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ARTICLE

Inside debt and firm risk-taking: Evidence from the UK pension reform

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Abstract

This paper provides new evidence on the relation between CEO inside debt and firm risk-taking by exploiting the change in the tax treatment of UK pensions following two pension amendments. The 2006 pension reform introduces the annual and lifetime allowance for UK pension schemes, significantly increasing income taxes associated with CEO inside debt. The 2011 allowance cut, which substantially reduces the annual allowance introduced in 2006, further increases income taxes on inside debt. We find that CEO inside debt, in the form of executive pensions declines after the 2006 reform while cash-in-lieu increases significantly. This effect is more severe after the 2011 allowance cut than the 2006 pension reform. UK firms appear to substitute away from pensions towards cash-in-lieu, where income taxes are less punishing. If the association between CEO inside debt and firm risk-taking is causal, we should observe a change of risk-taking after the decline of inside debt. Our results, which exploit the exogenous nature of the reforms, show that the decline of CEO pensions does not lead to any change in firm risk-taking. This result suggests that no causal relationship exists between CEO inside debt and firm risk-taking. Our results extend the inside debt literature, where empirical evidence is mainly documented in the US. Contrary to findings in the US, our evidence suggests that the use of

CEO inside debt is motivated to minimise income tax rather than a tool to moderate firm risk.

KEYWORDS
executive compensation, inside debt, pension regulation, risk-taking

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1 | INTRODUCTION

Inside debt, managerial holdings of a firm's debt, accounts for a considerable amount of a CEO's total compensation. Sundaram and Yermack (2007) document that Fortune 500 CEOs have on average $900,000 inside debt in the form of annual executive pension and deferred compensation, representing 10% of CEO's total pay between 1996 and 2002. Comparable to their US data, our sample of FTSE 100 CEOs have defined benefit pensions (hereafter DB) of £208,000 on average, accounting for 5% of their annual compensation between 2003 and 2016. Due to its significance, there is a growing literature that examines inside debt's effect on managerial behaviours. Edmans and Liu (2011) theorize that inside debt could be used as an efficient tool to reduce a firm's risk, as it makes managers potential debtholders of the firm, aligning the interests of managers with those of a firm's debtholders. The literature finds that managerial inside debt is positively related to various risk-averse policies (e.g., Cassell, Huang, Sanchez, & Stuart, 2012) and firm cash holdings (e.g., Liu, Mauer, & Zhang, 2014), while being negatively related to loan yield (e.g., Anantharaman, Fang, & Gong, 2014) and dividend pay-out (e.g., Eisdorfer, Giaccotto, & White, 2015; Srivastav, Armitage, & Hagendorff, 2014).[1] Table 1 summarises the main findings of inside debt on firm risk-taking in the literature. The empirical evidence overwhelmingly supports a negative association between inside debt and firm risk-taking.

In this study, we seek to re-examine the impact of inside debt on firm risk-taking. Our motivations are twofold. First, the evidence related to inside debt and various firm policies is mostly documented in the US.[2] Edmans and Liu (2011) are very cautious about their theoretical results. They argue that the impact of inside debt on risk-taking is only tested in the US; whether it applies in another country should be further examined.[3] In a recent study, Li, Rhee, and Shen (2018) call for extending researches of CEO inside debt from the US market to the global market.[4] Using hand-collected UK pension data, our study extends the literature by examining inside debt in a new market. The differences in pension tax rules between the US and the UK lead to our new results.

Second, our quasi-experimental design provides new evidence to assess the causal association between CEO inside debt and firm risk-taking. Similar to other studies in corporate finance, the endogeneity problem also plagues research on inside debt. To address this problem, the literature usually employs instrumental variables (e.g., Cassell et al., 2012; Liu et al., 2014; van Bekkum, 2016). However, instrumental variables also suffer from validity and multi-endogenous regressor problems (e.g., Gow, Larcker, & Reiss, 2016; Roberts & Whited, 2013). Another approach to mitigate endogeneity is a quasi-experiment, where a natural event is used to explore exogenous variations of independent variables.

[1] Caliskan and Doukas (2015) find that inside debt increases dividend payout due to CEO risk aversion. They argue that dividend payout is less risky than capital investment.

[2] Kabir, Li, and Veld-Merkoulova (2013) test the relation between CEO pension and bond yield on a small UK sample. While their findings support the risk reduction incentives from inside debt, they do not test any firm risk taking policy explicitly. Kabir, Li, and Veld-Merkoulova (2018) provide evidence that R&D will decline if retiring CEOs have more inside debts, while this is not the case for CEO of other age groups.

[3] As Edmans and Liu (2011) suggest, 'existing studies are focused on large firms in the U.S. It is not clear whether these findings are representative of all firms, or firms overseas.'

[4] As Li, Rhee, and Shen (2018) state, 'Although our analyses are based on US data, we believe that an interesting avenue for future research would be to extend our approach to the global debate…'.

TABLE 1 Main results of the literature on inside debt and firm risk-taking

Paper	Sample country	Main results
Sundaram and Yemack (2007)	US	Inside debt is positively associated with distance to default.
Wei and Yemack (2011)	US	Firms with more inside debts 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 et al. (2012)	US	Inside debt is associated with a variety of firm risk-averse policies.
Anantharaman et al. (2014)	US	Inside debt leads to a lower promised loan yield. Inside debt only reduces firm risk if it is a junior debt.
Kabir et al. (2013)	UK	Inside debt, in the form of DB pension, is negatively associated with bond yield spread.
Liu et al. (2014)	US	Inside debt is positively associated with firm cash holdings.
Srivastav et al. (2014)	US	Inside debt is negatively associated with bank pay-out policy.
Choy, Lin, and Officer (2014)	US	Freezing DB leads to a higher level of total risk.
Phan (2014)	US	Inside debt is positively associated with abnormal bond return in the event of M&A announcement.
He (2015)	US	Inside debt is positively associated with financial reporting quality.
Eisdorfer et al. (2015)	US	Inside debt is negatively associated with firm dividend pay-out.
Caliskan and Doukas (2015)	US	Inside debt induces CEOs to pay more dividends.
Bennett et al. (2015)	US	Inside debt is negatively associated with bank default risk.
van Bekkum (2016)	US	Inside debt is negatively associated with various measures of bank risk.
Dang and Phan (2016)	US	Inside debt is positively related to short-maturity debt.
Li et al. (2018)	US	Inside debt is negatively related to the level of outstanding convertible debt and probability of issuing convertible debt.
Belkhir, Boubaker, and Chebbi (2018)	US	The value of excess cash to shareholders declines as CEO inside debt increases.
Kabir et al. (2018)	UK	R&D spending decreases for retiring CEO with more inside debts.
Cambrea, Colonnello, Curatola, and Fantini (2019)	US	CEO inside debt investing plan is depending on firm safety.
Deng, He, Kong, and Zhang (2019)	China	Inside debt leads to a lower level of risk-taking in banking industry.
Sheikh (2019)	US	Inside debt is negatively associated with measures of future risk.
Borah, James, and Park (2020)	US	Inside debt leads to a lower cost of debt and default risk.

In this paper, we identify two UK pension reforms that directly affect CEO inside debt but have no apparent effect on firm risk-taking policies. The natural experiment adds new evidence to the existing inside debt literature. Our empirical approach is inspired by Hayes, Lemmon, and Qiu (2012), who use the adoption of FAS 123R in the US as the natural experiment. Stock option usage declines sharply after FAS 123R is implemented, but FAS 123R adoption does not directly affect a firm's operating policy. The 2006 pension reform in the UK is surprisingly similar to FAS 123R adoption in the US. CEO pension decreases significantly after the reform, but the reform does not affect a firm's risk-taking policies.

Our main findings are threefold. First, we provide new quantitative evidence on the rapid decline of DB pension. Similar to industry surveys (e.g., Lane Clark & Peacock LLP, 2015), our data show a downtrend of CEO DB pension. After the 2006 reform, UK CEOs are less likely to receive DB pension, while more likely to be paid with cash-in-lieu.[5] Our results also show the scale and timing effects of the tax reform, including the impact of a few gradual changes in the follow-up years. Specifically, the proportions of DB pension as a fraction of pension are 27.38%, 24.06%, 57.5% and 83.02% lower in the reform pending period (between August 2004 to March 2006), the reform introduction period (April 2006 to March 2011), a big allowance cut period (April 2011 to March 2014) and a further allowance cut period (after April 2014) respectively, compared to that in 2003. On the other hand, cash-in-lieu as the fraction of pension increased by 28.98%, 71.10%, 120.39% and 134.79% in corresponding periods. The effect was more pronounced in 2011 (when annual allowance is cut down further) than it was in 2006. The period has the largest decline in DB pension and the highest increase in cash-in-lieu. Besides, we find that CEOs with high DB pension prior to the 2006 reform show a larger reduction of DB pension after the reform.

Second, our results are indicative that the sharp decline of DB is driven by the tax saving (of CEOs' income taxes) rather than a simple cost reduction practice (to cut employers/firms' pension expenses). DB pension is known to be in decline since the 1990s (Broadbent, Palumbo, & Woodman, 2006), due to its high cost. Firms have been shifting DB to defined contribution (hereafter DC) pension to reduce pension expenses for almost two decades. However, the accelerated decline of DB in recent years was primarily driven by the 2006 tax reform. If the recent decline of DB is caused by firm cutting costs, we should also observe an increase in DC pension. In contrast, our results show that DC pension stayed almost constant after the 2006 pension reform and started to decline after the annual allowance was further cut in 2014. There is a clear shift from DB to cash-in-lieu, rather than from DB to DC. The reform makes both DB and DC pension tax inefficient, while cash-in-lieu becomes the optimal form of pension. The result confirms our tax benefit hypothesis that pension is a tool for tax optimisation. Firms alternate the form and level of CEOs' pension once tax on pension changes. Our result is also in line with Murphy (2012) who argues that 'government intervention into executive compensation—largely ignored by researchers—has been both a response to and a major driver of time trends in CEO pay'.

Our final finding is that the change of CEO DB pension after the reforms does not lead to any change of firm risk-taking. DB pension is a form of inside debt as its payoff depends on the survival of the firm. If the relationship between inside debt and firm risk-taking is causal, then a change of CEO DB pension after the reform should lead to a change in firm risk-taking. However, we do not find a corresponding change in firm risk-taking after the decline in DB pension. Previous studies suggest that executive compensation and corporate governance are important determinants of a firm's risk policies (e.g., Dutordoir, Strong, & Ziegan, 2014). Hence, we consider the market measure of risk-taking: firm total risk (stock return volatility) and three policies with risk implications: cash holdings, R&D and CAPEX.

To ensure the robustness of our results, we first employ differenced cross-section regressions (Hayes et al., 2012) using the pension reforms as the exogenous shocks, which provides new evidence on the causal relationship of inside debt and risk-taking. Since our results differ from previous studies in the US, we test conventional designs that are widely used in the literature, firm and CEO fixed-effect models. To further address the endogeneity problem, we employ 2SLS with CEO age as the instrumental variable which is also widely used in the compensation literature.

[5] The LCP FTSE 100 Executive Pension Survey 2015 also documents that recently UK CEOs are paid with a lower level pension in exchange for a higher level of cash compensation, namely cash-in-lieu of pension.

Finally, to ensure that our results are not driven by zero value observations, as many CEOs do not have any inside debt, we employ two additional models. First, we run the fixed-effect models excluding observations that have zero inside debt (Cassell et al., 2012). Second, we re-run our previous regressions using a DB dummy instead of a continuous DB variable to ensure that our results are not biased by zero values (van Bekkum, 2016). Overall, our findings suggest that there is no causal relationship between CEO inside debt and firm risk-taking. The risk reduction hypothesis of CEO inside debt does not hold in the UK.

Our results on inside debt are not consistent with those in the US. There are two possible explanations. First, the risk associated with CEO pension can be managed or circumvented. An underlying assumption of executive pension is that top managers can only access it when they reach their retirement ages. In such a circumstance, pensions generate risk-averse incentives for CEOs. However, UK top managers have several options to shield this risk. One of these options is the early withdrawal of pension. Typically, pension access age is 55 in the UK, but early withdrawal is possible depending on the rules of pension schemes. An unapproved pension scheme can also be structured to allow early withdrawal (Goh & Li, 2015). For instance, Richard Solomons, CEO of InterContinental, withdrew his entire DB pension of £2,958,000 when he was 53 in 2014.[6] While early pension withdrawal is not a common practice due to its punishing tax,[7] it undermines the seniority assumption of a firm's outside debt.[8] Early withdrawal of an entire pension would make CEO inside debt more senior or completely secured. Another option is transferring CEO pension to a separate and more secure pension scheme. For example, Michael Geoghegan, director of HSBC, transferred his entire DB pension of £12,918,000 from his employer HSBC to an independent pension scheme in 2006.[9] After the transfer, a CEO's DB pension no longer depends on his or her firm's survival, effectively shielding the CEO from a firm's default risk.

The second possible explanation is that a pension is a tool for optimising CEOs' income taxes, which has little to do with firm risk-taking. The fact that firms substitute away from pension towards cash-in-lieu suggests that firms are concerned with tax effects on CEO compensation, but are relatively unconcerned with risk incentives provided by DB pension. The widespread use of Supplemental Executive Retirement Plans (hereafter SERPs) in the US is mainly due to their favourable tax treatment. The Internal Revenue Service (hereafter IRS) explicitly supports the use of SERP to defer income tax on pension contribution, and there is no limit on the number of deferrals. On the other hand, the use of Employer-Financed-Retirement-Benefit-Scheme (hereafter EFRBS), the equivalent of SERP in the UK, is rare (Goh & Li, 2015). This is because Her Majesty's Revenue and Customs (HMRC, the UK tax authority) imposes strict rules for EFRBS, deliberately preventing it from working as a tax evasion tool. We discuss tax rules differences between the US and the UK in Section 2. If CEOs employ pensions to minimise income tax, then the pension's role in firm risk-taking is negligible.

This paper contributes to the existing literature in three ways. First and most importantly, we address CEO inside debt from a new angle by looking at the income tax of pension. The previous literature tends to explain the use of CEO inside debt from the point of view of corporate tax (e.g., Anantharaman & Lee, 2014; Chaudhry, Au Yong, & Veld, 2017; Chi, Huang, & Sanchez, 2017; Gerakos, 2010). Studies have found that DB pension leads to corporate tax saving. In addition to corporate tax, we argue that income tax plays a vital role in determining CEO pension. Taking advantage of detailed disclosure in tax allowances and executive pension in the UK, we are able to identify individual CEOs' tax treatment in their pension scheme for a given tax year. This paper highlights the importance of income tax in determining CEO compensation.

Our second contribution is to use a natural experiment approach to provide new causality evidence of inside debt. By employing the differenced cross-sectional estimation around the 2006 UK pension reform and the 2011 allowance cut (two exogenous events), our research method provides an alternative control to the endogeneity problem that

[6] See InterContinental Hotels Group plc Annual Report 2014, p. 82.

[7] Withdrawing pension gradually over many years will result in significantly less income tax. More details about tax on early pension withdrawal is available at: https://www.gov.uk/early-retirement-pension/personal-and-workplace-pensions

[8] This is also true in the US. Based on data from Execucomp, there are 11 (out of 1,744) CEOs who withdrew the full balance of their inside debt in 2014.

[9] See HSBC Holdings plc 2006 Remuneration Report, pp. 286–7.

affects many studies in corporate finance. This paper also enriches the executive remuneration literature by using regulation change as an exogenous shock to assess the causal relationship between managerial pay and firm policies.

