATENT1* are 0.021 and 0.020, both significant at 1% levels. In addition, columns (4) to (6) show the estimation results in the second way, where the estimation coefficients of *EW* on *PATENT* and *PATENT1* both are 0.020. They are also both significant at 1% level. All the outcomes indicate that the positive relationship between employee welfare and innovation performance remains valid after excluding the data samples from first-tier cities in China.

4.4.6. Regression analysis by using variables in difference forms

According to Chen et al. (2016a) and Ben-Nasr and Ghouma (2018), the estimation results by simple OLS using level variables may be heavily affected by the effects from corporation levels. They suggest that using first-order differences of all the explained and explanatory variables in a regression can effectively erase the affects from corporation levels. Thereby, in this subsection, we further do the regression by employing variables in their first-order differences. Table 9 reports the estimation results.

Table 9 shows that the estimation coefficients of first-order difference of employee welfare (*ΔEW*) on first-order difference of *PATENT* and *PATENT1* (*ΔPATENT* and *ΔPATENT1*) are both 0.008. Although a little small than the estimation results by using level values, they are also significant at the 5% and 10% level, respectively, indicating that after cancelling the possible effects from corporation levels, the significant positive impacts of employee welfare on corporate innovation are still valid. In addition, estimation results for other independent variables are qualitatively similar to those in the above findings.

4.4.7. Poisson counting and Fama-MacBeth regressions

According to the researches of Zhou (2001) and Chen et al. (2016b), the Poisson counting model is more suitable for regression analysis with dependent variables that are non-negative integers with stable occurrence probability and independent time without mutual influence. Furthermore, they also argue that Fama-MacBeth method can make best use of the cross-sectional variation in the employee welfare on corporate innovation. The variation in innovation is largely driven by cross-sectional variation in the employee relations scores. The lack of within-corporation time series variation works against finding a significant effect of the employee relations score on innovation in corporations fixed effects regressions, which mainly estimate the effect of time series variation in the employee relations score within a corporation on innovation. To improve the conclusion robustness, we utilize two more regression methods, i.e., Poisson counting model and Fama-MacBeth model to re-examine the estimation results of employee welfare on innovation performance of China's manufacturing corporations.

Columns (1) to (3) in Table 10 show the estimation outcomes of Poisson model. We can see that the estimation coefficients of *EW* on *PATENT* and *PATENT1* both are 0.006 and significant at the 1% level. In addition, the regression results of Fama-MacBeth model in columns (4) to (6) also present that the estimation coefficients of *EW* on *PATENT* and *PATENT1* are 0.028 and 0.029, which are also both significant at 1% level. In line with other findings above, we can confirm that the positive impacts of employee welfare on corporate innovation still hold even using different regression methods here.

Table 9
Robustness check-Change regression analysis.

	ΔPATENT	ΔPATENT1	ΔPATENT2_3
	(1)	(2)	(3)
ΔEW	0.008* (1.80)	0.008** (1.97)	−0.001 (−0.24)
ΔSIZE	0.327*** (5.10)	0.302*** (4.59)	0.338*** (5.39)
ΔROA	−0.244 (−0.58)	−0.243 (−0.70)	−0.336 (−0.80)
ΔLEV	−0.273* (−1.73)	−0.223 (−1.50)	−0.165 (−0.98)
ΔAGE	−0.053 (−0.68)	−0.005 (−0.08)	−0.093 (−1.15)
ΔTQ	0.006 (0.39)	0.006 (0.46)	0.001 (0.03)
ΔPPE	0.230 (1.11)	0.189 (1.01)	0.269 (1.30)
ΔCASH	−0.142 (−0.94)	−0.020 (−0.14)	−0.112 (−0.69)
ΔRDA	3.082** (2.37)	2.632** (2.07)	2.625* (1.90)
ΔBI	−0.271 (−0.79)	0.143 (0.46)	−0.342 (−0.91)
ΔDUALITY	0.004 (0.08)	−0.029 (−0.72)	0.020 (0.43)
ΔSTATE	−0.096 (−0.63)	−0.204 (−1.34)	0.035 (0.20)
ΔTOP1	−0.005 (−1.54)	−0.004 (−1.48)	−0.003 (−1.09)
ΔR&D_SUM	0.256*** (4.55)	0.219*** (4.44)	0.232*** (4.02)
ΔR&D_RATIO	0.200*** (3.18)	0.170*** (3.03)	0.159** (2.46)
Constant	0.106*** (3.79)	0.147*** (5.79)	0.091*** (3.13)
Year	Yes	Yes	Yes
Industry	Yes	Yes	Yes
R-squared	0.026	0.026	0.021
Observations	7527	7527	7527

Note: This table presents the results of the first robustness check using change regression analysis method. The sample includes corporation-year observations from 2010 to 2017. *Δ* indicates the first difference of the variable. *PATENT*, *PATENT1* and *PATENT2_3* are the corporate innovation measures. *EW* is the corporation's employee welfare. The variables such as *SIZE* are the corporation-level control variables. All variables are the first-order difference of Appendix A including variables. Both the industry- and year-fixed effects are included in the model estimation. The numbers in parentheses are the *t*-statistics corrected for heteroscedasticity, as suggested by White (1980). ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

4.5. Channel tests

According to H1, improved employee welfare level can enhance the quality of corporate innovation by helping the corporation to retain outstanding employees and increasing positive media reports. The next two sections examine whether this is true.

4.5.1. Retaining outstanding employees

To determine whether the positive impact of employee welfare on corporate innovation stems from retaining outstanding employees, reference is again made to Chen et al. (2016a), and the variable *MS* is introduced. It pertains to the proportion of individuals in the corporation with Master's level education and above. According to the median of *MS*, the sample corporations are divided into two categories: high education and low education. If this channel is effective, employee welfare is expected to have a greater impact on corporate innovation in the low-education category and less or no significant impact on corporation innovation in the high-education category. The first three columns of Table 11 report the regression results of employee welfare and corporate innovation in the high-education group. The last three columns report the regression results of employee welfare and corporate innovation in the low-education group. For the high-education category, the estimation coefficients of *PATENT*, *PATENT1* and *PATENT2_3* are not significant. For the low-education category, the estimation coefficients of *PATENT* and *PATENT1* are both significant at 1%, whereas the estimation coefficient of *PATENT2_3* is not. Thus, in the low-education category, employee welfare has a more significant impact on corporate innovation. This is mainly reflected in the impact on innovation quality, with no significant impact on innovation quantity. That is, improving employee welfare can indeed enhance the quality of corporate innovation by retaining outstanding employees.

