CEO INSIDE DEBT COMPENSATION AND INNOVATIVE OUTPUT

Ha Nguyen

ha.nguyen@auckland.ac.nz

Accounting and Finance Department

Business School, the University of Auckland, New Zealand

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Abstract

This study investigates the association between CEOs' inside debt compensation and innovative outputs measured by patents and citations. I find that CEO inside debt compensation is negatively correlated with innovative outputs in high technology firms. In addition, the association between pension benefits and innovative outputs is more negative in high technology firms than in non-high technology firms. Finally, I also find a significant negative link between pension benefits and innovative outputs in highly technology-intensive firms.

Keywords: Inside Debt, Innovation, Patents, Citations

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1. Introduction and motivation

Executive compensation arrangement is one of the primary internal corporate governance mechanisms that affect decisions of executives (Bebchuk & Weisbach, 2010). While some scholars focus on the level of executive compensation (Kaplan, 2008), others debate about the structure of executive pay package (Mehran, 1995). For many years, equity-like compensation such as stocks and stock options is preferred by many companies to align interests of managers with those of shareholders. However, top executives with a large portion of stocks and options tend to engage in highly risky activities, follow short-term gain in share prices and probably destroy the long-term growth opportunities (Murphy, 1999). The failure of many corporations during the financial crisis has encouraged the idea that companies should pay top managers more debt-based compensation (pension benefits and deferred compensation) rather than more equity-based compensation (Cassell, Huang, Sanchez, & Stuart, 2012). Pension plans provide payments for employees after retirement. Pension benefits of CEOs are much larger than broad-based pension plans of normal employees. A large portion of pension benefits held by CEOs is under the form of Supplemental Executive Retirement Plans (SERPs). Deferred compensation is a portion of current compensation that companies will pay for their employees later on a specified date.

The debt-like instruments (known as inside debt) have now started to gain greater attention (Edmans & Liu, 2011). Understanding the incentive effects and economic consequences of debt-like instruments is important because the inside debt holdings of CEOs account for a substantial part in the total compensation (Cassell et al., 2012). For example, the total present value of inside debt held by Jack Welch, CEO of General Electric Corporation was $109 million by the time he retired (Sundaram & Yermack, 2007, p. 1552). The value of deferred compensation of Roberto Goizueta, the former CEO of Coca-Cola was more than $1 billion (Edmans & Liu, 2011, p. 76). CEO Rex Tillerson of ExxonMobil received supplemental pension benefits of approximately $21.1 million in 2013 (Hymowitz & Collins, 2015). In addition, the Wall Street Journal also reported that there was an increase of 19% in pension benefits hold by top managers in 2008. Also, the total value of pension benefits and deferred compensation was equal to approximately 43% of the total value of equity-based compensation in 2008 (Anantharaman, Fang, & Gong, 2013).

Some scholars argue that debt-like instruments may align interests of managers with those of outside debt-holders and thus may incentivize top executives to make less risky decisions

(Edmans & Liu, 2011; Jensen & Meckling, 1976). The pension benefits and deferred compensation function as debt-like instruments because they are generally unsecured and unfunded debt claims[1]. The beneficiaries cannot receive payment while their firms go bankrupt. For instance, the CEO of General Motors, Rick Wagoner lost nearly $20 million in his pension benefits when GM went bankrupt (Cassell et al., 2012). Until now, there is still limited empirical evidence of inside debt's economic consequences (Anantharaman et al., 2013; Sundaram & Yermack, 2007). Consistent with the argument that inside debt compensation aligns interests of executives and creditors, previous empirical studies find a negative link between inside debt pay and the default risk (Sundaram & Yermack, 2007), R&D expenditures (Cassell et al., 2012), bond yield spread (Anantharaman et al., 2013), the credit default swap spread (Wei & Yermack, 2011), and the risk-decreasing mergers and acquisitions (Phan, 2014).

However, there is an ongoing debate on the efficiency of debt-like compensation (Phan, 2014). The debate is based on the argument that managers with high inside debt may follow safer and more conservative managerial policies (Cassell et al., 2012; Sundaram & Yermack, 2007). The excessive safety management style of CEOs may make their companies become too safe (Campbell, Galpin, & Johnson, 2016). If the argument is right, is that good or bad for firms wishing to enhance innovative output with high probability of failure? This question is especially important for corporations operate in technology intensive industries which require substantial investment in risky innovative projects.

This research contributes to the ongoing debate on the efficiency of debt-based compensation. Is the use of inside debt compensation efficient in the context of innovation which involves a variety of risky projects and high probability of failure? A variety of research mainly focuses on how firms can design compensation packages for top executives to encourage innovation because they are key people who make important decisions relating to innovative projects carried out within organizations. There have been widespread studies on the impact of equity-based compensation (stocks and options) and cash-based

[1] In general, firms are not required to fund or secure non-qualified pension benefits and deferred compensation (Anantharaman et al., 2013). In practice, pension plans include qualified pension plans (Rank-and-File plans which are secured and funded) and non-qualified pension plans (SERPs which are normally unsecured and unfunded). Due to the limitation of Execucomp database, it is impossible to decompose pension benefits into Rank-and-File plans and SERPs. However, the majority of total pension benefits received by top executives are in the form of SERPs. More than 50% of the retirement income of top executives is under the form of non-qualified retirement plans (MacDonald & Kirk, 2007). In the hand-collected sample of Anantharaman et al. (2013), the value of non-qualified pension benefits of CEOs is also much greater than the value of qualified pesion benefits. Particularly, the mean (median) value of SERP relative leverage is 1.064 (0.432). The mean (median) value of Rank-and-File relative leverage is 0.192 (0.025).

compensation (salary and bonus) on innovation. Those studies find that salary and bonus do not likely incentivize top managers to enhance the number of patents and citations because those kinds of pay provide short-term incentives for top executives. Moreover, equity-based compensation is positively correlated with innovative output because it provides long-term incentives (Faurel, Li, Shanthikumar, & Teoh, 2016; Francis, Hasan, & Sharma, 2011; Holthausen, Larcker, & Sloan, 1995; Lerner & Wulf, 2007). In practice, firms also pay CEOs a large amount of debt-based compensation including pension benefits and deferred compensation. If firms ignore the effect of inside debt in the total compensation package, it is impossible to fully understand the overall effect of all compensation components on innovative output. Does the existence of debt-based compensation complement or weaken the efficiency of equity-based compensation, especially in highly innovative firms with high probability of failure?

As far as I am aware, there is still no research on the effect of inside debt on the innovation output measured by patents and patent citations. This research aims to fill in this gap by examining the association between inside debt and innovative output of corporations. The study explores the economic consequences of CEO inside debt compensation in the context of innovation activities. Particularly, this research will not only examine the effect of equity-based compensation, but also at the same time investigate the impact of debt-based compensation on the behaviours of CEOs toward their willingness to enhance innovative outputs. Innovative outputs measured by patents and citations are the focus of this research. Although many studies on innovation employ R&D expenditure as a proxy for innovation, R&D expenditure only represents for innovation inputs. However, increase in R&D investment does not necessarily have implication that top executives succeed in inventing new ideas and enhancing R&D productivity. R&D expenditure does not contain the information of innovation success (Francis et al., 2011; Holthausen et al., 1995). In contrast, patents and citations can be considered as one of good measurements of innovative output. Patents and citations partly represent R&D productivity. The number of patents measures the scale of R&D activity. The number of citations measures the novelty of R&D activity (Seru, 2014). Patents and citations provide explicit signals to outside investors about the success of innovative projects carried out by firms. In addition, there is strong positive link between patent counts and firm value and profits (Holthausen et al., 1995).

This study makes three main contributions to the existing literature. First, this study contributes to the literature on determinants of innovative activities by firms. This research not only investigates the effect of equity-based compensation but also includes the effect of debt-based compensation on innovation output. Second, this research adds to the literature of the effect of incentive alignment of executive compensation, especially inside debt compensation. Finally, the findings of this research may suggest boards of innovative firms carefully consider the design of appropriate structures of debt-based and equity-based compensation packages to incentivize top executives to enhance innovative activities.

This research is different from the studies of Faurel et al. (2016), Francis et al. (2011), Holthausen et al. (1995) and Lerner and Wulf (2007). The focus of this study is on the impact of inside debt component on innovation while those studies emphasize the effect of equity-based compensation on innovation. Moreover, while the empirical research of Sundaram and Yermack (2007), Wei and Yermack (2011), Anantharaman et al. (2013), Phan (2014), and Cassell et al. (2012) examine the link between inside debt and risk default, investors' reactions, design of loan contracts, M&A, investment and financial policies, this research investigates the link between inside debt and innovation output. The innovation output is measured by patents and citations which reflect R&D productivity. The use of patents and citations is widely applied by some innovation-related studies (Francis et al., 2011; Hall, Jaffe, & Trajtenberg, 2005; Lerner & Wulf, 2007; Seru, 2014).

Previous theoretical and empirical studies find that high levels of inside debt pay may induce CEOs to pursue conservative management policies and prefer less risky projects (Anantharaman et al., 2013; Edmans & Liu, 2011; Jensen & Meckling, 1976; Phan, 2014; Sundaram & Yermack, 2007; Wei & Yermack, 2011). Innovation is typically risky and unpredictable (Francis et al., 2011). The default risks of firms increase if too many innovative projects are carried out, especially in technology intensive industries (Eisdorfer & Hsu, 2011). Therefore, downside risks become major concerns of CEOs with large portion of inside debt holdings in high technology firms. As a result, the first hypothesis is that the association between CEO inside debt compensation and innovation output is more negative in high technology firms than in non-high technology ones. The second hypothesis is that CEOs in technology-intensive companies are unwilling to enhance patenting activities when they hold a large portion of debt-like components.

To test hypotheses, this study uses a sample of 5,705 firm-year observations with 1,092 distinct firms with and without patents and citations during the period 2007-2014. Innovative output variable is measured by the number of patents and citations per patent (Becker-Blease, 2011; Hall et al., 2005). Inside debt variable of interest is based on the ratio of CEO debt-to-equity scaled by firm leverage ratio which measure whether the interest of CEOs are more aligned with debtholders versus shareholders. Particularly, this research uses four different measurements for inside debt compensation including CEO's relative leverage, CEO's relative incentive, relative leverage > 1 dummy, and relative incentive > 1 dummy (Cassell et al., 2012; Phan, 2014; Wei & Yermack, 2011).

This research also further investigates the impact of each component of inside debt including pension benefits and deferred compensation. The main reason is that pension benefits and deferred compensation may have different characteristics and thus differently impact the behaviors of CEOs to enhance innovative output. Particularly, deferred compensation may have shorter maturity than pension benefits. Moreover, in some cases, firms allow executives to enjoy flexible withdrawal options[2] (Anantharaman et al., 2013). Thus, CEOs may not have to wait for a long time to withdraw the deferred compensation while they can only obtain pension benefits at the date of retirement. In addition, some firms offer flexible options for CEOs to invest a portion of their deferred compensation in equity (Campbell et al., 2016). Those flexible options in association with deferred compensation in practice may not make CEOs take less risk as expected by the theory. Regarding the different characteristics of pension benefits and deferred compensation, this research continues to decompose total inside debt holdings into two sub-components to explore the influence of those components on innovative output. Specifically, CEO's relative leverage (incentive) ratio is decomposed into pension-based relative leverage (incentive) and deferred compensation-based relative leverage (incentive).

Overall, preliminary results support the first hypothesis that the association between CEO inside debt compensation and innovation output is more negative in high technology firms than in non-high technology firms. There is significant evidence that pension benefits are more detrimal to innovative outputs in high technology firms than non-high technology firms. Because pension benefits provide stronger incentive-alignment between CEOs and debtholders in high technology companies. Moreover, pension components negatively affect the innovative output in technology-intensive firms.

Next, sections 2 shows related literature review and hypotheses development. Section 3 describes the data and measurement of variables. Section 4 explains the research methods.

[2] For example, Enron's top executives withdrew a significant amount of deferred compensation shortly before its bankruptcy announcement (Bebchuk & Fried, 2006)

Section 5 shows the univariate analysis. Section 6 presents multivariate analysis. Section 7 shows robustness check. Section 8 presents conclusions.

2. Literature review and hypotheses development

2.1. Prior literature

Inside debt

The existing research emphasizes the prevalence of debt-based compensation (inside debt) including pension benefits and deferred compensation as an efficient mechanism to align the interests of managers with those of debtholders and thus alleviate the agency costs of debt (Edmans & Liu, 2011). The broad-based pension plans of employees in US companies are subject to the Employee Retirement Income Security Act of 1974 (ERISA). The pension plans regulated by ERISA are secured by the Pension Benefit Guaranty Corporation (PBGC). As a result, employees holding ERISA-qualified pension benefits face a limited default risk if their firms become insolvent. However, ERISA-qualified pension plans have certain limits on the pension benefits. Therefore, if companies want to pay top executives pension benefits exceeding the limits imposed by ERISA, they have to provide non-qualified pension plans such as Supplemental Executive Retirement Plans (SERPs) (Anantharaman & Fang, 2012). More than 50% of the retirement income of top executives is under the form of non-qualified retirement plans (MacDonald & Kirk, 2007). Unlike qualified plans, those non-qualified plans are not subject to any regulations of ERISA. Thus, the main advantage of those non-qualified plans is that they are used to maximize the retirement benefits of top managers to attract and retain them in the context of high competition. However, the future payments of those non-qualified plans are usually unfunded and unsecured. There is no requirement for those non-qualified plans to be funded by companies. Therefore, the payments of those non-qualified plans are similar to risky debt claims against the companies (Anantharaman et al., 2013; Gerakos, 2010).