Our third contribution is providing new evidence of inside debt outside the US. Although DB pension is not unique in the US, most studies are US-based.[10] Our study of CEO inside debt in the UK is a direct response to the previous literature, such as Edmans and Liu (2011) and Li et al. (2018), which explicitly calls for extension of the US study to other countries. OECD (2019) shows that over the last decade (2008–18), 17 out of 22 reporting countries witnessed a significant decline of DB pension. If the decline of DB pension is universal across the globe, what are the impacts on firm risk policy? Our findings provide an answer to the question. In short, our paper offers new implication for other countries, where DB pensions are also in sharp decline.

2 | EXECUTIVE PENSION IN THE UK

2.1 | Tax treatment in the US and the UK

We first discuss the tax treatment of executive pension in the US and the UK. In the US, firms can grant pensions to their CEOs in two ways: tax-qualified pension plan and non-qualified pension plan. A qualified plan, usually taking the form of 401(k), is a DC pension plan that is available to every employee. Contribution to 401(k) plans is tax-free up to an annual limit, which is set at $19,500 in 2020. Contributions beyond this limit are possible but subject to income tax. Non-qualified plans, usually taking the form of SERPs, are pension plans that are specifically designed to reward top managers. SERPs are very popular in the US because CEOs do not pay income tax on any contribution immediately as long as the SERP is unfunded and unprotected. Tax deferral allows CEOs to accumulate pensions at a pre-tax return rate. Since SERPs are usually non-qualified, they provide firms with certain flexibility on how to structure them. Unfunded non-qualified plans are designed to be tax efficient and are publicly recognised by the IRS.[11] Since there is no limit on the amount of contribution, SERPs are usually used to top up executive pensions once CEOs exhaust their limits in 401(k). While CEOs still pay taxes when they start receiving retirement benefits, many options to reduce income tax are available. For example, CEOs can move to a state where there is a lower state income tax rate.

Similar to CEOs in the US, a typical UK CEO receives pension from two sources: tax approved pension schemes and unapproved pension schemes. Tax approved schemes usually take the form of occupational DC or DB pension schemes and function almost identically to 401(k) plans in the US. CEOs can make tax-free contributions up to a specific limit into the scheme. In the 2020–21 tax year, the annual tax-free limit for pensions is £40,000. Unapproved schemes in the UK, on the other hand, are quite different from non-qualified plans in the US. Contributions to unapproved pension schemes do not attract any tax relief in the UK, and they are also subject to the annual contribution limit. Unlike SERPs in the US, income taxes on pension contributions are not deferrable in the UK.[12] HMRC specifically states that unapproved pension schemes are not tax evasion tools.[13]

In short, the main difference in tax rules between the UK and the US is the income tax deferral. Since UK CEOs cannot defer income tax on pensions, it is expensive to award CEOs with pension directly. As our results will later show, firms are increasingly replacing executive pensions with cash-in-lieu. In contrast, SERPs are very popular in the US because of their tax efficiency.

[10] The Organisation for Economic Co-operation and Development (OECD, 2013) reports that 18 out of 35 OECD countries provide DB pension for all public sector workers, while private (occupational) scheme of DB pension is mandatory or quasi-mandatory in three countries: Iceland, the Netherlands and Switzerland.

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

[12] Special unapproved schemes, such as the Employer-Financed-Retirement-Benefit-Scheme (EFRBS) can be set up to evade the contribution limit, but the scheme is overwhelmingly complex and quite costly to operate. Its uses were not widespread before 2011 AA reduction (Goh & Li, 2015).

[13] 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

2.2 | The 2006 UK pension reform

In the UK, a series of tax rules were introduced in April 2006. The new rules intended to replace complicated tax regimes that govern different categories of pension schemes. The most notable feature of the reforms was the introduction of annual allowance (hereafter AA) and lifetime allowance (hereafter LTA), which limits the amount of pension income/contribution that is tax deductible. The AA limits tax relief when funds allocate/contribute to a registered pension scheme. It caps the amount of pension contribution that is tax-free for a given tax year. Any amount of pension contribution beyond AA is taxed as regular income. On the other hand, LTA limits tax relief when the employee (or pensioner) begins to receive a pension benefit. It caps the total pension amount that can be drawn from registered pension schemes without triggering an extra tax charge. Any pension benefit received above this limit will be subject to additional tax.

In the pre-2006 era, applying tax relief to pension contributions was very complex, involving adding up contributions under different tax regimes. The AA simplifies this process and puts a total limit on all contributions to all registered pension schemes. Since similar but more complicated tax relief was already in place before the 2006 reform, it is not clear how AA would affect top managers' pay.[14] The AA was £215,000 when it was first introduced in 2006 and was still very generous compared to the Earnings Cap in previous years. Table 2 presents Earnings Cap, AA and LTA in the UK from 2003 to 2019.

Before the introduction of LTA, top managers paid income tax when they started receiving pension benefits, usually at the top income tax rate.[15] Since 2006, there has been an additional charge if their total pension benefits are paid over LTA. Excessive withdrawal of pension over LTA would trigger a tax charge of 25% if it is taken as an income, or 55% if it is taken as a cash lump sum. EFRBS can be set up to avoid both AA and LTA, but HMRC introduces new rules to address special vehicles that are deliberately set up to avoid taxes. EFRBS is also very costly to operate. Therefore, the use of EFRBS in the UK is not as widespread as SERPs in the US (Goh & Li, 2015).

In short, the 2006 UK pension reform has significantly increased income tax associated with pension. CEOs with a large amount of pension would incur extra tax when their pensions exceed either AA or LTA.

2.3 | AA reduction in 2011

Since AA and LTA were introduced in 2006, AA and LTA have been reviewed annually in the government budget. These changes were small and gradual. However, in 2011, AA was slashed from £255,000 to £50,000. After this cut, the amount of allowance available for tax relief was dramatically reduced. While the change is small in terms of complexity, the amount of tax relief involved is substantial. After the reduction, AA is only one-fifth of its original amount in 2010. CEOs who do not exceed pension allowance in 2010 could face an income tax charge at 40% from 2011, even though their pension incomes have not changed at all. We also call the 2011 allowance cut a big reduction in AA and a big cut in allowance (or AA change) in later sections.

[14] For example, before 2006, tax reliefs on pension contributions are offered on a percentage basis, usually at 15% of pensionable income and subject to an Earnings Cap (which was later replaced by AA and LTA). Given that the Earnings Cap in the 2005–06 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. CEOs can use unfunded unapproved retirement benefit scheme (UFRBS) to top up their pension contribution beyond the restriction. Since 2006, UFRBS has been renamed to EFRBS. But these additional contributions do not attract any tax relief; for example, they are taxed as normal income. However, an unapproved scheme has a critical advantage: at retirement, pension benefit can be withdrawn as a lump sum tax-free.

[15] Before 2006, annual pension benefit was limited by a maximum amount. The maximum pension was usually two thirds of a CEO's final salary or Earnings Cap, whichever is lower. For example, the Earnings Cap in the 2005–06 tax year was £105,600, which means the maximum benefits retired CEOs can get from an approved pension scheme was £70,400 in that year. However, CEOs can receive additional benefits beyond this limit using unapproved schemes. As discussed in the previous footnote, an unapproved scheme is very attractive because the total benefit can be withdrawn tax-free. It is also a common practice to top up a CEO's pension based on this method.

TABLE 2 Earnings Cap, annual allowance and lifetime allowance in the UK

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	£1.50 m
2007/08	£112,800	£225,000	£1.60 m
2008/09	£117,600	£235,000	£1.65 m
2009/10	£123,600	£245,000	£1.75 m
2010/11	£123,600	£255,000	£1.80 m
2011/12	£129,600	£50,000	£1.80 m
2012/13	£137,400	£50,000	£1.50 m
2013/14	£141,000	£50,000	£1.50 m
2014/15	£145,800	£40,000	£1.25 m
2015/16	£149,400	£40,000	£1.25 m
2016/17	£150,600	£40,000	£1.00 m
2017/18	£154,200	£40,000	£1.00 m
2018/19	£160,800	£40,000	£1.03 m
2019/20	£166,200	£40,000	£1.06 m

Notes: This table reports information for the pre-2006 pension allowance—Earnings Cap and the post-2006 pension allowances—annual and lifetime allowances in the UK. 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.
Source: HM Revenue & Customs pension tax manual: https://www.gov.uk/hmrc-internal-manuals/pensions-tax-manual

The 2006 pension reform and 2011 allowance cut are so influential that many stakeholders are affected. Its effect is still valid today. For example, survey data from Lane Clark & Peacock LLP (2015) show that salary supplements in lieu of any pension provision continue to grow after the 2006 reform. In 2015, 38% of FTSE 100 executives used cash as an alternative to pensions. They call the phenomenon of shifting pensions to cash-in-lieu 'the end of the road for executive pensions'. On the other hand, the reforms generated huge tax revenue for HMRC. According to Pension Policy Institute (2016), tax receipts on pensions reached £13 billion in 2015, a 60% increase from 2002 thanks to the introduction of tax allowances. The reform has also accelerated closure of DB pension schemes across the UK, as this could lower pension liability and improve firms' financial standing. For example, Rauh (2006) documents that firms reduce capital expenditures in response to a reduction in internal resources caused by mandatory pension contributions. The reform also affects pension funds. Too rapid growth in pension assets (e.g., exceeding allowance) may result in disadvantaged tax treatment or the so-called 'penalty for good performance'. Pension funds need to structure new tax-efficient investment plans for their members. Finally, the pension reform has ignited several ongoing debates. A key argument is that AA and LTA undermine pensions as a long-term saving vehicle. Steve Webb, the UK's pension minister (2012–15), had suggested that frequent LTA reductions have created uncertainty in long-term financial planning and have undermined people's trust in long-term savings (Royal London, 2016).

3 | HYPOTHESES DEVELOPMENT

3.1 | Tax benefit hypothesis

CEOs may favour pensions over other forms of compensation for two reasons. First, pensions are similar to salary, which is independent of any firm performance measures. A higher level of pension inflates a CEO's non-contingent pay. Goh and Li (2015) document that pension works as a substitute for performance-based compensation, especially bonuses. They suggest that CEOs take advantage of pensions to lower pay-performance sensitivity. Second, pensions have tax advantages compared to other forms of compensation. Income tax on pensions is usually deferred, or even free if pension contributions are below specific tax allowances. Firms and CEOs have strong incentives to take advantage of pensions to maximise CEOs' take-home pay and also minimise firms' compensation expenses. However, the introduction of AA and LTA after the 2006 pension reform significantly increases the income tax that CEOs have to pay. In our sample, 81% of FTSE 100 CEOs with DB pension either exceed AA or LTA between 2003 and 2016. Depending on their overall income, the highest tax rate could reach 55% after the reform. This significantly reduces the attractiveness of pension as a form of tax-efficient compensation.

Tax is an important consideration when firms make decisions related to CEO compensation. A small but growing literature is investigating the impact of tax on CEO compensation. For example, Widdicks and Zhao (2014) show that option exercise behaviours are affected by different tax rules. They find different compensation practices in the UK and the US are driven by the different tax treatment of CEO stock options. Focusing on CEO inside debt in the US, Chaudhry et al. (2017) document that firms are using DB pension deficit to achieve corporate tax savings. Their study indicates that firms may manipulate pension value to obtain benefits from corporate tax.

In our UK pension case, we argue that if top managers (firms) use pensions to evade income tax (reduce expenses), they should alternate the form and level of pension payment once tax rules change. Due to the complexity of pension tax, a direct comparison of income tax before and after the 2006 reform is very difficult and could distract the focus of the paper. We provide a simple demonstration in Appendix C. Overall, income tax on pension increases significantly after 2006 as AA and LTA offer less tax relief than rules based on the pre-2006 Earnings Cap.

Firms are also willing to pay CEOs with cash-in-lieu instead of pension, as the same amount paid in cash provides CEOs with more net pay. In other words, minimising CEO income taxes also reduces expenses as firms could pay CEOs with a lowered gross amount. Yet CEOs still receive the same amount of after-tax pay. This leads to our tax benefit hypothesis. We expect a significant decline in both DB and DC pension, while a sharp increase of cash-in-lieu as the substitute. Our specific hypothesis is listed as follows.

H1: After the 2006 pension reform, CEOs receive fewer *defined benefit (DB) pensions*, fewer *defined contribution (DC) pensions*, and more *cash-in-lieu of pensions*.

The AA and LTA are reviewed annually by the UK government. In 2011, AA decreased to £50,000 from its highest level of £255,000 in the previous year. In 2014, AA was slashed further to £40,000. Therefore, we expect that the change in 2011 is more severe than the introduction of AA and LTA in 2006. While the 2006 reform completely overhauls pension tax rules, tax reliefs from the new rules were still generous in some areas. For example, a CEO only pays an AA charge when his or her annual pension contribution is above £255,000, which is a generous amount even in our sample of FTSE 100 CEOs who have a mean pension of £204,000. More than half of the CEOs in our sample would not pay an AA charge before 2011 but would have to pay an AA charge of 40% on the same pension contribution afterwards.

Another important aspect of the 2011 AA reduction is that the change was not expected. All pension allowances are reviewed and amended in the UK government budget every year. In the April 2009 budget, AA was set to be held constant at £255,000 until 2016. However, in the June 2010 budget, HM treasury took a complete U-turn on the

pension tax and planned to reduce AA from £255,000 to £50,000.[16] This change was unexpected by the pension industry. Our second hypothesis is as follows:

H2: Compared to the 2006 pension reform, the annual allowance (AA) reduction in 2011 leads to a larger reduction of defined benefit (DB) pensions and defined contribution (DC) pensions, but a larger increase in cash-in-lieu of pensions.

3.2 | Risk reduction hypothesis

The US literature unambiguously documents that CEO inside debt encourages risk-averse behaviours. The theoretical argument is that inside debt, such as DB pensions, makes CEOs potential debtholders. In the event of bankruptcy, CEOs suffer considerable losses as they may not recover the full value of their DB pensions. As a junior debtholder of a firm's asset, a CEO is not the first in the queue to claim a firm's residual value. Both the US and the UK governments set up related schemes to guarantee pension payments to some extent. However, these guarantees offer limited protections to CEOs with a large amount of pension. In the US, the Pension Benefit Guaranty Corporation (PBGC) could fund pension deficit when employers go bankrupt, up to a maximum limit of $64,432 per beneficiary in 2017 if the employee is retired at the age of 65. In the UK, the Pension Protection Fund (PPF) provides a similar guarantee against employer bankruptcy, capping at an annual payment of £41,461 after April 2020. In our sample of FTSE 100 CEOs in 2003–2016, the average DB value is over £1.6 million. Therefore, a large proportion of UK CEOs' DB pension remains exposed to firms' default risk.

As CEOs' wealth is tied to firms' future financial health, CEOs are likely to take less risks and adopt conservative policies. For example, He (2015) notes that a large amount of inside debt is associated with high-quality financial reporting. Eisdorfer et al. (2015) find that firms with more inside debts pay fewer dividends. Cassell et al. (2012) observe that inside debt is associated with a number of risk-averse firm policies (e.g., low leverage and R&D). All these findings utilise accounting-based measures to capture firms' risk-taking choices. They directly observe firms' risk-averse policies. Inside debt is also negatively associated with market-based measures of firm risk. For example, Bennett, Güntay, and Unal (2015) find that inside debt is negatively associated with bank default risk. Wei and Yemack (2011) document bond prices rise in firms with high CEO inside debt after SEC mandate inside debt disclosure. Anantharaman et al. (2014) find that inside debt leads to low loan yield. In more recent studies, the effect of inside debt on risk-taking is documented as conditional. Kabir, Li, and Veld-Merkoulova (2018) show that CEOs cut R&D spending if they have more DB pensions and shorter career horizons. Li, Lin, Sun, and Tucker (2018) provide evidence that the relationship between inside debt and corporate conservatism is mostly for non-investment grade firms.

