Inside debt and managerial risk taking:

Evidence from UK pension reform

Hao Li [1] (Heriot-Watt University, the United Kingdom)

Jinsha Zhao [2] (Kingston University, the United Kingdom)

This version: January 2017

Abstract

We provide new evidence on the relation between inside debt and risk-taking behaviour by exploiting the change in the tax treatment of pension following the UK pension reform in 2006. The reform significantly increases income taxes associated with inside debt. CEOs inside debt, in the form of executive pensions, decline sharply after the reform, while cash compensation increases significantly. Our natural experiment, which based on difference-in-differences estimation, shows that the decline of pension compensation does not associate with any change of risk-taking behaviours. The result suggests that no causal relation exists between inside debt and risk-taking behaviour, contrary to findings in the US. Our evidences suggest that usage of CEO inside debt is a tradeoff between income taxes, firm characteristics and top managers' individual circumstances, rather than a tool to moderate firm risk.

EFM classification code: 190

Key words: Management Compensation; inside debt; pension regulation; risk-taking;

[1] Heriot-Watt University, EH14 4AS. E-mail: Hao.Li@hw.ac.uk
[2] Kingston University, KT1 1LQ. E-mail: J.Zhao@Kingston.ac.uk Corresponding author

1. Introduction

Inside debt, managerial holdings of a firm's debt, accounts for a considerable amount of a CEO's overall compensation. Sundaram and Yermack (2007) find that inside debt in the form of executive pension and deferred compensation represents about 10% of CEO's total pay. Due to its significance, many recent studies examine its effect on managerial behaviour. Edmans and Liu (2011) theorize that inside debt could be used as an efficient tool to reduce risk, as it aligns the interests of managers with that of the firm's debtholders. Cassell, Huang, Sanchez and Stuart (2012) find that inside debt is positively associated with various risk-averse firm policies. Using different measures of firm risk, other studies find similar association between inside debt and firm policies.

It is well established that a negative association exists between firm risk and inside debt, where inside debt is found to reduce firm risk. We call this the risk reduction hypothesis. For example, higher use of inside debt leads to lower loan yield (Anantharaman, Fang and Gong 2013), inside debt reduces dividend payout (Srivastav, Armitage and Hagendorff 2014 and Eisdorfer, Giaccotto and White 2015), inside debt is also positively associated with firm cash holding (Liu, Mauer and Zhang 2014), etc. Table 1 below presents a more comprehensive list of studies. It is clear that inside debt always leads to safer policy choices, be it more cash holding, lower default risk, lower bond yield spread, higher quality of financial reporting, or lower dividend payout policy.[3] While empirical work supports the risk reduction hypothesis of inside debt, all these studies are conducted in the US. Edmans and Liu (2011) are very cautious about their theoretic result, they argue that inside debt is only tested in the US, whether the same applies in another country is yet to be examined.[4] Since inside debt only reduces firm risk when the manager's payoff is less senior than outside debtholders, regulations (and other market frictions) that implicitly favour managers over outside debtholders may well make inside debt risk-inducing. If managers have the expectation that their inside debt are protected and can be withdrawn, inside debt may even increase managerial risk-taking.

[Insert Table 1 here]

[3] There are 3 papers on the list that examine inside debt and dividend payout: Srivastav, Armitage and Hagendorff (2014), Eisdorfer, Giaccotto and White (2015), Caliskan and Doukas (2015). Yet the last paper has opposite conclusions with the former two. Inside debt increases dividend payout due to CEO risk aversion. As Caliskan and Doukas (2015) argue dividend payout is less risky than investment. The 3 papers still agree on the risk reduction effect of inside debt.

[4] Kabir, Li and Veld-Merkoulova (2013) test inside debt usage and cost of debt based on a small UK sample, their results are consistent with the risk reduction hypothesis. Their final regression only has 47 observations.

In the paper we address this problem by investigating the risk implication of inside debt in the UK. Similar to managers in the US, inside debt is also widely used in the UK. A British CEO usually has more than 15% of pay in the form of debt compensation. However, results from our quasi-experiment shows that there is no consistent association between inside debt and various measures of firm riskiness. The result also holds with different measures of inside debt that is widely used in the literature, e.g. CEO leverage and CEO relative leverage. Although the result is at odds with previous studies in the US, it is worth emphasizing that empirical findings can be ambiguous yet fully support the risk reduction hypothesis. This is because proxies used for firm risk interact with inside debt as well as other firm characteristics.

For example, firm cash balance, which usually associates with low level of equity volatility, is used as a measure of firm risk. According to the risk reduction hypothesis from the literature, inside debt reduces firm risk. Naturally, inside debt should positively associate with cash balance, suggesting CEOs with more inside debt preserve more cash to improve firm's overall risk. However, cash balance also affects (and is affected by) other firm characteristics which could mitigate the risk reduction effect of inside debt. As Liu, Mauer and Zhang (2014) point out, inside debt and cash balance relation can well be negative, due to weak corporate governance and high firm leverage. To mitigate these ambiguous predictions, we control for both effects in our test similar to Liu, Mauer and Zhang (2014). Yet our results still show no consistent association between cash balance and firm risk.

Dividend payout is the second example. Inside debt is found to increase dividend payout (Caliskan and Doukas, 2015) as well as decreasing it (Srivastav, Armitage and Hagendorff, 2014, Eisdorfer, Giaccotto and White, 2015). Inside debt should increase dividend payout if payout is interpreted as risk averse behaviour (Caliskan and Doukas 2015). On the other hand, inside debt should also reduce dividend payout as it aligns CEOs' interest with that of bondholders who benefit from firms not paying dividend. We also test association between inside debt and dividend payout, again results still support a no effect relationship.

While our results differ from previous literatures conducted in the US, this is due to two possible reasons:

Firstly, risk associated with inside debt can be managed or circumvented. A few CEOs in our sample withdraw their entire inside debt well before the retirement age. While this is not a

common practice due to large tax associated with pension withdrawal,[5] it undermines the seniority assumption of firm's outside debt. Moreover, although CEOs have to disclose inside debt withdrawal during their tenure, it is not required once they leave the board, providing more options to manage the long-term risk after they leave the firm. Goh and Li (2015) also discuss the possibility that certain inside debt (unapproved pension benefits) may be structured to be payable immediately on retirement. If CEOs understand these withdrawal options, inside debt may be much more senior than it appears based on simple duration estimate, e.g. Anantharaman, Fang and Gong (2013). So inside debt may not have any impact on firm risk.

Secondly, inside debt is a tool for optimising CEO income tax. This is evident from widespread use of Supplemental Executive Retirement Benefit (SERP) in the US, yet very limited use of Employer-Financed-Retirement-Benefit-Scheme (EFRBS) in the UK. SERP and EFRBS are similar non-qualified (for tax purposes) pension plans that are designed to reward top management. As we discuss in the next section, they are both inside debt awarded to US and UK CEOs. SERP is very common in the US because income contributed into the plan is tax free, and IRS explicitly supports the use of SERP to avoid income tax. On the other hand, implementing an EFRBS plan, which provides tax free contribution, is significantly more complex and costly. This is because HMRC (UK tax authority) specifically prohibits use of non-qualified plans to avoid taxes. Similar results are also found in Goh and Li (2015), where EFRBS are rarely used in FTSE 100 firms. If CEOs use inside debt mainly to maximise tax efficiency, then its impact on firm risk is minimum.

A rather unique feature of British firms is that many CEOs have overseas pensions, i.e. inside debt that are domiciled in a different country. Although these pensions are unfunded and payout still depends on firm's solvency,[6] they may subject to completely different tax rules. As in our previous explanation, the total pension balance may be withdrawn with minimum taxes, further increases seniority of inside debt and its capacity to reduce firm risk. To mitigate this effect, we also modified our base model to accommodate CEOs with overseas pension. But this does not change our results; inside debt still has no effect on firm risk.

Our quasi-experiment also addresses the endogeneity problem that plagues empirical studies. We use the 2006 UK pension reform as an exogenous event to test whether the association

[5] This is also true in the US. Based on data from Execucomp, there are 11 (out of 1,744) CEOs withdraw the full balance of their inside debt in 2014.
[6] Most overseas pensions are based in the US.

between inside debt and firm risk is truly causal. The UK pension reform significantly increases taxes associated with various types of pension compensation. Our results show that inside debt in the form of defined benefits (DB) pension suffered a significant drop after the reform. Specifically, firms are 30% less likely to reward DB. Most firms simply close their DB schemes (or have it frozen) and start replacing DB with cash compensation. Apart from reducing inside debt, the pension reform does not affect other firm characteristics. If the association between inside debt and risk is indeed causal, we should observe an equally increase in the firm's risk corresponding to a drop in the use of inside debt. Yet we do not observe those risk increases during the same period. Firms that rigorously reduce CEO inside debt also witness the largest decrease in firm risk, suggesting that inside debt are motivated by objectives other than risk reduction. In short, our results show that inside debt has no consistent impact on the four measures of risk – CAPEX, cash balance, market volatility and dividend payout. There is simply no causal association between inside debt and firm risk. The result is quite robust in the UK.

The quasi-experiment is based on difference-in-differences (DID), which is widely used in the economics literature to examine impact of regulation change. The UK pension reform has different tax impact on each CEO's compensation depending on the amount of inside debt he/she receives every year. We define CEOs with the highest amount of inside debt (who are also the mostly affected) as our treatment group; and CEOs with lower inside debt are the control group. A main criticism of this approach (and all natural experiment based research) is that the allocation of treatment and control may not be random. Since CEOs with large inside debt usually works for the largest firms, this means our treatment group only contains the largest firms. The group allocation between treatment and control may well be endogenous. To mitigate this problem, we employ cross-sectional time differenced regressions (Khwaja and Mian, 2008; Hayes, Lemmon and Qiu 2012) using observations from pre- and post regulation change, this approach directly examines the sample as a whole so avoid the endogenous allocation problem in our baseline design. Again, the results is still the same, inside debt does not affect firm risk at all.

This paper contributes to the executive compensation literature in three ways. Firstly, it provides evidences of inside debt usage outside the US. The results of the paper suggest that the risk reduction effect of inside debt (documented in the US) is simply not present in the UK, where more strict tax rules on pension tax deferral is in place. To best of our knowledge, we are the first study that comprehensively examines relationship between inside debt and

firm risk in the UK. Secondly, our natural experiment provides new causality evidences between inside debt and firm risk. Previous studies rely mostly on instrumental variables to make causal inference between inside debt and firm risk. While this is a standard procedure for mitigating endogenity problem, it also suffers a number of criticisms (Larcker and Rusticus, 2010, Gow, Larcker and Reiss, 2016). Our difference-in-differences test addresses this problem by using the UK pension reform as an exogenous event; the results suggest that there is no causal relationship between inside debt and firm risk. Finally, the paper provides new empirical evidences on executive compensation and regulation. Although theory suggests that inside debt reduces firm risk, regulations are rarely incorporated into theoretic models. Our unique results suggest that regulations are far more important than the simple agency interaction among CEO, shareholders and bondholders.

2. Hypotheses development

2.1 Tax Benefit hypothesis

Pension is an important component in executive remuneration contract design. In our sample of FTSE 100 CEOs from 2003 to 2015, annual pension stands at £560,000 on average, accounting for more than 10% of annual compensation. Executive may favour pension for two reasons. Firstly, it is a windfall payment. CEO pension is normally a fixed percentage of salary, which is independent from any firm performance measurement. Goh and Li (2015) document that pension works as a substitute for performance-based compensation, especially for bonus. Secondly, pension may have tax advantages over other forms of compensation. In the US, the mains stream executive pension SERP is tax-free on contribution, unlike any of other pay components. In the UK, tax rules of pension were very complex. It creates room to use pensions as tools for tax avoidance. In another word, the tax avoidance may motivate managers to abuse the usage of pension.

In order to curb tax avoidance, HM Revenue & Customs introduces annual and lifetime allowances for all UK pension schemes in April 2006. After the regulation change, tax bill will impose immediately if annual pension contribution exceeds annual allowance, or pension withdraw accumulation reaches life allowance. The highest tax rate stands as high as 55%. More importantly, such an allowance reduces dramatically in recent years. From 2014/2015 tax year, the annual allowance for pension is £40,000, while that for life allowance is £1.25 million. Such a reform significantly impairs the tax benefit for UK pension holders, especially for those with a large chunk of pension. It hits UK CEOs hard.

If top managers are motivated to employ pension as a tool for tax evasion, then CEOs will alternate the form or level of pension if tax treatment on pension changes. Here comes our tax benefit hypothesis. The UK pension reform introduces new tax allowances which limit tax-free pension contribution. Therefore, we expect a significant decline of using both DB and DC, while a sharp use of cash in lieu as the substitute. The specific hypotheses are listed as follows.

H_1: *CEOs receive fewer defined benefit pensions (DB) after the pension reform*

H_2: *CEOs receive fewer defined contribution pensions (DC) after the pension reform*

H_3: *CEOs receive more cash-in-lieu of pension after the pension reform*

2.2 Risk reduction hypothesis

As summarized in Table 1, there are dominating findings that CEO inside debt in terms of pension will discourage firm risk in the literature. The theoretical argument is that pension make CEOs potential debt-holders. It should be addressed that the concept of inside debt applies to defined benefit (DB) pension only, not for defined contribution (DC) pension. Firms are responsible for funding the deficit of DB, while not for DC plans.

Following the literature, we expect a positive association between firm risk reduction and CEO pension. That is a decline of DB pension will lead to a higher level of firm risk taking. If UK 2006 pension reform significantly reduces the expected payoff of pension, then we should expect that firms with high CEO DB pension should experience a relatively small decline in risk taking.