Deferred compensation is a portion of current compensation which will be paid later on a pre-specified date agreed by employees and employers (Wei & Yermack, 2010, p. 1). Employees will receive fixed pay-offs in the future. The main advantage of this kind of compensation is the deferral of tax. An executive only pays taxes on deferred compensation when he or she receives it. As non-qualified pension plans of top executives, deferred compensation is also unfunded and unsecured. The maturity of deferred compensation is usually shorter than that of pension plans because managers can withdraw the deferred compensation before retirement (Anantharaman & Fang, 2012).

The value of pensions and deferred compensation is sensitive to default risk of the firm and liquidation value in case of bankcruptcy (Anantharaman et al., 2013). If the pay package of executives comprises both debt-based and equity-based compensation, their incentives are aligned with both debtholders and shareholders. Managers who hold a large portion of inside debt including pension benefits and deferred compensation face the same default risks as unsecured debt-holders because the inside debt is unsecured and unfunded (Sundaram & Yermack, 2007). Executives only receive their pension benefits and deferred compensation when their firms remain solvent. Jensen and Meckling (1976, pp. 352-353) predict that when the ratio of inside debt to inside equity held by the manager is equal to the ratio of total debt to equity of the firm, the manager will not transfer wealth from creditors to stockholders. In the case, the conflicts between stockholders and debtholders are weaken. If the executive's debt-to-equity ratio is higher than the debt-to-equity ratio of the firm, the executive may reallocate wealth from stockholders to debtholders. In this situation, Jensen and Meckling conjecture that the managers holding excessive inside debt tend to behave in a conservative way and are reluctant to make risky decisions. Overall, the results of the prior existing empirical studies support the prediction of Jensen and Meckling (1976).

Empirical evidence of the effect of inside debt

Sundaram and Yermack (2007) report evidence of a negative relationship between the risk of default and inside debt. They measure the default risk by using the distance-to-default statistic. Inside debt is measured by using the CEO's personal debt-to-equity ratio, which is equal to the actuarial present value of pensions divided by the market value of stocks and options. They did not include deferred compensation in inside debt calculations because at that time the disclosure of deferred compensation was limited. Because of this limitation, their calculation of debt-based compensation may be below the true value. In their sample, the value of pension benefits accounts for a substantial fraction of total compensation of CEOs. For instance, the total value of pensions of CEOs aging between 61 and 65 is 40% higher than the base salary and 23% of the total inside equity pay. Moreover, the significance of the inside debt component increases with age of CEO. The CEO's personal leverage tends to be larger than the firm's leverage when the CEO's age is higher. For example, more than 20 percent of CEOs in the 61-65 age group have the ratio of personal debt-to-equity holdings exceeding the firm's leverage. They also find that CEOs with high debt-based compensation tend to have a conservative management style to safeguard for the value of their pension benefits. Moreover, CEOs are likely to decrease R&D expenditure in their last years of tenure to achieve profit maximization and thus receive higher bonuses. In summary, CEOs have incentives to mitigate the debt default probability and manage the firm more conservatively if they hold a debt-to-equity ratio which is higher than their firms' leverage ratio.

Another study of Wei and Yermack (2011) finds evidence of a negative link between debt-like compensation and credit default swap spreads when top executives' debt-based pay is publicly released following the new disclosure requirements of Securities and Exchange Commission (SEC) in 2006. They employ three different measurements of inside debt including the CEO's debt-to-equity ratio, the CEO's relative debt-to-equity ratio, and the CEO's relative incentive ratio representing for changes in the value of debt and equity of the CEO and the company in response to a unit change in the total value of the firm. CEOs with the relative incentive ratio larger than 1 tend to prefer less risky decisions. They may implement more conservative management strategies. In contrast, if this ratio is lower than 1, the CEO is expected to choose risky policies. If this ratio is equal to 1, the CEO will be not incentivized to transfer wealth from debtholders to shareholders at the expense of the former and vice versa. They also find that at the time of disclosing the information of pension benefits and deferred compensation, firms that have CEOs with high inside debt holdings will have increased bond prices and decreased stock prices.

Following the research of Sundaram and Yermack (2007) and Wei and Yermack (2011), Cassell et al. (2012) continue to examine the influence of CEO inside debt holdings on investment and financial policies. Their empirical results support the hypothesis that top executives with excessive inside debt pursue less risky and more conservative investment and financial policies. In particular, there is a negative relationship between debt-based compensation and stock returns, research and development expenditures, and leverage ratio. Moreover, there is a positive link between debt-like instruments and diversification as well as asset liquidity.

The negative association between debt-based compensation and risk-shifting behaviours of top executives is also evidenced by the empirical study of Anantharaman et al. (2013). This paper investigates the influence of debt-like instruments on the design of private loan contracts including the promised yield and contract covenants. They report that when the ratio of CEO's debt-to-equity to the firm's leverage is higher, the promised yield of private loan contracts is lower and their covenants become fewer. In addition, that association even become stronger in firms with a high risk of default which is represented by low Alman's Z-score or below-investment-grade credit ratings. Their findings imply that debt-based compensation mitigates risk-shifting behaviors by top managers and private creditors recognize its incentive-alignment influence, especially in firms with a high probability of insolvency. Their empirical results are consistent with the hypothesis of the incentive-alignment effect of inside debt posited by Jensen and Meckling (1976), Sundaram and Yermack (2007), and Edmans and Liu (2011). Interestingly, Anantharaman et al. (2013) further find that under the Supplemental Executive Retirement Plan (SERP), if the CEO has an option to receive a lump-sum payment at the retirement date, the incentive-alignment effect of SERP becomes weaker. The reason is that the lump-sum payoff probably reduces the risk of loss suffered by the CEOs in case their firms become insolvent. The main implication is that the practice in designing the inside debt components of companies may weaken the incentive alignment role of debt-based compensation as predicted by Bebchuk and Jackson (2005).

2.2. Hypothesis development

Previous theoretical and empirical research suggests that CEOs with a large portion of inside debt compensation may tend to mitigate their risk-taking behaviours and pursue conservative strategies (Anantharaman et al., 2013; Edmans & Liu, 2011; Jensen & Meckling, 1976; Sundaram & Yermack, 2007; Wei & Yermack, 2011). They are expected to be reluctant to choose risky projects which may increase the default risk of firms. Investment in innovative projects is risky (Balkin, Markman, & Gomez-Mejia, 2000; Manso, 2011). However, increase in innovative activities does not always lead to high default risk for firms. Czarnitzki and Kraft (2004) find that innovative firms have better credit rating scores than non-innovative ones. Nevertheless, if firms carry out too many innovative activities, their default risks may increase because of high probability of failure. In addition, Eisdorfer and Hsu (2011) report that there is a positive link between the increase in patent activities of technology-intensive firms and their bankruptcy risk because of the intensity of the patent competition. Therefore, I predict that CEOs of high technology companies with high portion of inside debt compensation tend to pay more attention to the downside risks and become more conservative than those of non-high technology firms. As a result, CEOs in technology-intensive firms are expected to mitigate patenting activities when they hold a large portion of debt-like pay. The association between CEO inside debt compensation and innovation output is uncertain in case of non-high technology firms. That leads to the two hypotheses as below.

Hypothesis 1: The link between CEO inside debt compensation and innovation output is more negative in high-technology firms than in non-high technology firms.

Hypothesis 2: In high-technology firms, higher CEO inside debt compensation is associated with less innovation output.

3. Data and variable measurement

3.1. Data

This research collects and constructs the database of firms in the S&P 1500 indexes from six sources. The information of executive compensation is taken from the Execucomp. The information of firm characteristics is retrieved from the North America Annual Updates – Compustat. The stock price and stock return volatility are taken from the Center for Research in Security Prices (CRSP). The information of independent directors is from the Directors – ISS (formerly RiskMetrics). The names of subsidiaries of listed firms are also hand-collected from SEC Edgar. The data of patents and patent citations is retrieved from the OECD patent statistics portal.

The full sample is restricted from 2007 to 2014. The minimum fiscal year in the sample is restricted to 2007 because the information of independent directors from the Directors – ISS database is only available from 2007. In addition, the information of inside debt holdings from Execucomp is only available after the disclosure requirement of Securities and Exchange Commission (SEC) in August 2006. The maximum year in the sample is 2014 because the OECD patent statistic portal provides the number of patents applied by firms before 2014. Financial firms which have SIC codes from 6000 to 6999 and utility firms which have SIC codes from 4900-4999 were removed from the sample[3]. Moreover, firms

[3] I follow Fama and French (1992, p. 429) to exclude financial and utility firms because those firms normally have higher leverage ratios than other companies. While high leverage is one of an indicator as financial distress faced by non-financial and non-utility companies, high leverage in the financial and utility companies is not necessary to indicate distress.

with missing research and development (R&D) expenditure will be assumed to have zero value of R&D[4].

Most existing studies use the available patent database which is already matched with Compustat and obtained from the National Bureau of Economic Research (NBER) as described by Hall, Jaffe, and Trajtenberg (2001). However, this database only covers the number of patents and citations made by firms from 1976 to 2006. Therefore, to get the patent and citation data from 2007 to 2014, this research use the OECD patent statistics portal[5]. The sample obtained from OECD includes 413,226 firm-year observations in which there are 236,113 distinct firms applying for patents at United States Patent and Trademark Office (USPTO) from 2007 to 2014. The year is chosen based on the application date of patents[6]. After merging the patent and citations database with Execucomp, North America Annual Updates – Compustat, and Directors - ISS based on company names, this study has the sample including 7,944 firm-year observations. In this sample, 1,899 merged firm-year observations have patents and patent citations and 6,045 firm-year observations in Compustat and ISS cannot be found in the OECD database.

However, it is not possible to conclude that the number of patents of unmerged firms is zero. Because Bessen (2009) notes that the assignees listed in OECD patent database may be subsidiaries of parent firms in Compustat. Therefore, some parent companies in Compustat and ISS may have some patents and patent citations applied by their subsidiaries. Thus, it is necessary to retrieve the list of subsidiaries in the Exhibit 21 in annual reports disclosed by

[4] To deal with the issues of "missing" R&D expenditures provided by Compustat, this research follows the conventional approach suggested by Hirschey, Skiba, and Wintoki (2012). They suggest setting "missing" R&D expenditure in Compustat to zero because the SEC and the Financial Accounting Standards Board have required listed firms to disclose all material R&D expenditure in the fiscal year. Therefore, "missing" R&D value in Compustat can be understood as firms do not disclose because their material R&D expenditure is zero. In addition, Hirschey et al. (2012) also randomly check the annual reports of 500 firms with "missing" R&D fields. They find that 99 percent of those companies have no material R&D expenditure. Given their findings, it is reasonable to replace "missing" R&D with "zero".

[5] The OECD patent statistics portal provides researchers with the updated data of patents and citations of firms and individuals filed at the European Patent Office (EPO) and United States Patent and Trademark Office (USPTO). The primary data source of OECD is from the EPO's Worldwide Statistical Patent Database (PATSTAT). The database covers all patents and citations made from 1978 onwards.

[6] This research follows the suggestion of Hall et al. (2001, pp. 9-10) to use the application date as the appropriate time placer for patents instead of using publication date and grant date. The reason is that the application date is considered to be closer to the actual time of invention because inventors are assumed to file for patents as soon as possible to protect their property rights. Publication date is the date of publishing the patent application on the Patent Office Website and usually occurs 18 months after application. Grant date is the date when a patent is granted or issued to the applicant by the Patent Office. It normally takes approximately three to five years for the Patent Office to examine and decide to grant a patent for an investor (OECD, 2011)

firms through SEC Edgar search tools. After matching the list of subsidiaries with the OECD database, there are 1,485 firm-year observations (out of 6,045 firm-year observations in Compustat and ISS which cannot be found in the OECD database) which have patents applied by their subsidiaries. Thus, there are 4,560 firm-year observations which have no patents. After removing missing values, the final sample includes 5,705 firm-year observations with 1,092 distinct firms from 2007 to 2014. In the final sample, there are 3,171 firm-year observations which do not have patents and 3,836 firm-year observations which do not have citations.