Overall, the findings in the literature are consistent: inside debt is associated with a number of risk-averse firm policies as well as various market measures of firm risk. Table 1 provides a review of the literature on inside debt and risk-taking. These findings have profound policy implications as compensation reforms concentrate exclusively on equity and other incentive pay. CEO pension and its risk-averse effect are often overlooked. Sundaram and Yermack (2007) even argue that firms award CEO large equity to counteract conservative incentives of large pension.[17] These findings suggest another possibility for future compensation reforms. For example, the UK Remuneration Code and the EU bonus cap were introduced in the aftershock of the credit crisis. The aims of these two reforms are limiting bank CEO pay and bank risk-taking, but neither reform has any rule related to the executive pension which could be an effective tool to curb bank risk-taking. While studies in the US are abundant, evidence of inside debt in another country is

[16] The 2009 budget for UK government is available at: *https://webarchive.nationalarchives.gov.uk/20100407203659/http://www.hm-treasury.gov.uk/d/bud09_completereport_2520.pdf.* The 2010 budget for UK government is available at: https://www.gov.uk/government/publications/budget-june-2010

[17] As stated in Sundaram and Yermack (2007): 'It is possible that the large equity awards Welch received in his final years in office were partly intended to counteract the incentives for conservative management that would otherwise have arisen from his large pension value.'

scarce. Confirming evidence outside the US is important, as inside debt could offer a new instrument to policymakers in those countries.

We closely follow the literature from the US to motivate risk reduction hypothesis for three reasons. First, pension regulations are quite similar and comparable in the UK and the US. As we have discussed in Section 2.1, the 401(k) plan in the US is almost identical to an approved DC pension scheme in the UK. SERPs in the US are also very similar to approved DB pension schemes in the UK, though their tax treatment is different. Second, the implicit role of DB on firm risk is comparable in the UK and the US. DB is not a secured benefit for CEOs and sponsors are liable to pay the deficit of DB pension in both countries. In the event of firm bankruptcy, capped protections for DB pension are provided by governments in both countries. Third, previous literature also employs the same risk implications for UK studies. For instance, Kabir, Li, and Veld-Merkoulova, 2013, 2018) find that CEO DB pension provides risk-averse incentives in the UK, which is consistent with the US literature.

Following the literature, we also expect a negative association between CEO inside debt and firm risk-taking. Our empirical test utilises the 2006 pension reform and 2011 allowance cut as natural experiments. If inside debt and firm risk policies are causally associated, then we should observe an immediate change of firm policies following the pension reform. That is a decline (increase) of DB pension would lead to a higher (lower) level of firm risk-taking. Our main risk reduction hypothesis is as follow:

H3: If CEO defined benefit pensions (DB) and firm risk-taking are negatively associated, then the change of firm risk-taking should be negatively related to the change of CEO DB pension after the pension reform.

We first consider two firm policies with risk implications: R&D and CAPEX. Both research and development (R&D) and capital expenditure (CAPEX) are risky firm policies due to their uncertainty and timing of expected payoff. Cassell et al. (2012) provide empirical evidence that R&D and working capital are negatively associated with CEO inside debt in the US. Similar to their study, we expect a negative association between R&D, CAPEX and CEO DB pension in the UK. If the 2006 UK pension reform led to a decrease in DB pension, we should observe an increase of R&D and CAPEX after the reform.

Apart from accounting-based measures of firm risk, we also examine market measures of firm risk-taking. Stock return volatility is a proxy of a firm's total risk. A large return volatility implies a high level of risk. Based on the risk-averse argument, van Bekkum (2016) documents that a high level of CEO inside debt leads to a low level of risk for US banks. He considers stock return volatility along with other risk proxies, including value at risk (VaR) and expected shortfall (ES). Following Cassell et al. (2012) and van Bekkum (2016), we also expect a negative association between stocks return volatility and CEO DB pension in the UK.

We also examine the association between cash holding and inside debt. Since firms hold cash for various reasons besides risk aversion, we need to look further at how inside debt could interact with firm cash holdings. The previous literature identifies several motivations for a firm to hold cash: (1) transaction needs (e.g., Miller & Orr, 1966); (2) precautionary needs (e.g., Han & Qiu, 2007); (3) tax-saving needs (e.g., Foley, Hartzell, Titman, & Twite, 2007); and (4) agency self-interests (e.g., Harford, Mansi, & Maxwell, 2008). In addition to those theories, we argue that CEO DB pensions also provide incentives for firm cash holdings.

First, DB pension is a risky and unsecured pay component that makes CEOs potential debtholders. There is a growing literature that examines the relationship between risk and cash holdings from debtholders' points of view. For instance, Acharya, Davydenko, and Strebulaev (2012) document that a firm is more likely to accumulate a higher level of cash reserve if it faces a higher level of default risk. Harford, Klasa, and Maxwell (2014) find that a firm is more likely to increase cash holdings and save cash from operating cash flows if it has a higher level of refinancing risk. CEOs with DB pension are potential debtholders of their own firms. They are more likely to hold cash if they have a large amount of DB pensions, which is in line with the interests of debtholders who prefer cash for security. Consistent with this risk aversion argument, Liu et al. (2014) document that cash holdings are positively related to CEOs' inside debt in the US.

Second, cash is the most liquid asset to fund any DB pension deficit. Since the introduction of the Pension Act 1995, UK firms have a legal obligation to pay DB pension deficit within a pre-specified period. When a firm fails to meet its statutory funding objective, the UK pension regulator has the power to issue a contribution notice, financial support directions and restoration orders. In other words, firms with a significant pension liability are under pressure to raise sufficient cash to fund the DB pension deficit.

Liu et al. (2014) argue that a high level of cash holdings indicates a conservative firm policy.[18] Cash holdings help to fund DB pension deficit, easing the concern of pension safety. We expect a high level of firm cash holdings for a large DB pension size. That is a decline (increase) of firm cash holdings when CEOs' DB pensions are lowered (increased). If the UK pension reforms lead to a decrease in DB pensions, we should observe a drop in cash holdings after the reform. Our specific hypothesis is as follows:

H4: If CEO defined benefit pensions (DB) and firm cash holdings are positively associated, then the change of firm cash holding should be positively related to the change of CEO DB pension after the pension reform.

4 | RESEARCH DESIGN

4.1 | Test tax benefit hypothesis

According to the tax benefit hypothesis, we expect a significant decline in DB and DC pensions, coinciding with a sharp increase of cash-in-lieu after the 2006 UK pension reform. Although the reform became effective in 2006, AA and LTA are reviewed annually, so gradual changes in tax allowances are still slowly introduced. For example, even though AA was reduced substantially in 2011, it was further reduced in 2014. For this reason, we expect pensions to continue declining long after 2006. Furthermore, discussions of the 2006 reform started in 2001 and were then amended several times during the consultation period until it was finalised in 2004. Therefore, we expect some changes of pension arrangements to occur before 2006. Table 3 presents a summary of the reform timeline below.

To fully examine the impact of the reforms and investigate the effects of the gradual reduction of tax allowances, the sample period is divided into five sub-periods to coincide with four key milestones of the pension reform. The first milestone date is chosen to be August 2004, as the Finance Act 2004 was published when all details of the pension reform were finalised. This is the date when firms were fully aware of the reform's implementation, and we expect them to start making anticipatory changes. The second milestone date is April 2006, which was when the reform became effective. Naturally, we choose this date to study the impact of reform before and after its effective date. The third milestone date is April 2011 when the big cut in AA became effective. As this is a big policy surprise, we expect a larger impact on pension arrangements. The last milestone date is April 2014, which is the date when AA was cut further. We expect DB pension to continue its gradual decline after the 2014 allowance cut. By testing these periods separately, we examine how CEO pensions change in response to each regulation change. The extended testing period also allows us to examine the evolution of CEO pensions. Employing different event windows to explore the impact of law and regulation change is common. Li, Pincus, and Rego (2008) investigate the market reaction to the Sarbanes-Oxley Act of 2002. They document that the market is sophisticated enough to interpret and respond to legislative events surrounding the Sarbanes-Oxley Act of 2002. Our model is as follows:

[18] 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 cash holdings.

TABLE 3 Timeline of the UK pension reform

Date	Event
01/03/2001	Pension tax review was initiated.
01/07/2002	Lifetime Allowance was proposed. Preliminary effective date was set for April 2004.
01/06/2003	Discussion paper was published. Reform effective date was delayed to April 2005.
01/03/2004	The Finance Act 2004 was published. Reform effective date was finalised to be 6 April 2006.
06/04/2006	Annual Allowance and Lifetime Allowance became effective.
01/04/2009	Budget 2009: Annual Allowance would remain at the same level until 2015–16.
01/06/2010	Budget 2010: Annual Allowance was proposed to be reduced to £30,000–£45,000.
14/10/2010	The UK government confirmed Annual Allowance would be reduced to £50,000, effective from 6 April 2011.
06/04/2011	Annual Allowance was reduced to £50,000 from £255,000.
06/04/2014	Annual Allowance was further reduced to £40,000 from £50,000.

$$\begin{aligned}\text{Pension structure}_{i,t} = {} & \alpha_0 + \alpha_1 \text{Between Aug04 to Mar06 (law pending)} \\ & + \alpha_2 \text{Between Apr06 to Mar11 (initial introduction)} \\ & + \alpha_3 \text{Between Apr11 and Mar14 (a big cut in allowance)} \\ & + \alpha_4 \textit{After} \text{ Apr14 (a further cut in allowance)} \\ & + \alpha_5 \Sigma \text{ CEO characteristics}_{i,t} + \alpha_6 \Sigma \text{ Board characteristics}_{i,t} \\ & + \alpha_7 \Sigma \text{ Firm characteristics}_{i,t} + \alpha_8 \text{Industry}_i + \delta_{i,t} \end{aligned} \quad (1)$$

We expect a big change in pension arrangement to happen between August 2004 and March 2006 (coefficient α_1). This is because the reform is already finalised, and the two-year period was designed to give firms time to prepare for the upcoming reform. The impact is likely to be moderate between April 2006 and March 2011 (coefficient α_2) as changes are already implemented for many firms in the prior period. Due to a big surprise in AA reduction, we expect to find a large impact between April 2011 and March 2014 (coefficient α_3). The difference between these two coefficients (α_2 and α_3) is used to test hypothesis H2, where we expect that changes in AA reduction are larger than changes in the initial reform. As far as the further cut in AA is concerned, we also expect a significant change after April 2014 (coefficient α_4), as pension becomes even less tax efficient after a further cut in AA in 2014.

We employ a Tobit model in equation (1). As a large proportion of UK CEOs do not have any DB pension, our pension structure variables contain a large number of zero value observations. Excluding these zero value observations would introduce selection bias as firms' decisions to award inside debt are not random. In our sample, firms that award inside debts to their CEOs are usually large and less risky. If we treat inside debt as censored at zero, we have a significantly censored dependent variable in regressions. The use of a Tobit model for censored dependent variables is well documented in compensation studies. Domínguez-Barrero and López-Laborda (2007) use a Tobit model to estimate the determinants of personal pension plans, while Brian, Hwang, and Lilien (2000) employ a Tobit model to estimate the determinant of CEO stock-based compensation.

For dependent variables, we consider pension structure in terms of DB, DC and cash-in-lieu. For independent variables, we use four dummy variables ($\alpha 2$–$\alpha 5$) to capture the five testing periods. To control other factors that may

affect CEO pension type, we add CEO (age, tenure, nationality, gender and equity pay), board (CEO duality and board independence) and firm characteristics (size, market to book ratio, leverage, profitability and stock return volatility) in equation (1). These control variables are widely used in the CEO pension literature (e.g., Anantharaman et al., 2014; Cassell et al., 2012). We also control for industry fixed-effect but not for year fixed-effect in equation (1), as year fixed-effect overlaps our main independent variables. The design to drop year fixed-effect is consistent with Goh and Li (2015), who investigate the impact of the financial crisis on the UK executive pension.

In addition, we conduct Wald tests to examine the difference between independent variables. We would like to see whether the coefficients of these four period dummies of regulation change are different. As stated in hypothesis H2, we expect the 2011 cut in AA would lead to a bigger reduction in CEO pensions than the initial reform in 2006.

4.2 | Test risk reduction hypothesis

We summarise the research designs of the literature on inside debt and risk-taking in Table 4. In these studies, OLS and firm fixed-effect models are widely used. Typically, dependent variables are proxies of risk-taking, and independent variables are proxies of DB pension.

The literature usually assumes the following relationships between firm risk, firm characteristics and DB pension:

$$\text{Risk}_{i,t} = b_0 + b_1\text{Firm Characteristics}_{i,t} + b_2\text{DB pension}_{i,t} + u_i + \varphi_{i,t} \quad (2)$$

In equation (2), Risk is a firm risk-taking proxy (e.g., cash holdings, R&D, CAPEX, and stock volatility). DB pension is a proxy for CEO inside debt. u_i are some time-invariant characteristics that are unobservable by the researcher, which include CEO risk-aversion and outside wealth or a firm's productivity function. Firm fixed-effect regressions are natural candidates to address the time-invariant omitted variable. Himmelberg, Hubbard, and Palia (1999) propose another approach to address the unobservable variable if we take a differenced version of equation (2) as follows:

$$\Delta\text{Risk}_{i,t} = c_0 + c_1\Delta\text{Firm Characteristics}_{i,t} + c_2\Delta\text{DB pension}_{i,t} + \Delta\varphi_{i,t} \quad (3)$$

By using differenced regression, u_i is cancelled out from equation (2). If $\Delta\text{DB pension}_{it}$ and $\Delta\text{Firm Characteristics}_{it}$ are uncorrelated, the equation is well specified to identify the causal association between inside debt and firm risk-taking. However, firm characteristics and CEO DB pension could be jointly determined. Any endogenous change in inside debt is likely to come from (or affect) changes of firm characteristics. Therefore, the following relationship between DB pensions and firm characteristics should also hold:

$$\text{DB pension}_{i,t} = e_0 + e_1\text{Firm Characteristics}_{i,t} + \omega_{i,t} \quad (4)$$

Since both DB pension and firm risk-taking are determined by firm characteristics, a simple OLS regression on equation (2) would lead to a biased and inconsistent coefficient, b_2. Regression on equation (3) is also problematic as variation in ΔDB pension comes primarily from variation in ΔFirm Characteristics, as shown in equation (4). The regression could lack the power to reject the null, as ΔFirm Characteristics are already included as control variables in equation (3). The standard solution offered from the literature is using instrumental variables which isolate variation of DB pension that are uncorrelated with firm characteristics (e.g., Anantharaman et al., 2014). While these studies use instrumental variables to mitigate the endogeneity problem, it does not completely remove the bias.[19]

[19] Cassell, Huang, Sanchez, and Stuart (2012) are aware of this: 'we cannot completely eliminate endogeneity as a potential confounding factor'. Lacker and Rusticus (2010) also 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.