We consider several proxies for firm risk taking. Our first proxy is a firm's cash holding level. Following Liu, Mauer and Zhang (2014), we expect that a higher level of cash holdings may indicate a more conservative policy.[7] A high level of cash holdings may help to fund possible DB pension deficit, easing the concern of the safety of pension. Hence, we expect a decline of cash holding if CEOs have lower level of DB pension. Putting the risk reduction hypothesis in the context of 2006 UK pension reform, we specify our hypothesis as follows.

[7] Liu, Mauer and Zhang (2014) also argue that cash balance is a tool to counter weak firm corporate governance. Their financial contracting hypothesis also predicts a negative association between inside debt and a firm's cash holding.

H_4: *If DB pension reduces firm risk, then the increase of a firm's cash holding is lower for CEO with high level of DB pension after the pension reform.*

Our second proxy for firm risk taking is dividend payout. This hypothesis follows findings of Srivastav, Armitage and Hagendorff (2014); Eisdorfer, Giaccotto and White (2015); Caliskan and Doukas (2015). Since inside debt aligns CEOs' interest with that of the bondholders, it may reduce shareholders returns in the form of dividend payout. Hence, we expect a negative relation between CEO DB pension and dividend payout. Similar with H4, our specific hypothesis is as follows.

H_5: *If DB pension reduces firm risk, then the reduction of a firm's dividend payout is lower for CEO with high level of DB pension after the pension reform.*

We also use research & development expenditure (R&D), capital expenditure (CAPEX) and stock return volatility as alternative proxies for firm risk taking. Those proxies are examined in the US data (e.g. Cassell, Huang, Sanchez and Stuart, 2012). They document that CEO inside debt is negatively related with R&D, CAPEX and equity volatility. If CEO DB pension does discourage R&D, CAPEX and volatility, then its effect will be smaller after the UK 2006 pension reform. Because there is a significant discount for the expected payoff of pension after the reform.

H_6: *If DB pension reduces firm risk, then the reduction of a firm's R&D is lower for CEO with high level of DB pension after the pension reform.*

H_7: *If DB pension reduces firm risk, then the reduction of a firm's CAPEX is lower for CEO with high level of DB pension after the pension reform.*

H_8: *If DB pension reduces firm risk, then the reduction of a firm's return volatility is lower for CEO with high level of DB pension after the pension reform.*

3. Compare the tax treatment on pension in the US and the UK

Our results depend on the unique institutional setting in the UK. It is important to explain the main regulatory differences in executive pension between the US and the UK. As pension choices are partially driven by tax efficiency, it is important to look at the differing tax rules in the US and UK. In the US, firms can grant debt-like compensations to their CEOs in two ways: tax qualified pension plan and nonqualified pension plan. Qualified plan, usually take the form of 401(k), is a defined contribution (DC) pension plan that are available to every

employees. Contribution to 401(k) plan is tax-free up to an annual limit, which is set to $18,000 in 2016. Any contribution beyond this limit is subject to income tax. DC pension is independent from the firm. DC pension assets are protected and separate. Hence, DC pension does not generate incentives for firm risk taking or avoiding (e.g. Anantharaman, Fang and Gong 2013). Nonqualified plans, usually take the form of supplemental executive retirement plan (SERP), are pension plans that specifically designed to reward top managers. SERP is very popular in the US because CEOs do not pay income tax on any contribution, as long as SERP is unfunded and unprotected. Because SERP is nonqualified, it provides firms certain flexibility on how to structure it. Unfunded nonqualified plans are designed to be tax efficient, recognized by US tax authority IRS publically.[8] Since there is no limit on the amount of contribution, SERP is usually used to top up executive pension once CEOs exhaust the limit in 401(k). While CEOs still pay taxes when they start receiving retirement benefit, many options to reduce income tax are available at retirement. For example, US CEOs can move to a state with a lower state income tax rate.

Similar to their US counterparts, UK CEOs receive pension from two sources: tax approved pension schemes and unapproved pension schemes. Tax approved schemes, usually takes the form of occupational defined contribution scheme, functions almost identical to 401(k) in the US. CEOs can make tax-free contribution up to a certain limit into the scheme. In 2016/2017 tax year, such a tax-fee allowance is £40,000. Again, since approved schemes are protected and funds set aside, it may not generate any incentives for CEOs to moderate firm risk. However, unapproved schemes in the UK are quite different to their US counterparts. Contribution to unapproved pension schemes do not benefit any tax relief in the UK. Special unapproved scheme, such as Employer-Financed-Retirement-Benefit-Scheme (EFRBS) can be setup to evade the contribution limit, but the scheme is overwhelmingly complex and quite costly to operate. The literature also documents that it is popular in the UK (e.g. Goh and Li 2015). It is very clear that UK tax authority HMRC deliberately disqualifies tax benefit for unapproved pension scheme in the UK[9]. In summary, UK CEOs cannot match the tax benefit for their pension schemes with their US counterparts. The expected payoff of CEO pension ("taking home value") is much lower than its paper value in the annual report in the UK

[8] See IRS Technical Guidelines for Employment Tax, available at: https://www.irs.gov/irm/part4/irm_04-023-005r-cont01.html#d0e1980

[9] See "Tackling disguised remuneration avoidance schemes" technical note at: https://www.gov.uk/government/publications/tackling-disguised-remuneration-avoidance-schemes-overview-of-changes-and-technical-note/technical-note

4. UK 2006 pension reform

In the UK, a series of tax rules were introduced in 2006. The new rules intend to replace complicated tax regimes that govern different categories of pension schemes. The most notable features of the reforms are introduction of annual and lifetime allowances, which limits the amount of pension income/contribution that are tax deductible. The Annual Allowance (AA) limits tax relief when fund allocate/contribute to a pension scheme. It caps the amount of pension contribution that is tax-free at a given year. Any amount of pension contribution beyond the allowance is taxed as normal income. On the other hand, the Lifetime Allowance (LTA) limits tax relief when the employee (or pensioner) is receiving pension benefit. It caps the total pension amount that can be drawn from any pension schemes without triggering an extra tax charge. Any pension benefit received above this limit will be subject to the additional tax. The highest tax rate of 55% applies in such a circumstance.

The Annual Allowance (AA) was introduced primarily to streamline tax rules on pension contribution. In pre-2006 era, applying tax relief to pension contribution is very complex, involving adding up contributions under different tax regimes which governing different categories of pension schemes. The Annual Allowance(AA) simplifies this process and put a total limits on all contributions to all pension schemes. Since similar but more complicated tax reliefs are already in place prior to the 2006 reform, it is not obvious how AA will affect top managers' pay. For example, before 2006, tax reliefs on pension contributions are offered on a percentage basis, usually at 15% of pensionable income and subject to Earnings Cap (which was later replaced by AA and LTA). Given that Earnings Cap in 2005/6 tax year was £105,600, the maximum tax free contribution a CEO can put into a company pension scheme is merely £15,840 (105,600 × 15%) in that year.[10] On the other hand, AA is £215,000 when first introduced in 2006, it is enormous compared to Earnings Cap in previous year. However, a further reform in 2011 reduced AA from its highest level of £255,000 to only £50,000. This is a significant change and imposes large tax cost to top managers. Table 2 presents Earnings Cap, AA and LTA for our sample period.

[Insert Table 2 here]

[10] CEOs can use funded unapproved retirement benefit scheme (FURBS) to top up their pension contribution beyond the restriction. Since 2006, FURBS is renamed to EFRBS. But these additional contributions do not attract any tax relief, e.g. they are taxed as normal income. However, unapproved scheme has a critical advantage: at retirement, pension benefit can be withdrawn as a lump sum tax-free.

The Lifetime Allowance (LTA) puts a more significant cost to pension benefits. Prior to LTA, retired top managers pay income tax when they start receiving pension benefits, usually at the top income tax rate, currently at 45%. Before 2006, annual pension benefit is also limited by a maximum amount. The maximum pension is usually two thirds of a CEOs final salary or Earnings Cap, whichever is lower. For example, the Earnings Cap in 2005/06 tax year was £105,600, which means the maximum benefits retired CEOs can get from an approved pension scheme is £70,400 in that year.[11] Since 2006, such a limit is lifted and replaced by the LTA. Under the new rule, there is additional charge if their total pension benefits are valued over the LTA. The excess attracts a tax charge of 25% if it is withdrawn as an income or 55% if it is withdrawn as a cash lump sum. The LTA is £1.25 million from 2014/2015 tax year, indicating no or little impact on ordinary pensioners. However, top managers are highly likely to be affected by LTA, due to their generous remuneration package.

5. Research design

According to our tax benefit hypothesis, we expect a significant decline of defined benefit (DB) and defined contribution pension (DC), while a sharp increase of cash in lieu after UK 2006 pension reform. Since the introduction of LTA and AA reduce pension expected payoff, this reduction hurts CEOs the most as they usually have a large amount of pension. We also consider the introduction of lower AA in 2011 separately. Because such a change decreases CEOs' pension payoff even further. In short, we split our regulation examination into two periods. The first period is between 2006 and 2011, addressing the impact of initial LTA introduction. The second period is between 2011 and 2015, focusing on the impact of significant cut in AA. Those models are listed below.

$$\begin{aligned}\text{Prob (pension type =1)}_{i,t} &= \alpha_0 + \alpha_1 \text{ Between Apr06 and Apr11} + \alpha_2 \text{ After Apr11} \\ &+ \alpha_3 \Sigma \text{ CEO characteristics}_{i,t} + \alpha_4 \Sigma \text{ Board characteristics}_{i,t} \\ &+ \alpha_5 \Sigma \text{ Firm characteristics}_{i,t} + \alpha_6 \text{ Industry}_t + \varepsilon_{i,t} \qquad (1)\end{aligned}$$

We use probit model in equation (1), where dependent variables are indicator variables of DB pension, DC pension and Cash in lieu. They equal to one if a CEO has defined benefit, defined contribution or cash in lieu pension individually, otherwise zero. Our most interested variables are indicator variables of "BetweenApr06 and Apr11" as well as "AfterApr11". The former equals to one if an observation is between 6th April 2006 and 5th April 2011, otherwise

[11] Again, CEOs can receive additional benefits beyond this limit using unapproved schemes. As discussed in previous footnote, unapproved scheme is very attractive because the total benefit can be withdrawn for tax-free. It is also a common practice to top up CEOs pension based on this method.

zero. The latter equals to one if an observation is after 5th April 2011, otherwise zero. To control other factors that may affect CEO pension type, we add CEO (age, tenure and nationality), board (CEO duality and board independence) and firm characteristics (size, market to book ratio, leverage, profitability and stock return volatility) in equation (1). Those control variables are widely used in CEO pension literature (e.g. Cassell, Huang, Sanchez and Stuart 2012; Anantharaman Fang and Gong 2013). We also control for industry fixed effect, but not for years fixed effect in equation (1). As years fixed effect overlap our variables of "Between Apr06 and Apr11" as well as "AfterApr11". Such a design to drop years fixed effect is consistent with similar studies (e.g. Goh and Li, 2015) for investigating the impact of financial crisis on UK executive pension.

$$\begin{aligned}\text{Pension value}_{i,t} &= \alpha_0 + \alpha_1 \text{ Between Apr06 and Apr11} + \alpha_2 \text{ After Apr11} \\ &+ \alpha_3 \Sigma\text{CEO characteristics}_{i,t} + \alpha_4 \Sigma \text{ Board characteristics}_{i,t} \\ &+ \alpha_5 \Sigma \text{ Firm characteristics}_{i,t} + \alpha_6 \text{ Industry}_t + \varepsilon_{i,t} \end{aligned} \quad (2)$$

In equation (2), we employ firm fixed effect model, where dependent variables are continuous pension variables. We consider both of the absolute value of a particular pension type (e.g. CEO total DB pension value in pound sterling) as well as its relative value (e.g. CEO annual DB pension / total annual pension). Our interested independent variables and control variables are the same as those in equation (1). We further conduct Wald test to examine differences between variables of "Between Apr06 and Apr11" and "After Apr 11" both in equation (1) and (2). We intend to investigate whether those two important pension regulations changes (April 2006 and April 2011) have any impact on CEO pension or not.

Previous literatures normally employ OLS and fixed effect models to investigate the association between inside debt and firm risk. In most cases, dependent variables are proxies of risk taking and independent variables are CEO pensions. Table 3 summarises most relevant research designs for this topic in the literature. While all these studies used instrumental variables to mitigate the endogeneity problem, it does not completely remove the bias.[12] As Cassell, Huang, Sanchez and Stuart (2012) suggest: "we cannot completely eliminate endogeneity as a potential confounding factor".

[Insert Table 3 here]

[12] Lacker and Rusticus (2010) criticise the overwhelming application of instrumental variables in empirical studies. They argue, in many cases, estimates from instrumental variables are no better than estimates from OLS.

To solve this problem, we use an experiment-based approach that is widely used to examine effects of regulation change. To identify a true causal relationship between CEO defined benefit pension and a firm's risk taking policies (e.g. a firm's cash holding). we require an exogenous shock which affects CEO's pension value. The shock also must not influence the firm's cash holding policy. The introduction of pension allowances after April 2006 is an ideal shock in this circumstance. The pension regulation change decreases CEO pension, while have little or no direct impact on a firm's cash holding policy. We take advantage of the pension regulation change to investigate the causal relationship between CEOs defined benefits pension and firm risk.