3.2. Variable measurement

Measuring innovation output

The innovative output is measured by the number of patents and patent citations made by firms. The patents and citations are widely used as the most important and appropriate measure of innovation output because innovative activities of firms are known publicly through a patent announcement by the Patent Office. Moreover, companies in the US are increasingly realizing the importance of filing their patents at the Patent Office to protect their property rights (Hirshleifer, Hsu, & Li, 2013). Patent can be a good measure of a firm's ability to innovate because it represents the ability of a firm to accrue knowledge and create novel ideas (Sharma, 2011). Citation measures the quality and originality of innovation (Hall et al., 2001).

Measuring inside debt variable

Following the research of Cassell et al. (2012), Wei and Yermack (2011), and Phan (2014) this research uses four different measures of the inside debt variable including the CEO's relative leverage ratio, relative leverage > 1 dummy, relative incentive ratio, and relative incentive > 1 dummy.

First, the CEO's relative leverage is equal to the ratio of CEO debt-to-equity to the firm's leverage. The CEO's debt-to-equity ratio is equal to the total inside debt holdings divided by the total equity holdings. The inside debt is the sum of the accumulated value of pension benefits and the aggregate deferred compensation. The inside equity is the sum of value of stocks and options held by CEOs (Coles, Daniel, & Naveen, 2006; Wei & Yermack, 2011). The value of stock is calculated by multiplying the stock price at the end of fiscal year by the number of shares held by CEOs. The value of stock option is calculated based on the option valuation formula suggested by Black and Scholes (1973) and modified by Merton (1973). The firm's leverage is the ratio of book value of total debt to the market value of total equity at the end of the fiscal year. The CEO's relative leverage can measure the incentive alignment of CEOs with shareholders versus creditors (Wei & Yermack, 2011)

Second, the CEO's relative incentive ratio represents for changes in the value of debt and equity of the CEO and the company in response to a unit change in the total value of the firm (Cassell et al., 2012; Wei & Yermack, 2011)

Relative incentive = (ΔCEO inside debt / ΔCEO inside equity) / (Δfirm debt / Δfirm equity)

Where ΔCEO inside debt is assumed to be equal to CEO inside debt; ΔCEO inside equity is calculated by totalling the number of shares and the number of options times the option delta which is measured based on Black and Scholes (1973) and Merton (1973)'s method of option valuation for each option tranche; Δfirm debt is assumed to be equal to total debt; Δfirm equity is calculated similarly to the ΔCEO inside equity, but the inputs for the valuation include the number of outstanding stock options of employees and the mean exercise price. The assumption of the remaining life of all options held by employees is four years (Cassell et al., 2012, p. 608).

Third, CEO's relative leverage > 1 dummy variable equals 1 if the relative leverage ratio is higher than 1, and 0 otherwise (Cassell et al., 2012; Phan, 2014; Wei & Yermack, 2011)

Fourth, CEO's relative incentive > 1 dummy variable equals 1 if the relative incentive ratio is higher than 1, and 0 otherwise (Cassell et al., 2012; Phan, 2014; Wei & Yermack, 2011)

This research also further investigates the incentive-alignment effect of two different components of inside debt compensation including pension benefits and deferred compensation. Because deferred compensation may have shorter maturity than pension benefits. Moreover, some firms allow CEOs to invest a certain percentage of deferred compensation in equity. As a result, deferred compensation is not necessary induce CEOs to take less risk or follow conservative policies like pension benefits do. For instance, in the study of Anantharaman et al. (2013), it is found that deferred compensation does not significantly associated with promised yield and loan covenants. In contrast, there is a significantly negative link between pension benefits and promised yield and covenants. Those findings imply that deferred compensation does not strongly align interests of managers with creditors. CEO's relative leverage is divided into two components including pension-based and deferred compensation-based relative leverage as suggested by Anantharaman et al. (2013). Similarly, I divide CEO's relative incentive into two components including pension-based and deferred compensation-based relative incentive. Moreover, pension-based relative leverage or incentive dummy variables take value of 1 if pension-based relative leverage or incentive is higher than 1, and 0 otherwise. Deferred compensation-based relative leverage or incentive dummy variables take value of 1 if deferred compensation-based relative leverage or incentive is higher than 1, and 0 otherwise.

Measuring control variables

This research utilizes three primary groups of control variables including executive characteristics, corporate governance characteristics, and firm-specific characteristics. In terms of executive characteristics, this study controls for CEO tenure and CEO age as suggested by Faleye, Kovacs, and Venkateswaran (2014) because CEOs near retirement probably become short-sighted and follow conservative management policies which discourages innovation. In the second group, this research controls for the monitoring role of the board of directors (board independence) as the independent board of directors may positively influence the innovative outcomes through reducing agency costs and improving the corporate governance quality (Balsmeier, Fleming, & Manso, 2015). In addition, the incentive effect of equity-based compensation including CEO vega and delta is also controlled. The CEO's portfolio delta measures the change of the wealth of CEO per one percent change in the stock price. The CEO's option vega captures the change of the wealth of CEO per 0.01 change in stock return volatility. The equity-based compensation incentivizes CEOs to invest more in risky projects such as innovative activities (Anantharaman et al., 2013; Cassell et al., 2012; Francis et al., 2011; Sharma, 2011). In the final group, important firm characteristics including firm size, R&D intensity, growth opportunities, profitability, and financial constraint are also controlled. Firm size, which can be measured by the total assets, is positively associated with innovation because larger firms may have advantages in economies of scales in innovative activities (Faleye et al., 2014). Moreover, firms with high growth opportunities, which can be measured by the market to book ratio, may enhance innovative activities to strengthen competitive advantages and achieve new opportunities (Faleye et al., 2014). Also, profitability which is measured by returns on assets may improve innovation (Becker-Blease, 2011). R&D intensity, which is calculated by R&D expenditure scaled by total sales, can be an appropriate measurement of the effort of firms to invest in long-term and risky innovation projects (Becker-Blease, 2011).

Furthermore, firms with high financial constraints are expected to reduce innovation because of limited resources for investment in risky projects and increased managerial risk aversion (Becker-Blease, 2011; Faleye et al., 2014). This study includes leverage as proxy for financial constraint.

4. Research methods

I test the Hypothesis H1 with the following model specification in the full sample including high technology and non-high technology firms

Model (1): $Innovation_{i,t} = \alpha + \beta_1 Insidedebt_{i,t-1} + \beta_2 Tech_{i,t-1} + \beta_3 Insidedebt*Tech_{i,t-1} + \gamma Control_{i,t-1} + Year\ fixed\ effects + Industry\ fixed\ effects + \varepsilon_{i,t-1}$

I test the Hypothesis H2 with the following model specification in the sub-sample of high technology firms

Model (2): $Innovation_{i,t} = \alpha + \beta_1 Insidedebt_{i,t-1} + \gamma Control_{i,t-1} + Year\ fixed\ effects + Industry\ fixed\ effects + \varepsilon_{i,t-1}$

- "$Innovation_{i,t}$" denotes for innovative output of firm i in time t
- "$Insidedebt_{i,t-1}$" denotes for CEO inside debt of firm i in time t-1
- "$Tech_{i,t-1}$": dummy variable which takes value of 1 if firms operate in high technology industries, or 0 otherwise
- "$Insidedebt_{i,t-1}*Tech_{i,t-1}$": interaction variable between CEO inside debt and high-technology firm dummy
- "$Control_{i,t-1}$" denotes for control variables of firm i in time t-1

(See Table 1 for more details of variable descriptions)

Following the paper of Faleye et al. (2014), the research employs Fixed Effects Tobit model. The Fixed Effects Tobit model is estimated with year-fixed effects and industry-fixed effects based on 2-digit US Standard Industrial Classification (SIC) code. The study extract the sub-sample of high-technology firms based on the 4-digit SIC code used by Bebchuk, Cremers, and Peyer (2011). The study of Bebchuk et al. (2011) defines high-technology industries including computer equipment, software, electronics, and telecommunication industries [7].

[7] 3570 (Computer and Office Equipment), 3571 (Electronic computers), 3572 (Computer storage devices), 3576 (Computer Communication Equipment) , 3577 (Computer Peripheral Equipment), 3661 (Telephone and Telegraph Apparatus), 3674 (Semiconductors and Related Devices), 4812 (Radiotelephone Communications), 4813 (Telephone Communications, except

Table 1 **Variables and description**		
Variables	Description	Sources
Dependent variables (innovation)		
Ln_patent	The natural logarithm of one plus the number of patents	Becker-Blease (2011); Hall et al. (2005)
Ln_citation	The natural logarithm of one plus the number of citations per patent	Hall et al. (2005)
Explanatory variables (inside debt)		
Ln_CEO relative leverage	The natural log of one plus the CEO's debt-to-equity ratio scaled by the debt-to-equity ratio of the firm	Cassell et al. (2012), Wei and Yermack (2011), Phan (2014)
Ln_CEO relative incentive	The natural log of one plus the CEO relative incentive ratio. Relative incentive = (ΔCEO inside debt / ΔCEO inside equity) / (Δfirm debt / Δfirm equity)	Cassell et al. (2012), Wei and Yermack (2011), Phan (2014)
CEO relative leverage > 1	The dummy variable is equal to 1 if the CEO relative leverage ratio is larger than 1, and zero otherwise	Cassell et al. (2012), Wei and Yermack (2011), Phan (2014)
CEO relative incentive > 1	The dummy variable is equal to 1 if the CEO relative incentive ratio is larger than 1, and zero otherwise	Cassell et al. (2012), Wei and Yermack (2011), Phan (2014)
Ln_pension relative leverage	The natural log of one plus pension-to-equity ratio scaled by the debt-to-equity ratio of the firm	Anantharaman et al. (2013)

Radiotelephone), 5045 (Computers and Computer Peripheral Equipment and Software), 5961 (Catalog and Mail Order Houses), 7370 (Computer Programming and Data Process), 7371 (Computer Programming Services), 7372 (Prepackaged Software), 7373 (Computer Integrated Systems Design). Kile and Phillips (2009) point out that the classification of high-technology industry based on 2-digit or 3-digit industry code may lead to higher observations, but the disadvantage is that some firms in the sub-level of industry code may be not truly high technology ones. Thus, it is better to classify based on 4-digit industry code.

Ln_pension relative incentive	The natural log of one plus pension relative incentive ratio. Pension relative incentive = (ΔCEO pension / ΔCEO inside equity) / (Δfirm debt / Δfirm equity)	Anantharaman et al. (2013)
Pension relative leverage > 1	The dummy variable is equal to 1 if the pension relative leverage ratio is larger than 1, and zero otherwise	Anantharaman et al. (2013)
Pension relative incentive >1	The dummy variable is equal to 1 if the pension relative incentive ratio is larger than 1, and zero otherwise	Anantharaman et al. (2013)
Ln_defer relative leverage	The natural log of one plus deferred compensation-to-equity ratio scaled by the debt-to-equity ratio of the firm	Anantharaman et al. (2013)
Ln_defer relative incentive	The natural log of one plus deferred compensation relative incentive ratio. Defer relative incentive = (ΔCEO deferred compensation / ΔCEO inside equity) / (Δfirm debt / Δfirm equity)	Anantharaman et al. (2013)
Defer relative leverage > 1	The dummy variable is equal to 1 if the deferred compensation relative leverage ratio is larger than 1, and zero otherwise	Anantharaman et al. (2013)
Defer relative incentive >1	The dummy variable is equal to 1 if the deferred compensation relative incentive ratio is larger than 1, and zero otherwise	Anantharaman et al. (2013)
Control variables		
Tech	Dummy variable which takes value of 1 if firms operate in high technology industries (with four-digit SIC code of 3570, 3571, 3572, 3576, 3577, 3661, 3674, 4812, 4813, 5045, 5961, 7370, 7371, 7372, 7373), and 0	Bebchuk et al. (2011)

	otherwise.	
Firm_size	The natural logarithm of total assets	Faleye et al. (2014)
RD_intensity	The R&D expenditure divided by total sales	Becker-Blease (2011)
ROA	The operating income divided by total assets	Becker-Blease (2011), Faleye et al. (2014)
MB	The ratio of market value to book value of equity	Becker-Blease (2011)
Leverage	The ratio of long-term debt to total asset	Faleye et al. (2014)
Ln_CEO age	The natural log of the age of CEOs in years	Faleye et al. (2014)
Ln_CEO tenure	The natural log of the number of years that CEOs work for the companies	Faleye et al. (2014)
Ln_CEO delta	The natural log of one plus the change of CEO stock and option holdings per 1% change of stock price	Faleye et al. (2014)
Ln_CEO vega	The natural log of one plus the change of CEO stock and option holdings per 0.01 change of stock returns volatility	Faleye et al. (2014)
Ln_in_directors	The natural log of one plus the ratio of the number of independent directors to total number of board directors	Balsmeier et al. (2015)

5. Univariate analysis

Table 2 reports the distribution of firms in the full sample and the sub-sample of high-technology firms during the period 2007-2014. The average percentage of firms without patents (citations) in full sample is 55% (67%). The average percentage of firms without patents (citations) in sub-sample of high-technology firms is 42% (51%). Companies in technology-intensive industries tend to enhance more patent activities and also receive more citations than those operate in non-high technology industries. In 2014, the percentage of firms without patents is higher than that in previous years because the OECD patent database only includes patents applied by firms before September 2014[8]. Moreover, the percentage of firms without citations becomes higher overtime because patents applied by firms more recently will receive fewer citations.