TABLE 4 Research design of the literature on inside debt and firm risk-taking

Paper	Sample	Cross-section	Period	No. of observation	Proxies for risk-taking	Proxies for inside debt	Model Employed
Sundaram and Yemack (2007)	Fortune 500	237 firms	1996–2002	1,570	Distance to default	(1) CEO's pension value/ CEO's stock and option value (2) CEO's pension/equity > firm's debt/equity	Fixed-effect models with a separate intercept assigned to each unique CEO-company pair
Cassell et al. (2012)	S&P 1500	1,265 firms	2006–2008	1,059–2,994	(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

(Continues)

TABLE 4 (Continued)

Paper	Sample	Cross-section	Period	No. of observation	Proxies for risk-taking	Proxies for inside debt	Model Employed
Liu et al. (2014)	US firms available in ExecuComp	N/A	2006–2011	6,009	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 payout	Log of CEO relative incentive ratio	Binary choice model
Eisdorfer et al. (2015)	700 largest US firms	272 firms	2000–2009	1,611	(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	2,117	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

(Continues)

TABLE 4 (Continued)

Paper	Sample	Cross-section	Period	No. of observation	Proxies for risk-taking	Proxies for inside debt	Model Employed
Bennett et al. (2015)	371 US bank	371 firms	2006–2008	371	(1) Distance to default	(1) Log of inside debt	OLS, WLS and Probit
					(2) Equity volatility	(2) Log of CEO inside debt/CEO equity	
					(3) Expected default frequency	(2) Inside debt/total compensation	
					(4) CAMELS Rating	(3) Log CEO relative leverage	
Van Bekkum (2016)	US banks	N/A	2007–2009	319	(1) Total volatility	Log of CEO leverage relative to firm leverage	OLS
					(2) Idiosyncratic volatility		
					(3) Systematic volatility		
					(4) Value at Risk (VaR)		
					(5) Expected shortfall (ES)		
					(6) Financial distress		
Dang and Phan (2016)	S&P	N/A	2006–2012	4,793	Short-term debt	CEO leverage	OLS and firm fixed-effect
Li et al. (2018)	S&P	898	2006–2011	3,558	(1) Proportion of convertible debt to total debt outstanding	CEO-to-firm relative debt-to-equity ratio	Tobit and Probit
					(2) Probability of issuing convertible debt		
					(3) Probability of convertible debt conversion		

To mitigate the endogeneity concern, we use a framework similar to Hayes et al. (2012), who examine the effects of stock options on firm risk-taking. They use the implementation of FAS 123R in the US, where the regulation change increases the accounting cost of awarding stock options to CEOs, as an exogenous shock. In their study, the widespread decline of stock options award after the implementation of FAS 123R serves as a natural experiment.

In our setup, the pension reforms explicitly affect DB pensions but have little or no direct impact on a firm's operating policies. Hence, the reforms serve as exogenous events for our experimental design. We perform cross-sectional regressions on differenced variables in pre- and post-reform periods to account for the exogenous shock. Considering the following cross-sectional differenced regression:

$$\Delta \text{Risk}_i = a_0 + a_1 \Delta \text{Firm Characteristics}_i + a_2 \Delta \text{DB pension}_i + \Delta \varepsilon_i \quad (5)$$

This regression is based on time differenced variables.[20] This is different from equation (4), where all variables are first differenced. The time difference in equation (5) is taken around the pension reforms, for instance an average is calculated using observations before the reform, and another average is calculated using observations after the reform. The difference between these two average values is the new change variable. This regression provides evidence of the causal association between firm risk-taking and CEO DB pension. This is because, first, the time difference removes the time-invariant omitted variable, u_i, as shown in equation (2). Second, the time difference is taken before and after the pension reform, as changes in DB pension are largely driven by the new regulation, and these changes are exogenous to any firm characteristics. We should observe a statistically significant coefficient a_2 in equation (5), if the association between inside debt and firm risk-taking is causal.

5 | DATA AND SAMPLE DESCRIPTION

Our sample consists of non-financial and non-utility firms in the FTSE 100 index. We exclude financial and utility firms, as strict regulation in these two industries limits their comparability with firms in other industries. We also restrict our sample to CEOs who have tenure over one year as the previous CEO's decisions can carry over to the newly appointed CEO. Our sample is from 2003 to 2016, covering both pre- and post-reform periods. Our final sample consists of 1,155 firm-year observations from 126 firms and 254 CEOs. Our data are comparable to Li and Young (2016) who investigate compensation practices of FTSE 350 firms.

We hand collect all UK CEO pension data from company annual reports. Compared to other pay components, the estimation of DB pension value is less straightforward. Following Kabir et al. (2013, 2018), we use hand-collected data from annual reports to estimate the CEO DB pension value. An example of the estimation based on the company's annual report is provided in Appendix B. CEO non-pension compensation and corporate governance data are collected from BoardEx. All other firm-level data come from Bloomberg.

The sample descriptive statistics are listed in Table 5. The proportions of CEOs with DB, DC and cash-in-lieu are 34%, 31% and 42% respectively. Cash-in-lieu is the most popular pension type in our sample. On average, the proportions of CEO annual pension are 58%, 14% and 28% for DB, DC and cash-in-lieu, respectively. DB pension is by far the most generous pension type. On average, CEOs hold a £1.6 million DB pension in terms of transferable value. CEO DB pension value is 18% of his or her equity incentives value (DB to equity ratio = 0.18).[21] Our sample shows that CEOs are 54 years old with 6-year tenure on average; 40% of CEOs are non-British (Foreign CEO = 0.40); and

[20] Difference-in-difference approach does not apply in our case as the tax reform is universally applied to every firm in the UK. For difference-in-difference to work, an independent and random condition needs to apply to a subset of firms. For example, Low (2009) uses geographic location (firm located in Delaware) to distinguish treatment and control firms. Firms which locate in Delaware are treatment firms; while other firms are control ones. We could only use difference-in-difference approach if certain UK firms are subject to the pension reform, while other UK firms are not subject to the reform.

[21] This result is comparable to the US CEOs. Bebchuk and Jackson (2005) find that the ratio between executive pension and total compensation has a median value of 34% in the US.

TABLE 5 Descriptive statistics

Variables	Mean	Q1	Med	Q3	Std.
DB Pension (dummy)	0.34	0	0	1	0.47
DC Pension (dummy)	0.31	0	0	1	0.46
Cash-in-lieu (dummy)	0.42	0	0	1	0.49
DB pension annual (£000s)	208	0	0	68	602
DC pension annual (£000s)	51	0	0	32	114
Cash-in-lieu annual (£000s)	101	0	0	175	237
DB/Total pension (%)	58	0	0	18	40
DC/Total pension (%)	14	0	0	8	42
Cash-in-lieu/Total pension (%)	28	0	0	46	45
Pension annual (£000s)	360	51	204	378	539
Annual compensation (£000s)	4,403	1,921	3,176	4,958	5,068
DB pension total (£000s)	1,605	0	0	1,330	3,346
DB to equity ratio (times)	0.18	0	0	0.12	0.41
DB to equity ratio relative (times)	0.64	0	0	0.28	1.93
CEO equity (£000s)	58,127	4,705	10,634	23,062	264,599
CEO age (years)	53.95	49.98	54.25	57.89	6.06
CEO tenure (years)	6.29	2.70	4.60	7.80	5.87
Foreign CEO (dummy)	0.40	0	0	1	0.49
Female CEO (dummy)	0.04	0	0	0	0.19
CEO duality (dummy)	0.03	0	0	0	0.18
Board independence (%)	68.17	60.00	70.00	77.78	11.69
Cash holdings (%)	8.52	3.23	5.99	11.10	7.74
Firm size (£ m)	18,386	3,592	7,671	22,331	50,475
Market to book ratio (times)	4.15	1.57	2.76	4.84	6.91
Leverage (%)	24.95	15.07	23.88	33.98	14.56
Pension deficit (£ m)	−418	−292	−60	0	1,178
Operating cash flows (%)	10.88	6.75	10.00	14.05	6.15
Stock return volatility (%)	33.72	22.46	29.20	40.18	16.01
R&D expenses (%)	1.75	0	0	0.91	4.57
CAPEX expense (%)	7.82	2.13	4.07	8.36	10.18
Dividend payer (dummy)	0.90	1	1	1	0.30
ROA (%)	6.83	3.48	6.50	10.10	7.55

Notes: This table reports descriptive statistics for a sample of 1,155 observations from 126 UK FTSE 100 non-financial and non-utility firms during 2003–16. All variables are defined in Appendix A.

only 4% of CEOs are female. The vast majority of CEOs do not hold the position as chairperson (CEO duality = 0.03). Independent directors also outnumber executive directors (Board independence = 68.17).

For risk-taking proxies, our sample demonstrates that firms have 8.52% of their total assets in the form of cash on average. They spend 1.75% and 7.82% on R&D and CAPEX as a percentage of total sales respectively. The mean stock return volatility is 33.72%, and 90% of our observations pay a cash dividend. In short, these characteristics are consistent with the profile of FTSE 100 firms.

Table 6 shows the correlations between our main variables. At the 1% significance level, CEO DB pension variables are negatively related to the variable of After April11. This fits our tax benefit hypothesis that CEO DB pension declines after the regulation change, especially after the 2011 AA cut. CEO total DB pension (DB total) is negatively related to firm cash holdings, CAPEX and stock return volatility. These correlations are consistent with the risk reduction hypothesis for CAPEX and stock return volatility, while this is not the case for cash holding and R&D spending. In addition, CEOs tend to have more DB pensions if they are British and their firms have a higher market to book ratio.

6 | MAIN RESULTS

6.1 | The impact of pension reform on CEO pension structure

Table 7 demonstrates the impact of pension reform when other factors are controlled. The dependent variables are three pension structure variables: DB/Total pension in column (1), DC/Total pension in column (2) and Cash-in-lieu/Total pension in column (3). Our interested variables are those four period dummies (law pending, initial introduction, a big cut in allowance and a further cut in allowance).

First, the DB pension shows a significant decline throughout the sample period. The coefficients of law pending, initial introduction, a big cut in allowance and a further cut in allowance are −27.38, −24.06, −57.50 and −83.02 respectively (column 1 in Table 7). They are all statistically significant at the 5% level. It suggests that DB pension as a percentage of annual pensions declined by 27.38%, 24.06%, 57.50% and 83.02% in these four periods. Considering that the mean proportion of DB pension in our sample is 58%, a decline of 83.02% suggests that DB pension constitutes only 9.84% (58% × [1 − 83.02%]) of annual pension after April 2014.

Second, cash-in-lieu increased dramatically throughout the sample period. The coefficients of law pending, initial introduction, a big cut in allowance and a further cut in allowance are 28.98, 71.10, 120.39, 134.79 individually + (column 3 in Table 7). They are all statistically significant at the 1% level. It shows that cash-in-lieu as a percentage of annual pensions increased by 28.98%, 71.10%, 120.39% and 134.79% in these four periods. Considering that the mean proportion of cash-in-lieu in our data is 28%, an increase of 134.79% indicates that cash-in-lieu constitutes 65.74% (28% × [1 + 134.79%]) of annual pension after April 2014.

Third, DC pension only shows a moderate decline after a further cut in AA in 2014. The coefficient of further cut in allowance is −27.63 and significant at 10% level (column 2 in Table 7). Other period variables are not statistically significant. Considering that the mean proportion of DC pension in our sample is 14%, a decrease of 27.63% suggests that DC pension constitutes only 10.13% (14% × [1 − 27.63%]) of annual pension after April 2014.

These results confirm a big shift from DB pension to cash-in-lieu. As we discussed previously, only DB and DC pension are subject to AA and LTA charge. CEOs are likely to be taxed twice for holding DB and DC pension. That is the tax on annual contribution if it exceeds AA, and tax on access to pension benefit if it exceeds LTA. Unlike DB and DC, cash-in-lieu is just a normal salary with a different name, and it is taxed once as a regular income. In short, the pension is less tax efficient than cash-in-lieu after the 2006 pension reform. We present a more detailed discussion about pensions' tax treatments in Appendix C.

These results are not only statistically significant but also economically important. After the pension reform, CEO pension structure is completely changed in the UK. Hundreds of millions of pounds are paid in cash rather than contribution in the pension scheme for top managers in the UK's largest companies. The result clearly supports our first hypothesis (H1), a decline of pension and an increase of cash-in-lieu after the reform. Our results are also consistent with Morris, Gregory-Smith, Main, Montagnoli, and Wright (2015). They show a decrease in DB pension following the 2006 UK pension reform.

Our second hypothesis (H2) argues that the big cut in AA allowance in 2011 has a bigger impact on pension. We employ Wald tests at the bottom of Table 7 to examine the differences between different periods. The coefficient of a big cut in allowance is −57.50, while that for the initial introduction is −24.06 (column 1 in Table 7). The difference

TABLE 6 Correlation matrix

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	**0.68**	1																	
(3) DB to equity ratio relative	**0.52**	**0.75**	1																
(4) CEO equity	−0.03	**−0.12**	**−0.09**	1															
(5) CEO tenure	0.06	0.08	0.03	**0.26**	1														
(6) CEO age	0.07	**0.11**	**0.10**	−0.02	**0.32**	1													
(7) Foreign CEO	**−0.16**	**−0.16**	**−0.13**	0.07	**−0.13**	0.03	1												
(8) Female CEO	−0.03	−0.15	−0.05	−0.02	−0.04	0.01	**0.10**	1											
(9) Between Apr06 and Apr11	0.06	0.04	0.04	0.02	0.03	−0.07	−0.04	−0.03	1										
(10) After Apr11	**−0.15**	**−0.18**	**−0.14**	0.08	0.02	**0.11**	**0.12**	0.06	**−0.64**	1									
(11) Cash holdings	**−0.15**	**−0.10**	−0.06	0.01	−0.01	**−0.14**	0.13	**0.14**	0.06	−0.06	1								
(12) R&D expenses	−0.07	−0.06	−0.04	0.03	−0.01	**−0.09**	−0.03	−0.07	−0.01	−0.04	**0.15**	1							
(13) CAPEX expense	**−0.21**	**−0.13**	**−0.09**	0.05	**0.11**	−0.03	**0.22**	−0.02	0.01	0.01	0.04	**−0.10**	1						
(14) Stock return volatility	**−0.15**	−0.02	−0.03	**−0.10**	−0.06	**−0.16**	0.01	−0.01	**0.25**	**−0.15**	**0.12**	−0.03	**0.21**	1					
(15) Firm size	0.07	−0.01	0.02	**0.21**	−0.05	**0.19**	**0.22**	0.03	−0.05	**0.18**	**−0.22**	−0.05	**0.13**	**−0.12**	1				
(16) Market to book ratio	**0.09**	0.01	−0.07	0.04	0.02	**−0.10**	−0.02	−0.03	−0.01	0.01	0.04	0.04	−0.07	**−0.18**	**−0.10**	1			
(17) Leverage	**0.15**	**0.10**	**−0.14**	−0.03	−0.07	−0.01	0.03	−0.06	−0.02	−0.01	**−0.22**	**−0.20**	0.06	−0.04	0.04	**0.16**	1		
(18) ROA	0.03	−0.07	−0.03	**0.13**	0.06	−0.06	−0.01	0.02	**0.09**	**−0.08**	**0.11**	0.05	−0.06	**−0.32**	**−0.12**	**0.29**	**−0.13**	1	
(19) Dividend payer	**0.09**	0.01	−0.01	**0.10**	−0.01	**0.12**	0.04	0.02	−0.02	0.02	**−0.23**	−0.05	**−0.08**	**−0.42**	**0.12**	**0.10**	0.01	**0.26**	1

Notes: This table presents the correlation matrix for the sample of 1,155 observations from 126 UK FTSE 100 non-financial and non-utility firms during 2003–16. Typeface is bold if it is significant at least at 1% level.