4.5.2. Attracting more positive media reports

Ben-Nasr and Ghouma (2018) find that the increase of negative media reports will bring great psychological pressure to managers. Managers will reduce their investment in corporate innovation, that is, the "market pressure hypothesis", due to fear of more negative media reports and investor dissatisfaction caused by declining performance or innovation failure. On the contrary, a positive and relaxed external environment is conducive to corporates' peace of mind in research and development. Corporations with good employee welfare often enjoy a good reputation and are more likely to be praised by the media. Based on this, we try to take positive media coverage as an important path for

Table 10
Poisson counting and Fama-MacBeth regressions.

	PATENT	PATENT1	PATENT2_3	PATENT	PATENT1	PATENT2_3
	(1)	(2)	(3)	(4)	(5)	(6)
EW	0.006*** (3.10)	0.006*** (2.94)	0.001 (0.35)	0.028*** (11.95)	0.029*** (8.47)	0.008 (1.52)
SIZE	0.064*** (5.67)	0.138*** (10.33)	0.033** (2.59)	0.269*** (17.96)	0.394*** (21.80)	0.159*** (19.65)
ROA	0.472*** (3.09)	0.450** (2.47)	0.687*** (3.99)	0.810** (2.73)	0.625** (2.58)	1.136*** (4.38)
LEV	−0.069 (−1.55)	−0.076 (−1.42)	−0.041 (−0.82)	−0.188** (−3.16)	−0.165** (−2.58)	−0.069 (−1.24)
AGE	0.016 (1.55)	0.013 (1.03)	0.030** (2.56)	−0.014 (−0.68)	−0.052** (−2.52)	0.006 (0.33)
TQ	−0.015** (−2.42)	−0.006 (−0.75)	−0.020*** (−2.81)	−0.007 (−0.56)	0.038** (2.90)	−0.005 (−0.34)
PPE	−0.310*** (−5.72)	−0.395*** (−6.13)	−0.280*** (−4.57)	−1.015*** (−11.87)	−0.927*** (−16.37)	−0.774*** (−9.30)
CASH	−0.059 (−1.04)	−0.202*** (−2.96)	0.028 (0.44)	−0.034 (−0.49)	−0.201*** (−12.01)	0.177** (2.22)
RDA	5.389*** (12.13)	7.966*** (15.53)	3.973*** (7.88)	18.524*** (8.89)	19.832*** (9.71)	11.696*** (8.57)
BI	−0.068 (−0.61)	−0.154 (−1.16)	−0.029 (−0.23)	0.179 (0.99)	0.094 (0.53)	0.350 (1.76)
DUALITY	0.014 (1.08)	0.013 (0.78)	0.003 (0.21)	0.070* (2.18)	0.045** (3.11)	0.033 (1.44)
STATE	−0.036** (−2.31)	−0.023 (−1.24)	−0.062*** (−3.49)	−0.082*** (−4.53)	−0.03 (−0.14)	−0.127*** (−5.06)
TOP1	−0.001 (−1.58)	−0.001** (−2.20)	−0.001 (−0.49)	−0.003** (−3.69)	−0.003*** (−9.13)	−0.002 (−1.53)
R&D_SUM	0.163*** (15.03)	0.164*** (12.64)	0.227*** (18.56)	0.519*** (54.01)	0.377*** (40.75)	0.579*** (40.60)
R&D_RATIO	0.088*** (6.43)	0.062*** (5.88)	0.176*** (11.48)	0.312*** (17.90)	0.075*** (5.74)	0.472*** (36.29)
Constant	−0.813* (−1.79)	−3.456*** (−6.67)	−0.786* (−1.76)	−4.796*** (−12.27)	−8.960*** (−23.39)	−2.786*** (−14.36)
Year	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.078	0.107	0.117	0.445	0.426	0.444
Observations	9689	9689	9689	9689	9689	9689

Note: This table presents the results of Poisson counting and Fama-MacBeth regressions. Columns (1) to (3) report the results of Poisson counting regression, and Columns (4) to (6) indicate the estimation results of Fama-MacBeth regression. The sample includes corporation-year observations from 2010 to 2017. *PATENT*, *PATENT1* and *PATENT2_3* are the corporate innovation measures. *EW* is the employee welfare measure. The variables such as *SIZE* are the corporation-level control variables. All of the other variables are defined in Appendix A. Both the industry- and year-fixed effects are included in the model estimation. The numbers in parentheses are the *t*-statistics corrected for heteroscedasticity, as suggested by White (1980). ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

Table 11
Channels test- Retention of outstanding employees.

	High talent ratio			Low talent ratio		
	PATENT	PATENT1	PATENT2_3	PATENT	PATENT1	PATENT2_3
EW	0.005 (0.46)	0.012 (1.12)	0.002 (0.14)	0.024*** (2.83)	0.027*** (3.16)	0.015 (1.56)
SIZE	0.289*** (3.51)	0.330*** (4.10)	0.265*** (2.81)	0.230*** (3.96)	0.280*** (4.61)	0.167*** (2.85)
ROA	2.664*** (3.12)	1.647** (1.97)	2.090** (2.08)	0.701 (1.06)	0.313 (0.51)	1.039 (1.57)
LEV	−0.416 (−1.47)	−0.589** (−2.14)	−0.097 (−0.32)	−0.145 (−0.74)	−0.109 (−0.56)	−0.056 (−0.27)
AGE	−0.019 (−0.24)	−0.059 (−0.74)	−0.026 (−0.36)	0.026 (0.57)	0.008 (0.18)	0.041 (0.83)
TQ	−0.028 (−0.93)	−0.003 (−0.11)	−0.005 (−0.15)	−0.017 (−0.67)	0.016 (0.64)	−0.008 (−0.31)
PPE	−0.464 (−1.17)	−0.595 (−1.54)	−0.202 (−0.42)	−0.910*** (−3.29)	−0.497* (−1.87)	−1.035*** (−3.70)
CASH	−0.454* (−1.74)	−0.542** (−1.96)	0.069 (0.24)	−0.220 (−0.91)	−0.231 (−1.06)	−0.089 (−0.35)
RDA	9.133*** (3.63)	11.153*** (4.37)	10.394*** (3.84)	21.684*** (9.36)	20.806*** (8.77)	16.335*** (6.64)
BI	−0.358 (−0.53)	−0.025 (−0.04)	−0.694 (−0.88)	−0.471 (−0.92)	0.024 (0.05)	−0.342 (−0.64)
DUALITY	0.054 (0.58)	0.048 (0.53)	0.029 (0.28)	0.106* (1.85)	0.062 (1.11)	0.071 (1.12)
STATE	−0.070 (−0.68)	0.026 (0.25)	−0.138 (−1.13)	−0.142* (−1.75)	−0.076 (−0.94)	−0.164* (−1.89)
TOP1	−0.008** (−2.48)	−0.007** (−2.24)	−0.008** (−2.41)	0.002 (0.76)	0.002 (0.81)	0.002 (0.59)
R&D_SUM	0.598*** (7.57)	0.549*** (7.16)	0.564*** (6.13)	0.577*** (10.02)	0.469*** (8.24)	0.617*** (10.45)
R&D_RATIO	0.396*** (3.56)	0.268** (2.56)	0.526*** (4.06)	0.457*** (6.35)	0.316*** (4.29)	0.515*** (6.98)
Constant	−5.082*** (−3.10)	−6.928*** (−4.48)	−4.838** (−2.51)	−3.914*** (−3.47)	−6.689*** (−5.61)	−3.068*** (−2.66)
Year	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Adj-R^2	0.562	0.538	0.551	0.464	0.416	0.461
Observations	2055	2055	2055	4391	4391	4391