Table 3 reports descriptive statistics of 5,705 firm-year observations during 2007-2014. The panel A of table 3 reports that the mean (median) number of patents applied by firms is 34 (0). The mean (median) number of citations per patent applied by firms is 57.5 (0). The mean value of both patents and citations per patent are larger than the median value. Thus, the distribution of patents and citations is highly skewed.

The panel B of table 3 shows that inside debt compensation accounts for a significant portion in CEO's pay package. Specifically, the mean (median) value of inside debt holdings of CEOs is 6,565 (1,183) thousand US Dollar per year. The mean value of pension benefits held by CEOs (3,589) is higher than that of deferred compensation (2,975). The mean (median) value of inside equity holdings of CEOs is 100,900 (19,068) thousand US Dollar per year. The mean (median) value of salary and bonus is 1,067 (900) thousand US Dollar per year. The mean and median value of inside debt and equity holdings of CEOs is larger than the total salary and bonus received by CEOs. The mean (median) value of the CEO debt to equity ratio is 0.26 (0.07). The mean (median) of CEO relative leverage ratio is 3.5 (0.32). The mean (median) of CEO relative incentive ratio is 4.54 (0.37). In addition, there is a substantial number of companies having the CEO's relative leverage and incentive ratio higher than 1 (the mean of CEO relative leverage > 1 and CEO relative incentive > 1 is 0.33 and 0.35). The mean value of pension-based relative leverage (incentive) is 6.12 (8.14) while the respective median value is nearly zero. The mean value of deferred compensation-based relative leverage (incentive) is 1.61 (2.03) while the respective median value is 0.06 (0.07).

The panel C of table 3 indicates that the mean (median) value of R&D intensity is 0.03 (0). The mean (median) value of leverage ratio is 0.23 (0.22). The average age and tenure of a CEO is 60 and 8 years (See panel D of table 3). Moreover, the mean percentage of independent directors sitting on the board is 80% (See panel E of table 3).

Table 4 reports the mean and median difference between high technology and non-high technology groups. Firms in high-tech industries tend to have higher mean and median value

[8] Due to this limitation of OECD patent statistic data, I also re-estimate the results based on the sample excluding observations in year 2014. The empirical results are also consistent with those estimated based on the sample during 2007-2014.

of patents and citations. In addition, high-tech firms have lower mean and median values of CEO relative leverage and CEO relative incentive ratios than those in non-high technology peers. Similarly, pension-based and deferred compensation-based relative leverage and incentive ratios in technology-intensive firms have lower mean values than those in non-high technology firms.

6. Multivariate analysis

Table 6 and 7 present the test results of Model (1) based on the full sample including both high-technology and non-high technology firms. Model (1) includes the variable *Tech* and interaction between *Tech* and other proxies of CEO inside debt. The dependent variable is *Ln_patent* (the natural logarithm of one plus the number of patents), and *Ln_citation* (the natural logarithm of one plus the number of citations per patent). Each column in each table is different in terms of different measures of CEO inside debt including *Ln_CEO relative leverage, Ln_CEO relative incentive, CEO relative leverage > 1, CEO relative incentive >1, Ln_pension relative leverage, Ln_defer relative leverage, Ln_pension relative incentive, Ln_defer relative incentive, Pension relative leverage > 1, Defer relative leverage > 1, Pension relative incentive > 1, and Defer relative incentive > 1*. In Table 6 and 7, it is found that there is a significantly negative association between interaction variables of *Tech* and CEO relative leverage (incentive) ratios and number of patents and citations. Overall, those results support the Hypothesis H1 that the link between CEO inside debt compensation and innovation output is more negative in high-technology firms than in low-technology firms. Moreover, the coefficients of interaction variables of *Tech* and pension-based relative leverage as well as pension-based relative incentive are also negatively significant. The negative association between pension benefits and innovative outputs is stronger in high technology firms than in non-high technology firms. Because CEOs with high pension benefits in technology-intensive firms tend to pay more attention to default risks and behave more conservatively. However, the coefficients of deferred compensation-based relative leverage (incentive) are insignificant. Deferred compensation may have shorter maturity than pension benefits. In addition, in some special cases, executives are able to invest a portion of deferred compensation in equity. Therefore, CEOs with high deferred compensation unlikely take less risk as expected by the theory. Pension benefits provide stronger incentive alignment between CEOs and creditors than deferred compensation.

Table 8 and 9 present the test results to investigate the Hypothesis H2 that in high-technology firms, higher CEO inside debt compensation is associated with less innovation output. The dependent variable in Table 8 and 9 is respectively *Ln_patent* and *Ln_citation.* Each table includes eight alternative specifications of Model (2). I estimate the Model (2) based on the sub-sample of only high-technology firms. The estimated results show that the higher CEO relative leverage (incentive) ratios, the lower innovative output. Coefficients of pension-based relative leverage (incentive) are significantly negative while coefficients of deferred compensation—based leverage (incentive) are insignificant. Overall, there is significant link between total inside debt holdings and innovation output. Moreover, when investigating the effect of pension benefits and deferred compensation on innovative output separately, there is significant evidence that pension benefits are negatively correlated with innovative output.

7. Robustness check

Instead of using SIC code to distinguish between high-technology and non-high technology firms, I divide the sample into highly and non-highly R&D intensive groups. Firms with R&D expenditure scaled by their total sales in the 75^{th} percentile are assumed to be in highly R&D intensive groups. I create a dummy variable RDQ4 which takes value of 1 if firms having R&D intensity in the 75^{th} percentile, and 0 otherwise. Table 12-13 provide significant evidence that the link between CEO inside debt compensation and innovative output is more negative in highly R&D intensive firms than non-highly R&D intensive firms. The negative link mostly comes from the effect of pension components. Table 14 shows that CEOs with more inside debt holdings, specifically more pension benefits, tend to mitigate innovative outputs in highly R&D intensive firms. In table 15, signs of coefficients of deferred compensation-based relative leverage (incentive) become significantly positive. Maybe in highly R&D intensive firms, firms may want to encourage CEOs to invest their deferred compensation in equity to enhance innovative activities.

Moreover, one may argue that the negative link between inside debt compensation and innovative output may be due to the increase in equity-based compensation, but not the increase in debt-based compensation. This study further investigates the impact of the ratio of inside debt compensation to cash compensation (salary and bonus) on innovative output. Cash compensation including salary and bonus unlikely encourage innovative outputs because this kind of compensation is quite stable and provide short-term incentive for top managers (Holthausen et al., 1995). The ratio of inside debt compensation to cash compensation does not include the effect of equity-based compensation on innovative output. Table 16 provides evidence that the higher inside debt-to-cash compensation ratio, the lower innovative output in high-technology industries. The negative effect also mainly comes from the effect of pension benefit component. Moreover, the interaction variables between *Tech* and inside debt-to-cash compensation as well as pension-to-cash compensation are significantly negative.

8. Conclusions

This research examine the association between inside debt holdings of CEOs and innovative output measured by patents and citations. Overall, CEOs in technology-intensive firms tend to mitigate patenting activities because they pay more attention to downside risks and thus follow more conservative policies than in non-technology firms. Particularly, CEOs with high portion of pension benefits are less willing to increase innovative output in high technology firms than in non-high technology peers because pension benefits provide stronger incentive-alignment between CEOs and debtholders in high technology companies. Moreover, pension components negatively affect the innovative output in technology-intensive firms. Deferred compensation does not necessarily induce CEOs take less risk and reduce innovative output.

Table 2

The distribution of firms by year

Table 2 reports the total number of firms in the full sample, the sub-sample of high-technology firms and the number of firms without patents and citations from 2007 to 2014

Panel A: The distribution of firms by year in the full sample

Year	Number of firms	Number of firms without patents	Percentage of firms without patents	Number of firms without citations	Percentage of firms without citations
2007	696	371	53.30%	392	56.32%
2008	718	372	51.81%	404	56.27%
2009	714	362	50.70%	412	57.70%
2010	694	343	49.42%	399	57.49%
2011	713	346	48.53%	427	59.89%
2012	718	366	50.97%	495	68.94%
2013	721	382	52.98%	580	80.44%
2014	731	629	86.05%	727	99.45%
Total	5705	3171	55.58%	3836	67.24%

Panel B: The distribution of firms by year in the sub-sample of high-tech firms

Year	Number of firms	Number of firms without patents	Percentage of firms without patents	Number of firms without citations	Percentage of firms without citations
2007	85	28	32.94%	28	32.94%
2008	92	36	39.13%	36	39.13%
2009	97	38	39.18%	42	43.30%
2010	102	42	41.18%	43	42.16%
2011	107	43	40.19%	47	43.93%
2012	101	41	40.59%	52	51.49%
2013	94	40	42.55%	59	62.77%
2014	94	60	63.83%	90	95.74%
Total	772	328	42.49%	397	51.42%

Table 3

Summary statistics

Table 3 reports summary statistics of 5,705 firm-year observations during 2007-2014. The description and definition of variables are provided in table 1.

Variable	N	mean	median	25thquartile	75th quartile	Std. Dev
Panel A: Patents and Citations						
Citations per patent	5705	57.55	0.00	0.00	4.00	496.25
Number of patents	5705	34.21	0.00	0.00	8.00	171.01
Ln_citation	5705	0.94	0.00	0.00	2.08	1.31
Ln_patent	5705	1.24	0.00	0.00	2.20	1.77
Panel B: CEO compensation, relative inside debt ratios						
CEO inside debt (1000$)	5705	6565.02	1183.00	0.00	6695.79	14822.00
CEO deferred compensation (1000$)	5705	2975.94	316.93	0.00	2172.81	3.93
CEO pension compensation (1000$)	5705	3589.08	0.00	0.00	3016.57	10029.00
CEO inside equity (1000$)	5705	100899.80	19067.54	8003.59	46163.03	8412.51
Salary & bonus (1000$)	5705	1067.33	900.00	680.00	1143.33	1205539.00
CEO delta (1000$)	5705	1135.96	259.19	105.11	638.59	12228.25
CEO vega (1000$)	5705	193.37	85.39	23.87	226.26	374.85
Ln_ CEO delta	5705	5.55	5.56	4.66	6.46	1.42
Ln_ CEO vega	5705	4.14	4.46	3.21	5.43	1.83
CEO debt to equity ratio	5705	0.26	0.07	0.00	0.30	0.49
Ln_CEO debt to equity ratio	5705	0.18	0.06	0.00	0.26	0.27
CEO relative leverage	5705	3.50	0.32	0.00	1.54	14.49
CEO relative leverage > 1	5705	0.33	0.00	0.00	1.00	0.47
Ln_CEO relative leverage	5705	0.64	0.27	0.00	0.93	0.91
CEO relative incentive	5705	4.54	0.37	0.00	1.69	20.93
CEO relative incentive >1	5705	0.35	0.00	0.00	1.00	0.48
Ln_CEO relative incentive	5705	0.69	0.32	0.00	0.99	0.96
Pension relative leverage	5705	6.12	0.00	0.00	0.59	144.94
Pension relative leverage > 1	5705	0.19	0.00	0.00	0.00	0.39
Ln_pension relative leverage	5705	0.36	0.00	0.00	0.47	0.74
Pension relative incentive	5705	8.14	0.00	0.00	0.66	198.67
Pension relative incentive >1	5705	0.20	0.00	0.00	0.00	0.40
Ln_pension relative incentive	5705	0.38	0.00	0.00	0.51	0.78
Defer relative leverage	5705	1.61	0.06	0.00	0.54	7.06
Defer relative leverage > 1	5705	0.17	0.00	0.00	0.00	0.38
Ln_defer relative leverage	5705	0.38	0.06	0.00	0.43	0.71
Defer relative incentive	5705	2.03	0.07	0.00	0.61	9.65
Defer relative incentive > 1	5705	0.19	0.00	0.00	0.00	0.39
Ln_defer relative incentive	5705	0.41	0.06	0.00	0.48	0.76
Panel C: Firm-level characteristics						
Firm_size	5705	7.98	7.85	6.87	8.94	1.48
RD_intensity	5705	0.03	0.00	0.00	0.03	0.05
ROA	5705	0.05	0.06	0.03	0.09	0.09
MB	5705	4.23	2.33	1.52	3.60	25.70
Leverage	5705	0.23	0.22	0.12	0.32	0.15

Table 3 (Cont.)

Summary statistics

Variable	N	mean	median	25th quartile	75th quartile	Std. Dev
Panel D: CEO characteristics						
CEO age	5705	60.53	60.00	56.00	65.00	6.76
CEO tenure	5705	8.91	7.44	3.84	11.76	7.04
Ln_CEO age	5705	4.10	4.09	4.03	4.17	0.11
Ln_CEO tenure	5705	1.86	2.01	1.35	2.46	0.87
Panel E: Board size and independent directors						
Ratio of independent directors	5705	0.80	0.82	0.73	0.89	0.11
Ln_in_directors	5705	0.58	0.60	0.55	0.64	0.06
Board size	5705	9.26	9.00	8.00	11.00	2.06
Independent directors	5705	7.43	7.00	6.00	9.00	2.05

Table 4

Mean and median difference between high technology and non-high technology firms

Table 4 reports the mean and mean difference between high technology and non-high technology firms during the period 2007-2014. The description and definition of variables are provided in table 1.