TABLE 7 The impact of pension reform on CEO pension structure

Variables	(1)DB/Total pension (%)	(2)DC/Total pension (%)	(3)Cash-in-lieu/Total pension (%)
Between Aug04 to Mar06 (law pending)	−27.38**	10.83	28.98**
	(−2.03)	(0.68)	(2.03)
Between Apr06 to Mar11 (initial introduction)	−24.06***	6.03	71.10***
	(−2.04)	(0.43)	(5.69)
Between Apr11 to Mar14 (a big cut in allowance)	−57.50***	−24.58	120.39***
	(−4.30)	(−1.59)	(9.03)
After Apr14 (a further cut in allowance)	−83.02***	−27.63*	134.79***
	(−5.74)	(−1.72)	(9.82)
CEO age	−17.46	127.70***	80.26***
	(−0.50)	(3.37)	(2.77)
CEO tenure	−1.73	4.50	−17.35***
	(−0.33)	(0.82)	(−4.13)
Foreign CEO	−32.99***	27.10***	−17.12***
	(−4.16)	(3.24)	(−2.76)
Female CEO	−18.55	58.09***	3.16
	(−0.99)	(3.20)	(0.22)
CEO equity	−2.94	0.15	1.08
	(−1.40)	(0.07)	(0.65)
CEO duality	30.47	−33.47	−42.16**
	(1.64)	(−1.56)	(−2.16)
Board independence	−1.68***	1.29***	−0.82***
	(−4.42)	(3.27)	(−2.70)
Firm size	19.06***	−10.70***	−8.76***
	(5.91)	(−3.23)	(−3.44)
Market to book ratio	0.83*	0.90*	−0.37***
	(1.73)	(1.67)	(−2.94)
Leverage	0.85***	−0.18	0.24
	(3.34)	(−0.65)	(1.21)
ROA	−0.41	0.33	−1.19
	(−0.75)	(0.60)	(1.30)
Stock return volatility	−0.11***	0.02	0.06
	(−4.13)	(0.08)	(0.29)
Constant	−6.97	−490.36***	−223.54**
	(−0.05)	(−3.23)	(−1.94)
Industry	Yes	Yes	Yes
Left censored	798	794	668
Uncensored	357	361	487

(Continues)

TABLE 7 (Continued)

Variables	(1)DB/Total pension (%)	(2)DC/Total pension (%)	(3)Cash-in-lieu/Total pension (%)
Coefficients restriction 1	Coe. (Law pending) = Coe. (Initial introduction)		
Difference in coefficients (restriction 1)	−3.33	4.80	−42.12***
Coefficients restriction 2	Coe. (Initial introduction) = Coe. (a big cut)		
Difference in coefficients (restriction 2)	33.44***	30.61***	−49.28***
Coefficients restriction 3	Coe. (a big cut) = Coe. (a further cut)		
Difference in coefficients (restriction 3)	25.52**	3.05	−14.40*

Notes: This table reports results from Tobit regressions describing the impact of UK pension reforms on CEO pension structure. The sample includes UK FTSE 100 non-financial and non-utility firms from 2003–16. The total number of observations is 1,155 from 126 unique firms. The dependent variables are DB/Total pension, DC/Total pension and Cash-in-lieu/Total pension in columns (1), (2) and (3) respectively. The independent variables are four dummy variables representing four periods of reform: Between Aug04 to Mar06 (law pending), Between Apr06 to Mar11 (initial introduction), Between Aprl11 to Mar14 (a big cut in allowance) and After Apr14 (a further cut in allowance). The asterisks *, **, *** denote statistical significance at 10%, 5% and 1% level, respectively. *Z* statistics are reported in parentheses. All other variables are defined in Appendix A.

between these two coefficients is −33.44 (−57.5 + 24.06), which indicates that the percentage in DB pension/total pension declines 33.44% more in the period of a big cut in allowance compared to the period of initial introduction (coefficient restriction 2 in column 1 at the bottom of Table 7). A similar result is also observed for cash-in-lieu (column 3 in Table 7) where the coefficient difference between a big cut in allowance and initial introduction is 49.28 (120.39 – 71.10), and such a difference is statistically significant (coefficient restriction 2 in column 3 at the bottom of Table 7). In other words, cash-in-lieu has a bigger increase in the period of a big cut in allowance compared to the period of the initial introduction. These results strongly support our hypothesis H2 which states that the 2011 AA cut would lead to a larger reduction of DB pension and a bigger increase of cash-in-lieu than the 2006 pension reform.

As far as controlled variables are concerned, our results show that UK CEOs would have more DB pensions if their firms are larger and more geared, which is consistent with US studies (e.g., Sundaram & Yermack, 2007). Older CEOs in the UK would have more pensions, which is also in line with the US literature (e.g., Cen, 2010; Sundaram & Yermack, 2007). However, CEOs in the UK have fewer DB pensions if their firms have a higher proportion of independent directors, which opposes findings in the US (e.g., Cen, 2010). It may highlight the monitoring role of independent directors in the UK. In addition, CEO nationality is a significant explanatory factor for DB pension. The proportion of DB pension in annual pension is 32.99% lower if a CEO is non-British. This finding is never documented in studies conducted in the US. A possible explanation is that foreign CEO is relatively rare in the US compared to the UK.

In short, the results in Table 7 support our tax benefit hypotheses (H1–H2). That is, the regulation changes increase income tax and significantly decrease the usage of DB pension, while they encourage the adoption of cash-in-lieu. Compared to DB pension, we do not observe the same level of decline in DC pension. UK firms appear to substitute away from DB pension towards cash-in-lieu, where income taxes are less punishing.

We offer an alternative explanation to our results in Table 7 here. DB pension may decline for reasons that are completely independent of the tax reform. Firms' total pension liabilities could be huge. Changing firm-wide pension policies could make a significant difference in a firm's balance sheet. DB pensions are more expensive than DC pensions as employers have to bear the risk of longevity. Therefore, it makes financial sense to shift pension from DB to DC. Pension Policy Institute (2003) documents such a shift in the early 2000s. It argues that the growing DB pension cost is due to increased longevity and low investment return. Firms may close DB pension plans and shift CEO pensions to alternative deferred compensation arrangements, simply because DB pension is too costly to maintain. Once a DB pension scheme is closed, it may stop future contribution to the scheme. However, sponsors are still liable for pension benefits accumulated before the winding-up period.

If the change of pension structure was mainly driven by cost saving, we should expect a shift from DB pension to DC pension because DC pension is cheaper to maintain than DB pension. However, we document a shift of DB pension to cash-in-lieu, rather than a shift of DB pension to DC pension. If the change of pension structure was purely driven by tax treatment, we should expect a decline of DB and DC pension at the same time because the tax treatment is the same for both DB and DC pension. However, we find that DC pension only started to decline after April 2014 when AA was further cut. The main reason is that firms take advantage of AA to exhaust allowance for DC pension. To illustrate this with an example: Ian Cheshire, CEO of Kingfisher, received DC pension of £203,000, £205,000, £208,000, £49,400 and £70,000 in 2008, 2009, 2010, 2011 and 2012 respectively. These annual DCs are all in line with AA for their respective years. It suggests that Kingfisher employed DC pension to exhaust its CEO's AA for each financial year. Firms appear to award DC pension to exhaust their CEOs' AA, and then use cash-in-lieu to top up further benefit. In short, both tax and cost saving factors influence CEOs' pension choices. Cash-in-lieu is the most tax efficient and cheapest to maintain. We witness its strong growth throughout the sample period. On the other hand, DB pension is not tax efficient. It is also the costliest type of pension to maintain. It is not a surprise that we find DB pension declines dramatically. DC pension is cheaper than DB pension to maintain, but it is less tax efficient compared to cash-in-lieu. Therefore, we only demonstrate a moderate decrease in DC pension in the later stages. All in all, the tax treatment is a key determinant of CEO pension structure in the UK.

Next, we examine the impact of *ex-ante* pension value on the change of pension structure. We argue that CEOs with more pensions should be more affected by tax change. Therefore, they should have a stronger incentive to reduce their pension after the reform. To investigate this, we divide the sample into two groups based on whether CEOs exceed pension allowances or not. We define high pension group as CEOs who exceed either AA or LTA before the 2006 reform. As discussed in the introduction, our sample contains a large number of zero value observations, because many CEOs do not have any inside debt. We run Tobit regressions with interactive terms in Table 8. The table shows that CEOs with a high level of DB pension receive fewer DB pensions after the reform. For instance, the coefficient of After April06 × High DB_AA is −50.77 in column (3). Such a coefficient suggests that if a CEO exceeds AA before the 2006 reform, his or her DB pension as a fraction of total pension declines by 50.77% after the reform. A similar result is also documented when the dependent variable is the natural logarithm of DB pension in columns (1) and (2).

Overall, the results in Table 8 indicate that CEOs with a large amount of DB pensions reduce their DB pensions substantially more after the reform. Table 8 also shows that the magnitude of DB pension reduction depends on *ex-ante* pension value, the amount of DB pension prior to pension reform. Since the amount of DB pensions affects the amount of income taxes that CEOs are liable to pay, these results further strengthen our argument that income tax is the key driver for the sharp decline of DB pension.

6.2 | The impact of CEO pension on firm risk-taking

The previous literature finds that inside debt is negatively associated with a number of firm risk-taking measures, as summarised in Table 1. If the relationship between inside debt and risk-taking is causal, then we should observe an increase in risky policies as firms shift away from inside debt compensation in response to the pension reforms. In Tables 9–12, we present a formal analysis of the association between changes in firm risk-taking and changes in DB pension that corresponds to our research design. As described in Section 4.2, our research design allows us to exploit the cross-sectional relation between changes in firm risk-taking and changes in DB pension while controlling omitted factors that might have affected firm risk policies in the same period. Our test procedure is as follows. For each firm, we calculate averages of variables in both pre- and post-reform periods. We then calculate the difference between those two average values for each variable. The newly formed differenced variables are then used in the regressions of equation 5. Since there are two major changes to the pension taxes, the 2006 pension reform that introduces AA and LTA and the 2011 AA cut that significantly lowers AA, we present results for both regulation changes. Following the previous literature, we calculate three measures of inside debt. The first inside debt variable is the natural logarithm

TABLE 8 The impact of pension reform on CEO pension: Comparison between high and low DB pension groups

	(1)	(2)	(3)	(4)
Variables	**DB pension total (ln£000s)**		**DB/Total pension (%)**	
After Apr06	0.53	0.94	−0.37	3.98
	(0.65)	(1.14)	(−0.04)	(0.41)
High DB_AA	12.80***		144.27***	
	(11.94)		(11.90)	
High DB_LTA		12.72***		141.59***
		(11.97)		(11.51)
After Apr06* High DB_AA	−3.32***		−50.77***	
	(−2.84)		(−3.83)	
After Apr06* High DB_LTA		−3.84***		−56.74***
		(−3.29)		(−4.19)
CEO age	5.32**	−1.31	2.63	−64.58**
	(2.01)	(−0.50)	(0.09)	(−2.12)
CEO tenure	−0.71*	−0.33	−9.10**	−5.45
	(−1.81)	(−0.84)	(−1.99)	(−1.18)
Foreign CEO	−0.06	−0.45	−3.90	−9.10
	(−0.11)	(−0.76)	(−0.96)	(−1.29)
Female CEO	0.56	0.76	−11.25	−10.08
	(0.40)	(0.55)	(−0.66)	(−0.58)
CEO equity	−0.14	−0.06	−1.42	−0.81
	(−0.84)	(−0.38)	(−0.75)	(−0.42)
CEO duality	2.41*	2.62*	46.31******	48.10***
	(1.66)	(1.83)	(2.91)	(2.99)
Board independence	−0.13***	−0.14***	−1.39***	−1.54***
	(−4.55)	(−0.90)	(−4.23)	(−4.62)
Firm size	1.26***	1.17******	13.96***	13.64***
	(5.19)	(4.85)	(5.00)	(4.79)
Market to book ratio	0.01	0.04	0.19	0.48
	(0.25)	(1.10)	(0.47)	(1.17)
Leverage	0.06***	0.06***	0.56***	0.64***
	(2.94)	(3.30)	(2.58)	(2.89)
ROA	0.01	0.04	−0.01	0.39
	(0.11)	(1.02)	(−0.01)	(0.81)
Stock return volatility	−0.04**	−0.04*	−0.42*	−0.38*
	(−2.14)	(−1.91)	(−1.93)	(−1.72)
Constant	−30.09***	−4.36	−114.46	144.69
	(−2.81)	(−0.42)	(−0.94)	(−0.94)
Industry	Yes	Yes	Yes	Yes

Notes: This table reports results from Tobit regressions describing the impact of UK pension reforms on CEO pension. The dependent variables are CEO total DB pension (ln£000s) in columns (1) and (2); and DB/ Total pension (%) in columns (3) and (4). High DB_AA (LTA) refers to firms whose CEO DB pension exceeds the annual allowance (lifetime allowance) prior to 2006. Among our 1,155 observations, 763 observations are left-censored while 392 observations are uncensored. The asterisks *, **, *** denote statistical significance at 10%, 5% and 1% level, respectively. *Z* statistics are reported in parentheses. All other variables are defined in Appendix A.

TABLE 9 Differenced cross-sectional regressions of CEO pension and firm cash holdings around the UK pension reform

	Full sample firm if it has at least one observation both before and after the reform						Sub-sample firm if it has at least one observation both before and after the reform; also CEOs do not change during the reform					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Variables	2006 reform			2011 AA cut			2006 reform			2011 AA cut		
Change in DB total	−0.324			−0.0564			1.337			0.082		
Change in DB to equity ratio		−0.005			0.002			0.020			−0.012	
Change in DB to equity relative			−0.073			0.1638			0.519**			0.262
Change in firm size	−1.747	−1.991	−2.071	−3.93***	−4.04***	−4.11***	0.247	−0.130	−0.017	−4.77***	−4.76***	−4.76***
Change in market to book ratio	−0.238**	−0.238**	−0.241**	0.154	0.155	0.157	−0.205*	−0.225**	−0.166	0.154	0.141	0.160
Change in leverage	−0.010	−0.009	−0.013	0.018	0.017	0.019	0.027	0.035	0.073	0.079	0.082	0.084
Change in operating cash flows	0.135	0.132	0.127	0.056	0.059	0.061	0.200	0.196	0.189	0.234	0.231	0.244
Constant	−0.231	−0.087	−0.039	0.523	0.628	0.702	−1.452*	−1.048	−1.028	0.269	0.263	0.278
Firm number	95	95	95	97	97	97	86	86	86	86	86	86
Adjusted *R*-squared	0.038	0.029	0.029	0.101	0.101	0.103	0.012	0.007	0.045	0.136	0.137	0.137

Notes: This table reports the estimation of the relation between changes in CEO DB pension and changes in firm cash holdings (Cash / Total assets) around the UK pension reform. *t* statistics are not reported for conciseness. The asterisks *, **, *** denote statistical significance at 10%, 5% and 1% level, respectively. All variables are defined in Appendix A.

Following Hayes et al. (2012), we take the average of each variable for each firm before and after the UK pension reform and then use the difference in the regression.

$\Delta Cash_i = a_0 + a_1 \Delta Firm\ \ Characteristics_i + a_2 \Delta DB\ pension_i + \Delta"_i$

Columns (1) to (3) and columns (7) to (9) are used to test the effect of 2006 reform by using observations from 2003 to 2009 (3 years before and after the 2006 reform). Columns (4) to (6) and columns (10) to (12) are used to test the effect of 2011 AA cut by using observations from 2008 to 2014 (3 years before and after the 2011 reform). The dependent variable, change in firm cash holdings (Cash / Total assets), is calculated as the difference between average before the reform (2003–05 or 2008–10) and average after the reform (2007–09 or 2012–14). A firm can only be included if it has at least one observation both before and after the reform. In columns (1) to (6), the sample is 95 unique FTSE 100 non-financial and non-utility firms. In columns (7) to (12), the sample is 86, as we exclude firms with CEO change over the reform period. OLS model without firm and year fixed-effect is applied because the sample is not panel data with repeated observations from different periods.