Note: This table presents the results of the second channel test: retention of outstanding employees. The test compares the differences in the relationship between employee welfare and corporate innovation under different talent ratios. The sample includes corporation-year observations from 2010 to 2017. *PATENT*, *PATENT1* and *PATENT2_3* are the corporate innovation measures. *EW* is the employee welfare measure. The variables such as *SIZE* are the corporation-level control variables. All of the other variables are defined in Appendix A. Both the industry- and year-fixed effects are included in the model estimation. The numbers in parentheses are the *t*-statistics corrected for heteroscedasticity, as suggested by White (1980). ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

employee welfare to affect corporate innovation.

In order to test whether employee welfare can affect the innovation output of corporates through positive media reports, the number of positive media reports (PM) is selected, and the cross-product (EW*PM) of employee welfare and positive media reports is included in regression analysis. The results are shown in Table 8. It can be seen from Table 12 that the coefficient of EW*PM is significantly positive, indicating that employee welfare can increase positive media reports, create a relaxed and pressureless external environment for corporate innovation, and promote corporate innovation output.

4.5.3. Increasing R&D efficiency

In previous sections, we have proved that employee welfare can increase corporate innovation output by retaining outstanding employees and attracting positive media reports. In this subsection we go further to investigate other possible impact channels. Innovation (or R&D) is high-

Table 12
Channels test-Positive media reports.

	PATENT	PATENT1	PATENT2_3
	(1)	(2)	(3)
EW	−0.024 (−1.29)	−0.030 (−1.64)	0.012 (0.67)
*EW*PM*	0.010** (2.53)	0.012*** (3.13)	−0.001 (−0.28)
PM	0.062** (2.50)	0.044* (1.84)	0.074*** (2.97)
SIZE	0.226*** (5.37)	0.341*** (8.04)	0.119*** (2.72)
ROA	0.993** (2.09)	0.218 (0.50)	0.995** (2.01)
LEV	−0.235* (−1.65)	−0.204 (−1.45)	−0.123 (−0.84)
AGE	0.014 (0.37)	−0.015 (−0.41)	0.032 (0.83)
TQ	−0.031* (−1.66)	0.006 (0.32)	−0.029 (−1.57)
PPE	−1.050*** (−5.19)	−0.942*** (−4.88)	−0.832*** (−4.01)
CASH	−0.096 (−0.59)	−0.237 (−1.52)	0.169 (1.01)
RDA	18.246*** (10.87)	19.712*** (11.25)	11.626*** (6.65)
BI	−0.067 (0.18)	0.081 (0.22)	0.290 (0.77)
DUALITY	0.056 (1.32)	0.032 (0.76)	0.026 (0.57)
STATE	−0.083 (−1.43)	−0.010 (−0.17)	−0.121* (−1.95)
TOP1	−0.003 (−1.44)	−0.003* (−1.72)	−0.001 (−0.73)
R&D_SUM	0.524*** (13.00)	0.380*** (9.53)	0.587*** (13.83)
R&D_RATIO	0.309*** (6.36)	0.257*** (5.13)	0.473*** (9.10)
Constant	−3.126*** (−3.51)	−7.127*** (−7.68)	−2.197** (−2.53)
Year	Yes	Yes	Yes
Industry	Yes	Yes	Yes
R-squared	0.454	0.432	0.445
Observations	9536	9536	9536

Note: This table presents the results of the second channel test: positive media reports. The sample includes corporation-year observations from 2010 to 2017. *PATENT*, *PATENT1* and *PATENT2_3* are the corporate innovation measures. *EW* is the employee welfare measure. *PM* is the positive media reports measure. *EW*PM* is the intersection item of employee welfare and positive media reports. The variables such as *SIZE* are the corporation-level control variables. All of the other variables are defined in Appendix A. Both the industry- and year-fixed effects are included in the model estimation. The numbers in parentheses are the t-statistics corrected for heteroscedasticity, as suggested by White (1980). ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

risk behavior that requires high tolerance of failure for corporations and employees (Chen et al., 2016a). Bloom et al. (2011) figure out that better employee welfare can increase employee loyalty to the corporation, and further stimulate employee's productivity. At the same time, it can solve the worries of employees, increase their risk tolerance, and improve the quantity and quality of R&D, thereby promoting corporate innovation output (Tian and Wang, 2011; Chen et al., 2016b). Therefore, we argue that employee welfare can affect the innovation output of the Chinese manufacturing corporations through improving the inventor efficiency.

In this subsection, we test whether employee welfare can affect corporate innovation output through inventor efficiency. Referring to the definition in Chen et al. (2016b), the inventor efficiency (*EFFICIENCY*) can be measured by the logarithm of (1+number of patent applications/the number of scientific and technical personnel). Table 13 reports the results of this channel test. Table 13 shows that the coefficients of the product of employee welfare and inventor efficiency (*EW*EFFICIENCY*) are significantly positive for the total number of patent applications (*PATENT*) and the number of invention patent applications (*PATENT1*), indicating that the improvement of employee welfare will help to stimulate the inventor efficiency, and then increase the innovation output of manufacturing corporations.

4.6. Mediating effect analysis

In order to test whether the channels of employee welfare affecting corporate innovation identified in Section 4.5 is correct, we further employ the Sobel mediating factor testing method in Baron and Kenny (1986) to verify the robustness of the channel test.

4.6.1. Mediating effect analysis for retaining outstanding employees

In order to test the robustness of the path of retaining outstanding employees, we follow the methods of Baron and Kenny (1986) and set the path models as *Path a*, *Path b,* and *Path c* as follows:

Table 13
Channels test-Inventor efficiency.