If CEOs' defined benefit pension leads to a lower firm risk (positive association between defined benefit pension and a firm's cash holdings); then firms with high CEO defined benefit pension should experience a relatively small increase in firm's cash holding after April 2006. As the introduction of pension allowance discounts pension value significantly, CEOs with large amount of defined benefits are likely to see their pension value drops the most. We employ the difference-in-difference method (DD) to capture the possible impact of regulation change. This method has been widely used to test the impact of regime shift in labour economics (e.g. Gruber, 1994; Meyer, Viscusi and Durbin 1995) and CEO remuneration contract design (e.g. Low, 2009; Sauset, Waller and Wolff, 2015). Our models are listed below.

$$\text{Cash}_{i,t} = \alpha_t + \beta_i + \gamma X_{i,t}\,(\text{CEO / board / firm characteristics}) + \varphi \text{High}_{i,t} * \text{After Apr 06} + \varepsilon_{i,t} \quad (3)$$

Equation (3) is a difference-in-difference estimation (DD), where dependent variable is a firm's cash holding (cash/ total assets). α_t and β_i are years and firm fixed effect individually. $X_{i,t}$ is a vector of control variables, including CEO, board and firm characteristics. Previous literatures suggest that those control variables may affect a firm's cash holding (e.g. Bates, Kahle and Stulz 2009; Liu, Mauer and Zhang 2014). Our interested variable is the indicator variable, $\text{High}_{i,t}$*After Apr 06. "High" is an indicator variable, which equals to one if a CEO's defined benefit pension exceeds pension allowance. As there are two types of allowance (lifetime and annual), we employ three separate indicator variables to represent the group of "high" defined benefit pension: CEO whose DB pension exceeds lifetime allowance; CEO whose DB pension exceeds annual allowance; and CEO whose DB pension exceeds either lifetime or annual allowance. "After Apr 06" is another indicator variable, which equals to one if the observation is after 6th April of 2006. In short, the coefficient φ of

variable "High $_{i,t}$*After Apr 06" is expected to compare the change in firm cash holding for CEOs with high level of defined benefit pension before and after pension regulation change with that for CEOs with control firms over the same periods. Control firms are those CEOs with low level of defined benefit pension. Their pension value does not exceed any of the two pension allowances. Following Low (2009) and Sauset, Waller and Wolff (2015), our model cannot contain non-interactive variables of "High" and "After Aday 06", because year and firm fixed effects are already involved in α_t and β_i.

In equation (3), we consider the treatment group as those CEOs' pension exceeds pension allowance. However, a CEO's pension may not be affected by UK pension regulation at all, if the pension registered outside of the UK. There are quite a few non-British CEOs in FTSE 100 firms. These CEOs are contributing into overseas pension schemes, particularly in the form of US SERP. This is because most foreign CEOs in our sample are US citizens. As those non-UK pension schemes are not subject to British pension regulation, we redefine our treatment groups as follow: (1) pension value exceeds allowance; and (2) pension scheme is not registered outside of the UK. Therefore, we modify our equation (3) as below.

$$\text{Cash}_{i,t} = \alpha_t + \beta_i + \gamma X_{i,t}\,(\text{CEO / board / firm characteristics}) + \varphi\, \text{UK}_{i,t} * \text{High}_{i,t} * \text{After Apr 06} + \psi_1\, \text{UK}_{i,t} * \text{High}_{i,t} + \psi_2\, \text{UK}_{i,t} * \text{After Apr06} + \psi_3\, \text{High}_{i,t} * \text{After Apr06} + \varepsilon_{i,t} \quad (4)$$

Equation (4) is a difference-in-difference-in-difference estimation (DDD). The extra difference comes from the difference of "High and non-UK" CEOs. Such a group of CEOs exceed pension allowances but may be immune from the regulation change. These CEOs do not belong to the treatment (UK CEOs exceeded pension allowances) nor control group. Such a difference is added in, so that changes that are not attributable to the treatment effect (regulation change) are removed from the difference-in-difference estimator. Those variables of Cash, α_t, β_i, $X_{i,t}$, "High" and "After Apr 06" in equation (4) are identical with those in equation (3). A new indicator variable, "UK", is added. It equals to one if a CEO does not have non-UK pension scheme, otherwise zero. Our interested variable is "UK $_{i,t}$ * High $_{i,t}$*After Aday 06". It highlights a firm's cash holding policy, when its CEO is subject to UK pension regulation and his or her pension value exceeds any allowance after April 2006. Following Gruber (1994) and Meyer, Viscusi and Durbin (1995), three additional interactive variables (ψ_1 ,ψ_2 and ψ_3 as coefficients) are also added in equation (4). Because the higher-level interaction effect (UK * High $_{i,}$*After Aday 06) may be confounded if lower-level interactions are omitted.

6. Data and sample description

The sample consists of all non-financial and non-utility firms that are listed in the FTSE 100 index. The sample period starts from financial year 2003 through 2015. CEO compensation data is mainly collected from BoardEx. This database provides information on the values of most compensation components. Pension data are hand-collected from company annual report. All firm level data are collected from Bloomberg. Since the first set of pension reforms took effect in April 2006, we define 1st April 2006 as the beginning of the first post-reform period. A second set of reforms takes effect in April 2011 where annual allowance was dropped to £50,000. We define financial year 2011 as the second post-reform period. Our sample covers 3 years before and after each reform. We also restrict our sample to those CEOs who have tenure over one year period. It is difficult to judge whether current CEO or predecessor decides a firm's financial policy, when a CEO have tenure less than one year. Our final sample consists of 744 firm year observations from 122 unique firms.

[Insert Table 4 here]

The sample descriptive statistics are listed in Table 4. Those percentages of CEOs who have defined benefit, defined contribution and cash in lieu pension are 47%, 33% and 38% respectively. Defined benefit is the most popular CEO pension type. On average, CEO annual pensions are £392,000, £63,000 and £105,000 for defined benefit, defined contribution and cash in lieu respectively. Defined benefit is by far the most generous pension type for CEO. On average, CEOs hold £2.7 million defined benefit pension in terms of transferable value. In our sample, CEOs' defined benefit pension value is 18% of his or her equity incentives value (DB to equity ratio=0.18). The mean value for the variable of "high DB" is 0.38. It indicates that 38% of CEOs exceeds either annual or lifetime allowance due to their defined benefit pension. The mean value for the variable of "UK" is 0.93. It suggests that 7% of CEOs do have non-UK pension scheme in our sample. Their overseas pensions are usually based in the US.

For CEO and board characteristics, our sample shows that CEOs are 54 years old with 6-year tenure on average. A large proportion of CEOs are non-British (Foreign CEO=0.43). The vast majority of CEOs do not hold the position as chairperson (CEO duality=0.04). Independent directors also outnumber executive directors (Board independence=69.29).

As far as a firm's cash holding is concern, our sample demonstrates that a firm has 7.82% of its total assets in the form of cash on average. Liu, Mauer and Zhang (2014) shows that the

US firms' cash holding level is much higher (close to 20%). Our sample firms are in general large, profitable and not highly geared. They also spend substantial amount of resources in both research & development expenses and capital expenditure. 94% of our observations do pay cash dividend. In short, those firm characteristics are consistent with the perception of FTSE 100 firms' profiles.

[Insert Table 5 here]

Table 5 shows correlation between our main variables. It shows that post regulation change period (e.g. Between Apr06 and Apr11; After Apr11) and CEO defined benefit pension variables (e.g. DB to equity ratio) are negatively related in most cases. This fits our prediction that CEO defined benefits pension decline after regulation change. Cash holdings are negatively correlated to CEO defined benefit pension. This is consistent with the spending and financial contracting hypothesis (where cash holdings and inside debt are negatively associated) proposed in Liu, Mauer and Zhang (2014). In addition, correlations indicate that CEOs tends to have more defined benefit pensions when firms are large, more geared and less volatile.

7. Result

7.1 CEO pension trends

Figure 1 plots time evolution of CEO's annual pension and percentage of pension value. It is clear that pension pay declined dramatically after regulation change. The mean annual pension value was £751,000 in April 2006. Such figure decreases to only £331,000 at the end of 2015, over 55% drop. In addition, pension accounted for over 17% of CEO annual compensation in April 2003, while only 6% at the end of 2015. After regulation change, firms are paying less and less pension to their top managers.

[Insert Figure 1 here]

Pension type changes considerably as well. As shown in Figure 2, cash in lieu gradually replaces defined benefit pension as the dominate type of pension pay. The percentage of CEOs with defined benefit pension declined from 79% in the early 2003 to just 33% at the end of 2015. On the contrary, the percentage of CEOs with cash in lieu increases from 14% to 48% over the same period. In another word, cash in lieu is becoming the most important pension type for UK CEOs.

[Insert Figure 2 here]

The regulatory changes introduced in the past few years gradually increases tax cost of awarding pension. The annual allowance (AA) was £215,000 in April 2006 and then cut to £40,000 in April 2014. The lifetime allowance (LTA) was £1.5 million and then cut to £1 million over the same period. In Figure 3, we see that 77% of CEOs with defined benefit pension exceeded either annual or lifetime allowance in April 2007. Such a figure increased to 100% at the end of 2015. Figure 3 clearly show that more and more CEOs are subject to unfavourable tax treatment in recent period.

[Insert Figure 3 here]

7.2 Univariate analysis

In Table 6, we present the mean and median value of a firm's cash holding for CEOs with different level of defined benefit pension over different periods. In panel A, we split our sample into two categories, depending on their defined benefit pension value. The group of "High CEO DB pension" indicates CEOs whose defined benefit pension exceeds either annual or lifetime allowance at a given year. For those CEOs prior to April 2006, we use allowance figures in April 2006 as the benchmark. In panel B and C, we classify "high CEO DB pension in terms of life allowance" and "high CEO DB pension in terms of annual allowance", based on lifetime and annual allowance figure respectively. We also consider three periods to address the possible impact of regulation change. The period of "Prior Apr06" indicates the effect prior to pension allowances introduction. The period of "Between Apr06 and Apr11" shows the impact after initial pension allowance introduction. The period of "After Aday11" addresses the impact of a significant cut in annual allowance.

If CEO defined benefit pension really causes firms to reduce risk, we expect to observe a significant difference in firms' cash holding between firms that pay large amount of defined benefits to their CEOs and those that pay small amount. This is demonstrated in Table 6: the average cash holding for CEOs with high level of defined benefit pension prior to April 06 is 6.52% in panel A. Such a figure for firms with low CEO defined benefit pension in the same period is 6.46%. The difference of cash holding between those two groups is not significant. We find similar results in panel B and C as well. The only exception is in the period of "Between Apr06 and Apr 11". The result shows that CEOs with high level of defined benefit pension intend to have a lower level of cash holding in such a period, and is significant at 1% level. Overall, this simple demonstration shows that the mean and median value of a firm's cash holding are not significantly different between CEOs with high and low levels of defined benefits.

[Insert Table 6 here]

7.3 The impact of pension regulation change on CEO pension

Table 7 demonstrates impact of pension regulation change. In panel A, we look at the impact of regulation change on CEO pension type. Results clearly show that the introduction of pension allowance (variable of "Between Apr06 and Apr11") and a significant cut in annual allowance (variable of "After Apr11) make CEOs more likely to receive cash in lieu (columns 5 and 6), while less likely to get defined benefit pension (columns 1 and 2). As far as the defined contribution pension is concerned, its popularity declined significantly after April 2011 (column 3 and 4). According to control variables, we observe that CEOs are more likely to receive defined benefit pension when he or she is a British with shorter tenure; there are fewer independent directors in the boardroom; firm is larger and more profitable; and firm's stock return is less volatile.

In panel B, we examine the impact of regulation change on CEO pension value. We consider both of absolute value of CEO pension (column 1) as well as of its relative value (columns 2-6). Similar with those results in panel A, we find that pension regulation changes in April 2006 and April 2011 significantly decrease CEO's defined benefit pension value; while increase cash in lieu value. For instance, the proportion of CEO defined benefit pension in total pension decreases by 33.33% after April 2011 (column 4). On the contrary, the proportion of cash in lien in total pension increases by 39.06% over the same period (column 6).

Furthermore, we examine whether April 2006 and April 2011 affect CEO pension differently. The Wald test results confirm that April 2011, a significant cut in annual allowance, imposes a stronger effect on CEO pension, compared to April 2006. For example, the coefficients of "Between Apr06 and Apr11" and "After Apr11" are -0.302 and -0.809 respectively in column (1) of Panel A. It shows that both regulation changes make CEOs less likely to receive defined benefit pension. However, the coefficient of "After Apr11" is larger than that of "Between Apr06 and Apr 11", and such a difference is significant at 1% level in Wald test. Clearly, the annual allowance reduction in 2011 leads to even a lower likelihood of use defined benefit pension.

In short, results of Table 7 strongly support our tax benefit hypotheses (H_1-H_3). The regulation changes increase tax cost and significantly decrease usage of defined benefits and defined contribution pension, while encourage the use of cash in lieu. The introduction of

pension allowances, especially the annual allowance cut in 2011, forces many CEOs to give up traditional pensions.

[Insert Table 7 here]

7.4 The impact of exceeding pension allowance on CEO pension

In Table 8, we examine CEO's pension choice when he or she exceeds pension allowance. Those independent variables are indicator variables that equal to one if a CEO exceeds either annual or lifetime allowance. Results show that CEOs are more likely to adopt a mix type of pension when their pensions exceed any allowance. For example, the coefficient of "CEO DB pension exceeds annual allowance" is 1.155 at 1% significance level in column (5). It indicates that CEOs are more likely to combine defined benefits pension and cash in lieu together, when their defined benefit pensions exceed annual allowance.