TABLE 10 Differenced cross-sectional regressions of CEO pension and firm R&D expenses around the UK pension reform

	Full sample firm if it has at least one observation both before and after the reform						Sub-sample firm if it has at least one observation both before and after the reform; also CEOs do not change during the reform					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Variables	2006 reform			2011 AA cut			2006 reform			2011 AA cut		
Change in DB total	0.002			0.010			0.148			−0.047		
Change in DB to equity ratio		−0.001			−0.001			0.001			−0.002	
Change in DB to equity relative			0.032			−0.002			0.017			−0.062
Change in firm size	−0.425	−0.403	−0.428	−0.78***	−0.75**	−0.76***	−0.525	−0.558	−0.557	−1.08***	−1.08***	−1.08***
Change in market to book ratio	−0.012	−0.012	−0.011	0.003	0.002	0.003	−0.015	−0.016	−0.015	0.030	0.028	0.028
Change in leverage	0.023	0.023	0.024	0.013	0.014	0.013	0.019	0.020	0.021	0.014	0.014	0.013
Change in operating cash flows	0.025	0.026	0.024	−0.069**	−0.070**	−0.069**	0.029	0.029	0.029	−0.10***	−0.10***	−0.10***
Constant	−0.137	−0.154	−0.128	0.155	0.126	0.142	−0.112	−0.073	−0.070	0.131	0.120	0.124
Firm number	95	95	95	97	97	97	86	86	86	86	86	86
Adjusted *R*−squared	−0.026	−0.025	−0.025	0.073	0.074	0.073	−0.032	−0.034	−0.033	0.193	0.194	0.196

Notes: This table reports the estimation of the relation between changes in CEO DB pension and changes in firm R&D expenses (R&D / Total sales) around the UK pension reform. *t* statistics are not reported for conciseness. The asterisks *, **, *** denote statistical significance at 10%, 5% and 1% level, respectively. All variables are defined in Appendix A.

Following Hayes et al. (2012), we take the average of each variable for each firm before and after the UK pension reform and then use the difference in the regression.

$\Delta RD_i = a_0 + a_1 \Delta \text{Firm Characteristics}_i + a_2 \Delta \text{DB pension}_i + \Delta"_i$

Columns (1) to (3) and columns (7) to (9) are used to test the effect of 2006 reform by using observations from 2003 to 2009 (3 years before and after the 2006 reform). Columns (4) to (6) and columns (10) to (12) are used to test the effect of 2011 AA cut by using observations from 2008 to 2014 (3 years before and after the 2011 reform). The dependent variable, change in firm R&D expenses (R&D / Total sales), is calculated as the difference between average before the reform (2003–05 or 2008–10) and average after the reform (2007–09 or 2012–14). A firm can only be included if it has at least one observation both before and after the reform. In columns (1) to (6), the sample is 95 unique FTSE 100 non-financial and non-utility firms. In columns (7) to (12), the sample is 86, as we exclude firms with CEO change over the reform period. OLS model without firm and year fixed-effect is applied because the sample is not panel data with repeated observations from different periods.

TABLE 11 Differenced cross-sectional regressions of CEO pension and firm CAPEX expenses around the UK pension reform

	Full sample firm if it has at least one observation both before and after the reform						Sub-sample firm if it has at least one observation both before and after the reform; also CEOs do not change during the reform					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Variables	2006 reform			2011 AA cut			2006 reform			2011 AA cut		
Change in DB total	−0.252			−0.006			−0.857			−0.302		
Change in DB to equity ratio		−0.008			−0.005			−0.006			−0.009	
Change in DB to equity relative			−0.197			−0.039			−0.168			−0.088
Change in firm size	2.088	1.980	1.859	−0.487	−0.423	−0.471	1.196	1.413	1.379	−1.840	−1.811	−1.830
Change in market to book ratio	−0.26***	−0.26***	−0.27***	0.107	0.101	0.106	−0.010	−0.001	−0.020	0.052	0.039	0.047
Change in leverage	−0.042	−0.040	−0.050	0.083	0.084	0.083	−0.088*	−0.093*	−0.105**	0.098	0.098	0.095
Change in operating cash flows	−0.045	−0.042	−0.048	−0.213	−0.216	−0.214	−0.253*	−0.251*	−0.249*	−0.227	−0.230	−0.231
Constant	−0.945	−0.895	−0.841	0.539	0.459	0.519	−0.110	−0.353	−0.361	1.253	1.189	1.205
Firm number	95	95	95	97	97	97	86	86	86	86	86	86
Adjusted *R*-squared	0.118	0.113	0.114	−0.008	−0.008	−0.008	0.025	0.018	0.023	−0.010	−0.010	−0.010

Notes: This table reports the estimation of the relation between changes in CEO DB pension and changes in firm CAPEX expenses (CAPEX / Total sales) around the UK pension reform. *t* statistics are not reported for conciseness. The asterisks *, **, *** denote statistical significance at 10%, 5% and 1% level, respectively. All variables are defined in Appendix A.

Following Hayes et al. (2012), we take the average of each variable for each firm before and after the UK pension reform and then use the difference in the regression.

$\Delta CAPEX_i = a_0 + a_1 \Delta \text{Firm Characteristics}_i + a_2 \Delta \text{DB pension}_i + \Delta"_i$

Columns (1) to (3) and columns (7) to (9) are used to test the effect of 2006 reform by using observations from 2003 to 2009 (3 years before and after the 2006 reform). Columns (4) to (6) and columns (10) to (12) are used to test the effect of 2011 AA cut by using observations from 2008 to 2014 (3 years before and after the 2011 reform). The dependent variable, change in firm CAPEX expenses (CAPEX / Total sales), is calculated as the difference between average before the reform (2003–05 or 2008–10) and average after the reform (2007–09 or 2012–14). A firm can only be included if it has at least one observation both before and after the reform. In columns (1) to (6), the sample is 95 unique FTSE 100 non-financial and non-utility firms. In columns (7) to (12), the sample is 86, as we exclude firms with CEO change over the reform period. OLS model without firm and year fixed-effect is applied because the sample is not panel data with repeated observations from different periods.

TABLE 12 Differenced cross-sectional regressions of CEO pension and stock return volatility around the UK pension reform

	Full sample firm if it has at least one observation both before and after the reform						Sub-sample firm if it has at least one observation both before and after the reform; also CEOs do not change during the reform					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Variables	2006 reform			2011 AA cut			2006 reform			2011 AA cut		
Change in DB total	0.624			−0.663			1.334			−0.643		
Change in DB to equity ratio		0.010			0.007			0.135**			−0.037	
Change in DB to equity relative			0.650			−0.166			0.422			−1.664
Change in firm size	11.63***	12.07***	12.17***	0.826	−0.148	0.064	12.49***	11.71***	12.22***	7.373*	7.465*	7.318*
Change in market to book ratio	0.098	0.097	0.120	−0.063	−0.068	−0.082	0.395	0.309	0.424	−0.077	−0.126	−0.116
Change in leverage	0.202	0.200	0.230	0.323***	0.311**	0.311**	0.197	0.206	0.235	0.237	0.241	0.206
Change in operating cash flows	−0.041	−0.037	−0.036	−0.223	−0.208	−0.216	0.192	0.175	0.183	−0.227	−0.238	−0.295
Constant	8.708***	8.453***	8.503***	−5.32***	−4.41***	−4.66***	6.311***	6.974***	6.722***	−8.22***	−8.39***	−8.30***
Firm number	95	95	95	97	97	97	86	86	86	86	86	86
Adjusted *R*-squared	0.110	0.105	0.110	0.067	0.044	0.044	0.117	0.173	0.119	0.029	0.030	0.040

Notes: This table reports the estimation of the relation between changes in CEO DB pension and changes in stock return volatility (SD of return) around the UK pension reform. *t* statistics are not reported for conciseness. The asterisks *, **, *** denote statistical significance at 10%, 5% and 1% level, respectively. All variables are defined in Appendix A.

Following Hayes et al. (2012), we take the average of each variable for each firm before and after the UK pension reform and then use the difference in the regression.

$\Delta\text{Stock return volatility}_i = a_0 + a_1 \Delta\text{Firm Characteristics}_i + a_2 \Delta\text{DB pension}_i + \Delta''_i$

Columns (1) to (3) and columns (7) to (9) are used to test the effect of 2006 reform by using observations from 2003 to 2009 (3 years before and after the 2006 reform). Columns (4) to (6) and columns (10) to (12) are used to test the effect of 2011 AA cut by using observations from 2008 to 2014 (3 years before and after the 2011 reform). The dependent variable, change in stock return volatility (SD of return), is calculated as the difference between average before the reform (2003–05 or 2008–10) and average after the reform (2007–09 or 2012–14). A firm can only be included if it has at least one observation both before and after the reform. In columns (1) to (6), the sample is 95 unique FTSE 100 non-financial and non-utility firms. In columns (7) to (12), the sample is 86, as we exclude firms with CEO change over the reform period. OLS model without firm and year fixed-effect is applied because the sample is not panel data with repeated observations from different periods.

of total DB pension in pounds sterling (Caliskan & Doukas, 2015). It captures the absolute incentive from CEO DB pension. The second one is the ratio of DB pension to equity incentives (Cassell et al., 2012; Sundaram & Yermack, 2007). It captures the relative incentives of inside debt compared to equity pay. The last inside debt variable is the relative ratio of DB pension to equity incentives based on firms' debt-to-equity ratio (Kabir et al., 2013, 2018; Liu et al., 2014). It captures the trade-off between a CEO's personal leverage and his or her firm leverage.

In Table 9, we regress changes in firm cash holdings on changes in DB pension, while controlling for firm size, market to book ratio, firm leverage and operating cash flow. Our sample size is quite small as a firm can only be included if it has observations both before and after the reform. Our full sample contains 126 unique firms, but only 95 firms have observations both before and after the 2006 pension reform (97 for the 2011 AA change). We also control for CEO changes during the reform period. DB pension may change due to CEO turnover, rather than changes in a firm's compensation policy.[22] Thus, six regressions excluding firms that have CEO changes during the reform period are listed in columns 7–12. For the 2006 pension reform, most coefficients of inside debt variables are insignificant except the DB to equity relative (column 9) when CEO changes are excluded. Our results are inconsistent with hypothesis H4 and previous findings documented in the US. Turning to the 2011 AA change (columns 4–6 and 10–12), none of the inside debt variables is significant.

Table 10 examines the relationship between change in R&D and change in inside debt. The results are similar to those in Table 9. Coefficients of inside debt variables are all statistically insignificant. Overall, the results do not support our hypothesis H3. Table 11 examines the relationship between change in CAPEX and change in inside debt. All inside debt coefficients are negative, which is in line with the previous literature. However, none of the coefficients of inside debt is statistically significant. Table 12 presents the results for the relationship between changes in stock volatility and changes in inside debt. Similar to the results in Tables 9 and 10, coefficients of inside debt variables are not significant except DB to equity ratio (column 8). However, the sign of the coefficient is positive and contradicting to our hypothesis H3. Therefore, we do not find evidence that firm risk-taking and inside debt are negatively associated.

In summary, our results in Tables 9–12 do not support the risk reduction hypotheses (H3–H4). The change of the CEO DB pension after the reform does not lead to a change of firm risk-taking. Our results hold for both the 2006 reform and the 2011 AA cut. These results are consistent for different proxies of CEO DB pension and firm risk-taking. There is no relationship between CEO inside debt and firm risk-taking.

7 | ROBUSTNESS CHECK

Our results in Section 6 differ from the previous literature documented in the US. To ensure that our results are robust, we present additional tests in this section.

7.1 | Panel data regression

Following the mainstream research design employed in the literature (summarised in Table 4), we employ fixed-effect models to directly investigate the relationship between firm cash holdings and CEO DB pension. We separate analysis of cash holdings from the rest of the risk proxies. As discussed previously, cash is the most liquid asset to fund any pension deficit. Ideally, CEOs should be cautious about cash policy if they have a large amount of pension tied to the firm. Table 13 presents the regression results of inside debt on cash holdings. Our dependent variable is cash/total assets.

[22] For example, Michael Bailey of Compass Group plc was replaced by Richard Cousins just before the 2006 pension reform at the end of financial year 2005. At the time of the CEO change, Michael had DB pension of £15 million. After the change, Richard does not have any DB pension. A crude difference between CEO DB pension before and after the reform counts this as a change of compensation policy.

TABLE 13 CEO pension and firm cash holdings: Panel regressions

Panel A: Full sample						
	Firms fixed-effect			CEO fixed-effect		
Variables	(1)	(2)	(3)	(4)	(5)	(6)
DB total (ln£000s)	−0.023			0.125		
	(−0.261)			(0.652)		
DB to equity ratio		0.001			−0.004	
		(0.191)			(−0.618)	
DB to equity ratio relative			0.010			0.038
			(0.109)			(0.368)
CEO equity	−0.053	−0.053	−0.053	0.137	0.133	0.137
	(−0.382)	(−0.367)	(−0.371)	(0.763)	(0.788)	(0.763)
CEO duality	1.790	1.789	1.784	2.400	2.406	2.398
	(1.458)	(1.403)	(1.384)	(1.151)	(1.156)	(1.515)
Board independence	0.065**	0.066***	0.066**	0.106***	0.104***	0.105***
	(2.575)	(2.589)	(2.574)	(2.865)	(2.881)	(2.886)
Firm size	−2.786***	−2.831***	−2.822***	−2.175**	−2.192**	−2.175***
	(−3.245)	(−3.437)	(−3.568)	(−2.134)	(−2.175)	(−2.164)
Market to book ratio	0.021	0.021	0.021	0.012	0.013	0.013
	(0.956)	(0.927)	(0.920)	(0.288)	(0.308)	(0.312)
Leverage	−0.019	−0.019	−0.019	0.003	0.002	0.004
	(−0.978)	(−0.980)	(−0.916)	(0.092)	(0.074)	(0.114)
Operating cash flows	0.218***	0.218***	0.218***	0.231***	0.230***	0.231***
	(6.067)	(6.130)	(6.072)	(3.942)	(3.908)	(3.893)
Stock return volatility	0.020	0.020	0.020	0.009	0.009	0.008
	(1.328)	(1.277)	(1.317)	(0.428)	(0.452)	(0.403)
R&D expenses	0.307*	0.307*	0.306*	0.150	0.148	0.151
	(1.871)	(1.872)	(1.870)	(0.742)	(0.734)	(0.748)
CAPEX expense	0.061	0.060	0.060	0.016	0.016	0.016
	(1.502)	(1.486)	(1.482)	(0.291)	(0.298)	(0.289)
Dividend payer	−2.722***	−2.741***	−2.739***	−4.114***	−4.139***	−4.129***
	(−3.567)	(−3.550)	(−3.549)	(−4.772)	(−4.791)	(−4.762)
Constant	27.51***	27.81***	27.73***	18.85**	19.58**	19.23**
	(3.849)	(3.977)	(4.121)	(2.048)	(2.255)	(2.227)
Years	Yes	Yes	Yes	Yes	Yes	Yes
Firms	Yes	Yes	Yes	No	No	No
CEOs	No	No	No	Yes	Yes	Yes
Cross-section number	126	126	126	254	254	254
Cross-section F	9.14***	9.16***	9.13***	6.01***	6.03***	6.02***
Number of observations	1,155	1,155	1,155	1,155	1,155	1,155
Adjusted *R*-squared	0.578	0.578	0.578	0.623	0.623	0.622

(Continues)

TABLE 13 (Continued)