	PATENT	PATENT1	PATENT2_3
	(1)	(2)	(3)
EW	−0.001 (−0.17)	0.004 (0.56)	−0.003 (−0.32)
*EW*EFFICIENCY*	8.826*** (2.63)	7.951** (2.12)	1.142 (0.37)
EFFICIENCY	4.047*** (18.34)	2.949*** (15.34)	3.613*** (19.61)
SIZE	0.105*** (2.84)	0.281*** (7.08)	0.329*** (8.46)
ROA	0.926** (2.24)	1.076** (2.41)	1.129** (2.56)
LEV	−0.143 (−1.15)	−0.140 (−1.09)	0.005 (0.04)
AGE	0.054* (1.72)	0.013 (0.41)	0.066* (1.94)
TQ	−0.020 (−1.41)	0.018 (1.16)	−0.023 (−1.51)
PPE	−0.823*** (−4.56)	−0.745*** (−4.14)	−0.669*** (3.55)
CASH	−0.309** (−2.16)	−0.387*** (−2.65)	−0.018 (−0.12)
RDA	14.802*** (8.94)	17.931*** (9.96)	8.156*** (4.56)
BI	−0.323 (−1.00)	−0.274 (−0.80)	−0.116 (−0.34)
DUALITY	0.021 (0.57)	0.003 (0.09)	−0.001 (−0.03)
STATE	−0.135** (−2.55)	−0.057 (−1.01)	−0.153*** (−2.61)
TOP1	−0.003 (−1.61)	−0.003* (−1.78)	−0.001 (0.87)
R&D_SUM	1.150*** (25.80)	0.820*** (18.83)	1.132*** (24.90)
R&D_RATIO	1.076*** (19.85)	0.623*** (11.59)	1.135*** (20.34)
Constant	−3.625*** (−4.98)	−7.986*** (−10.15)	−1.677** (−2.12)
Year	Yes	Yes	Yes
Industry	Yes	Yes	Yes
R-squared	0.482	0.475	0.463
Observations	8934	8934	8934

Note: This table presents the results of the third channel test: Inventor efficiency. The sample includes corporation-year observations from 2010 to 2017. *PATENT*, *PATENT1* and *PATENT2_3* are the corporate innovation measures. *EW* is the employee welfare measure. *EFFICIENCY* is the inventor efficiency measure. *EW*EFFICIENCY* is the intersection item of employee welfare and inventor efficiency. The variables such as *SIZE* are the corporation-level control variables. All of the other variables are defined in Appendix A. Both the industry- and year-fixed effects are included in the model estimation. The numbers in parentheses are the *t*-statistics corrected for heteroscedasticity, as suggested by White, 1980. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

$$Innovation_{i,t} = \alpha_0 + \alpha_1 EW_{i,t} + \alpha_i Controls_{i,t} + Fixed \quad effects + \varepsilon_{i,t}, \quad (Path \quad a) \tag{2}$$

$$GROUP_{i,t} = \beta_0 + \beta_1 EW_{i,t} + \beta_i Controls_{i,t} + Fixed \quad effects + \varepsilon_{i,t}, \quad (Path \quad b) \tag{3}$$

$$Innovation_{i,t} = \gamma_0 + \gamma_1 EW_{i,t} + \gamma_2 GROUP_{i,t} + \gamma_i Controls_{i,t} + Fixed \quad effects + \varepsilon_{i,t}, \quad (Path \quad c) \tag{4}$$

where *Innovation* represents corporate innovation, specifically defined as *PATENT*, *PATENT1* and *PATENT2_3*; *EW* is the employee welfare; *Controls* represents the control variables, consisting of a series of corporate and industry characteristic variables that may affect corporate innovation; and *Fixed effects* are the industry-fixed effects and year-fixed effects. *GROUP* is an indicator variable for outstanding employees. If the proportion of people with *MS* is higher than the industry average, *GROUP* is set to be 1; otherwise, it is 0.

To test whether retaining outstanding employees has intermediary and adjustment effects on employee welfare and corporate innovation, we use the three-step method as suggested by Baron and Kenny (1986): 1) the first step is to test the impact of employee welfare on corporate innovation and observe the regression coefficient α_1 of the model *Path a* in Eq. (2); the second step is to test the impact of employee welfare on the indicator variable *GROUP* of outstanding employees and observe the regression coefficient β_1 of the model *Path b* in Eq. (3); then the third step is to analyze the impact of employee welfare and outstanding employee indicator *GROUP* on corporate innovation, and observe the regression coefficients γ_1 and γ_2 of model *Path c* in Eq. (4). When the following conditions are met, we can conclude that the path (channel) test passes and the mediating effect holds (Baron and Kenny, 1986): 1) if the regression coefficient α_1 in *Path a* is significant, the regression coefficient β_1 in *Path b* is significant, the regression coefficient γ_2 of *Path c* is significant, γ_1 is not significant, and the *Sebel Z* index is significant, then *GROUP* has a completely mediating effect; 2) if the regression coefficient α_1 in *Path a* is significant, the regression coefficient β_1 in *Path b* is significant, the regression coefficient γ_2 of *Path c* is significant, γ_1 is significantly lower than α_1, and the *Sebel Z* index is significant, then *GROUP* has a partial mediating effect.

Table 14 reports the results of the mediating effect analysis for the path of retaining outstanding employees. It shows that, first in the model *Path a* in Eq. (2), regression coefficients α_1 for *PATENT*, *PATENT1* and *PATENT2_3* are 0.006, 0.008 and 0.007, respectively. The regression coefficients of *PATENT* and *PATENT1* are significant at 5% and 1% levels, respectively, while the regression coefficients of *PATENT2_3* are not significant. Secondly, in the model *Path b* in Eq. (3), the regression coefficient β_1 of the mediating factor *GROUP* on employee welfare is 0.005, and it is significant at the 1% level. This shows that employee welfare has significant positive impact on the proportion of outstanding employees. Finally, in the model *Path c* in Eq. (4), the regression coefficients γ_1 of employee welfare on *PATENT*, *PATENT1* and *PATENT2_3* are 0.005, 0.007 and 0.007, respectively. In particular, the regression coefficients of *PATENT* and *PATENT1* are significant at 10% and 5% levels, which are smaller than those of α_1 in model *path a* in Eq. (2). Similarly, the regression coefficients for *PATENT2_3* is not significant. At the same time, the regression coefficients γ_2 of the mediating factor *GROUP* are 0.324, 0.510 and 0.021, respectively. The regression coefficients for *PATENT* and *PATENT1* are significant at 1% level, while the regression coefficient of *PATENT2_3* is not. Furthermore, the *Sobel Z* index for *PATENT* and *PATENT1* are 1.688 and 1.791, which are significant at 10% levels. However, the *Sobel Z* index for *PATENT2_3* is not significant.

In summary, these results confirm that the impact of employee welfare on corporate innovation has an overall partial intermediary effect through retaining outstanding employees, but this intermediary effect is mainly observed in the quality of innovation (*PATENT1*), instead of in the quantity of innovation (*PATENT2_3*).

4.6.2. Mediating effect analysis for attracting positive media reports

Similar to the steps in Section 4.6.1, we test the robustness of the path for attracting positive media reports in the following path models:

$$Innovation_{i,t} = \alpha_0 + \alpha_1 EW_{i,t} + \alpha_i Controls_{i,t} + Fixed\ \ effects + \varepsilon_{i,t}, \quad (Path\ \ a) \tag{5}$$

$$PM_{i,t} = \beta_0 + \beta_1 EW_{i,t} + \beta_i Controls_{i,t} + Fixed\ \ effects + \varepsilon_{i,t}, \quad (Path\ \ b) \tag{6}$$

$$Innovation_{i,t} = \gamma_0 + \gamma_1 EW_{i,t} + \gamma_2 PM_{i,t} + \gamma_i Controls_{i,t} + Fixed\ \ effects + \varepsilon_{i,t}, \quad (Path\ \ c) \tag{7}$$

where *PM* is the number of positive media reports and all the other variables are defined the same as those in Eqs. (2)–(4).