	Mean (non-high tech)	Mean (high tech)	Difference in mean	P-value (mean difference)	Median (non-high tech)	Median (high tech)	Difference in median	P-value (median difference)
Ln_patent	1.11	2.08	-0.97	0.00	0.00	1.39	-1.39	0.00
Ln_citation	0.87	1.36	-0.49	0.00	0.00	1.16	-1.16	0.00
CEO relative leverage	3.60	2.85	0.75	0.18	0.42	0.00	0.42	0.00
Ln_CEO relative leverage	0.69	0.36	0.33	0.00	0.35	0.00	0.35	0.00
CEO relative leverage > 1	0.35	0.17	0.18	0.00	0.00	0.00	0.00	0.00
CEO relative incentive	4.57	4.34	0.23	0.77	0.48	0.00	0.48	0.00
Ln_CEO relative incentive	0.73	0.42	0.31	0.00	0.39	0.00	0.39	0.00
CEO relative incentive > 1	0.37	0.19	0.18	0.00	0.00	0.00	0.00	0.00
Pension relative leverage	1.14	0.44	0.70	0.00	0.00	0.00	0.00	0.00
Ln_Pension relative leverage	0.39	0.11	0.28	0.00	0.00	0.00	0.00	0.00
Pension relative incentive	1.28	0.57	0.71	0.00	0.00	0.00	0.00	0.00
Ln_Pension relative incentive	0.40	0.13	0.27	0.00	0.00	0.00	0.00	0.00
Pension relative leverage > 1	0.21	0.06	0.15	0.00	0.00	0.00	0.00	0.00
Pension relative incentive > 1	0.22	0.06	0.16	0.00	0.00	0.00	0.00	0.00
Defer relative leverage	1.66	1.26	0.40	0.15	0.09	0.00	0.09	0.00
Defer relative incentive	2.06	1.87	0.19	0.62	0.10	0.00	0.10	0.00
Ln_Defer relative leverage	0.40	0.26	0.14	0.00	0.09	0.00	0.09	0.00
Ln_Defer relative incentive	0.42	0.30	0.12	0.00	0.10	0.00	0.10	0.00
Defer relative leverage > 1	0.18	0.12	0.06	0.00	0.00	0.00	0.00	0.00
Defer relative incentive > 1	0.20	0.14	0.06	0.00	0.00	0.00	0.00	0.00
Ln_CEO tenure	1.86	1.88	-0.02	0.46	2.00	2.02	-0.02	0.66
Ln_CEO delta	5.53	5.67	-0.14	0.01	5.55	5.65	-0.10	0.16
Ln_CEO vega	4.11	4.27	-0.16	0.02	4.42	4.61	-0.19	0.00
Ln_CEO age	4.10	4.06	0.04	0.00	4.11	4.06	0.05	0.00
Ln_in_directors	0.59	0.58	0.01	0.01	0.61	0.59	0.02	0.00
Firm_size	8.00	7.89	0.11	0.06	7.89	7.63	0.26	0.00
RD_intensity	0.02	0.07	-0.05	0.00	0.00	0.06	-0.06	0.00
ROA	0.05	0.04	0.01	0.00	0.06	0.05	0.01	0.12
MB	4.27	3.97	0.30	0.76	2.30	2.55	-0.25	0.00
Leverage	0.23	0.19	0.04	0.00	0.22	0.16	0.06	0.00
Observations	4933	772			4933	772		

Table 5

Correlation matrix

Table 5 reports the correlation matrix of variables. The description and definition of variables are provided in table 1. * represents the significance at the 5% level

	1	2	3	4	5	6	7	8	9	10	11	12
1. Ln_patent	1											
2. Ln_citation	0.7963*	1										
3. CEO relative leverage >1	0.1317*	0.1031*	1									
4. Ln_CEO relative leverage	0.1104*	0.0868*	0.7641*	1								
5. CEO relative incentive >1	0.1341*	0.1170*	0.8999*	0.7420*	1							
6. Ln_CEO relative incentive	0.1003*	0.0867*	0.7467*	0.9868*	0.7478*	1						
7. Pension relative leverage > 1	0.1020*	0.0821*	0.7058*	0.5970*	0.6405*	0.5725*	1					
8. Ln_pension relative leverage	0.0780*	0.0715*	0.5737*	0.7327*	0.5523*	0.7123*	0.7735*	1				
9. Pension relative incentive > 1	0.0954*	0.0805*	0.6549*	0.5817*	0.6824*	0.5754*	0.9087*	0.7615*	1			
10. Ln_pension relative incentive	0.0674*	0.0691*	0.5630*	0.7214*	0.5571*	0.7198*	0.7620*	0.9892*	0.7697*	1		
11. Defer relative leverage > 1	0.1075*	0.0786*	0.6474*	0.6454*	0.6017*	0.6310*	0.2062*	0.2579*	0.1948*	0.2419*	1	
12. Ln_defer relative leverage	0.0975*	0.0677*	0.5758*	0.8141*	0.5599*	0.8078*	0.2128*	0.2851*	0.1986*	0.2726*	0.7978*	1
13. Defer relative incentive > 1	0.1189*	0.1014*	0.6139*	0.6274*	0.6488*	0.6325*	0.2002*	0.2460*	0.1957*	0.2400*	0.9139*	0.7784*
14. Ln_defer relative incentive	0.0889*	0.0670*	0.5589*	0.7979*	0.5597*	0.8127*	0.1919*	0.2625*	0.1852*	0.2613*	0.7801*	0.9882*
15. Firm_size	0.2834*	0.1853*	0.1847*	0.1263*	0.1665*	0.0839*	0.1837*	0.1509*	0.1577*	0.1204*	0.0830*	0.0408*
16. RD_intensity	0.3639*	0.2568*	-0.0187	0.0049	-0.0257	0.0072	-0.0518*	-0.0490*	-0.0592*	-0.0512*	0.0510*	0.0514*
17. ROA	0.0348*	0.0051	0.1228*	0.1237*	0.1034*	0.1035*	0.0804*	0.0648*	0.0658*	0.0503*	0.1073*	0.1010*
18. MB	0.0451*	0.0121	0.0339*	0.0321*	0.0282	0.0186	0.0472*	0.0255	0.0429*	0.0131	0.0476*	0.0289
19. Leverage	-0.0957*	-0.0830*	-0.1937*	-0.2937*	-0.1963*	-0.2943*	-0.0966*	-0.1658*	-0.0900*	-0.1650*	-0.2342*	-0.2759*
20. Ln_CEO age	0.0066	0.0499*	0.1457*	0.1533*	0.1411*	0.1463*	0.1371*	0.1607*	0.1429*	0.1595*	0.0771*	0.0755*
21. Ln_CEO tenure	-0.0408*	-0.0252	0.0044	0.017	0.0073	0.0225	-0.0084	0.0072	-0.0059	0.0125	0.0165	0.0224
22. Ln_CEO delta	0.1455*	0.0935*	0.0064	-0.0199	-0.0213	-0.0541*	-0.0017	-0.0202	-0.0312*	-0.0441*	0.0124	-0.0024
23. Ln_CEO vega	0.2730*	0.2162*	0.0988*	0.0589*	0.0932*	0.0422*	0.0956*	0.0634*	0.0782*	0.0496*	0.0630*	0.0383*
24. Ln_in_directors	0.1376*	0.0794*	0.1623*	0.1107*	0.1614*	0.1005*	0.1356*	0.1009*	0.1343*	0.0916*	0.0948*	0.0657*

Table 5 (Cont.)

Correlation matrix

	13	14	15	16	17	18	19	20	21	22	23	24
1. Ln_patent												
2. Ln_citation												
3. CEO relative leverage >1												
4. Ln_CEO relative leverage												
5. CEO relative incentive >1												
6. Ln_CEO relative incentive												
7. Pension relative leverage > 1												
8. Ln_pension relative leverage												
9. Pension relative incentive > 1												
10. Ln_pension relative incentive												
11. Defer relative leverage > 1												
12. Ln_defer relative leverage												
13. Defer relative incentive > 1	1											
14. Ln_defer relative incentive	0.7827*	1										
15. Firm_size	0.0592*	0.0075	1									
16. RD_intensity	0.0529*	0.0544*	-0.1245*	1								
17. ROA	0.0971*	0.0851*	0.0906*	-0.1326*	1							
18. MB	0.0211	0.0176	0.0195	0.0248	0.0730*	1						
19. Leverage	-0.2322*	-0.2749*	0.1803*	-0.1829*	-0.1493*	0.0797*	1					
20. Ln_CEO age	0.0638*	0.0671*	0.1036*	-0.0806*	-0.0074	-0.022	-0.0065	1				
21. Ln_CEO tenure	0.0146	0.0244	-0.0493*	-0.0047	0.0268	-0.0147	-0.0202	0.3775*	1			
22. Ln_CEO delta	-0.0121	-0.0295*	0.4596*	0.0133	0.3185*	0.0478*	-0.0406*	0.1486*	0.3570*	1		
23. Ln_CEO vega	0.0543*	0.0256	0.5025*	0.1003*	0.1777*	0.0487*	0.0231	0.0580*	0.1444*	0.6779*	1	
24. Ln_in_directors	0.0957*	0.0607*	0.2116*	0.0123	0.0477*	0.0006	0.0648*	-0.0232	-0.0321*	0.0326*	0.1625*	1

Table 6
The interactive effect of technology intensive industry and CEO inside debt compensation on the number of patents

Table 6 presents the empirical results of Tobit model with 2-digit SIC code industry and year fixed effects in the full sample.
Model (1): $Innovation_{i,t} = \alpha + \beta_1 Insidedebt_{i,t-1} + \beta_2 Tech_{i,t-1} + \beta_3 Insidedebt*Tech_{i,t-1} + \gamma Control_{i,t-1}$ *+ Year fixed effects + Industry fixed effects +* $\varepsilon_{i,t-1}$. The standard errors are estimated using bootstrap. The dependent variable is *Ln_patent* which is the natural logarithm of one plus the number of patents during a given year. The description and definition of other independent variables are provided in table 1. Bootstrapped tandard errors in parentheses. ***, **, * represent the significance at the 1%, 5%, and 10% levels.

Dependent variable: Ln_patent	Expected sign	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ln_CEO relative leverage	+/-	0.023							
		(0.036)							
Ln_CEO relative leverage * Tech	-	**-0.204****							
		(0.093)							
Ln_CEO relative incentive	+/-		0.022						
			(0.040)						
Ln_CEO relative incentive * Tech	-		**-0.165***						
			(0.088)						
CEO relative leverage > 1	+/-			0.127					
				(0.081)					
CEO relative leverage > 1 * Tech	-			**-0.569*****					
				(0.214)					
CEO relative incentive> 1	+/-				0.208**				
					(0.095)				
CEO relative incentive> 1 * Tech	-				**-0.676*****				
					(0.168)				
Ln_pension relative leverage	+/-					0.025			
						(0.060)			
Ln_defer relative leverage	+/-					-0.005			
						(0.061)			
Ln_pension relative leverage * Tech	-					**-1.756****			
						(0.688)			
Ln_defer relative leverage * Tech	+/-					0.117			
						(0.096)			
Ln_pension relative incentive	+/-						0.028		
							(0.064)		
Ln_defer relative incentive	+/-						-0.017		
							(0.063)		
Ln_pension relative incentive * Tech	-						**-1.504****		
							(0.674)		
Ln_defer relative incentive * Tech	+/-						0.116		
							(0.092)		
Pension relative leverage > 1	+/-							0.135	
								(0.121)	
Defer relative leverage >1	+/-							0.081	
								(0.162)	
Pension relative leverage > 1 * Tech	-							**-3.644*****	
								(0.816)	
Defer relative leverage >1 * Tech	+/-							-0.018	
								(0.299)	
Pension relative incentive > 1	+/-								0.179*
									(0.108)
Defer relative incentive > 1	+/-								0.115
									(0.111)
Pension relative incentive> 1 * Tech	-								**-2.923*****
									(0.683)
Defer relative incentive > 1 * Tech	+/-								-0.070
									(0.240)
Tech	+	0.726***	0.724***	0.767***	0.831***	0.766***	0.757***	0.825***	0.852***
		(0.174)	(0.217)	(0.160)	(0.159)	(0.174)	(0.198)	(0.184)	(0.212)

Table 6 (Cont.)
The interactive effect of technology intensive industry and CEO inside debt compensation on the number of patents