After the regulation change, many CEOs no longer receive any defined benefits pension. But their original defined benefits is still intact, they just do not make further contribution. CEOs are fully aware that pension is more costly after the regulation change. For instance, a CEO may only take home 45 pence for every £1 pension contribution, if the 55% rate of tax on pension apples. It is simply more cost-efficient to pay CEO with cash in lieu, where much lower tax rate implies.

[Insert Table 8 here]

7.5 Change in firm cash holding after pension regulation change

We employ difference-in-difference approach (DD) to address the causality between CEO pension and firm risk as discussed in the section five. In Table 9, the dependent variable is firms' cash holding, proxies by total cash balance over total assets. We consider CEOs with high level of defined benefit pension in terms exceeding annual or lifetime allowance separately. Our interest are the three interactive variables, "HighDB * AfterApr06", "HighDB Annual * AfterApr06", and "HighDB life * AfterApr06". As explained in previous section, if inside debt truly causes firm to engage in risk reduction policies, then we should observe a significant change in the level of a firms' cash holding.

Table 9 shows CEO pensions do not associate with the level of a firm' cash holdings. It is clear to see that there is no relation between a firm's cash holding and its CEO's defined benefit pension level. None of those coefficients ("HighDB * AfterAday06", "HighDB Annual * AfterAday06", and "HighDB life * AfterAday06") are statistically significant. It is possible that firm with more pensions intend to have weaker corporate governance, so

spending cash holdings can help reducing firm risk (as the the spending hypothesis of Liu, Mauer and Zhang 2014). It is also likely that CEOs with more pensions are more risk averse and maintain a large cash reserve. Taking those two effects together, the association between a firm's cash holdings level and its implication for risk may be not straightforward. However, we control the governance effects (e.g. independent directors, dual role of CEOs) as well as firm leverage (to control for the debt bias induced by pension), yet the result is still the same as shown in column 2, 4 and 6 in table 9.

[Insert Table 9 here]

In Table 10, we extend our difference-in-difference model (DD) to difference-in-difference-in-difference model (DDD). The rational justification is that CEOs may not be subject to UK pension regulation if his or her pension is registered outside the UK. We add one more level of interactive variable, UK. It is an indicator variable, which equals to one if a CEO does not have non-UK pension scheme (i.e. a CEO with only UK pension). Our focuses are three interactive variables, "UK * HighDB * AfterAday06", "UK * HighDB Annual * AfterAday06", and "UK * HighDB life * AfterAday06".

Results are similar to those in Table 9. We do not find any difference in a firm's cash holdings level after regulation change, despite the fact that CEO pension declines significantly after the reform.

[Insert Table 10 here]

In short, our results in Table 9 and Table 10 do not support our risk reduction hypotheses. That is CEO pension reduces firm risk. CEOs with high level of defined benefit pension do not have different level of cash holding after pension reform. The introduction of pension allowance after April 2006 does not affect a firm's cash holding level. It does not matter whether a CEO has high or low level of defined benefit pension. There is simply no association between CEO pension and firm risk.

8. Robustness check

8.1 Validation of difference-in-difference estimation

In this paper, we employ difference-in-difference (DD) and difference-in-difference-indifference (DDD) estimations to address the causal relation between CEO defined benefit pension and a firm's risk taking policies. A key assumption of the validation of DD and DDD estimation is "parallel trends". That is the trend of outcome (e.g. a firm's cash holding level)

in treat group (CEOs with high level of defined benefit pension) and control group (CEOs with low level of defined benefit pension) should be in a parallel pattern before the regulation change. We use figure 4 to illustrate the "parallel trends" assumption actually holds.

[Insert Figure 4 here]

Figure 4 shows that firms' cash holdings share similar trend for both treatment (high DB) and control group (low DB) before April 2006. Then firms' cash holding in control group is clearly higher than that in treat group after April 2006, in most observations. Such a pattern confirms the assumption of "parallel trends". Firms' cash holdings level do not change within treatment and control group, until the regulation change. In another word, the change in cash holdings for treatment group (decline after April 2006) and control group (increase after April 2006) is expected to be caused by the regulation change. DD and DDD estimation are set to capture such a treatment effect. Our models in Table 9 and Table 10 are valid.

8.2 Direct examination of CEO pension and cash holding

Following the literature summarized in Table 3, we employ OLS and firm fixed effect models to investigate the relation between a firm's cash holding level and CEO pension directly. Dependent variable is firms' cash holdings (cash / total assets). Independent variables are three defined benefit pension variables that are widely used in the literature. The first pension variable is the natural logarithm of total defined benefit pension in pound sterling (e.g. Caliskan and Doukas, 2015). It captures the absolute incentive from CEO defined benefit pension. The second pension variable is the ratio of defined benefit pension to equity incentives (e.g. Sundaram and Yermack, 2007; Cassell, Huang, Sanchez and Stuart, 2012). It captures the debt bias of CEOs' compensation. The last pension variable is a relative ratio of defined benefit pension to equity incentives, based on a firm's debt to equity ratio (Kabir, Li and Veld-Merkoulova, 2013; Liu, Mauer and Zhang, 2014). It captures the trade-off between CEO's personal leverage and that in his or her own firm level.

[Insert Table 11 here]

Those results are reported in Table 11. We employ pooled OLS in columns 1 to 3 and firm fixed effect in columns 4 to 6. Again, we do not find evidence to support the risk reduction hypothesis. The only exception is in column 1, where it shows that CEOs total defined benefit pension leads to a lower level of cash holding. However, such a result is not robust in firm fixed effect model (column 4). In summary, a firm' cash holding level is not related to

its CEOs' defined benefit pension. High level of defined benefit pension does not motivate CEO to choose a different level of cash holding.

8.3 Excluding CEOs without DB pension

In our sample, 53% of CEOs have no defined benefit pension at all. In other words, half observations for our dependent variables are zero. This is not a unique problem to the UK sample, since many firms choose not to provide CEOs with special pension arrangement. In the US, Cassell, Huang, Sanchez and Stuart (2012) also find similar percentage of zero values in their inside debt sample. It is possible that our results are driven by those zero values observations. Cassell, Huang, Sanchez and Stuart (2012) remove observations that have zero inside debt. The removal is easily explained from a modelling prospective. Since zero values do not have variation, keep these observation does not add more information to the coefficient estimate. Applying the same approach in our sample, removing 53% of the observation, our results remain similar to those in Table 8,Table 9 and Table 10. There is no evidence to support the risk reduction hypothesis.

Bekkum (2016) suggests that removing zero valued observation bias effect of inside debt. He replaces the inside debt value with an indicator variable, which equals 1 if CEOs have inside debt, 0 otherwise. Employing the same variable replacement in our sample, we re-run the DD and DDD tests. The result is still the same. There is no significant relation between inside debt and firm risk.

8.4 Alternative proxies for cash holding

In our study, we use a firm's total assets as the deflator of cash holding. We also use alternative deflators (net assets and total sale) in additional analysis. Those results remain the same as we employ cash/total assets. CEO defined benefit pension is still not related to a firm' cash holding level.

8.5 Alternative proxies for risk taking

Cash holdings are our primary proxy for risk-taking (H_4). We also employ alternative proxies to see whether our results remain robust. Those proxies are capital expenditure (e.g. Cassell, Huang, Sanchez and Stuart 2012); dividend payout ratio (e.g. Eisdorfer, Giaccotto and White 2015); dividend payout probability (e.g. Caliskan and Doukas, 2015) and total risk (e.g. Bekkum, 2016). Those proxies are also discussed in the section two, as hypothesis 5 to 8 (H_5 to H_8). Once again, we do not find that CEO pension is related with those proxies of risk taking.

8.6 Differenced cross-sectional regressions

One major criticism of natural experimental is that sample allocation may not be random. Since our treatment and control group are defined based on CEOs' pension value, which itself may be an endogenous variable. To mitigate such a problem, we use a framework similar to Khwaja and Mian (2008) and Hayes, Lemmon and Qiu (2012). The latter examines the impact of the implementation of FAS 123R in the US, where such a regulation change increases accounting cost of rewarding stock option to CEOs. The wide declines of usage of stock options after the regulation change is very similar to the UK pension reform, where pension usage simply diminishes. We follow their procedure here. Considering the following cross-sectional difference regression,

$$\Delta R_i = a_0 + a_1 \Delta F_i + a_2 \Delta D_i + \Delta \varepsilon_i \quad (5)$$

In equation (5), ΔR is change in firm risk, ΔF is change in firm characteristics and ΔD is change in CEO pension. If F and D are independent and there are no omitted variables,[13] this regression will provide evidence of the causal association between firm risk and CEO pension. Since firm characteristics, F and CEO pension, D are always jointly determined, any endogenous change of inside debt is likely to come from (or affect) changes of firm characteristics. It is crucial that change in CEO pension is exogenous, which has no effect on firm characteristics. The UK pension reform as we discussed extensively in previous sections is exogenous to any firm characteristics. The difference is taken over time, a firm is only included if it has at least one observation before and after the 2006 reform.[14] We also run the test with earlier reform date to mitigate the possibility that firms may adopt the new regulations before the final implementation in April 2006. Again, the result remain the same. We do not observe any consistent association between firm risk and CEO pension.

9. Conclusion

This paper provides new evidence on the relation between inside debt in the form of defined benefits pension and managerial risk-taking behaviour. Prior studies conducted in the US find that inside debt always leads to risk reduction policies, including higher firm cash balance, lower bond yield spread, lower dividend payout or even higher accounting reporting quality.

We examine the relation between CEO pension and risk-taking using the UK 2006 pension reform as an exogenous shock. The reform substantially increases tax cost of defined benefits

[13] This approach only eliminates time invariant omitted variables.
[14] Our final regression has 63 observations.

pension but has no direct effect on other firm characteristics. As our Figure 1 and Figure 2 show that inside debt in the form of defined benefits pension declines sharply after the 2006 reform. Yet managerial risk-taking in the forms of firm cash balance is not affected by such a change (see Figure 4). The UK 2006 pension reform provides an excellent opportunity for a natural experiment, where we employ difference-in-differences (DD) to investigate impact of CEO pension on managerial risk-taking. Our main DD results (Table 9) show that there is no consistent relation between CEO pension and managerial risk-taking. We also employ difference-in-differences-in-differences (DDD) to account for the fact that some non-UK CEOs in our samples may not be affected by the UK reform (Table 10). Yet those results remain similar.

While our results are different from all related studies conducted in the US, there are two possible explanations. Firstly, risk associated with CEO pension can be managed or circumvented by top managers in the UK. CEOs have a number of tools to influence the payoff of their pension, including when to pay and how to pay it. Therefore, CEO pension may not provide the significant incentives for risk avoiding as expected in the US literature. Secondly, the use of CEO pension is largely motivated by tax consideration. We document that UK CEOs change the level and form of their pension, following the change of tax treatment on pension. However, such a change in pension does not result in a corresponding change in firm risk taking policies.

Table 1: The literature of the impact of inside debt on firm risk taking

Papers	Sample country	Main results
Sundaram and Yemack (2007)	US	Inside debt is positively associated with distance to default
Wei and Yemack (2011)	US	Firm with more inside debt experienced bond prices rise after SEC disclosure reform
Edmans and Liu (2011)	N/A	Inside debt reduces firm risk and optimal inside debt should depend on CEO relative leverage
Cassell, Huang, Sanchez and Stuart (2012)	US	Inside debt use is associated with a variety of firm risk reduction policy
Anantharaman Fang and Gong (2013)	US	Inside debt leads to lower promised loan yield; inside debt only reduces firm risk if they are junior debt
Kabir, Li and Veld-Merkoulova (2013)	UK	Inside debt, in the form of defined benefit pension, is negatively associated with bond yield spread
Liu, Mauer and Zhang (2014)	US	Inside debt is positively associated with firm cash holdings
Srivastav, Armitage and Hagendorff (2014)	US	Inside debt is negatively associated with bank payout policy
Choy, Lin and Officer (2014)	US	Freezing defined benefit leads to higher total risk
Phan (2014)	US	Inside debt is positively associated with M&A announcement abnormal bond return
He (2015)	US	Inside debt is positively associated with financial reporting quality
Eisdorfer, Giaccotto and White (2015)	US	Inside debt is negatively associated with firm dividend pay-out
Caliskan and Doukas (2015)	US	Inside debt induces CEOs to pay more dividend
Bennett, Guntay and Unal (2015)	US	Inside debt is negatively associated with bank default risk
Bekkum (2016)	US	Inside debt is negatively associated with various measures of bank risk

Table 2: Earnings Cap, Annual Allowance and Lifetime Allowance

This table reports the pre-2006 pension allowance – Earnings Cap and the post-2006 pension allowances – annual and lifetime allowances. Earnings Cap determines annual contributions that can be made into a pension scheme without incurring any tax, it also determines the maximum amount a pensioner can receive from his/her pension scheme. Earnings Cap is replaced by Annual Allowance and Lifetime Allowance after April 2006.