Table 15 reports the results for the mediating effect on the path of attracting positive media reports. We can see that, firstly in the model *Path a* in Eq. (5), regression coefficients α_1 for *PATENT*, *PATENT1* and *PATENT2_3* are 0.007, 0.008 and 0.007, respectively. The regression coefficients of *PATENT* and *PATENT1* are significant at 5% and 1% levels, respectively, while the regression coefficients of *PATENT2_3* are not significant. Secondly, in the model *Path b* in Eq. (6), the regression coefficient β_1 of the mediating factor *PM* on employee welfare is 0.006, and it is significant at the 1% level. This indicates that employee welfare has significant positive impact on positive media reports. Finally, in the model *Path c* in Eq. (7), the regression coefficients γ_1 of employee

Table 14
Mediating effect analysis-Retaining outstanding employees.

	Path a (No mediating factor)		*Path b (Mediating factor test)*			*Path c (Including mediating factor)*	
	PATENT	*PATENT1*	*PATENT2_3*	*GROUP*	*PATENT*	*PATENT1*	*PATENT2_3*
EW	0.006** (2.13)	0.008*** (2.99)	0.007 (1.62)	0.005*** (3.14)	0.005* (1.86)	0.007** (2.11)	0.007 (1.59)
GROUP					0.324*** (9.15)	0.510*** (14.88)	0.021 (1.33)
SIZE	0.294*** (10.67)	0.385*** (14.28)	0.147*** (6.09)	0.242*** (25.07)	0.216*** (6.63)	0.262*** (9.42)	0.136*** (5.28)
ROA	1.294*** (3.59)	1.091*** (3.20)	1.170*** (3.72)	1.402*** (3.58)	1.425*** (3.97)	0.718** (2.07)	1.107*** (3.48)
LEV	−0.253** (−2.38)	−0.328*** (−3.16)	−0.128 (−1.38)	−0.183*** (−4.93)	−1.194* (−1.83)	−0.235** (−2.29)	−0.134 (−1.45)
AGE	0.006 (0.26)	−0.025 (−1.04)	0.040* (1.80)	−0.015* (−1.72)	0.011 (0.45)	−0.017 (−0.73)	0.043* (1.91)
TQ	−0.011 (−0.80)	0.026* (1.84)	−0.019 (−1.54)	0.045*** (9.05)	−0.026* (−1.83)	0.003 (0.19)	−0.024* (−1.84)
PPE	−0.986*** (−7.62)	−0.834*** (−6.59)	−0.843*** (−7.55)	−0.440*** (−9.72)	−0.843*** (−6.51)	−0.609*** (−4.86)	−0.844*** (−7.55)
CASH	−0.286** (−2.16)	−0.355*** (−2.73)	0.172 (1.47)	−0.027 (−0.58)	−0.277** (−2.10)	−0.341*** (−2.67)	0.164 (1.40)
RDA	17.718*** (16.14)	19.447*** (18.11)	11.734*** (11.74)	7.761*** (20.18)	15.202*** (13.51)	15.490*** (14.23)	11.643*** (11.63)
BI	−0.339 (−1.22)	0.173 (0.64)	0.124 (0.52)	0.039 (0.41)	−0.351 (−1.28)	0.153 (0.58)	0.116 (0.49)
DUALITY	0.067** (2.03)	0.032 (1.00)	0.017 (0.61)	−0.023** (−2.01)	0.075** (2.28)	0.044 (1.39)	0.016 (0.57)
STATE	−0.072* (−1.91)	−0.001 (−0.01)	−0.113*** (−3.36)	0.098*** (7.44)	−0.104*** (−2.76)	−0.050 (−1.38)	−0.113*** (−3.36)
TOP1	−0.001 (−0.85)	−0.001 (−0.86)	−0.001 (−1.14)	−0.001* (−1.74)	−0.001 (−0.65)	−0.001 (−0.56)	−0.001 (−1.07)
R&D_SUM	0.516*** (19.49)	0.401*** (15.50)	0.576*** (25.11)	0.214*** (23.14)	0.585*** (21.39)	0.510*** (19.28)	0.575*** (25.06)
R&D_RATIO	0.313*** (9.45)	0.105*** (3.23)	0.455*** (15.62)	0.440*** (37.94)	0.456*** (12.51)	0.329*** (9.34)	0.455*** (15.62)
Constant	−5.202*** (−9.47)	−8.633*** (−16.07)	−3.462*** (−6.03)	−4.649*** (−24.16)	−3.695*** (−6.48)	−6.262*** (−11.35)	−3.325*** (−5.55)
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.474	0.443	0.428	0.300	0.481	0.462	0.436
Observations	6446	6446	6446	6446	6446	6446	6446
Sobel Z (p-value)					1.688* (0.090)	1.791* (0.066)	0.767 (0.443)

Note: This table presents the results of the mediating effect analysis for retaining outstanding employees. *Path a* reports the regression results of no mediating factor, *Path b* presents the results of mediating factor test and *Path c* shows the results of including mediating factor. *PATENT*, *PATENT1* and *PATENT2_3* are the three corporate innovation measures. *EW* is the employee welfare measure. *GROUP* is the mediating factor. The *Sobel Z* is the results of mediating effect test. All of the other variables are defined in Table 1A. Both the industry-and year-fixed effects are controlled in the model estimation. The numbers in parentheses are the *t*-statistics corrected for heteroscedasticity, as suggested by White, 1980. ***, ** and * denote significant at the 1%, 5% and 10% levels, respectively.

Table 15
Mediating effect analysis-Attracting positive media reports.