Dependent variable: Ln_patent	Expected sign	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Firm_size	+	0.804***	0.803***	0.800***	0.796***	0.806***	0.803***	0.806***	0.797***
		(0.040)	(0.039)	(0.034)	(0.039)	(0.046)	(0.035)	(0.043)	(0.045)
RD_intensity	+	12.285***	12.301***	12.281***	12.271***	11.806***	11.799***	11.802***	11.705***
		(1.491)	(1.830)	(1.590)	(1.583)	(1.694)	(1.472)	(1.915)	(1.945)
ROA	+	0.399	0.399	0.349	0.340	0.340	0.339	0.280	0.245
		(0.400)	(0.481)	(0.413)	(0.416)	(0.528)	(0.396)	(0.492)	(0.512)
MB	+	0.004	0.004	0.004	0.004	0.004	0.004***	0.004	0.004
		(0.004)	(0.004)	(0.003)	(0.004)	(0.005)	(0.002)	(0.003)	(0.003)
Leverage	-	-1.593***	-1.582***	-1.542***	-1.492***	-1.651***	-1.653***	-1.609***	-1.563***
		(0.279)	(0.266)	(0.267)	(0.321)	(0.265)	(0.263)	(0.312)	(0.274)
Ln_CEO age	-	-0.930***	-0.932**	-0.967**	-1.017***	-0.854**	-0.853***	-0.938**	-0.986***
		(0.335)	(0.378)	(0.405)	(0.380)	(0.344)	(0.312)	(0.406)	(0.353)
Ln_CEO tenure	-	-0.117**	-0.118**	-0.119**	-0.122***	-0.120**	-0.121***	-0.122**	-0.125**
		(0.046)	(0.051)	(0.052)	(0.043)	(0.049)	(0.040)	(0.051)	(0.053)
Ln_CEO delta	+/-	-0.012	-0.011	-0.005	0.001	-0.027	-0.026	-0.023	-0.017
		(0.053)	(0.052)	(0.051)	(0.047)	(0.050)	(0.049)	(0.054)	(0.057)
Ln_CEO vega	+	0.123**	0.122***	0.119***	0.116**	0.130***	0.131***	0.128***	0.129***
		(0.050)	(0.043)	(0.044)	(0.048)	(0.042)	(0.043)	(0.047)	(0.043)
Ln_in_directors	+	3.194***	3.200***	3.179***	3.178***	3.325***	3.306***	3.291***	3.263***
		(0.592)	(0.689)	(0.640)	(0.612)	(0.668)	(0.649)	(0.720)	(0.576)
ChiSq		1936.43	2784.19	3071.33	3675.86	2609.09	4415.30	2306.45	2765.20
Pro>ChiSq		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Observations		4,448	4,448	4,448	4,448	4,448	4,448	4,448	4,448

Table 7
The interactive effect of technology intensive industry and CEO inside debt compensation on the number of citations per patent

Table 7 presents the empirical results of Tobit model which is estimated with 2-digit SIC code industry and year fixed effects in the full sample.
Model (1): $Innovation_{i,t} = \alpha + \beta_1 Insidedebt_{i,t-1} + \beta_2 Tech_{i,t-1} + \beta_3 Insidedebt*Tech_{i,t-1} + \gamma Control_{i,t-1} + Year\ fixed\ effects + Industry\ fixed\ effects + \varepsilon_{i,t-1}$. The dependent variable is *Ln_citation* (natural log of one plus the number of citations per patent. The description and definition of other independent variables are provided in table 1. Bootstrapped standard errors in parentheses. ***, **, * represent significance at the 1%, 5%, and 10% levels.

Dependent variable: Ln_citation	Expected sign	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ln_CEO relative leverage	+/-	-0.008							
		(0.035)							
Ln_CEO relative leverage * Tech	-	**-0.251****							
		(0.100)							
Ln_CEO relative incentive	+/-		0.006						
			(0.041)						
Ln_CEO relative incentive * Tech	-		**-0.201****						
			(0.079)						
CEO relative leverage > 1	+/-			0.018					
				(0.076)					
CEO relative leverage > 1 * Tech	-			**-0.438****					
				(0.213)					
CEO relative incentive> 1	+/-				0.118				
					(0.078)				
CEO relative incentive> 1 * Tech	-				**-0.594*****				
					(0.191)				
Ln_pension relative leverage	+/-					0.025			
						(0.060)			
Ln_defer relative leverage	+/-					-0.054			
						(0.065)			
Ln_pension relative leverage * Tech	-					**-1.304*****			
						(0.410)			
Ln_defer relative leverage * Tech	+/-					0.059			
						(0.129)			
Ln_pension relative incentive	+/-						0.044		
							(0.049)		
Ln_defer relative incentive	+/-						-0.052		
							(0.057)		
Ln_pension relative incentive * Tech	-						**-1.194*****		
							(0.262)		
Ln_defer relative incentive * Tech	+/-						0.088		
							(0.104)		
Pension relative leverage > 1	+/-							0.053	
								(0.076)	
Defer relative leverage >1	+/-							-0.018	
								(0.091)	
Pension relative leverage > 1 * Tech	-							**-2.405*****	
								(0.337)	
Defer relative leverage >1 * Tech	+/-							0.059	
								(0.205)	
Pension relative incentive > 1	+/-								0.084
									(0.101)
Defer relative incentive > 1	+/-								0.060
									(0.119)
Pension relative incentive> 1 * Tech	-								**-2.159*****
									(0.302)
Defer relative incentive > 1 * Tech	+/-								-0.009
									(0.224)
Tech	+	0.244**	0.247*	0.236**	0.311**	0.262*	0.263*	0.272*	0.311**
		(0.111)	(0.139)	(0.118)	(0.133)	(0.143)	(0.135)	(0.143)	(0.129)

Table 7 (Cont.)
The interactive effect of technology intensive industry and CEO inside debt compensation on the number of citations per patent

Dependent variable: Ln_citation	Expected sign	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Firm_size	+	0.394***	0.390***	0.391***	0.387***	0.396***	0.390***	0.395***	0.388***
		(0.031)	(0.023)	(0.029)	(0.029)	(0.031)	(0.032)	(0.034)	(0.033)
RD_intensity	+	4.042***	4.046***	4.070***	4.029***	3.811***	3.774***	3.814***	3.657***
		(1.061)	(0.992)	(1.103)	(0.907)	(1.010)	(0.882)	(1.019)	(0.846)
ROA	+	-0.033	-0.050	-0.058	-0.077	-0.057	-0.081	-0.078	-0.126
		(0.367)	(0.343)	(0.439)	(0.315)	(0.371)	(0.339)	(0.318)	(0.314)
MB	+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		(0.004)	(0.003)	(0.004)	(0.003)	(0.003)	(0.005)	(0.005)	(0.003)
Leverage	-	-0.845***	-0.798**	-0.777***	-0.721**	-0.888***	-0.854***	-0.834***	-0.780***
		(0.317)	(0.316)	(0.274)	(0.308)	(0.271)	(0.264)	(0.256)	(0.266)
Ln_CEO age	-	-0.027	-0.045	-0.040	-0.093	0.016	-0.002	-0.011	-0.053
		(0.312)	(0.273)	(0.293)	(0.302)	(0.311)	(0.293)	(0.303)	(0.330)
Ln_CEO tenure	-	-0.108**	-0.111**	-0.112**	-0.115**	-0.109**	-0.112**	-0.110**	-0.113***
		(0.043)	(0.047)	(0.045)	(0.055)	(0.046)	(0.053)	(0.048)	(0.042)
Ln_CEO delta	+/-	-0.048	-0.044	-0.040	-0.036	-0.057	-0.053	-0.054	-0.050
		(0.050)	(0.042)	(0.050)	(0.036)	(0.042)	(0.039)	(0.035)	(0.042)
Ln_CEO vega	+	0.184***	0.183***	0.179***	0.177***	0.188***	0.188***	0.187***	0.188***
		(0.036)	(0.030)	(0.036)	(0.033)	(0.036)	(0.031)	(0.030)	(0.030)
Ln_in_directors	+	0.303	0.304	0.338	0.308	0.394	0.386	0.367	0.349
		(0.591)	(0.508)	(0.602)	(0.565)	(0.593)	(0.570)	(0.559)	(0.582)
ChiSq		819.68	1054.05	820.27	570.36	641.25	919.21	1295.74	1088.82
Pro>ChiSq		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Observations		4,448	4,448	4,448	4,448	4,448	4,448	4,448	4,448

Table 8

The association between CEO inside debt compensation and the number patents in high technology industries

Table 8 presents the empirical results of Tobit model which is estimated with 2-digit SIC code industry and year fixed effects in the sub-sample of high technology firms. *Model (2):* $Innovation_{i,t} = \alpha + \beta_1 Insidedebt_{i,t-1} + \gamma Control_{i,t-1} + Year\ fixed\ effects + Industry\ fixed\ effects + \varepsilon_{i,t-1}$. The standard errors are estimated using bootstrap. The dependent variable is *Ln_patent* which is the natural logarithm of one plus the number of patents during a given year. The description and definition of other independent variables are provided in table 1. Bootstrapped standard errors in parentheses. ***, **, * represent the significance at the 1%, 5%, and 10% levels.

Dependent variable: Ln_patent	Expected sign	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ln_CEO relative leverage	-	**-0.263****							
		(0.129)							
Ln_CEO relative incentive	-		**-0.207****						
			(0.088)						
CEO relative leverage > 1	-			**-0.539***					
				(0.280)					
CEO relative incentive > 1	-				**-0.555*****				
					(0.173)				
Ln_pension relative leverage	-					**-2.324*****			
						(0.681)			
Ln_defer relative leverage	+/-					0.023			
						(0.115)			
Ln_pension relative incentive	-						**-2.018*****		
							(0.649)		
Ln_defer relative incentive	+/-						0.036		
							(0.096)		
Pension relative leverage > 1	-							**-3.989*****	
								(0.699)	
Defer relative leverage >1	+/-							-0.112	
								(0.305)	
Pension relative incentive > 1	-								**-3.280*****
									(0.674)
Defer relative incentive > 1	+/-								0.010
									(0.275)
Firm_size	+	0.691***	0.683***	0.705***	0.707***	0.720***	0.691***	0.753***	0.701***
		(0.124)	(0.121)	(0.136)	(0.119)	(0.124)	(0.114)	(0.124)	(0.136)
RD_intensity	+	11.417***	11.469***	11.668***	11.604***	10.309***	10.090***	10.515***	9.798***
		(2.822)	(3.732)	(3.481)	(2.700)	(3.299)	(2.818)	(3.016)	(3.228)
ROA	+	-0.212	-0.210	-0.223	-0.134	-0.408	-0.442	-0.448	-0.497
		(0.898)	(1.220)	(1.050)	(0.820)	(1.079)	(1.029)	(0.726)	(1.151)
MB	+	-0.002	-0.002	-0.003	-0.003	-0.003	-0.003	-0.001	-0.002
		(0.031)	(0.035)	(0.037)	(0.053)	(0.029)	(0.043)	(0.039)	(0.035)
Leverage	-	-2.532***	-2.474***	-2.382**	-2.424***	-2.640***	-2.572***	-2.839***	-2.730***
		(0.824)	(0.823)	(1.119)	(0.879)	(0.747)	(0.947)	(0.706)	(0.949)
Ln_CEO age	-	-3.368***	-3.403***	-3.354***	-3.410***	-3.189***	-3.242***	-3.141***	-3.302***
		(0.825)	(0.663)	(0.883)	(0.983)	(0.683)	(0.790)	(0.767)	(0.712)
Ln_CEO tenure	-	-0.319***	-0.324**	-0.331***	-0.326***	-0.374***	-0.380**	-0.365***	-0.358**
		(0.116)	(0.128)	(0.124)	(0.126)	(0.143)	(0.163)	(0.140)	(0.150)
Ln_CEO delta	+/-	-0.053	-0.049	-0.039	-0.056	-0.117	-0.109	-0.129	-0.142
		(0.120)	(0.152)	(0.116)	(0.111)	(0.118)	(0.143)	(0.128)	(0.136)
Ln_CEO vega	+	0.437***	0.434***	0.418***	0.427***	0.490***	0.497***	0.496***	0.527***
		(0.151)	(0.145)	(0.148)	(0.125)	(0.115)	(0.122)	(0.134)	(0.125)
Ln_in_directors	+	4.847***	4.892***	5.182***	5.354***	6.060***	6.012***	5.845***	5.989***
		(1.498)	(1.521)	(1.710)	(1.531)	(1.973)	(1.784)	(1.477)	(1.711)
ChiSq		533.18	508.12	503.53	400.77	514.79	579.15	432.17	683.13
Pro>ChiSq		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Observations		572	572	572	572	572	572	572	572

Table 9

The association between CEO inside debt compensation and the number of citations per patent in high technology industries

Table 9 presents the empirical results of Tobit model which is estimated with 2-digit SIC code industry and year fixed effects in the sub-sample of high technology firms. *Model (2):* $Innovation_{i,t} = \alpha + \beta_1 Insidedebt_{i,t-1} + \gamma Control_{i,t-1}$ + *Year fixed effects* + *Industry fixed effects* + $\varepsilon_{i,t-1}$. The standard errors are estimated using bootstrap. The dependent variable is *Ln_citation* which is the natural logarithm of one plus the number of citations per patent during a given year. The description and definition of other independent variables are provided in table 1. Bootstrapped standard errors in parentheses. ***, **, * represent the significance at the 1%, 5%, and 10% levels.