Tax year	Earnings Cap (Pre-2006)	Annual Allowance (post-2006)	Lifetime Allowance (post-2006)
2002/03	£97,200	-	-
2003/04	£99,000	-	-
2004/05	£102,000	-	-
2005/06	£105,600	-	-
2006/07	£108,600*	£215,000	£1.50m
2007/08	£112,800*	£225,000	£1.60m
2008/09	£117,600*	£235,000	£1.65m
2009/10	£123,600*	£245,000	£1.75m
2010/11	£123,600*	£255,000	£1.80m
2011/12	£129,600**	£50,000	£1.80m
2012/13	£137,400**	£50,000	£1.50m
2013/14	£141,000**	£50,000	£1.50m
2014/15	£145,800**	£40,000	£1.25m
2015/16	£149,400**	£40,000	£1.25m

*Nominal earnings cap for the transitional period under Finance Act 2004.
**The earnings cap is is no longer published by HMRC therefore this is a projected figure using RPI-basis.
***This is the projected earnings cap using CPI-basis.

Table 3: Summary of empirical literatures on inside debt: the impact of CEO pension on firm risk

Papers	Sample	Cross-section	Period	No. Observation	Proxies for firm risk	Proxies for CEO pension	Model Employed
Sundaram and Yemack (2007)	Fortune 500	237 firms	1996-2002	1570	Distance to default	(1)CEO's pension value/ CEO's stock and option value (2) CEO's pension/equity > firm's debt/equity	Fixed effects models with a separate intercept assigned to each unique CEO-company pair
Cassell *et al.,* (2012)	S&P 1500	1265 firms	2006-2008	1059-2994	(1)Log of total risk (2)Log of idiosyncratic risk (3)R&D/sales (4)Diversification (5)Working capital (6)Total book leverage	(1)Log of CEO to firm debt/ equity ratio (2)CEO to firm debt/equity ratio >1 (3)Log of CEO relative incentive ratio (4)Log of CEO relative incentive ratio CA	OLS with industry and year fixed effect
Kabir *et al*., (2013)	FTSE 350	47 firms	2003-2012	287	Bond yield	(1)Pension incremental / annual pay (2)Pension to equity ratio (3)CEO Relative leverage	OLS with industry and year fixed effect
Liu *et al*., (2014)	US firms Available in ExecuComp	N/A	2006-2011	6009	Cash holding / net assets	(1)CEO's pension value/ CEO's pension, stock and option value (2) CEO to firm debt/ equity ratio	OLS and firm fixed effect
Srivastav *et al*., (2014)	Largest US banks	N/A	2007-2011	403	Change of dividend pay-out	Log of CEO relative incentive ratio	Binary Choice model
Eisdorfer *et al*., (2015)	700 largest US firms	272 firms	2000-2009	1611	(1)Dividend yield (2)Dividend payout ratio (3)Dividend net of repurchase	(1)CEO's pension value/ CEO's pension, stock and option value (2)CEO Pension/ Total assets	Pooled OLS with year fixed effect
Caliskan and Doukas (2015)	S&P	N/A	2006-2011	2117	Dividend payer or not	(1)Dollar value for inside debt (2)Log of CEO leverage over firm leverage (3)CEO leverage > Firm leverage	Logistic model

Table 3 Continued

Bennett, Guntay and Unal (2015)	371 US bank	371 firms	2006-2008	371	(1) Distnace to default (2) Equity volaitlity (3) Expected default frequency (4) CAMELS Rating	(1) Log of inside debt (2) Log of CEO inside debt/CEO equity (2) Inside debt/total compensation (3) Log CEO relative leverage	OLS, WLS, Probit
Bekkum (2016)	US Banks	N/A	2007-2009	319	(1)Total volatility (2)Idiosyncratic volatility (3)Systematic volatility (4)Value at Risk (VaR) (5) Expected shortfall (ES) (6)Financial distress	Log of CEO leverage relative to firm leverage	OLS

Table 4: Descriptive Statistics

This table reports descriptive statistics for the sample of 744 UK FTSE 100 non-financial and non-utility firms from 2003-2015. All variables are defined in Appendix A.

Variables	Mean	Q1	Med	Q3	Std.
DB Pension (dummy)	0.47	0	0	1	0.50
DC Pension (dummy)	0.33	0	0	1	0.47
Cash in lieu (dummy)	0.38	0	0	1	0.49
DB pension annual (£000s')	392	0	0	552	736
DC pension annual (£000s')	63	0	0	50	131
Cash in lieu annual (£000s')	105	0	0	165	274
Pension annual (£000s)	560	153	289	674	720
Annual compensation (£000s')	5,337	2,715	4,126	6,340	4,490
DB pension total (£000s)	2,717	0	0	4,367	4,496
DB to equity ratio (times)	0.18	0	0	0.27	0.31
DB to equity ratio relative (times)	0.56	0	0	0.95	0.96
High DB (dummy)	0.38	0	0	1	0.48
High DB life (dummy)	0.34	0	0	1	0.47
High DB annual (dummy)	0.34	0	0	1	0.47
UK (dummy)	0.93	1	1	1	0.26
CEO equity (£000s)	63,166	7,003	13,247	25,561	28,9386
CEO age (years)	53.98	50.37	54.15	57.54	5.83
CEO tenure (years)	6.03	2.70	4.70	7.88	4.90
Foreign CEO (dummy)	0.43	0	0	1	0.50
CEO duality (dummy)	0.04	0	0	0	0.19
Board independence (%)	69.29	60.00	71.43	77.48	11.55
Cash holding (%)	7.82	2.89	5.51	10.24	7.26
Firm size (£ M))	24,493	3,592	7,671	22,331	50,475
Market to book ratio	4.14	1.73	2.84	5.08	8.64
Leverage (%)	20.03	11.19	18.84	27.62	12.32
Operating cash flows (%)	11.59	7.31	10.50	14.40	6.22
Stock return volatility (%)	30.58	20.99	27.02	35.82	13.26
R&D expenses (%)	1.75	0	0	0.79	4.44
CAPEX expense (%)	8.22	2.46	4.36	8.92	9.97
Dividend payer (dummy)	0.94	1	1	1	0.23
ROA (%)	7.98	4.22	7.04	10.57	6.59

Table 5: Correlation Matrix

This table presents the correlation matrix for the sample of 744 UK FTSE 100 non-financial and non-utility firms from 2003-2015. Typeface is bold if the significant at least at 10% level.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
(1) DB total	**1**																		
(2) DB to equity ratio	**0.70**	**1**																	
(3) DB to equity ratio relative	**0.70**	**0.79**	**1**																
(4) HighDB	**0.91**	**0.67**	**0.66**	**1**															
(5) HighDB life	**0.89**	**0.73**	**0.71**	**0.91**	**1**														
(6) HighDB annual	**0.85**	**0.65**	**0.63**	**0.93**	**0.83**	**1**													
(7) CEO equity	-0.02	**-0.25**	**-0.14**	0.01	-0.02	-0.01	**1**												
(8) CEO tenure	-0.01	-0.02	0.01	0.01	0.04	-0.01	**0.16**	**1**											
(9) Between Aday06 and Aday11	0.02	**-0.09**	-0.01	-0.01	-0.02	-0.02	**0.06**	0.04	**1**										
(10) After Aday11	**-0.17**	**-0.15**	**-0.17**	**-0.09**	**-0.10**	**-0.09**	0.04	0.05	**-0.62**	**1**									
(11) Cash holding	**-0.10**	-0.06	0.01	**-0.09**	**-0.10**	**-0.09**	0.01	-0.01	**0.12**	-0.03	**1**								
(12) Firm size	**0.20**	**0.13**	**0.13**	**0.19**	**0.22**	**0.19**	**0.15**	**-0.12**	-0.01	**0.09**	**-0.16**	**1**							
(13) Market to book ratio	0.02	-0.03	-0.03	0.04	0.03	0.02	0.02	0.05	-0.01	-0.01	0.05	**-0.11**	**1**						
(14) Leverage	**0.07**	0.03	**-0.14**	**0.09**	**0.11**	**0.08**	-0.03	0.02	-0.03	-0.01	**-0.24**	-0.03	**0.13**	**1**					
(15) Operating cash flows	-0.05	**-0.12**	-0.03	-0.02	-0.02	-0.02	**0.14**	-0.02	0.04	-0.02	**0.20**	**-0.14**	**0.18**	0.01	**1**				
(16) Stock return volatility	**-0.20**	**-0.11**	**-0.14**	**-0.19**	**-0.19**	**-0.18**	-0.03	-0.04	**0.32**	**-0.21**	**0.14**	**-0.07**	**-0.15**	**-0.17**	0.02	**1**			
(17) R&D expenses	0.03	**0.06**	**0.11**	0.04	**0.07**	0.04	0.05	-0.04	-0.01	0.02	**0.11**	0.01	0.05	**-0.16**	**0.11**	-0.06	**1**		
(18) CAPEX expenses	**-0.17**	**-0.14**	**-0.13**	**-0.18**	**-0.16**	**-0.16**	0.05	**0.12**	**0.08**	-0.02	0.04	**0.16**	-0.05	-0.02	**0.09**	**0.33**	**-0.15**	**1**	
(19) Dividend payer	0.03	-0.03	0.02	0.03	0.04	0.05	**0.12**	-0.01	-0.04	0.06	**-0.16**	0.04	**0.08**	0.06	**0.15**	**-0.23**	0.04	-0.04	**1**

Table 6: Univariate analysis

This table reports the mean and median value for a firm's cash holding (Cash/ Total Assets) in subsamples bases on high or low level of CEO defined benefit pension prior to and after UK pension regulation change. The sample includes UK FTSE 100 non-financial and non-utility firms from 2003-2015. Statistical significance of differences between means is tested using an independent samples t-test. A Wilcoxon/Mann-Whitney U test is used to determine significance of differences between medians. *, **, *** denote statistical significance at 10%, 5% and 1% level respectively. All variables are defined in Appendix A.

Panel A: Cash holding for high/low CEO DB pension prior to and after regulation change

	High CEO DB pension		Low CEO DB Pension		Difference	
	(1)Mean	(2)Median	(3)Mean	(4)Median	(1)-(3)	(2)-(4)
Prior Aday06	6.52	4.74	6.46	4.29	0.06	0.45
Between Aday06 and Aday11	7.02	5.14	10.09	6.46	-3.07***	-1.32
After Aday11	7.31	6.31	7.62	5.66	-0.31	0.65

Panel B: Cash holding for high/low CEO DB pension in terms of lifetime allowance prior to and after regulation change

	High CEO DB pension in terms of life allowance		Low CEO DB Pension in terms of life allowance		Difference	
	(1)Mean	(2)Median	(3)Mean	(4)Median	(1)-(3)	(2)-(4)
Prior Aday06	6.28	4.45	6.66	4.56	-0.38	-0.11
Between Aday06 and Aday11	7.10	5.07	9.88	6.26	-2.70**	-1.19
After Aday11	7.13	6.23	7.67	5.71	-0.54	0.52

Panel C: Cash holding for high/low CEO DB pension in terms of annual allowance prior to and after regulation change

	High CEO DB pension in terms of annual allowance		Low CEO DB Pension in terms of annual allowance		Difference	
	(1)Mean	(2)Median	(3)Mean	(4)Median	(1)-(3)	(2)-(4)
Prior Aday06	6.66	4.95	6.35	4.17	0.31	0.78
Between Aday06 and Aday11	6.92	5.26	9.96	6.30	-3.04**	-1.04
After Aday11	7.12	6.36	7.68	5.66	-0.56	0.70

Table 7: The impact of pension regulation change on CEO pension

This table reports the estimation of the impact of UK pension regulation change on CEO pension. The sample includes UK FTSE 100 non-financial and non-utility firms from 2003-2015.In Panel A, dependent variables are indicator variables that equal to one if CEO have a particular type of pension, otherwise zero. Variables of "Between Aday06 and Aday11" and "After Aday11" are indicator variables that equals to one if observations are between 6th April 2006 to 6th April 2011; and after 6th April 2011 individually, otherwise zero. Coefficients estimates and z-statistics (in parentheses) from probit model are reported. Industry fixed effects are included but not reported. The asterisks *, **, *** denote statistical significance at 10%, 5% and 1% level, respectively. All variables are defined in Appendix A.