	Path a (No mediating factor)		Path b (Mediating factor test)			Path c (Including mediating factor)	
	PATENT	PATENT1	PATENT2_3	PM	PATENT	PATENT1	PATENT2_3
EW	0.007** (2.12)	0.008*** (3.23)	0.007 (1.62)	0.006*** (2.94)	0.004 (1.22)	0.006 (1.38)	0.007 (1.59)
PM					0.087*** (5.85)	0.073*** (5.11)	0.021 (1.33)
SIZE	0.279*** (12.36)	0.387*** (17.79)	0.147*** (6.09)	0.546*** (34.90)	0.232*** (9.69)	0.347*** (15.05)	0.136*** (5.28)
ROA	1.267*** (4.31)	1.181*** (3.90)	1.170*** (3.72)	3.005*** (14.77)	1.007*** (3.39)	0.889** (2.37)	1.107*** (3.48)
LEV	−0.217** (−2.52)	−0.191** (−2.30)	−0.128 (−1.38)	0.299*** (5.02)	−0.243*** (−2.82)	−0.213** (−2.56)	−0.134 (−1.45)
AGE	0.001 (0.01)	−0.027 (−1.33)	0.040* (1.80)	−0.133*** (−9.11)	0.012 (0.55)	−0.017 (−0.85)	0.043* (1.91)
TQ	−0.010 (−0.82)	0.024** (2.11)	−0.019 (−1.54)	0.222*** (27.14)	−0.029** (−2.36)	0.008 (0.67)	−0.024* (−1.84)
PPE	−1.052*** (−10.09)	−0.946*** (−9.40)	−0.844*** (−7.55)	0.016 (0.22)	−1.054*** (−10.12)	−0.947*** (−9.43)	−0.844*** (−7.55)
CASH	−0.060 (−0.55)	−0.206* (−1.96)	0.172 (1.47)	0.381*** (5.04)	−0.093 (−0.85)	−0.234** (−2.22)	0.164 (1.40)
RDA	18.614*** (19.96)	20.020*** (22.28)	11.734*** (11.74)	4.349*** (6.74)	18.238*** (19.54)	19.703*** (21.90)	11.643*** (11.63)
BI	0.120 (0.54)	0.133 (0.62)	0.124 (0.52)	0.379** (2.48)	0.088 (0.40)	0.105 (0.50)	0.116 (0.49)
DUALITY	0.063** (2.38)	0.039 (1.52)	0.017 (0.61)	0.059*** (3.22)	0.058** (2.19)	0.034 (1.35)	0.016 (0.57)
STATE	−0.082*** (−2.60)	−0.009 (−0.29)	−0.113*** (−3.36)	0.005 (0.21)	−0.082*** (−2.62)	−0.009 (−0.30)	−0.113*** (−3.36)
TOP1	−0.003*** (−3.30)	−0.003*** (−3.80)	−0.001 (−1.14)	−0.003*** (−5.08)	−0.003*** (−3.00)	−0.003*** (−3.54)	−0.001 (−1.07)
R&D_SUM	0.530*** (24.73)	0.385*** (18.67)	0.576*** (25.11)	0.041*** (2.74)	0.526*** (24.60)	0.382*** (18.54)	0.575*** (25.06)
R&D_RATIO	0.311*** (11.46)	0.076*** (2.91)	0.455*** (15.62)	0.340*** (13.93)	0.311*** (11.46)	0.076*** (2.90)	0.455*** (15.62)
Constant	−3.993*** (−3.28)	−7.914*** (−6.74)	−3.002** (−2.03)	−8.002*** (−9.48)	−3.300*** (−2.70)	−7.331*** (−6.22)	−2.323*** (−3.55)
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.451	0.430	0.428	0.467	0.453	0.431	0.428
Observations	9536	9536	9536	9536	9536	9536	9536
Sobel Z (p-value)					2.770*** (0.006)	2.891*** (0.004)	1.121 (0.262)

Note: This table presents the results of the mediating effect analysis for retaining outstanding employees. *Path a* reports the regression results of no mediating factor, *Path b* presents the results of mediating factor test and *Path c* shows the results of including mediating factor. *PATENT*, *PATENT1* and *PATENT2_3* are the three corporate innovation measures. *EW* is the employee welfare measure. *PM* is the mediating factor. The *Sobel Z* is the results of mediating effect test. All of the other variables are defined in Table 1A. Both the industry-and year-fixed effects are controlled in the model estimation. The numbers in parentheses are the *t*-statistics corrected for heteroscedasticity, as suggested by White, 1980. ***, ** and * denote significant at the 1%, 5% and 10% levels, respectively.

welfare on *PATENT*, *PATENT1* and *PATENT2_3* are 0.004, 0.006 and 0.007, respectively. Nevertheless, they are not significant. At the same time, the regression coefficients γ_2 of the mediating factor *PM* are 0.087, 0.073 and 0.021, respectively. The regression coefficients for *PATENT* and *PATENT1* are both significant at 1% level, while the regression coefficient of *PATENT2_3* is not. Moreover, the *Sobel Z* index for *PATENT* and *PATENT1* are 2.770 and 2.891, which are both significant 1% level. However, the *Sobel Z* index for *PATENT2_3* is not significant.

In short, according to the testing criterion suggested by Baron and Kenny (1986), these findings confirm that the impact of employee welfare on corporate innovation has a full mediating effect through attracting positive media reports, but this intermediary effect is mainly observed in the quality of innovation (*PATENT1*), instead of in the quantity of innovation (*PATENT2_3*).

4.6.3. Mediating effect analysis for increasing R&D efficiency

In this section, we further test the third mediating effect through increasing R&D efficiency. The path models are as follows:

$$Innovation_{i,t} = \alpha_0 + \alpha_1 EW_{i,t} + \alpha_i Controls_{i,t} + Fixed\ \ effects + \varepsilon_{i,t}, \quad (Path\ \ a) \tag{8}$$

$$EFFICIENCY_{i,t} = \beta_0 + \beta_1 EW_{i,t} + \beta_i Controls_{i,t} + Fixed\ \ effects + \varepsilon_{i,t}, \quad (Path\ \ b) \tag{9}$$

$$Innovation_{i,t} = \gamma_0 + \gamma_1 EW_{i,t} + \gamma_2 EFFICIENCY_{i,t} + \gamma_i Controls_{i,t} + Fixed\ \ effects + \varepsilon_{i,t}, \quad (Path\ \ c) \tag{10}$$

where *EFFICIENCY* is the measurement of R&D efficiency defined in Table 1A and all the other variables are defined the same as those in Eqs. (2)–(4).

Very similar to the findings in Section 4.6.2, Table 16 shows that, firstly in the model *Path a* in Eq. (8), regression coefficients α_1 for *PATENT*, *PATENT1* and *PATENT2_3* are 0.008, 0.009 and 0.001, respectively. The regression coefficients of *PATENT* and *PATENT1* are both significant at 1% levels, while the regression coefficients of *PATENT2_3* are not significant. Secondly, in the model *Path b* in Eq. (9), the regression coefficient β_1 of the mediating factor *EFFICIENCY* on employee welfare is 0.001 with significant level of 1%. This proves that employee welfare has significant positive impact on R&D efficiency. Finally, in the model *Path c* in Eq. (10), the regression coefficients γ_1 of employee welfare on *PATENT*, *PATENT1* and *PATENT2_3* are 0.006, 0.007 and 0.001, respectively. However, they are not significant. Moreover, the regression coefficients γ_2 of the mediating factor *EFFICIENCY* on *PATENT*, *PATENT1* and *PATENT2_3* are 4.266, 3.146 and 0.068, respectively. Among them, the regression coefficients for *PATENT* and *PATENT1* are both significant at 1% level, while the regression coefficient of *PATENT2_3* is not. Additionally, the *Sobel Z* index for *PATENT* and *PATENT1* are 2.967 and 3.006 with significance level of 1%. However, the *Sobel Z* index for *PATENT2_3* is not significant.