Panel B: Subsample						
	Firms with pension deficit			Firms with pension surplus		
Variables	(1)	(2)	(3)	(4)	(5)	(6)
DB total (ln£000s)	−0.137			0.343		
	(−1.190)			(1.046)		
DB to equity ratio		−0.001			0.011	
		(−0.278)			(0.599)	
DB to equity ratio relative			0.029			−0.023
			(0.254)			(−0.076)
CEO equity	0.016	0.013	0.016	−1.169	−1.009	−0.864
	(0.090)	(0.074)	(0.090)	(−1.075)	(−0.916)	(−0.796)
CEO duality	0.912	0.757	0.889	−11.16***	−11.16***	−11.41***
	(0.726)	(0.589)	(0.682)	(−2.664)	(−2.722)	(−2.789)
Board independence	0.056*	0.059**	0.059**	−0.066	−0.057	−0.060
	(1.946)	(2.046)	(2.038)	(−0.358)	(−0.287)	(−0.287)
Firm size	−0.507	−0.745	−0.794	−5.245**	−5.173**	−5.355**
	(−0.593)	(−0.923)	(−1.017)	(−2.056)	(−2.040)	(−2.204)
Market to book ratio	−0.001	−0.003	−0.002	0.009	0.006	0.003
	(−0.022)	(−0.116)	(−0.093)	(0.152)	(0.099)	(0.056)
Leverage	−0.002	−0.001	0.001	−0.261**	−0.265**	−0.262**
	(−0.079)	(−0.045)	(0.013)	(−2.182)	(−2.215)	(−2.181)
Operating cash flows	0.187***	0.187***	0.188***	0.244	0.233	0.218
	(4.789)	(4.840)	(4.830)	(0.866)	(0.835)	(0.799)
Stock return volatility	−0.008	−0.009	−0.010	0.082	0.077	0.077
	(−0.350)	(−0.380)	(−0.436)	(0.918)	(0.852)	(0.809)
R&D expenses	−0.099	−0.100	−0.097	−0.876	−1.427	−1.600
	(−0.647)	(−0.682)	(−0.656)	(−0.477)	(−0.791)	(−0.859)
CAPEX expense	−0.064	−0.065	−0.064	0.013	0.011	0.013
	(−0.810)	(−0.818)	(−0.811)	(0.181)	(0.143)	(0.171)
Dividend payer	−2.159***	−2.269***	−2.321***	−0.875	−0.741	−0.648
	(−2.878)	(−3.063)	(−3.119)	(−0.337)	(−0.284)	(−0.246)
Constant	9.313	10.969	27.73***	69.67***	68.32**	69.07**
	(1.275)	(1.568)	(4.121)	(2.891)	(2.569)	(2.592)
Years	Yes	Yes	Yes	Yes	Yes	Yes
Firms	Yes	Yes	Yes	Yes	Yes	Yes
Industry	No	No	No	No	No	No
Cross-section number	107	107	107	52	52	52
Cross-section F	7.99***	7.95***	7.94***	2.45***	2.42***	2.41***
Number of observations	811	811	811	148	148	148

(Continues)

TABLE 13 (Continued)

Panel B: Subsample						
	Firms with pension deficit			Firms with pension surplus		
Variables	(1)	(2)	(3)	(4)	(5)	(6)
Adjusted *R*-squared	0.537	0.536	0.536	0.479	0.475	0.473

Notes: **Panel A**: This table reports the estimation of the relation between CEO DB pension and firm cash holdings (Cash/Total assets). The sample includes UK FTSE 100 non-financial and non-utility firms from 2003–16. The total number of observations is 1,155 from 126 unique firms. The dependent variable is firms cash holdings (Cash / Total assets). DB total is the natural logarithm of a CEO's total DB pension value. DB to equity ratio is CEO DB pension total value, scaled by the sum of CEO's shares, stock options and LTIPs holding value. DB to equity ratio relative is DB to equity ratio, scaled by a firm's debt to equity ratio. Columns (1) to (3) employ firm (number = 126) and year (number = 14) fixed-effect model. Columns (4) to (6) employ CEO (number = 254) and year (number = 14) 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. *t* statistics are reported in parentheses. All variables are defined in Appendix A.
Panel B: Columns (1) to (3) are for observations with pension deficit (pension assets is lower than pension liability) for a given year. Columns (4) to (6) are for observations with pension surplus (pension assets is larger than pension liability) for a given year.

As shown in Table 13 Panel A, none of the coefficients on inside debt variables is statistically significant. There is no association between firm cash holdings and inside debt. In Panel B, we divide our sample into two groups based on whether firms have pension deficit or surplus. The expectation is that firms with pension deficit should be more conservative about their cash policies. Therefore, CEO inside debt in these firms should encourage more cash holdings. However, we do not see any of these effects in Panel B. All coefficients of inside debt are statistically insignificant. These results do not support the causal relationship between cash holdings and inside debt.

Table 14 reports the relationship between inside debt and other risk proxies, where dependent variables are R&D in Panel A, CAPEX in Panel B and stock return volatility in Panel C. To save space, we do not report control variables results. Panel D summarises all regression results in Tables 13 and 14. As shown, most coefficients of inside debt variables are statistically insignificant. When they are significant, the sign of the coefficients is opposite to the risk reduction hypothesis, except for R&D in the CEO fixed-effect model. Overall, Table 14 reinforces our results in Tables 9–12. There is simply no relationship between inside debt and firm risk-taking.

7.2 | 2SLS regression

To address endogeneity concerns, we employ the differenced regression of equation (5). These results are already reported in Tables 9–12. There are also other approaches to mitigate the endogeneity problem, as discussed in Section 4.2. Instrumental variables can be applied to equation (2). Following Cassell et al. (2012) and van Bekkum (2016), we use CEO age as the instrumental variable and re-run regressions in equation (2). CEO DB pension mechanically increases with CEO age (tenure) which has no direct interaction with firm policy. The correlation matrix in Table 5 also confirms that CEO's age is positively related to two DB pension variables at the 1% significance level.

The first-stage and the second-stage results are presented in Panel A and Panel B of Table 15, respectively. In panel A, all three CEO DB pension variables are positively related to the instrument, log of CEO age, as expected. The Durbin-Wu-Hausman test confirms that all three DB pension variables are endogenous. In panel B (the second-stage regression), we use the fitted value of DB pension from Panel A (the first-stage regression) as an independent variable. CEO DB total is not significantly related to firm cash holding, volatility, R&D and CAPEX (columns 1, 4, 7 and 10). DB to equity ratio and DB to equity ratio relative are negatively associated with volatility (columns 5 and 6) and R&D (columns 8 and 9). These results are consistent with the risk reduction hypothesis. However, these results do not

TABLE 14 CEO pension and firm risk-taking: Panel regressions

Panel A: Dependent variable = R&D expenses (R&D / sales)						
	Firm fixed-effect			CEO fixed-effect		
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
DB total (ln£000s)	0.022***			0.019		
	(2.624)			(0.959)		
DB to equity ratio		−0.001			−0.002*	
		(−0.930)			(−1.797)	
DB to equity ratio relative			0.001			−0.023
			(0.036)			(−0.990)
Constant	Yes	Yes	Yes	Yes	Yes	Yes
CEO equity	Yes	Yes	Yes	Yes	Yes	Yes
Corporate governance	Yes	Yes	Yes	Yes	Yes	Yes
Firm characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Years	Yes	Yes	Yes	Yes	Yes	Yes
Firms	Yes	Yes	Yes	No	No	No
CEOs	No	No	No	Yes	Yes	Yes
Cross-section number	126	126	126	254	254	254
Cross-section F	107***	107***	107***	53***	53***	53***
Number of observations	1,155	1,155	1,155	1,155	1,155	1,155
Adjusted *R*-squared	0.925	0.925	0.935	0.924	0.924	0.924
Panel B: Dependent variable = CAPEX expenses (CAPEX / sales)						
	Firm fixed-effect			CEO fixed-effect		
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
DB total (ln£000s)	0.107***			0.202		
	(2.870)				(1.021)	
DB to equity ratio		0.002			0.001	
		(0.730)			(0.198)	
DB to equity ratio relative			0.093**			0.159**
			(1.974)			(2.551)
Constant	Yes	Yes	Yes	Yes	Yes	Yes
CEO equity	Yes	Yes	Yes	Yes	Yes	Yes
Corporate governance	Yes	Yes	Yes	Yes	Yes	Yes
Firm characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Years	Yes	Yes	Yes	Yes	Yes	Yes
Firms	Yes	Yes	Yes	No	No	No
CEOs	No	No	No	Yes	Yes	Yes
Cross-section number	126	126	126	254	254	254
Cross-section F	30***	31***	31***	15***	15***	15***
Number of observations	1,155	1,155	1,155	1,155	1,155	1,155
Adjusted *R*-squared	0.781	0.809	0.809	0.775	0.774	0.775

(Continues)

TABLE 14 (Continued)

Panel C: Dependent variable = Stock return volatility						
	Firm fixed-effect			CEO fixed-effect		
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
DB total (ln£000s)	0.022			−0.311		
	(0.159)				(−1.111)	
DB to equity ratio		0.015			0.063***	
		(1.519)			(3.683)	
DB to equity ratio relative			0.029			0.068
			(0.186)			(0.509)
Constant	Yes	Yes	Yes	Yes	Yes	Yes
CEO equity	Yes	Yes	Yes	Yes	Yes	Yes
Corporate governance	Yes	Yes	Yes	Yes	Yes	Yes
Firm characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Years	Yes	Yes	Yes	Yes	Yes	Yes
Firms	Yes	Yes	Yes	No	No	No
CEOs	No	No	No	Yes	Yes	Yes
Cross-section number	126	126	126	254	254	254
Cross-section F	7.72***	8.08***	8.08***	6.11***	6.46***	6.32***
Number of observations	1,155	1,155	1,155	1,155	1,155	1,155
Adjusted *R*-squared	0.662	0.663	0.662	0.725	0.729	0.725

Panel D: Summary of regression results							
		DB pension total		DB to equity ratio		DB to equity ratio relative	
	Expected Sign	**Firm fixed-effect**	**CEO fixed-effect**	**Firm fixed-effect**	**CEO fixed-effect**	**Firm fixed-effect**	**CEO fixed-effect**
Cash holdings	(+)	No	No	No	No	No	No
R&D expenses	(-)	**Positive**	No	No	**Negative**	No	No
CAPEX expenses	(−)	**Positive**	No	No	No	**Positive**	**Positive**
Stock return volatility	(−)	No	No	No	**Positive**	No	No

Notes: **Panel A**: This table reports the estimation of the relation between CEO DB pension and firm risk-taking proxies. The sample includes UK FTSE 100 non-financial and non-utility firms from 2003–16. The total number of observations is 1,155 from 126 unique firms. DB total is the natural logarithm of a CEO's total DB pension value. DB to equity ratio is CEO DB pension total value, scaled by the sum of CEO's shares, stock options and LTIPs holding value. DB to equity ratio relative is DB to equity ratio, scaled by a firm's debt to equity ratio. Columns (1) to (3) employ firm (number = 126) and year (number = 14) fixed-effect model. Columns (4) to (6) employ CEO (number = 254) and year (number = 14) 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. *t* statistics are reported in parentheses. All variables are defined in Appendix A.

Panel D: This panel summarises regression results in Panels A, B and C in Table 14 as well as Panel A in Table 13. 'No' indicates that the result is not statistically significant for the level of 10%. 'Positive' ('Negative') indicates that the result is statistically significant (10%) and the coefficient is positive (negative).

TABLE 15 CEO pension and firm risk-taking: 2SLS regression

Panel A First-stage results			
Variables	**Dependent variable = DB total (ln£000s)**	**Dependent variable = DB to equity ratio**	**Dependent variable = DB to equity ratio relative**
Log (CEO age)	1.720*	45.977***	1.566***
Variables from 2-step regression	Yes	Yes	Yes
Constant	Yes	Yes	Yes
Industry	Yes	Yes	Yes
Year	Yes	Yes	Yes
Number of observations	1115	1115	1115
Adjusted *R*-squared	0.093	0.066	0.062
Durbin-Wu-Hausman Test			
Null: DB total is exogenous (*p* value)	0.008***		
Null: DB2equity is exogenous (*p* value)		0.011**	
Null: DB to equity relative is exogenous (*p* value)			0.011**

(Continues)

TABLE 15 (Continued)

Panel B Second-stage results												
	Dependent variable = Cash2asssets			Dependent variable = Volatility			Dependent variable = RD2sales			Dependent variable = CAPEX2sales		
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
DB total (ln£000s)	−5.361			−14.703			−1.284			−1.646		
DB to equity ratio		−0.132**			−0.363**			−0.032**			−0.041	
DB to equity ratio relative			−4.071**			−11.17**			−0.975*			−1.250
Main controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	1,155	1,155	1,155	1,155	1,155	1,155	1,155	1,155	1,155	1,155	1,155	1,155
Weak instrument test: Cragg-Donald statistic Critical value = 16.38 ($p = 0.1$)	1.016	13.786	6.467	1.016	13.786	6.467	1.016	13.786	6.467	1.016	13.786	1.016

Notes: This table reports the 2SLS estimation of the relation between CEO DB pension and risk-taking proxies. The sample includes UK FTSE 100 non-financial and non-utility firms from 2003–16. The total number of observations is 1,155 from 126 unique firms. DB total is the natural logarithm of a CEO's total DB pension value. DB to equity ratio is CEO DB pension total value, scaled by the sum of CEO's shares, stock options and LTIPs holding value. DB to equity ratio relative is DB to equity ratio, scaled by a firm's debt to equity ratio. Cash2assets is a firm's cash holdings scaled by its assets. Volatility is the standard deviation of a firm's daily return. RD2sales is a firm's R&D spending scaled by its sales. CAPEX2sales is a firm's CAPEX spending scaled by its sales. Panel A reports the results from first-stage regression, where the dependent variables are DB total, DB to equity ratio and DB to equity ratio relative. The instrument variable is the log of CEO age. Panel B reports the second-stage regressions results, where DB total, DB to equity ratio and DB to equity ratio relative are using the fitted values from first-stage regression. *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.