Dependent variable: Ln_citation	Expected sign	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ln_CEO relative leverage	-	**-0.221*** **							
		(0.085)							
Ln_CEO relative incentive	-		**-0.162***						
			(0.084)						
CEO relative leverage > 1	-			-0.228					
				(0.244)					
CEO relative incentive > 1	-				-0.302				
					(0.205)				
Ln_pension relative leverage	-					**-1.129*** **			
						(0.354)			
Ln_defer relative leverage	+/-					0.068			
						(0.118)			
Ln_pension relative incentive	-						**-1.006*** **		
							(0.323)		
Ln_defer relative incentive	+/-						0.101		
							(0.124)		
Pension relative leverage > 1	-							**-2.135*** **	
								(0.397)	
Defer relative leverage >1	+/-							0.197	
								(0.224)	
Pension relative incentive > 1	-								**-1.940*** **
									(0.325)
Defer relative incentive > 1	+/-								0.292
									(0.181)
Firm_size	+	0.220***	0.211***	0.210**	0.217**	0.221***	0.203***	0.233***	0.210***
		(0.078)	(0.073)	(0.086)	(0.094)	(0.076)	(0.070)	(0.078)	(0.081)
RD_intensity	+	5.365***	5.428***	5.663***	5.607***	4.769***	4.578***	4.785***	4.333***
		(1.597)	(1.211)	(1.768)	(1.884)	(1.300)	(1.517)	(1.565)	(1.452)
ROA	+	-0.143	-0.157	-0.221	-0.155	-0.255	-0.306	-0.280	-0.343
		(0.770)	(0.732)	(1.171)	(1.004)	(0.608)	(0.692)	(0.623)	(0.837)
MB	+	-0.003	-0.003	-0.004	-0.004	-0.004	-0.004	-0.003	-0.004
		(0.021)	(0.023)	(0.029)	(0.016)	(0.018)	(0.027)	(0.023)	(0.019)
Leverage	-	-1.164*	-1.084**	-0.888*	-0.952	-1.162**	-1.099*	-1.142**	-1.094**
		(0.597)	(0.438)	(0.497)	(0.610)	(0.584)	(0.571)	(0.537)	(0.502)
Ln_CEO age	-	0.536	0.504	0.511	0.488	0.776	0.764	0.711	0.637
		(0.628)	(0.618)	(0.709)	(0.655)	(0.705)	(0.553)	(0.669)	(0.690)
Ln_CEO tenure	-	-0.200	-0.206*	-0.220*	-0.214**	-0.209*	-0.213*	-0.208**	-0.204*
		(0.130)	(0.113)	(0.125)	(0.099)	(0.122)	(0.121)	(0.104)	(0.124)
Ln_CEO delta	+/-	-0.062	-0.055	-0.031	-0.044	-0.094	-0.089	-0.098	-0.109
		(0.112)	(0.086)	(0.095)	(0.072)	(0.082)	(0.083)	(0.080)	(0.098)
Ln_CEO vega	+	0.225***	0.221***	0.203**	0.209***	0.244***	0.248***	0.245***	0.264***
		(0.079)	(0.076)	(0.082)	(0.081)	(0.063)	(0.062)	(0.077)	(0.066)
Ln_in_directors	+	0.975	1.024	1.197	1.303	1.423	1.425	1.437	1.426
		(1.149)	(1.138)	(1.492)	(1.203)	(1.293)	(1.470)	(1.337)	(1.244)
ChiSq		123.95	73.31	91.28	69.02	101.88	115.60	268.94	240.37
Pro>ChiSq		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Observations		572	572	572	572	572	572	572	572

Table 10

The association between CEO inside debt compensation and the number of patents in non-high technology industries

Table 10 presents the empirical results of Tobit model which is estimated with 2-digit SIC code industry and year fixed effects in the sub-sample of non-high technology firms. *Model (2): Innovation*$_{i,t}$ = α + β_1*Insidedebt*$_{i,t-1}$ + γ*Control*$_{i,t-1}$ + *Year fixed effects* + *Industry fixed effects* + $\varepsilon_{i,t-1}$. The standard errors are estimated using bootstrap. The dependent variable is *Ln_patent* which is the natural logarithm of one plus the number of patents during a given year. The description and definition of other independent variables are provided in table 1. Bootstrapped standard errors in parentheses. ***, **, * represent the significance at the 1%, 5%, and 10% levels.

Dependent variable: Ln_patent	Expected sign	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ln_CEO relative leverage	+/-	0.017							
		(0.041)							
Ln_CEO relative incentive	+/-		0.015						
			(0.036)						
CEO relative leverage > 1	+/-			0.102					
				(0.075)					
CEO relative incentive > 1	+/-				**0.182****				
					(0.083)				
Ln_pension relative leverage	+/-					0.002			
						(0.059)			
Ln_defer relative leverage	+/-					0.009			
						(0.054)			
Ln_pension relative incentive	+/-						0.003		
							(0.053)		
Ln_defer relative incentive	+/-						-0.004		
							(0.058)		
Pension relative leverage > 1	+/-							0.121	
								(0.116)	
Defer relative leverage >1	+/-							0.087	
								(0.147)	
Pension relative incentive > 1	+/-								**0.158***
									(0.093)
Defer relative incentive > 1	+/-								0.130
									(0.132)
Firm_size	+	0.811***	0.812***	0.804***	0.798***	0.813***	0.814***	0.799***	0.795***
		(0.042)	(0.045)	(0.029)	(0.039)	(0.040)	(0.036)	(0.044)	(0.041)
RD_intensity	+	11.437***	11.441***	11.434***	11.453***	11.440***	11.459***	11.418***	11.407***
		(2.427)	(2.388)	(1.551)	(2.386)	(1.838)	(1.705)	(2.257)	(1.926)
ROA	+	0.596	0.599	0.527	0.482	0.611	0.620	0.506	0.469
		(0.560)	(0.571)	(0.538)	(0.553)	(0.543)	(0.559)	(0.658)	(0.525)
MB	+	0.004	0.004	0.004**	0.004*	0.004	0.004	0.004	0.004***
		(0.004)	(0.003)	(0.002)	(0.002)	(0.004)	(0.005)	(0.004)	(0.001)
Leverage	-	-1.361***	-1.365***	-1.310***	-1.236***	-1.384***	-1.409***	-1.258***	-1.207***
		(0.355)	(0.419)	(0.316)	(0.338)	(0.324)	(0.325)	(0.304)	(0.323)
Ln_CEO age	-	-0.105	-0.103	-0.149	-0.210	-0.090	-0.086	-0.184	-0.228
		(0.415)	(0.335)	(0.333)	(0.365)	(0.312)	(0.295)	(0.316)	(0.351)
Ln_CEO tenure	-	-0.079	-0.079	-0.080	-0.084*	-0.078	-0.077	-0.082	-0.085
		(0.059)	(0.056)	(0.055)	(0.050)	(0.053)	(0.055)	(0.054)	(0.057)
Ln_CEO delta	+/-	-0.034	-0.033	-0.026	-0.014	-0.036	-0.037	-0.022	-0.012
		(0.080)	(0.066)	(0.066)	(0.059)	(0.068)	(0.063)	(0.070)	(0.064)
Ln_CEO vega	+	0.101*	0.101*	0.099*	0.093*	0.101*	0.102*	0.097*	0.093*
		(0.057)	(0.061)	(0.054)	(0.050)	(0.055)	(0.055)	(0.058)	(0.052)
Ln_in_directors	+	2.865***	2.867***	2.813***	2.799***	2.869***	2.871***	2.819***	2.807***
		(0.696)	(0.705)	(0.561)	(0.780)	(0.633)	(0.664)	(0.725)	(0.735)
Pro>ChiSq		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Observations		3,876	3,876	3,876	3,876	3,876	3,876	3,876	3,876

Table 11

The association between CEO inside debt compensation and the number of citations per patent in non-high technology industries

Table 11 presents the empirical results of Tobit model which is estimated with 2-digit SIC code industry and year fixed effects in the sub-sample of non-high technology firms. *Model (2):* $Innovation_{i,t} = \alpha + \beta_1 Insidedebt_{i,t-1} + \gamma Control_{i,t-1} + \textit{Year fixed effects} + \textit{Industry fixed effects} + \varepsilon_{i,t-1}$.The standard errors are estimated using bootstrap. The dependent variable is *Ln_citation* which is the natural logarithm of one plus the number of citations per patent during a given year. The description and definition of other independent variables are provided in table 1. Bootstrapped standard errors in parentheses. ***, **, * represent the significance at the 1%, 5%, and 10% levels.

Dependent variable: Ln_citation	Expected sign	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ln_CEO relative leverage	+/-	-0.013							
		(0.041)							
Ln_CEO relative incentive	+/-		0.004						
			(0.041)						
CEO relative leverage > 1	+/-			-0.012					
				(0.067)					
CEO relative incentive > 1	+/-				0.099				
					(0.076)				
Ln_pension relative leverage	+/-					-0.004			
						(0.067)			
Ln_defer relative leverage	+/-					-0.039			
						(0.059)			
Ln_pension relative incentive	+/-						0.018		
							(0.053)		
Ln_defer relative incentive	+/-						-0.037		
							(0.047)		
Pension relative leverage > 1	+/-							0.016	
								(0.096)	
Defer relative leverage >1	+/-							-0.010	
								(0.086)	
Pension relative incentive > 1	+/-								0.054
									(0.097)
Defer relative incentive > 1	+/-								0.075
									(0.116)
Firm_size	+	0.441***	0.438***	0.440***	0.430***	0.443***	0.438***	0.437***	0.431***
		(0.033)	(0.034)	(0.037)	(0.043)	(0.039)	(0.037)	(0.030)	(0.034)
RD_intensity	+	2.872***	2.846***	2.856**	2.835**	2.930*	2.941***	2.867***	2.802***
		(1.090)	(0.937)	(1.205)	(1.302)	(1.541)	(0.894)	(1.086)	(1.049)
ROA	+	0.012	-0.008	0.005	-0.064	0.022	0.005	-0.007	-0.060
		(0.519)	(0.503)	(0.506)	(0.458)	(0.523)	(0.438)	(0.525)	(0.502)
MB	+	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000
		(0.005)	(0.004)	(0.005)	(0.004)	(0.004)	(0.007)	(0.004)	(0.004)
Leverage	-	-0.795***	-0.750**	-0.772**	-0.671**	-0.839**	-0.806**	-0.759**	-0.671*
		(0.295)	(0.304)	(0.370)	(0.319)	(0.382)	(0.377)	(0.369)	(0.355)
Ln_CEO age	-	-0.173	-0.194	-0.182	-0.252	-0.168	-0.197	-0.197	-0.243
		(0.408)	(0.278)	(0.368)	(0.389)	(0.321)	(0.356)	(0.316)	(0.300)
Ln_CEO tenure	-	-0.069	-0.070	-0.070	-0.074	-0.068	-0.069	-0.070	-0.074*
		(0.056)	(0.055)	(0.049)	(0.057)	(0.060)	(0.049)	(0.057)	(0.042)
Ln_CEO delta	+/-	-0.040	-0.037	-0.039	-0.026	-0.042	-0.039	-0.037	-0.028
		(0.055)	(0.043)	(0.057)	(0.056)	(0.062)	(0.057)	(0.056)	(0.059)
Ln_CEO vega	+	0.170***	0.170***	0.170***	0.166***	0.171***	0.171***	0.170***	0.167***
		(0.040)	(0.038)	(0.041)	(0.039)	(0.039)	(0.039)	(0.040)	(0.039)
Ln_in_directors	+	0.275	0.271	0.278	0.235	0.273	0.269	0.269	0.252
		(0.583)	(0.588)	(0.660)	(0.652)	(0.538)	(0.625)	(0.587)	(0.669)
Pro>ChiSq		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Observations		3,876	3,876	3,876	3,876	3,876	3,876	3,876	3,876

Table 12

The interactive effect of high R&D intensity and CEO inside debt compensation on the number of patents

Table 12 presents the empirical results of Tobit model which is estimated with 2-digit SIC code industry and year fixed effects in the full sample.

Model (3): $Innovation_{i,t} = \alpha + \beta_1 Insidedebt_{i,t-1} + \beta_2 RDQ4_{i,t-1} + \beta_3 Insidedebt*RDQ4_{i,t-1} + \gamma Control_{i,t-1} + \textit{Year fixed effects} + \textit{Industry fixed effects} + \varepsilon_{i,t-1}$. The dependent variable is *Ln_patent* (the natural logarithm of one plus the number of patents during a given year). RDQ4 is dummy variable which takes value 1 if R&D intensity of firms is in the 75th percentile and 0 otherwise. The description and definition of variables are provided in table 1. Bootstrapped standard errors in parentheses. ***, **, * represent significance at the 1%, 5%, 10% levels.