In general, according to the testing criterion suggested by Baron and Kenny (1986), these results indicate that the impact of employee welfare on corporate innovation has a full mediating effect through increasing R&D efficiency, and this intermediary effect is mainly observed in the quality of innovation (*PATENT1*), but not in the quantity of innovation (*PATENT2_3*).

5. Conclusions

This paper aims to shed lights on the role of employee welfare in promoting innovation performance in manufacturing corporations. We investigate the impact and its possible channels of employee welfare on innovation performance in China's listed manufacturing corporations. Two hypotheses on the relationship between employee welfare and

Table 16
Mediating effect analysis-Increasing R&D efficiency.

	Path a (No mediating factor)			*Path b (Mediating factor test)*	*Path c (Including mediating factor)*		
	PATENT	PATENT1	PATENT2_3	EFFICIENCY	PATENT	PATENT1	PATENT2_3
EW	0.008*** (3.12)	0.009*** (3.21)	0.001 (0.32)	0.001*** (4.32)	0.006 (1.39)	0.007 (1.42)	0.001 (0.32)
EFFICIENCY					4.266*** (6.11)	3.146*** (4.36)	0.608 (1.24)
SIZE	0.292*** (12.18)	0.418*** (18.26)	0.186*** (8.05)	0.449*** (14.71)	0.100*** (4.93)	0.277*** (13.16)	0.185*** (8.01)
ROA	0.703** (2.27)	1.001*** (2.70)	0.946*** (3.11)	0.530** (2.01)	0.929*** (3.58)	0.688** (2.07)	0.947*** (3.11)
LEV	−0.317*** (−3.51)	−0.269*** (−3.11)	−0.015 (−0.17)	−0.411*** (−3.67)	−0.142* (−1.86)	−0.139* (−1.77)	−0.016 (−0.19)
AGE	−0.016 (−0.73)	−0.038* (−1.81)	−0.026 -(1.23)	−0.172*** (−6.13)	−0.057*** (−3.09)	−0.016 (0.84)	−0.027 (−1.24)
TQ	−0.016 (−1.28)	0.021* (1.75)	−0.004 (−0.32)	0.012 (0.76)	−0.021** (−2.01)	−0.017 (−1.58)	−0.005 (−0.43)
PPE	−0.996*** (−9.03)	−0.874*** (−8.30)	−0.710*** (−6.57)	−0.038*** (−2.67)	−0.836*** (−9.03)	−0.756*** (−7.91)	−0.708*** (−6.56)
CASH	0.035 (0.31)	−0.135 (−1.25)	0.093 (0.85)	0.082*** (5.71)	−0.317*** (−3.33)	−0.394*** (−4.01)	0.094 (0.86)
RDA	20.576*** (20.72)	22.200*** (23.40)	11.149*** (11.62)	13.388*** (10.58)	14.865*** (17.73)	17.988*** (20.76)	11.148*** (11.63)
BI	0.089 (0.39)	0.027 (0.12)	0.217 (0.99)	0.998*** (3.40)	−0.336* (−1.74)	−0.286 (−1.43)	−0.218 (−1.00)
DUALITY	0.067** (2.45)	0.037 (1.41)	0.021 (0.79)	0.112*** (3.21)	0.019 (0.83)	0.002 (0.07)	0.021 (0.80)
STATE	−0.079** (−2.37)	−0.015 (−0.49)	−0.099*** (−3.12)	−0.131*** (−3.07)	−0.135*** (−4.81)	−0.057* (−1.96)	−0.098*** (−3.11)
TOP1	−0.003*** (−2.87)	−0.003*** (−3.21)	−0.002* (−1.75)	−0.001 (−0.12)	−0.003*** (−3.34)	−0.003*** (−3.49)	−0.002* (−1.74)
R&D_SUM	0.527*** (23.14)	0.360*** (16.55)	0.459*** (20.75)	1.458*** (50.21)	1.149*** (53.06)	0.819*** (36.59)	0.461*** (20.79)
R&D_RATIO	0.288*** (10.12)	0.376*** (12.71)	0.359*** (13.10)	0.184*** (5.67)	1..073*** (39.55)	0.620*** (22.12)	0.362*** (13.16)
Constant	−5.724*** (−12.04)	−9.521*** (−20.97)	−2.682*** (−5.72)	−5.109*** (−8.43)	−3.300*** (−2.70)	−7.331*** (−6.22)	−2.267*** (−5.68)
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.444	0.426	0.394	0.514	0.451	0.527	0.395
Observations	8934	8934	8934	8934	8934	8934	8934
Sobel Z (p-value)					2.967*** (0.002)	3.006*** (0.001)	0.285 (0.776)

Note: This table presents the results of the mediating effect analysis for increasing R&D efficiency. *Path a* reports the regression results of no mediating factor, *Path b* presents the results of mediating factor test and *Path c* shows the results of including mediating factor. *PATENT*, *PATENT1* and *PATENT2_3* are the three corporate innovation measures. *EW* is the employee welfare measure. *EFFICIENCY* is the mediating factor. The *Sobel Z* is the results of mediating effect test. All of the other variables are defined in Table 1A. Both the industry-and year-fixed effects are controlled in the model estimation. The numbers in parentheses are the *t*-statistics corrected for heteroscedasticity, as suggested by White, 1980. ***, ** and * denote significant at the 1%, 5% and 10% levels, respectively.

output of corporate innovation are developed: on the one hand, the incentive theory hypothesizes that higher level of employee welfare may help corporations to retain more outstanding employees, attract more positive media reports and increase the R&D efficiency. These should enhance the innovation capability and promote the innovation output of corporations. On the other hand, agency theory predicts a negative relationship between employee welfare and corporate innovation for the reason that managers might choose to generously invest in employee welfare in order to hide their bad-news-hoarding activities.

The empirical results with various robustness checks support the hypothesis based on incentive theory, indicating that the total number of patent applications and invention patent applications increase significantly in China's manufacturing corporations with higher employee welfare. However, the impact of employee welfare on non-inventive patents is not observed. These findings prove that better employee welfare can improve the overall innovation performance in China's manufacturing corporations, especially the numbers of invention patents, instead of the non-invention patents (utility model patents and design patents). In other words, promoting employee welfare can indeed accelerate the quality of innovation in China's manufacturing corporation, but not the quantity of it. Moreover, we investigate the channels through which employee welfare can affect corporate innovation performance. The first channel test indicates that the impact of employee welfare on corporate innovation performance is more significant in corporations with low proportions of highly educated employees than those with high proportions of them. This confirms that employee welfare enhances the quality of innovation by retaining outstanding employees. The second channel test shows that better employee welfare can increase positive media reports, create a relaxed and pressureless external environment for corporate innovation, and thus promote corporate innovation output. The last channel test proves that employee welfare can improve the corporation innovation performance through increasing inventor (R&D) efficiency. More importantly, the results of all three channel tests verify that employee welfare can significantly promote the quality instead of quantity of innovation output in the Chinese manufacturing corporations. The following mediating effect analyses further verify the robustness of the three impacting channels, revealing that the impacts of employee welfare on corporate innovation has a partial intermediary effect in retaining outstanding employees and full intermediary effects in attracting positive media reports and increasing R&D efficiency.