Panel A: CEO pension type (Probit model)

Variables	(1) DB pension (Dummy)	(2) DB pension only (Dummy)	(3) DC pension (Dummy)	(4) DC pension only (Dummy)	(5) Cash in lieu (Dummy)	(6) Cash in lieu only (Dummy)
Between Aday06 and Aday11	-0.302**	-0.513***	-0.120	0.008	0.605***	0.818***
	(-2.085)	(-3.404)	(-0.852)	(0.054)	(3.817)	(3.739)
After Aday11	-0.809***	-1.378***	-0.351**	-0.334**	1.371***	1.582***
	(-5.544)	(-8.757)	(-2.373)	(-2.053)	(8.273)	(7.253)
CEO age	-0.236	-1.615**	1.131**	-0.007	1.155**	0.457
	(-0.436)	(-2.567)	(2.113)	(-0.011)	(2.216)	(0.750)
CEO tenure	-0.272***	-0.098	0.369***	0.527***	-0.390***	-0.365***
	(-2.728)	(-0.922)	(3.611)	(4.610)	(-4.119)	(-3.400)
Foreign CEO	-0.414***	-0.503***	0.469***	0.486***	-0.300***	-0.054
	(-3.651)	(-3.919)	(4.074)	(4.047)	(-2.581)	(-0.395)
CEO equity	-0.043	0.004	-0.004	-0.015	0.024	0.067**
	(-1.598)	(0.145)	(-0.126)	(-0.463)	(0.962)	(2.280)
CEO duality	0.170	0.049	-1.065***	-0.679**	-0.343	-0.299
	(0.587)	(0.165)	(-3.774)	(-2.216)	(-1.038)	(-0.715)
Board independence	-0.021***	-0.011*	0.012**	0.020***	-0.007	-0.009
	(-3.855)	(-1.889)	(2.126)	(3.137)	(-1.319)	(-1.412)
Firm Size	0.414***	0.641***	-0.104*	-0.105*	-0.290***	-0.298***
	(7.648)	(9.396)	(-1.923)	(-1.821)	(-5.347)	(-4.928)
Market to book ratio	-0.002	0.005	0.002	0.004	-0.009	-0.001
	(-0.332)	(0.692)	(0.331)	(0.667)	(-1.440)	(-0.106)
Leverage	0.006	0.011**	0.001	0.008*	-0.002	-0.003
	(1.435)	(2.229)	(0.120)	(1.801)	(-0.476)	(-0.645)
ROA	0.014*	0.020**	-0.005	-0.10	-0.013	-0.042***
	(1.668)	(2.037)	(-0.493)	(-0.974)	(-1.560)	(-3.452)
Stock return volatility	-0.463***	-0.241	0.141	-0.010	-0.056	0.104
	(-2.792)	(-1.290)	(0.878)	(-0.056)	(-0.332)	(0.523)
Constant	-1.524	-2.177	-4.733**	-0.946	-0.078	1.567
	(-0.659)	(-0.878)	(-2.023)	(-0.367)	(-0.035)	(0.566)
Years	No	No	No	No	No	No
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Firm years	744	744	744	744	744	744
Firm years which dependent variable equals to one	346	231	246	152	282	140
McFadden R-Squared	0.184	0.278	0.110	0.114	0.172	0.207
Wald Test (coefficients restriction)	Null hypothesis: Coefficient (between Aday06 and Aday11) =Coefficient(After Aday11)					
Difference between coefficients	0.507***	0.865***	0.231*	0.325***	-0.766***	-0.764***
P value	0.000	0.000	0.060	0.000	0.000	0.000

Table 7 Continued

In panel B, dependent variables are continuous variables for both absolute and relative pension value. Other variables are the same with those in panel A. Coefficients estimates and t-statistics (in parentheses) from firm fixed effect model are reported. P-values are based on robust standard errors that adjusted for heteroscedasticity and clustered by firm (White cross-section).

Panel B: CEO pension value (Firm fixed effect)

Variables	(1) DB Total (LN£000)	(2) DB / Salary (%)	(3) DB/ Annual pay (%)	(4) DB/ Total pension (%)	(5) DC/ Total pension (%)	(6) Cash in lieu / Total pension (%)
Between Aday06 and Aday11	-1.575***	-17.031*	-4.402**	-20.41***	4.165	15.97***
	(-3.070)	(-1.952)	(-2.518)	(-2.813)	(1.047)	(4.150)
After Aday11	-2.526***	-37.12***	-6.849***	-33.33***	-7.021	39.06***
	(-4.266)	(-2.628)	(-3.132)	(3.935)	(-1.606)	(7.604)
CEO age	3.754***	57.536	16.975**	20.824	-26.004**	-26.222
	(4.038)	(1.318)	(2.100)	(0.974)	(-1.999)	(-0.990)
CEO tenure	0.691***	8.388**	0.250	3.216	2.115	-5.890*
	(3.076)	(2.077)	(0.376)	(1.367)	(1.058)	(-1.766)
Foreign CEO	-1.076***	-22.723**	-3.271***	-10.67***	12.03***	1.315
	(-4.313)	(-2.514)	(-2.733)	(-2.687)	(4.480)	(0.261)
CEO equity	-0.043*	-1.675	-0.570**	0.082	-0.277	-0.098
	(-1.681)	(-1.469)	(-2.091)	(0.316)	(-1.347)	(-0.277)
CEO duality	1.066	-11.608	-1.563	17.900	-13.542*	13.450
	(1.202)	(-1.530)	(-1.440)	(1.457)	(-1.918)	(1.402)
Board independence	0.015	-0.440	-0.064	0.155	-0.026	-0.057
	(0.884)	(-0.912)	(-0.762)	(0.594)	(-0.188)	(-0.234)
Firm Size	1.078**	17.566	1.538	14.155**	-7.538**	-0.948
	(2.222)	(1.620)	(0.959)	(2.078)	(-2.411)	(-0.331)
Market to book ratio	0.001	-0.037	-0.017	0.036	0.052	-0.086
	(0.184)	(-0.149)	(-0.341)	(0.418)	(0.485)	(-0.561)
Leverage	0.007	0.154	0.028	0.033	0.016	-0.009
	(0.824)	(0.549)	(0.607)	(0.172)	(0.115)	(-0.055)
ROA	0.017	-0.344	-0.054	0.020	-0.338*	0.388**
	(1.430)	(-0.802)	(-0.844)	(0.127)	(-1.757)	(2.187)
Stock return volatility	0.332	6.280	1.869*	6.463**	-1.872	-7.555***
	(1.299)	(0.929)	(1.671)	(2.073)	(-0.709)	(-2.739)
Constant	-29.819**	-426.044	-76.236	-289.441*	255.9***	165.553
	(-3.070)	(-1.532)	(-1.459)	(-1.648)	(4.763)	(1.374)
Years	No	No	No	No	No	No
Frim fixed	Yes	Yes	Yes	Yes	Yes	Yes
Firm years	744	744	744	744	744	744
Frim number	122	122	122	122	122	122
Adjusted R-Squared	0.847	0.547	0.583	0.755	0.730	0.678
Wald Test (coefficients restriction)	Null hypothesis: Coefficient (between Aday06 and Aday11) =Coefficient(After Aday11)					
Difference between coefficients	0.951***	20.092**	2.448*	12.93***	11.19***	-23.09***
P value	0.000	0.044	0.079	0.000	0.000	0.000

Table 8: Impact of exceeding pension allowance on CEO pension

This table reports the estimation of the impact of exceeding pension allowance on CEO pension. The sample includes UK FTSE 100 non-financial and non-utility firms from 2003-2015. Dependent variables are indicator variables that equal to one if CEOs have a particular type of pension, otherwise zero. Variables of "CEO DB pension exceeds annual allowance" and "CEO DB pension exceeds life allowance" are indicator variables that equal to one if a CEO's defined benefit pension exceeds annual and lifetime allowance individually, otherwise zero. Coefficients estimates and z-statistics (in parentheses) from probit model are reported. Industry and year fixed effects are included but not reported. The asterisks *, **, *** denote statistical significance at 10%, 5% and 1% level, respectively. All variables are defined in Appendix A.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	DB pension Mix with DC pension or cash in lieu		DB pension Mix with DC pension		DB pension Mix with cash in lieu	
CEO DB pension exceeds annual allowance	1.049***		0.038		1.155***	
	(6.773)		(0.144)		(7.016)	
CEO DB pension exceeds life allowance		1.077***		0.493**		0.957***
		(6.639)		(2.067)		(5.888)
CEO age	2.267***	2.012***	3.710***	3.592***	1.433**	1.086*
	(3.667)	(3.369)	(4.168)	(4.200)	(2.245)	(1.793)
CEO tenure	-0.322***	-0.346***	-0.273*	-0.248*	-0.315***	-0.333***
	(-3.004)	(-3.265)	(-1.840)	(-1.671)	(-2.749)	(-2.978)
Foreign CEO	0.182	0.272*	0.548***	0.659***	-0.013	0.042
	(1.297)	(1.917)	(2.881)	(3.389)	(-0.087)	(0.293)
CEO equity	-0.047*	-0.044*	-0.022	-0.025	-0.048*	-0.043*
	(-1.947)	(-1.821)	(-0.883)	(-0.944)	(-1.827)	(-1.668)
Board independence	-0.021***	-0.020***	-0.016*	-0.014*	-0.016**	-0.015**
	(-3.246)	(-3.095)	(-1.868)	(-1.690)	(-2.362)	(-2.315)
Firm Size	-0.320***	-0.329***	-0.129*	-0.176**	-0.299***	-0.279***
	(-4.838)	(-4.732)	(-1.930)	(-2.393)	(-3.861)	(-3.556)
Market to book ratio	-0.011	-0.012*	-0.012*	-0.010	-0.011	-0.012*
	(-1.500)	(-1.710)	(-1.833)	(-1.609)	(-1.485)	(-1.764)
Leverage	-0.008	-0.011**	-0.029***	-0.031***	-0.003	-0.006
	(-1.548)	(-2.139)	(-3.996)	(-4.107)	(-0.482)	(-0.971)
ROA	-0.014	-0.021**	-0.028**	-0.032**	-0.004	-0.011
	(-1.257)	(-2.187)	(-2.123)	(-2.386)	(-0.314)	(-1.088)
Stock return volatility	-0.310	-0.264	-0.490	-0.441	-0.351	-0.326
	(-1.227)	(-1.065)	(-1.409)	(-1.253)	(-1.302)	(-1.284)
Constant	-1.499	-0.478	-10.86***	-10.08***	0.994	2.007
	(-0.546)	(-0.176)	(-3.062)	(-2.949)	(0.315)	(0.687)
Years	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Firm years	744	744	744	744	744	744
Frim years which dependent variable equals to one	115	115	39	39	87	87
McFadden R-Squared	0.163	0.160	0.201	0.211	0.200	0.168

Table 9: Change in firm cash holding after pension regulation change

(Difference-in-difference estimation)

This table represents the results of regression of firm cash holding after UK pension regulation change in 2006. Dependent variable is a firm's cash holding (Cash/ total assets). Variables of "HighDB*AfterAday06", " HighDB Annual*AfterAday06" and " HighDB life*AfterAday06" measure the effect of the regime change. Coefficients estimates and t-statistics (in parentheses) from firm fixed effect model are reported. P-values are based on robust standard errors that adjusted for heteroscedasticity and clustered by firm (White cross-section). The asterisks *, **, *** denote statistical significance at 10%, 5% and 1% level, respectively. All variables are defined in Appendix A.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
HighDB*AfterAday06	-0.285	-0.125				
	(-0.418)	(-0.196)				
HighDB Annual*AfterAday06			-0.688	-0.542		
			(-1.398)	(-0.940)		
HighDB life*AfterAday06					0.245	0.350
					(0.576)	(0.836)
CEO equity		-0.033		-0.034		-0.035
		(-0.183)		(-0.187)		(-0.196)
CEO duality		0.368		0.392		0.368
		(0.257)		(0.274)		(0.256)
Board independence		0.054**		0.054**		0.055**
		(2.003)		(1.997)		(2.063)
Firm Size		-2.093***		-2.082***		-2.100***
		(-2.670)		(-2.638)		(-2.679)
Market to book ratio		0.013		0.012		0.014
		(0.384)		(0.364)		(0.415)
Leverage		0.015		0.014		0.015
		(0.564)		(0.560)		(0.579)
Operating cash flows		0.280***		0.277***		0.282***
		(4.058)		(4.075)		(4.048)
Stock return volatility		0.776		0.854		0.716
		(0.820)		(0.878)		(0.750)
R&D expenses		-0.307**		-0.328**		-0.280*
		(-2.107)		(-1.990)		(-1.800)
CAPEX expense		0.029		0.028		0.030
		(0.522)		(0.509)		(0.536)
Dividend payer		-0.032		-0.019		-0.051
		(-0.030)		(-0.017)		(-0.048)
Constant	7.894***	32.14***	7.981***	31.87***	7.762***	32.23***
	(43.979)	(3.164)	(68.946)	(3.082)	(78.031)	(3.173)
Years	Yes	Yes	Yes	Yes	Yes	Yes
Firms	Yes	Yes	Yes	Yes	Yes	Yes
Frim years	744	744	744	744	744	744
Firm number	122	122	122	122	122	122
Adjusted R-Squared	0.577	0.607	0.577	0.608	0.577	0.607

Table 10: Change in firm cash holding after pension regulation change

(Difference-in-difference-in-difference estimation)

This table represents the results of regression of firm cash holding after UK pension regulation change in 2006. Dependent variable is a firm's cash holding (Cash/ total assets). Variables of "UK*HighDB*AfterAday06", "UK*HighDB Annual*AfterAday06" and "UK*HighDB life*AfterAday06" measure the effect of the regime change. Panel A reports results for main variables, while controlling variables are reported in panel B. Coefficients estimates and t-statistics (in parentheses) from firm fixed effect model are reported. P-values are based on robust standard errors that adjusted for heteroscedasticity and clustered by firm (White cross-section). The asterisks *, **, *** denote statistical significance at 10%, 5% and 1% level, respectively. All variables are defined in Appendix A.