Dependent variable: Ln_patent	Expected sign	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ln_CEO relative leverage	+/-	0.014							
		(0.066)							
Ln_CEO relative leverage * RDQ4	-	-0.080							
		(0.074)							
Ln_CEO relative incentive	+/-		0.017						
			(0.060)						
Ln_CEO relative incentive * RDQ4	-		-0.074						
			(0.071)						
CEO relative leverage > 1	+/-			0.279***					
				(0.083)					
CEO relative leverage > 1 * RDQ4	-			**-0.657*** **					
				(0.161)					
CEO relative incentive> 1	+/-				0.382***				
					(0.105)				
CEO relative incentive> 1 * RDQ4	-				**-0.728*** **				
					(0.152)				
Ln_pension relative leverage	+/-					0.044			
						(0.077)			
Ln_defer relative leverage	+/-					-0.046			
						(0.098)			
Ln_pension relative leverage * RDQ4	-					**-0.281** **			
						(0.110)			
Ln_defer relative leverage * RDQ4	+/-					0.100			
						(0.114)			
Ln_pension relative incentive	+/-						0.060		
							(0.086)		
Ln_defer relative incentive	+/-						-0.059		
							(0.096)		
Ln_pension relative incentive *RDQ4	-						**-0.300** **		
							(0.127)		
Ln_defer relative incentive *RDQ4	+/-						0.107		
							(0.113)		
Pension relative leverage > 1	+/-							0.126	
								(0.162)	
Defer relative leverage >1	+/-							0.116	
								(0.204)	
Pension relative leverage > 1 * RDQ4	-							**-0.482** **	
								(0.207)	
Defer relative leverage >1 * RDQ4	+/-							-0.174	
								(0.205)	
Pension relative incentive > 1	+/-								0.220**
									(0.110)
Defer relative incentive > 1	+/-								0.223
									(0.168)
Pension relative incentive> 1 * RDQ4	-								**-0.650*** **
									(0.222)
Defer relative incentive > 1 * RDQ4	+/-								-0.267
									(0.197)
RDQ4	+	0.701***	0.699***	0.929***	0.982***	0.718***	0.723***	0.809***	0.883***
		(0.120)	(0.120)	(0.126)	(0.134)	(0.145)	(0.136)	(0.158)	(0.135)
Control variables		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ChiSq		2683.11	2021.81	3095.23	3343.26	2911.91	4063.07	2680.69	1728.50
Pro>ChiSq		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Observations		4,448	4,448	4,448	4,448	4,448	4,448	4,448	4,448

Table 13

The interactive effect of high R&D intensity and CEO inside debt compensation on the number of citations per patent

Table 13 presents the empirical results of Tobit model which is estimated with 2-digit SIC code industry and year fixed effects in the full sample.

Model (3): $Innovation_{i,t} = \alpha + \beta_1 Insidedebt_{i,t-1} + \beta_2 RDQ4_{i,t-1} + \beta_3 Insidedebt*RDQ4_{i,t-1} + \gamma Control_{i,t-1} + Year\ fixed\ effects + Industry\ fixed\ effects + \varepsilon_{i,t-1}$. The dependent variable is *Ln_citation* (natural log of one plus the number of citations per patent. RDQ4 is dummy variable which takes value 1 if R&D intensity of firms is in the 75th percentile and 0 otherwise. The description and definition of other independent variables are provided in table 1. Bootstrapped standard errors in parentheses. ***, **, * represent significance at the 1%, 5%, and 10% levels.

Dependent variable: Ln_citation	Expected sign	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ln_CEO relative leverage	+/-	-0.046							
		(0.056)							
Ln_CEO relative leverage * RDQ4	-	-0.000							
		(0.059)							
Ln_CEO relative incentive	+/-		-0.028						
			(0.057)						
Ln_CEO relative incentive * RDQ4	-		-0.003						
			(0.061)						
CEO relative leverage > 1	+/-			0.071					
				(0.086)					
CEO relative leverage > 1 * RDQ4	-			**-0.287*** **					
				(0.109)					
CEO relative incentive> 1	+/-				0.184***				
					(0.069)				
CEO relative incentive> 1 * RDQ4	-				**-0.380*** **				
					(0.099)				
Ln_pension relative leverage	+/-					0.041			
						(0.086)			
Ln_defer relative leverage	+/-					-0.124			
						(0.089)			
Ln_pension relative leverage * RDQ4	-					**-0.183***			
						(0.097)			
Ln_defer relative leverage * RDQ4	+/-					0.155			
						(0.104)			
Ln_pension relative incentive	+/-						0.076		
							(0.071)		
Ln_defer relative incentive	+/-						-0.131**		
							(0.063)		
Ln_pension relative incentive *RDQ4	-						**-0.228*** **		
							(0.111)		
Ln_defer relative incentive *RDQ4	+/-						**0.177*** **		
							(0.088)		
Pension relative leverage > 1	+/-							0.052	
								(0.101)	
Defer relative leverage >1	+/-							-0.035	
								(0.103)	
Pension relative leverage > 1 * RDQ4	-							**-0.342***	
								(0.175)	
Defer relative leverage >1 * RDQ4	+/-							0.025	
								(0.109)	
Pension relative incentive > 1	+/-								0.101
									(0.117)
Defer relative incentive > 1	+/-								0.116
									(0.122)
Pension relative incentive> 1 * RDQ4	-								**-0.463*** **
									(0.175)
Defer relative incentive > 1 * RDQ4	+/-								-0.108
									(0.153)
RDQ4	+	0.236**	0.241*	0.362***	0.417***	0.254*	0.265*	0.322***	0.384***
		(0.107)	(0.131)	(0.111)	(0.108)	(0.132)	(0.137)	(0.109)	(0.080)
Control variables		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ChiSq		860.69	795.59	771.29	834.72	940.91	809.15	1073.89	956.12
Pro>ChiSq		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Observations		4,448	4,448	4,448	4,448	4,448	4,448	4,448	4,448

Table 14

The association between CEO inside debt compensation and the number of patents in highly R&D intensive firms

Table 14 presents the empirical results of Tobit model which is estimated with 2-digit SIC code industry and year fixed effects in the sub-sample of R&D intensive firms. *Model (2): Innovation*$_{i,t}$ = α + β_1*Insidedebt*$_{i,t-1}$ + γ*Control*$_{i,t-1}$ + *Year fixed effects* + *Industry fixed effects* + $\varepsilon_{i,t-1}$. The standard errors are estimated using bootstrap. The dependent variable is *Ln_patent* which is the natural logarithm of one plus the number of patents during a given year. The description and definition of other independent variables are provided in table 1. Bootstrapped standard errors in parentheses. ***,

Dependent variable: Ln_patent	Expected sign	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ln_CEO relative leverage	-	-0.046							
		(0.059)							
Ln_CEO relative incentive	-		-0.027						
			(0.040)						
CEO relative leverage > 1	-			**-0.413*** **					
				(0.106)					
CEO relative incentive > 1	-				**-0.392*** **				
					(0.122)				
Ln_pension relative	-					**-0.269*** **			
						(0.075)			
Ln_defer relative leverage	+/-					**0.104* **			
						(0.055)			
Ln_pension relative	-						**-0.251*** **		
							(0.066)		
Ln_defer relative incentive	+/-						**0.104** **		
							(0.052)		
Pension relative leverage >	-							**-0.453** **	
								(0.220)	
Defer relative leverage >1	+/-							-0.052	
								(0.135)	
Pension relative incentive >	-								**-0.523*** **
									(0.168)
Defer relative incentive > 1	+/-								-0.049
									(0.156)
Control variables		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ChiSq		1010.29	1483.44	1010.36	1206.48	1204.33	1402.96	952.53	1406.25
Pro>ChiSq		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Observations		1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112

Table 15

The association between CEO inside debt compensation and the number of citations per patent in highly R&D intensive firms

Table 15 presents the empirical results of Tobit model which is estimated with 2-digit SIC code industry and year fixed effects in the sub-sample of R&D intensive firms. *Model (2): Innovation*$_{i,t}$ = $\alpha + \beta_1 Insidedebt_{i,t-1} + \gamma Control_{i,t-1}$ + *Year fixed effects* + *Industry fixed effects* + $\varepsilon_{i,t-1}$. The standard errors are estimated using bootstrap. The dependent variable is *Ln_citation* which is the natural logarithm of one plus the number of citations per patent during a given year. The description and definition of other independent

Dependent variable: Ln_citation	Expected sign	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ln_CEO relative leverage	-	0.039							
		(0.059)							
Ln_CEO relative incentive	-		0.046						
			(0.056)						
CEO relative leverage > 1	-			-0.004					
				(0.120)					
CEO relative incentive > 1	-				0.005				
					(0.103)				
Ln_pension relative leverage	-					-0.066			
						(0.086)			
Ln_defer relative leverage	+/-					**0.138*** **			
						(0.047)			
Ln_pension relative incentive	-						-0.082		
							(0.082)		
Ln_defer relative incentive	+/-						**0.143*** **		
							(0.048)		
Pension relative leverage > 1	-							-0.117	
								(0.153)	
Defer relative leverage >1	+/-							**0.184** **	
								(0.085)	
Pension relative incentive > 1	-								-0.203
									(0.136)
Defer relative incentive > 1	+/-								**0.195** **
									(0.091)
Control variables		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ChiSq		228.28	213.30	218.40	214.57	226.36	344.26	225.76	195.74
Pro>ChiSq		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Observations		1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112

Table 16

Robustness check: The association between inside debt-to-cash compensation ratio and innovative output

Table 16 presents the results of the link between inside debt-to-cash compensation ratio and innovative output. The Tobit model is estimated with 2-digit SIC code industry and year fixed effects in the sub-sample of R&D intensive firms. The dependent variables include *Ln_patent* and *Ln_citation*. The independent variables of interest include Ln_inside debt-to-cash compensation (natural log of one plus the ratio of total inside debt holdings to salary and bonus), Ln_pension-to-cash compensation (natural log of one plus the ratio of pension benefits to salary and bonus), Ln_Defer-to-cash compensation (natural log of one plus deferred compensation to salary and bonus). The standard errors are estimated using bootstrap. Bootstrapped standard errors in parentheses. ***, **, * represent the significance at the 1%, 5%, and 10% levels.

Panel A: The interactive effect of inside debt-to-cash compensation ratio and innovative output.

Model: $Innovation_{i,t} = \alpha + \beta_1 Insidedebt\text{-}to\text{-}cash_{\ i,t-1} + \beta_2 Insidedebt\text{-}to\text{-}cash_{\ i,t-1} * Tech + \beta_{31} Tech_{\ i,t-1} + \gamma Control_{i,t-1}$ *+ Year fixed effects + Industry fixed effects +* $\varepsilon_{i,t-1}$.

Variables	Expected sign	ln_patent (1)	ln_patent (2)	ln_citation (1)	ln_citation (2)
Ln_Pension-to-cash compensation	+/-		0.076*		0.074**
			(0.043)		(0.036)
Ln_Defer-to-cash compensation	+/-		-0.011		-0.033
			(0.064)		(0.058)
Ln_Pension-to-cash compensation * Tech	-		**-0.988*** **		**-0.671*** **
			(0.263)		(0.143)
Ln_Defer-to-cash compensation * Tech	+/-		-0.149		-0.121
			(0.120)		(0.077)
Ln_inside debt-to-cash compensation	+/-	0.059		0.044	
		(0.043)		(0.040)	
Ln_inside debt-to-cash compensation * Tech	-	**-0.374*** **		**-0.316*** **	
		(0.077)		(0.071)	
Tech	+	0.896***	0.942***	0.372***	0.385***
		(0.203)	(0.201)	(0.117)	(0.122)
Control variables		Yes	Yes	Yes	Yes
ChiSq		2005.73	3141.59	767.86	809.31
Prob>ChiSq		0.00	0.00	0.00	0.00
Observations		4,442	4,442	4,442	4,442

Panel B: The effect of inside debt-to-cash compensation ratio and innovative output in the sub-sample of high technology industries.

Model: $Innovation_{i,t} = \alpha + \beta_1 Insidedebt\text{-}to\text{-}cash_{\ i,t-1} + \gamma Control_{i,t-1}$ *+ Year fixed effects + Industry fixed effects +* $\varepsilon_{i,t-1}$.

Variables	Expected sign	ln_patent (1)	ln_patent (2)	ln_citation (1)	ln_citation (2)
Ln_Pension-to-cash compensation	-		**-1.187*** **		**-0.569*** **
			(0.220)		(0.114)
Ln_Defer-to-cash compensation	+/-		-0.215		-0.108
			(0.131)		(0.129)
Ln_inside debt-to-cash compensation	-	**-0.380*** **		**-0.202** **	
		(0.112)		(0.081)	
Control variables		Yes	Yes	Yes	Yes
ChiSq		573.28	963.85	70.59	202.83
Prob>ChiSq		0.00	0.00	0.00	0.00
Observations		572	572	572	572

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