In addition, this paper adopts a newly-built database, China-Hexun listed corporation social responsibility report database, to build a composite index for employee welfare and explores in depth the mechanism through which employee welfare can affect corporate innovation in China's manufacturing corporations. This paper adds to the growing literature by examining whether and how can employee welfare affect innovation performances. By focusing on employee welfare, our results broaden the understanding of the implications that employee welfare investments have on corporations and investors. Our findings also suggest that corporate managers may take full advantage of employee welfare to improve not only the overall innovation output, but the innovation quality of the corporation.

However, there are still several limitations in this paper and further directions in this research area. For example, in general, the data sample used in this paper is limited for the availability of the China-Hexun listed corporation social responsibility report database. The initial issue of this database happened in 2010, and thus we can only investigate the impact of employee welfare on corporate innovation from that time period. We know that, however, the 2008 financial crisis breaks many underlying financial and business rules, and may affect the relationship between employee welfare on corporate innovation performance before 2008. Therefore, to get more general image on the nexus of employee welfare and innovation output or compare the changes in this relationship, we need more data samples in longer time period. Next, we employ three channels through which employee welfare can affect the innovation output in China's manufacturing corporations. Nevertheless, other possible channels, e.g., in social or psychologic ways, may exist and deserve further investigations. Finally, although we adopt replace variable method, Heckman's two-step regression and instrumental variable regression to avoid the problem of endogeneity, there still may be a lot of other proper robustness checks that can be done in future researches to reduce the effects of endogeneity.

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Appendix A

Table 1A
Variable definitions.

Variables	Definitions
Innovation measures	
PATENT	The logarithm of 1 plus the number of invention patents, utility model patents and design patents
PATENT1	The logarithm of 1 plus the number of invention patents.
PATENT2_3	The logarithm of 1 plus the number of utility model patents and design patents.
ΔPATENT	First-difference of the logarithm of (1 plus the sum of number of invention patents, utility model patents and design patents).
ΔPATENT1	First-difference of the logarithm of (1 plus the number of invention patents).
ΔPATENT2_3	First-difference of the logarithm of (1 plus the number of utility model patents and design patents).
Welfare measures	
EW	The employee welfare measure, of which the employee performance, employee safety and employee care indicators each account for one third.
ΔEW	First-difference of the logarithm of employee welfare measure.
Control Variables	
SIZE	The natural logarithm of the total assets.
ROA	The net income scaled by the total assets.
LEV	The total debt divided by the total assets.
AGE	The logarithm of the number of years since listing.
TQ	Tobin's q, computed as the market value of equity plus the total assets minus the book value of equity, all divided by the total assets.
PPE	The asset tangibility, computed as the ratio of property, plants and equipment to the total book value of assets.
CASH	The cash and cash equivalents divided by the total assets.
RDA	The R&D intensity, computed as the ratio of R&D expenditure to the total book value of assets.
BI	The number of independent directors divided by the board size.
DUALITY	The duality of the CEO and chairman. It equals 1 if the CEO and chairman are the same and 0 otherwise.
STATE	The corporation's ultimate controller. It equals 1 if ultimate control belongs to the state/legal authorities and 0 otherwise.
TOP1	The shareholding ratio of the largest shareholder.
R&D_SUM	The logarithm of 1 plus the number of R&D personnel, indicating the quantity of R&D personnel.
R&D_RATIO	The logarithm of 1 plus the number of R&D personnel divided by the total number of employees, indicating the quality of R&D personnel.
ΔSIZE	First-difference of the natural logarithm of the total assets.
ΔROA	First-difference of the net income scaled by the total assets.
ΔLEV	First-difference of the total debt divided by the total assets.
ΔAGE	First-difference of the logarithm of the number of years since listing.
ΔTQ	First-difference of Tobin's q, computed as the market value of equity plus the total assets minus the book value of equity, all divided by the total assets.
ΔPPE	First-difference of the asset tangibility, computed as the ratio of property, plants and equipment to the total book value of assets.
ΔCASH	First-difference of the cash and cash equivalents divided by the total assets.
ΔRDA	First-difference of the R&D intensity, computed as the ratio of R&D expenditure to the total book value of assets.
ΔBI	First-difference of the number of independent directors divided by the board size, then translate to first-difference forms.
ΔDUALITY	First-difference of the duality of the CEO and chairman, which equals 1 if the CEO and chairman are the same and 0 otherwise.
ΔSTATE	First-difference of the corporation's ultimate controller, which equals 1 if ultimate control belongs to the state/legal authorities and 0 otherwise.
ΔTOP1	First-difference of the shareholding ratio of the largest shareholder.
ΔR&D_SUM	First-difference of the logarithm of 1 plus the number of R&D personnel.
ΔR&D_RATIO	First-difference of the logarithm of 1 plus the number of R&D personnel divided by the total number of employees.
YEAR	The year-fixed effects.
INDUSTRY	The industry-fixed effects.
Additional Variables	
EW_M	The mean of employee welfare of other corporations in the industry.
$EW_{t\text{-}2}$	The employee welfare with lags of 2 periods.
$EW_{t\text{-}3}$	The employee welfare with lags of 3 periods.
IFRD	The measure of a corporation's R&D investment. It equals 1 if the corporation demonstrates investment in the previous year and 0 otherwise.
PATENTSS	The logarithm of 1 plus the number of patents granted in the previous year.
LNWAGE_IND	The logarithm of 1 plus the corporation's wage minus the industry's average wage.
LNWELFARE_IND	The logarithm of 1 plus the corporation's employee welfare minus the industry's average employee welfare.
Inverse Mills Ratio	The ratio of the probability density function over the cumulative distribution function of a distribution.
GROUP	The indicator variable for outstanding employees. It equals 1 if the proportion of people *MS* is higher than the industry average and 0 otherwise.
PM	The logarithm of 1 plus the positive media reports measure.

(*continued on next page*)

Table 1A (*continued*)

Variables	Definitions
*EW*PM*	The intersection item of employee welfare and positive media reports.
EFFICIENCY	The R&D efficiency measure. It is measured by logarithm of 1 plus ratio of number of patent applications to number of scientific and technical personnel.
*EW*EFFICIENCY*	The intersection item of employee welfare and R&D efficiency.

Appendix B. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijpe.2020.107753.

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