Panel A: Main variables results

Variables	(1)	(2)	(3)	(4)	(5)	(6)
UK*HighDB*AfterAday06	0.533	0.538				
	(0.488)	(0.391)				
UK*HighDB Annual*AfterAday06			-0.388	-0.453		
			(-0.414)	(-0.345)		
UK*HighDB life*AfterAday06					1.399	1.138
					(1.300)	(0.942)
UK*HighDB	-1.187	-0.930				
	(-1.467)	(-1.048)				
UK*HighDB Annual			-0.925**	-0.503		
			(-2.066)	(-0.664)		
UK*HighDB life					-1.83***	-1.405**
					(-2.824)	(-2.093)
HighDB*AfterAday06	-0.157	-0.131				
	(-0.174)	(-0.139)				
HighDB Annual *AfterAday06			0.172	0.134		
			(0.226)	(0.150)		
HighDB life *AfterAday06					-0.005	0.103
					(-0.005)	(0.119)
UK*AfterAday06	-0.558	-0.470	-0.276	-0.201	-0.714	-0.576
	(-1.009)	(-0.802)	(-0.473)	(-0.322)	(-1.540)	(-1.127)
Constant	Yes	Yes	Yes	Yes	Yes	Yes
Control variables	NO	Yes	NO	Yes	NO	Yes
Years	Yes	Yes	Yes	Yes	Yes	Yes
Firms	Yes	Yes	Yes	Yes	Yes	Yes
Firm years	744	744	744	744	744	744
Firm number	122	122	122	122	122	122
Note:	Please see panel B for results of controls variables					

Table 10 continued

Panel B: Control variables results

Variables	(1)	(2)	(3)	(4)	(5)	(6)
Main variables			Please see panel A			
CEO equity		-0.026		-0.028		-0.040
		(-0.148)		(-0.155)		(-0.227)
CEO duality		0.289		0.302		0.272
		(0.198)		(0.206)		(0.185)
Board independence		0.055**		0.053*		0.057**
		(2.084)		(1.920)		(2.226)
Firm Size		-1.989**		-2.010**		-2.000**
		(-2.288)		(-2.451)		(-2.339)
Market to book ratio		0.013		0.012		0.014
		(0.409)		(0.374)		(0.429)
Leverage		0.012		0.012		0.013
		(0.442)		(0.469)		(0.469)
Operating cash flows		0.281***		0.278***		0.280***
		(4.058)		(4.064)		(3.988)
Stock return volatility		0.872		0.929		0.852
		(0.918)		(0.936)		(0.895)
R&D expenses		-0.296**		-0.312*		-0.264*
		(-2.006)		(-1.872)		(-1.649)
CAPEX expense		0.030		0.029		0.030
		(0.530)		(0.520)		(0.527)
Dividend payer		0.014		-0.015		0.106
		(0.013)		(-0.014)		(0.105)
Constant	8.532***	30.53***	8.335***	30.70***	8.600***	30.65***
	(25.048)	(2.693)	(28.279)	(2.819)	(20.482)	(2.733)
Years	Yes	Yes	Yes	Yes	Yes	Yes
Firms	Yes	Yes	Yes	Yes	Yes	Yes
Frim years	744	744	744	744	744	744
Firm number	122	122	122	122	122	122
Adjusted R-Squared	0.576	0.606	0.577	0.606	0.577	0.607

Table 11: Direct examination of CEO pension and cash holding

This table reports the estimation of the relation between CEO defined benefit pension and a firm's cash holding (Cash/ total assets). The variable of "DB total" is the natural logarithm of a CEO's total defined benefit pension value. The variable of "DB to equity ratio" is CEO defined benefit pension total value, scaled by the sum of CEO's shares, stock options and LTIPs holding value. The variable of "DB to equity ratio relative" is "DB to equity ratio", scaled by the firm's debt to equity ratio. The sample includes UK FTSE 100 non-financial and non-utility firms from 2003-2015. Columns (1)-(3) employ pooled OLS model with industry and year fixed effect. Columns (4)-(6) employ firm and year fixed effect model. P-values are based on robust standard errors that adjusted for heteroscedasticity and clustered by firm (White cross-section). The asterisks *, **, *** denote statistical significance at 10%, 5% and 1% level, respectively. All variables are defined in Appendix A.

	Pooled OLS			Firm fixed effect		
Variables	(1)	(2)	(3)	(4)	(5)	(6)
DB total (Ln£000s)	-0.073*			-0.091		
	(-1.739)			(-1.276)		
DB to equity ratio		0.683			1.009	
		(1.469)			(1.031)	
DB to equity ratio relative			-0.024			0.503
			(-0.0.83)			(1.094)
CEO equity	0.060	0.094	0.064	-0.031	0.010	0.008
	(0.399)	(0.631)	(0.409)	(-0.176)	(0.056)	(0.046)
CEO duality	3.154***	3.107***	3.119***	0.509	0.328	0.277
	(2.699)	(2.637)	(2.661)	(0.358)	(0.229)	(0.196)
Board independence	0.111***	0.116***	0.114***	0.055**	0.054**	0.054*
	(4.994)	(5.359)	(5.216)	(2.070)	(2.026)	(1.947)
Firm Size	-1.656***	-1.747***	-1.712***	-1.947**	-2.191***	-2.101***
	(-4.548)	(-4.768)	(-4.577)	(-2.222)	(-2.759)	(-2.746)
Market to book ratio	0.028	0.028	0.027	0.013	0.013	0.013
	(0.769)	(0.772)	(0.750)	(0.380)	(0.396)	(0.408)
Leverage	-0.094***	-0.097***	-0.096***	0.015	0.015	0.028
	(-3.550)	(-3.614)	(-3.702)	(0.577)	(0.601)	(1.211)
Operating cash flows	0.133***	0.132***	0.132***	0.279***	0.282***	0.286***
	(2.678)	(2.668)	(2.636)	(4.111)	(4.128)	(4.181)
Stock return volatility	2.393***	2.665***	2.577***	0.820	0.707	0.636
	(3.327)	(3.730)	(3.704)	(0.889)	(0.781)	(0.714)
R&D expenses	0.258***	0.234***	0.244***	-0.326**	-0.306*	-0.278
	(2.911)	(2.763)	(2.872)	(-2.043)	(-1.859)	(-1.607)
CAPEX expense	-0.048*	-0.041	-0.044	0.029	0.030	0.029
	(-1.788)	(-1.523)	(-1.549)	(0.512)	(0.524)	(0.502)
Dividend payer	-5.062***	-5.000***	-5.030***	-0.008	-0.069	-0.111
	(-3.247)	(-3.212)	(-3.235)	(-0.007)	(-0.065)	(-0.100)
Constant	23.20***	23.11***	23.29***	29.89***	33.30***	31.72***
	(3.012)	(3.006)	(3.130)	(2.645)	(3.283)	(3.263)
Years	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	No	No	No
Frim fixed effect	No	No	No	Yes	Yes	Yes
Firm years	744	744	744	744	744	744
Frim number	122	122	122	122	122	122
Adjusted R-Squared	0.229	0.228	0.227	0.608	0.608	0.609

Figure 1: Trend of CEO annual pension

This figure presents average CEO annual pension (£000s) and pension as percentage of annual compensation (%). The sample consists 744 FTSE 100 non-financial and non-utility observations from 2003 to 2015.

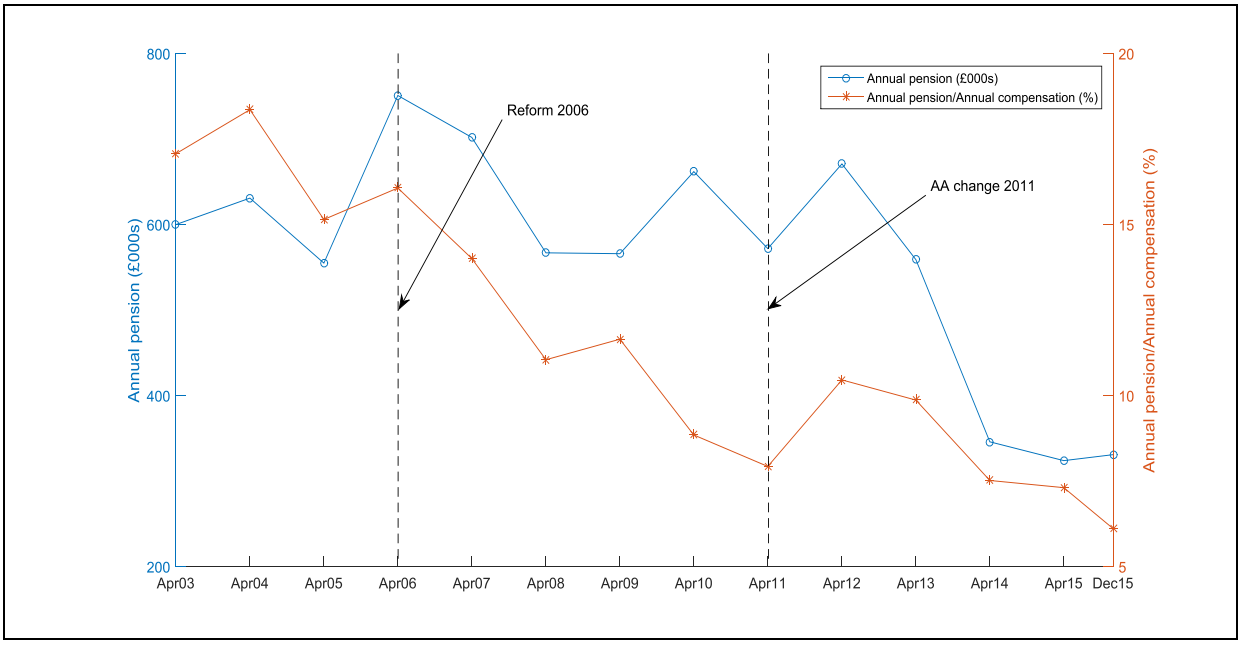


Figure 2: Trend of CEO pension types

This figure presents the percentage of CEO with a given type of pension. The sample consists 744 FTSE 100 non-financial and non-utility firms from 2003 to 2015.

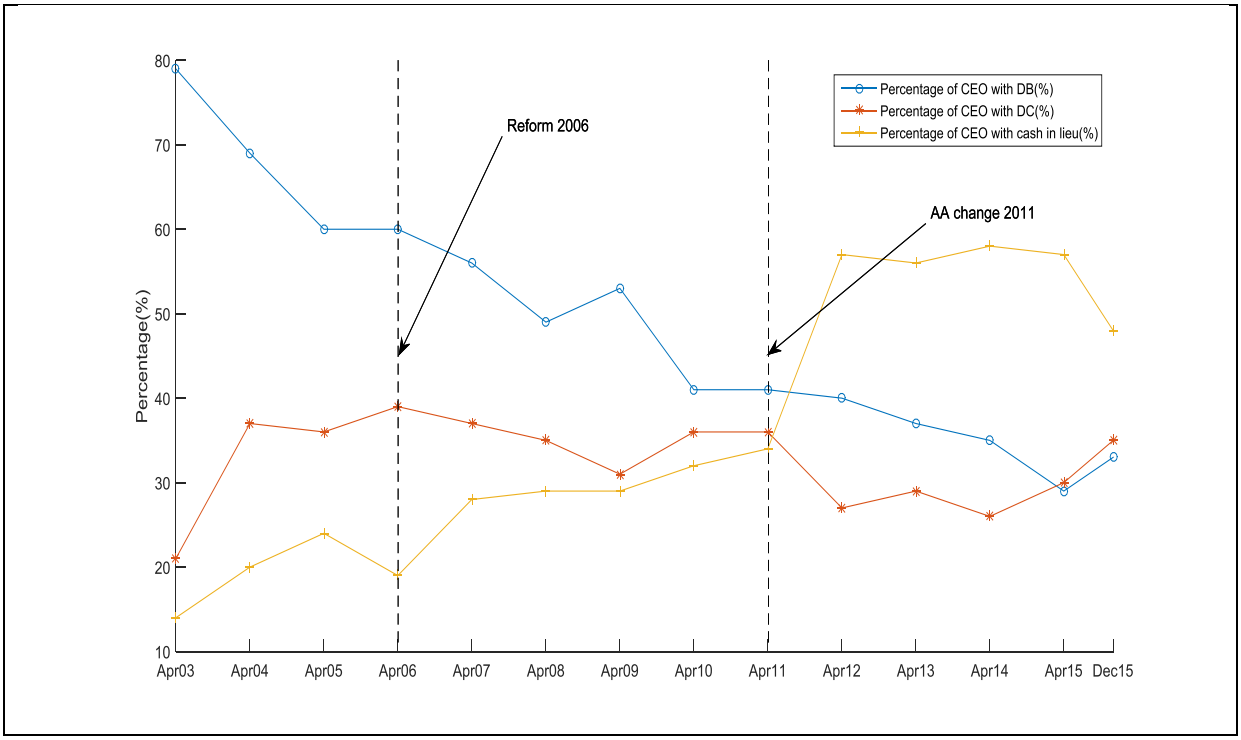


Figure 3: Trend of CEO DB pension exceeding allowance

This figure presents the percentage of CEO with DB pension exceeds the allowance. The sample consists 744 FTSE 100 non-financial and non-utility firms from 2003 to 2015.

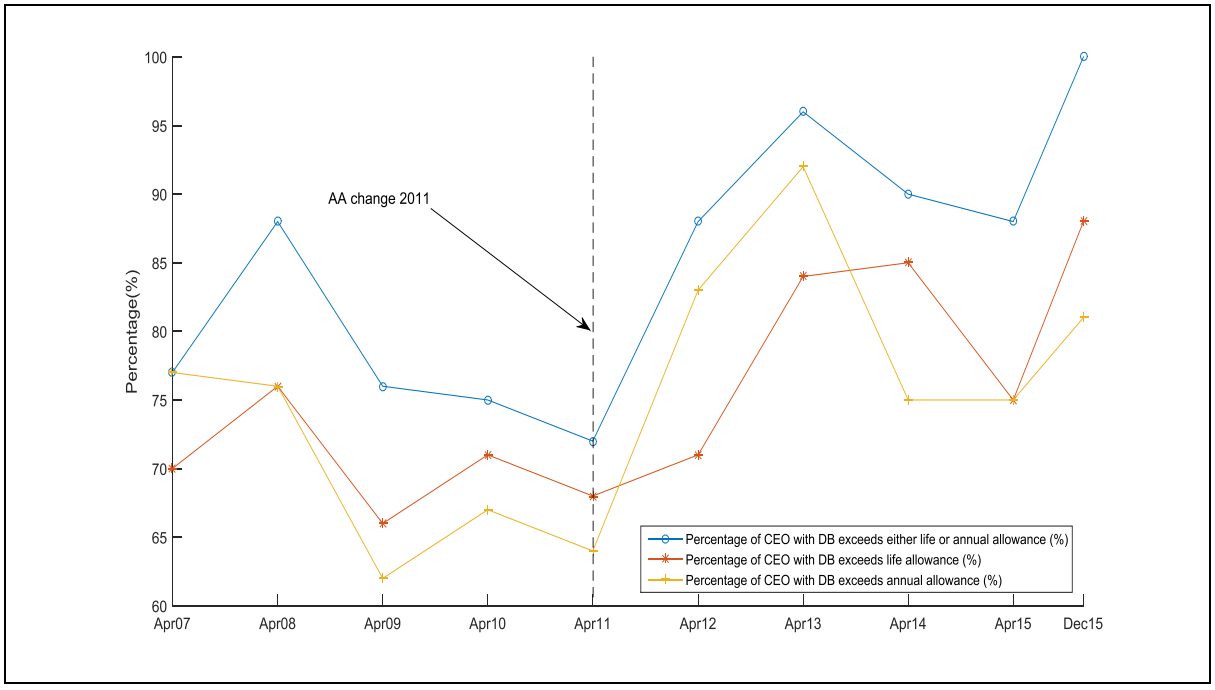
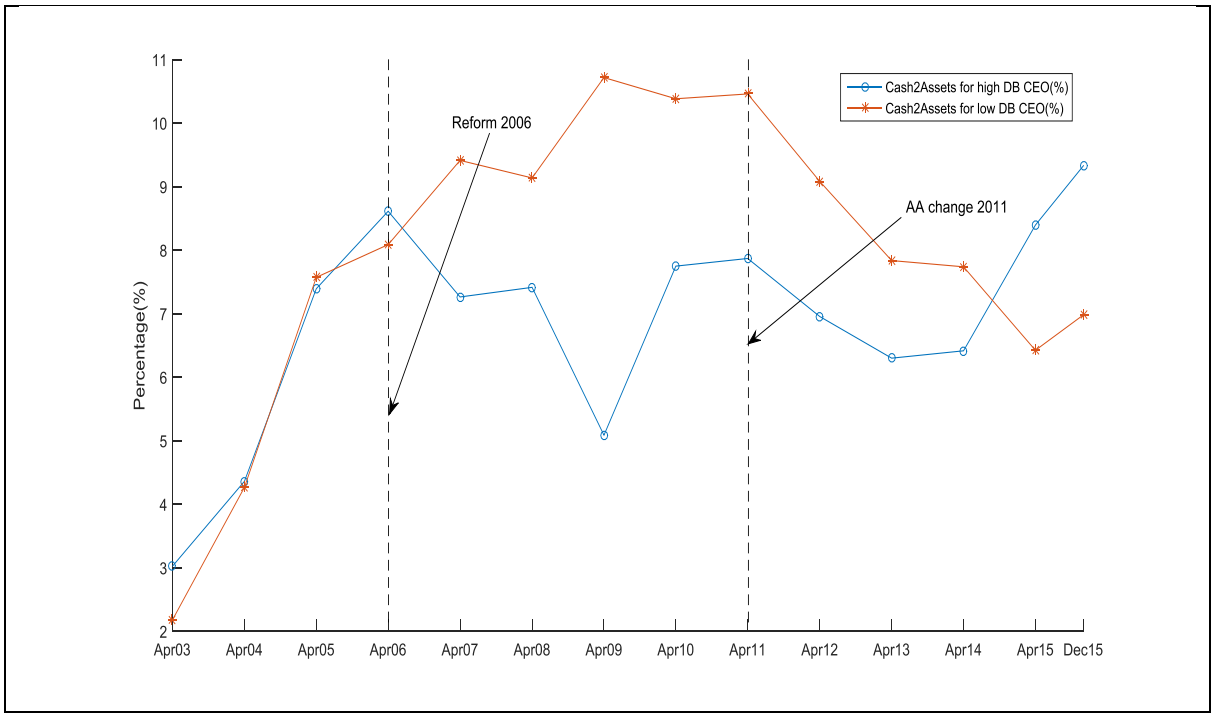


Figure 4: Cash holding (%) for CEO with different level of DB pension

This figure presents the percentage of a firm's cash holding for CEO with different level of DB pension. The sample consists 744 FTSE 100 non-financial and non-utility firms from 2003 to 2015.



Appendix A. Variables Definitions

Panel A: Compensation variables

Variable Name	Definition
DB pension	Dummy variable which takes a value of one if a CEO has defined benefit pension, otherwise zero
DC pension	Dummy variable which takes a value of one if a CEO has defined contribution pension, otherwise zero
Cash in lieu	Dummy variable which takes a value of one if a CEO has cash in lieu pension, otherwise zero
DB pension annual	The difference between a CEO defined benefit pension's total transfer value in year t and that in year t-1, less CEO's personal contribution
DC pension annual	CEO annual defined contribution pension grant by the firm
Cash in lieu annual	CEO annual cash in lieu pension grant by the firm
Pension annual	The sum of DB pension annual, DC pension annual and cash in lieu annual
Annual compensation	The sum of CEO salary, bonus, pension, stock options and LTIPs grants during a particular year
DB pension total	CEO defined benefit pension's total transfer value
DB to equity ratio	CEO defined benefit pension's total transfer value is scaled by the sum of CEO's shares, stock options and LTIPs holding value
DB to equity ratio relative	DB to equity ratio is scaled by the firm's debt to equity ratio
High DB	Dummy variable which takes a value of one if either High DB life or High DB annual equals to one, otherwise zero
High DB life	For observations prior to A day 2006, it takes a value of one if CEO defined benefit pension's total transfer value exceeds pension lifetime allowance in the level of 2006, otherwise zero. For observations after A day 2006, it takes a value of one if CEO defined benefit pension's total transfer value exceeds a particular year's pension lifetime allowance, otherwise zero.
High DB annual	For observations prior to A day 2006, it takes a value of one if CEO defined benefit pension's annual grant exceeds pension annual allowance in the level of 2006, otherwise zero. For observations after A day 2006, it takes a value of one if CEO defined benefit pension's annual grant exceeds a particular year's pension annual allowance, otherwise zero.
CEO DB pension exceeds life allowance	Dummy variable which takes a value of one if CEO defined benefit pension's total transfer value exceeds pension lifetime allowance after A day 2006, otherwise zero.
CEO DB pension exceeds annual allowance	Dummy variable which takes a value of one if CEO defined benefit pension's annual grant exceeds pension annual allowance after A day 2006, otherwise zero.
UK	Dummy variable which takes a value of one if CEO does not hold non-UK pension scheme
CEO equity	The sum of CEO's shares, stock options and LTIPs holding value

Panel B: Regulation change variables

Variable Name	Definition
Prior Aday06	Dummy variable which takes a value of one if observation is prior to 06 April 2006, otherwise zero
After Aday06	Dummy variable which takes a value of one if observation is after 06 April 2006, otherwise zero
Between Aday06 and Aday11	Dummy variable which takes a value of one if observation is after 06 April 2006 but prior to 06 April 2011, otherwise zero
After Aday11	Dummy variable which takes a value of one if observation is after 06 April 2011, otherwise zero

Panel C: CEO and board characteristics variables

Variable Name	Definition
CEO age	Natural logarithm of CEO age in years
CEO tenure	Natural logarithm of CEO's years in the job
Foreign CEO	Dummy variable which takes a value of one if CEO is non British, otherwise zero
CEO duality	Dummy variable which takes a value of one if CEO also holds the position of Chairman or Chairwoman, otherwise zero
Board independence	The number of non-executive directors is scaled by the number of all directors

Panel D: Firm characteristics variable

Variable Name	Definition
Cash holding	A firm's cash holding is scaled by its total assets
Firm size	Natural logarithm of a firm's total assets
Market to book ratio	A firm's market value of equity is scaled by its book value of equity
Leverage	A firm's long-term debt is scaled by its total assets
Operating cash flows	A firm's cash flows from operating activities is scaled by its total assets
Stock return volatility	The standard deviation of a firm's daily stock return during a particular fiscal year
R&D expenses	A firm's research and development expenses is scaled by its total sale
CAPEX expenses	A firm's capital expenditure is scaled by its total sale
Dividend payer	Dummy variable which takes a value of one if observation pays cash dividend, otherwise zero
ROA	A firm's EBTDA is scaled by its total assets

References

Anantharaman, D., Fang, V.W. & Gong, G. 2013, 'Inside Debt and the Design of Corporate Debt Contracts', *Management Science,* 60 (5), pp. 1260-1280.

Bates, T., K. Kahle and R. Stulz (2009). 'Why do U.S. firms hold so much more cash than they used to? ' *Journal of Finance*, 64, pp.1985–2021.

Bekkum, S. (2016). 'Inside debt and bank risk'. *Journal of Financial and Quantitative Analysis*, 51, pp.359–385.

Bennett, R., L. Güntay, and H. Unal (2015) 'Inside Debt, Bank Default Risk, and Performance during the Crisis.' Journal of Financial Intermediation, 24 (4), pp 487–513.

Caliskan, D. and J. A. Doukas (2015). 'CEO risk preferences and dividend policy decisions'. *Journal of Corporate Finance*, 35, pp. 18–42.

Cassell, C., S. Huang, J. Sanchez and M., Stuart (2012). 'Seeking safety: The relation between CEO inside debt holdings and the riskiness of firm investment and financial policies'. *Journal of Financial Economics*, 103, pp. 588–610.

Choy, H., Lin, J. & Officer, M.S. 2014, 'Does freezing a defined benefit pension plan affect firm risk?', *Journal of Accounting and Economics,* vol. 57, no. 1, pp. 1-21.

David F. Larcker, Tjomme O. Rusticus (2010). 'On the use of instrumental variables in accounting research', *Journal of Accounting and Economics*, 49(3), pp 186-205,

Edmans, A. & Liu, Q. 2011, "Inside Debt", *Review of Finance,* vol. 15, no. 1, pp. 75-102.

Eisdorfer, A., C. Giaccotto and R. White (2015). 'Do corporate managers skimp on shareholders' dividends to protect their own retirement funds? ' *Journal of Corporate Finance*, 30, pp.257–277.

Goh, L. and Y. Li (2015). 'Pension as a form of executive compensation'. *Journal of Business Finance & Accounting*, 42(9&10), pp. 1154–1187.

Gow, I.D., Larcker, D.F. & Reiss, P.C. (2016), 'Causal Inference in Accounting Research', *Journal of Accounting Research,* vol. 54, no. 2, pp. 477-523.

Gruber, J. (1994). 'The incidence of mandated maternity benefits'. *The American Economic Review*, 84(3), pp. 622–641.

Hayes, R. M. Lemmon, and M. Qiu (2012), 'Stock options and managerial incentives for risk taking: Evidence from FAS 123R', *Journal of Financial Economics*, vol. 105, no. 1, pp. 174-190.

He, G. (2015), 'The effect of CEO inside debt holdings on financial reporting quality', Review of Accounting Studies, vol. 20, no. 1, pp. 501-536.

Kabir, R., H. Li and Y. V. Veld-Merkoulova (2013). 'Executive compensation and the cost of debt'. *Journal of Banking & Finance*, 37(8), pp. 2893–2907.

Khwaja, Asim Ijaz and Mian, Atif. 2008. 'Tracing the Impact of Bank Liquidity Shocks: Evidence from an Emerging Market.' *American Economic Review,* 98(4): 1413-42.

Larcker, D.F. and T.O. Rusticus (2010). 'On the use of instrumental variables in accounting research'. *Journal of Accounting and Economics*, 49, pp. 186–205.

Liu, Y., D. Mauer and Y. Zhang (2013). 'Firm cash holdings and CEO inside debt'. *Journal of Banking & Finance*, 42, pp. 83–100.

Low, A. (2009). 'Managerial risk-taking behavior and equity-based compensation'. *Journal of Financial Economics*, 92, pp. 470–490.

Meyer, B., W. Viscusi and D. Durbin (1995). 'Workers' compensation and injury duration: Evidence from a natural experiment'. *The American Economic Review*, 85(3), pp. 322–340.

Phan, H.V. 2014, 'Inside Debt and Mergers and Acquisitions', *Journal of Financial and Quantitative Analysis,* vol. 49, no. 5-6, pp. 1365-1401.

Rachel M. Hayes, Michael Lemmon, Mingming Qiu (2012), Stock options and managerial incentives for risk taking: Evidence from FAS 123R, *Journal of Financial Economics*, 105(1), pp 174-190,

Robert, M. and T. Whited (2013). 'Endogeneity in empirical corporate finance'. *Handbook of the Economics of Finance*, 2, pp. 493–572.

Sauset, J., P. Waller and M. Wolff (2015). 'CEO contract design regulation and risk-taking'. *European Accounting Review*, 24(4), pp.685–725.

Srivastav, A., S. Armitage and J. Hagendorff (2014). 'CEO inside debt holdings and risk-shifting: Evidence from bank payout policies'. *Journal of Banking & Finance*, 47, pp. 41–53.

Sundaram, R. and D. Yermack (2007). 'Pay me later: inside debt and its role in managerial compensation'. *Journal of Finance*, 62, pp. 1551–1558.

Wei, C. & Yermack, D. 2011, 'Investor Reactions to CEOs' Inside Debt Incentives', *Review of Financial Studies,* vol. 24, no. 11, pp. 3813-3840.