TABLE 16 CEO pension and firm risk-taking: Excluding zero value DB pension

Panel A: Dependent variable = Cash holding (Cash / assets)						
	Firm fixed-effect			CEO fixed-effect		
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
DB total (ln£000s)	−0.123			−1.111		
	(−0.589)			(−1.016)		
DB to equity ratio		0.005			−0.001	
		(0.753)			(−0.043)	
DB to equity ratio relative			0.043			0.048
			(0.251)			(0.260)
Constant	Yes	Yes	Yes	Yes	Yes	Yes
CEO equity	Yes	Yes	Yes	Yes	Yes	Yes
Corporate governance	Yes	Yes	Yes	Yes	Yes	Yes
Firm characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Years	Yes	Yes	Yes	Yes	Yes	Yes
Firms	Yes	Yes	Yes	No	No	No
CEOs	No	No	No	Yes	Yes	Yes
Cross-section number	55	55	55	89	89	89
Number of observations	392	392	392	392	392	392
Adjusted *R*-squared	0.579	0.580	0.579	0.649	0.646	0.646
Panel B: Dependent variable = R&D expenses (R&D / sales)						
	Firm fixed-effect			CEO fixed-effect		
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
DB total (ln£000s)	−0.006			0.010		
	(−0.202)				(0.115)	
DB to equity ratio		−0.001			−0.001	
		(−1.304)			(−1.632)	
DB to equity ratio relative			−0.007			−0.020
			(−0.682)			(−1.175)
Constant	Yes	Yes	Yes	Yes	Yes	Yes
CEO equity	Yes	Yes	Yes	Yes	Yes	Yes
Corporate governance	Yes	Yes	Yes	Yes	Yes	Yes
Firm characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Years	Yes	Yes	Yes	Yes	Yes	Yes
Firms	Yes	Yes	Yes	No	No	No
CEOs	No	No	No	Yes	Yes	Yes
Cross-section number	55	55	55	89	89	89
Number of observations	392	392	392	392	392	392
Adjusted *R*-squared	0.956	0.956	0.956	0.973	0.973	0.973

(Continues)

TABLE 16 (Continued)

Panel C: Dependent variable = CAPEX expenses (CAPEX / sales)						
	Firm fixed-effect			CEO fixed-effect		
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
DB total (ln£000s)	0.019			0.729		
	(0.204)				(1.302)	
DB to equity ratio		−0.004			0.001	
		(−1.631)			(0.462)	
DB to equity ratio relative			−0.073**			0.048
			(−2.266)			(0.907)
Constant	Yes	Yes	Yes	Yes	Yes	Yes
CEO equity	Yes	Yes	Yes	Yes	Yes	Yes
Corporate governance	Yes	Yes	Yes	Yes	Yes	Yes
Firm characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Years	Yes	Yes	Yes	Yes	Yes	Yes
Firms	Yes	Yes	Yes	No	No	No
CEOs	No	No	No	Yes	Yes	Yes
Cross-section number	55	55	55	89	89	89
Number of observations	392	392	392	392	392	392
Adjusted *R*-squared	0.851	0.852	0.852	0.862	0.861	0.861
Panel D: Dependent variable = Stock return volatility						
	Firm fixed-effect			CEO fixed-effect		
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
DB total (ln£000s)	0.103			−0.040		
	(0.219)				(−0.029)	
DB to equity ratio		0.030**			0.069***	
		(2.049)			(4.223)	
DB to equity ratio relative			0.137			0.121
			(0.845)			(0.645)
Constant	Yes	Yes	Yes	Yes	Yes	Yes
CEO equity	Yes	Yes	Yes	Yes	Yes	Yes
Corporate governance	Yes	Yes	Yes	Yes	Yes	Yes
Firm characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Years	Yes	Yes	Yes	Yes	Yes	Yes
Firms	Yes	Yes	Yes	No	No	No
CEOs	No	No	No	Yes	Yes	Yes
Cross-section number	55	55	55	89	89	89
Number of observations	392	392	392	392	392	392
Adjusted *R*-squared	0.710	0.716	0.710	0.733	0.750	0.733

(Continues)

TABLE 16 (Continued)

Panel E: Summary of regression results

	Expected Sign	DB pension total		DB to equity ratio		DB to equity ratio relative	
		Firm fixed-effect	CEO fixed-effect	Firm fixed-effect	CEO fixed-effect	Firm fixed-effect	CEO fixed-effect
Cash holdings	(+)	No	No	No	No	No	No
R&D expenses	(–)	No	No	No	No	No	No
CAPEX expenses	(–)	No	No	No	No	**Negative**	No
Stock return volatility	(–)	No	No	**Positive**	**Positive**	No	No

Notes: **Panel A**: This table reports the estimation of the relation between CEO DB pension and risk-taking proxies. The sample contains 392 observations with non-zero DB pension value from UK FTSE 100 non-financial and non-utility firms from 2003–16. The dependent variables are firm cash holding, R&D, CAPEX and stock return volatility in Panels A, B, C and D, respectively. The independent variables are DB total, DB to equity ratio and DB to equity ratio relative. DB total is the natural logarithm of a CEO's total DB pension value. DB to equity ratio is CEO DB pension total value, scaled by the sum of CEO's shares, stock options and LTIPs holding value. DB to equity ratio relative is DB to equity ratio, scaled by a firm's debt to equity ratio. Columns (1) to (3) employ firm (number = 55) and year (number = 14) fixed-effect model. Columns (4) to (6) employ CEO (number = 89) and year (number = 14) 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. *t* statistics are reported in parentheses. All variables are defined in Appendix A.
Panel E: This panel summarises regression results in Panels A, B, C and D. 'No' indicates that the result is not statistically significant at the level of 10%. 'Positive' ('Negative') indicates that the result is statistically significant (10%) and the coefficient is positive (negative).

pass the weak instrument test, so our interpretation is limited here. In short, we could not confirm that inside debt leads to risk-averse policies when we use the 2SLS estimation.

7.3 | Skewed distribution for DB pension data

In our UK sample, 66% of CEOs have no DB pension at all. Furthermore, DB pension is highly skewed to the right where a small number of CEOs have a large amount of DB pensions. In the US, Cassell et al. (2012) also find a large number of firms with zero inside debt. Our results could be driven by a large proportion of zero value DB pension. We employ Tobit models in Tables 7 and 8 to mitigate such a problem (Brian et al., 2000; Domínguez-Barrero & López-Laborda, 2007).

To further address the skewed distribution of DB pensions, we employ two additional approaches. First, we use subsample analysis. Following Cassell et al. (2012), we remove all observations with zero value DB pension. Our sample size falls to 392 from 1,155. Both firm and CEO fixed-effect models are employed in Table 16. Firm cash holdings, R&D, CAPEX and stock return volatility are examined in Panels A, B, C and D, respectively. In Panel E, we summarise all regression results. Among all 24 regressions, we only find one regression result that is consistent with the risk reduction hypothesis. CAPEX is negatively related to DB to equity ratio relative, when a firm fixed-effect model is employed (column 3 of Panel C). For other regressions, the coefficients are either insignificant or opposite to the risk reduction hypothesis. We do not find convincing evidence to support the risk reduction hypothesis when we exclude all observations with zero value DB pension.

Our second approach employs DB dummy variable as suggested by van Bekkum (2016). In his sample of US banks, approximately 20% of CEOs and 40% CFOs do not have any inside debt. This raises the concern of sample selection bias. He argues that the value of a DB pension a CEO could have may be discretionary, as CEOs can choose the amount

TABLE 17 CEO pension and firm risk-taking: Using DB pension dummy

	Firm fixed-effect				CEO fixed-effect			
	Cash / assets	R&D / sales	CAPEX / sales	Stock return volatility	Cash / assets	R&D / sales	CAPEX / sales	Stock return volatility
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
DB dummy	−0.325	0.182**	0.92***	0.228	−0.739	0.091	3.470*	−5.894
	(−0.492)	(2.372)	(2.531)	(0.175)	(−0.369)	(0.336)	(1.820)	(−1.433)
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CEO equity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Corporate governance	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Years	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firms	Yes	Yes	Yes	Yes	No	No	No	No
CEOs	No	No	No	No	Yes	Yes	Yes	Yes
Cross-section number	126	126	126	126	254	254	254	254
No. of observations	1,155	1,115	1,155	1,155	1,154	1,154	1,154	1,154
DB dummy = 1	392	392	392	392	392	392	392	392
Adjusted *R*-squared	0.561	0.925	0.781	0.712	0.608	0.924	0.775	0.726

Notes: This table reports the estimation of the relation between CEO DB pension dummy and risk-taking proxies. The sample includes UK FTSE 100 non-financial and non-utility firms from 2003–16. The total number of observations is 1,155 from 126 unique firms and 254 unique CEOs. The dependent variables are Cash/assets, R&D/sales, CAPEX/sales and Stock return volatility in columns (1) and (5), (2) and (6), (3) and (7) and (4) and (8) respectively. The independent variable is DB dummy, which equals one if a CEO has DB pension, otherwise zero. Columns (1)–(4) employ firm (number = 126) and year (number = 14) fixed-effect model. Columns (5)–(8) employ CEO (number = 254) and year (number = 14) 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. *t* statistics are reported in parentheses. All variables are defined in Appendix A.

of pension contribution every year. A CEO could influence his or her DB pension contribution, based on his or her perception of a firm's default risk. However, a CEO's decision to own DB pension is less discretionary. Therefore, exploring the effect of whether CEOs have DB pension or not is more appropriate than examining the values of DB pension. In addition, testing the existence of DB pension rather than the value of DB pension would help to mitigate the impact of skewed distribution. Van Bekkum (2016) creates a dummy variable (CEO_with_inside debt 0/1) for all samples, which equals one if a CEO has any inside debt and zero otherwise.[23] Following van Bekkum (2016), we employ the same variable of DB dummy in Table 17. The coefficients of DB dummy are not statistically significant for cash holdings and stock return volatility in all regressions. It suggests that there is no relationship between cash policy, total risk and existence of DB pension. The coefficients for CAPEX and R&D are positively related to DB dummy, but this is contrary to our risk reduction hypothesis (H3). Similar to our previous results, we do not find evidence to support that CEO DB pensions lead to more risk-averse policies.

8 | CONCLUSION AND DISCUSSION

This paper provides the UK evidence on the relationship between CEO inside debt (in the form of DB pension) and firm risk-taking. Prior studies conducted in the US find that inside debt always leads to risk reduction policies, such as a high level of firm cash holding, a low level of stock return volatility and R&D spending. We examine the relationship between CEO DB pension and firm risk-taking by using two UK pension changes as exogenous shocks. The 2006 pension reform substantially increases the tax cost of pension, and the 2011 allowance cut further increases income tax associated with pension. Neither of these regulation changes has any direct effect on firm policies.

We employ differenced cross-section regressions, focusing on the change of firm risk-taking after the pension reforms and the change of CEO DB pension in the same period. If the causal relationship between CEO inside debt and firm risk-taking is true, we should observe a change of firm risk-taking corresponding to a change of CEO DB pension after the reforms. We find that CEO DB pension decreases dramatically after both reforms. This is consistent with our tax benefit hypothesis. However, the decline of DB pension does not lead to a corresponding increase in DC pension. Instead, cash-in-lieu increases substantially. Firms appear to substitute DB pension with cash-in-lieu. CEOs use pensions to minimise income tax, and they alternate their pensions when tax on pensions changes. However, a change in CEO DB pensions does not lead to any change of firm risk-taking. This is inconsistent with the risk reduction hypothesis. We do not find that inside debt induces risk-averse managerial behaviours.

Our results differ from related studies conducted in the US. There are two possible explanations. First, risk associated with CEO pension can be managed or circumvented by top managers in the UK. CEOs have a number of tools available to influence the payoff of their pensions, which can shield them from firms' default risk. These options include early withdrawal of pension and transferring pension out of firms. CEO inside debt may be more protected and secured than expected by the literature. Second, CEO DB pension is used mainly to maximise tax benefit. We show that CEOs with a high DB pension value would reduce their pensions more after the reform. The pension arrangement may be structured to avoid income tax, rather than moderating a firm's risk policies.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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[23] See Section B 'CEOs and CFOs with and without inside debt' in van Bekkum (2016) for detailed discussion.

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APPENDIX A

Variables Definitions

CEO pension and firm risk-taking: Using DB pension dummy

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 a 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 scaled by the sum of a CEO's shares, stock options and LTIPs holding value.
DB to equity ratio relative	DB to equity ratio scaled by the firm's debt to equity ratio.
CEO equity	The sum of CEO's shares, stock options and LTIPs value.
Panel B: Regulation change variables	
Variable name	**Definition**
Between Aug04 to Mar06 (law pending)	Dummy variable which takes a value of one if the observation is between August 2004 and March 2006, otherwise zero.
Between Apr06 to Mar11 (initial introduction)	Dummy variable which takes a value of one if the observation is between April 2006 and March 2011, otherwise zero.
Between Apr11 to Mar14 (a big cut in allowance)	Dummy variable which takes a value of one if the observation is between April 2011 and March 2014, otherwise zero.
After Apr14 (a further cut in allowance)	Dummy variable which takes a value of one if the observation is after 6 April 2014, otherwise zero.
After Apr06	Dummy variable which takes a value of one if the observation is after 6 April 2006, 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 a CEO is non-British, otherwise zero.
Female CEO	Dummy variable which takes a value of one if a CEO is female, otherwise zero.
CEO duality	Dummy variable which takes a value of one if a CEO also holds the position of chairperson, otherwise zero.
Board independence	The number of non-executive directors scaled by the total number of directors.

Panel D: Firm characteristics variable	
Variable name	**Definition**
Cash holdings	A firm's cash holdings 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 scaled by its book value of equity.
Leverage	A firm's total debt scaled by its total assets.
Operating cash flows	A firm's cash flows from operating activities 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 scaled by its total sale.
CAPEX expenses	A firm's capital expenditure scaled by its total sale.
Dividend payer	Dummy variable which takes a value of one if a firm pays cash dividend, otherwise zero.
ROA	A firm's EBTDA scaled by its total assets.

APPENDIX B

An example of pension valuation

Following Kabir et al. (2013, 2018), we use hand-collected data from annual reports to estimate CEO DB, DC and cash-in-lieu. The example is from Kingfisher Plc 2013 Annual Report, where Sir Ian Cheshire is CEO.

Part A: DB pension

			Accrued pension			Transfer value		
	Age	Years in service	Increased Accrued Pension £000 pa	2012/13 £000 pa	2011/12 £000 pa	Increase in transfer value £000 (net of director's contribution)	2012/13 £000	2011/12 £000
Ian Cheshire	53	14	2	33	32	72	596	519

Notes: DB increment (2013) = Transfer value of DB (2013) − Transfer value of DB (2012) − Personal contribution = £72,000

Part B: DC pension and cash-in-lieu

	Employer contribution to defined contribution pension scheme		Cash alternative		Total
£000	2012/13	2011/12	2012/13	2011/12	2012/13
Ian Cheshire	7.4	49.4	230.7	156.8	238.1

Notes: DC (2013) = Employer contributions to defined contribution scheme = £7,400
Cash-in-lieu (2013) = Cash alternative = £230,700

Part C: Pension variable construction in empirical analysis

1. Total pension = DB incremental + DC incremental + cash-in-lieu = 72,000 + 7,400 + 230,700 = £310,100
2. DB / total pension = 72,000 / 310,100 = 23%
3. DC / total pension = 7,400 / 310,100 = 2%
4. Cash-in-lieu / total pension = 230,700 / 310,100 = 74%
5. DB total = ln (596,000) = 13.30
6. DB to equity = Transfer value of DB to the estimated value of equity holding = 596,000 / 15,684,211 = 3.8%
7. DB to equity relative = DB to equity ratio scaled by the firm's debt to equity ratio = 3.8% / 4.55% 0.84

Part D: Interpretation of pension variables in panel C

In 2013, Kingfisher plc CEO Sir Ian Cheshire had an annual pension of £310,100, including 23% of DB pension, 2% DC pension and 74% of cash-in-lieu. His 2013 annual pension package was dominated by cash-in-lieu. His DB pension value is only 3.8% of his equity holding (DB to equity = 3.8%). His personal leverage (DB to equity) is smaller than Kingfisher's leverage (firm debt to equity) at 0.84 (DB to equity relative = 0.84).

APPENDIX C

A simple demonstration of 2006 pension reform

Directly comparing pension tax before and after the pension reform is very difficult. This is because tax rules are very complex and have multiple layers of special treatments and exceptions. The example we show below is a crude simplification, but the overall representation is still the same: the 2006 pension reform substantially increases income tax on pension. This is especially true for CEOs who are not restricted by the pre-2006 Earnings Cap rules but are later captured by the AA and LTA rules.

The table below reports a simple example related to the 2006 pension reform. All figures are based on a hypothetical CEO whose pension benefits already exceed the Earnings Cap, AA and LTA in 2006. The £100,000 pay in pension or cash is on top of the CEO's other compensation, hence 'incremental'. In other words, the CEO is subject to both AA and LTA charge on the pension payment. This is a simplifying assumption as the LTA charge is deducted at source by the pension administrator and only becomes payable when the benefits received exceed LTA. But the overall message remains the same; LTA is very expensive for a CEO with a large pension. Income tax rates are based on the tax year 2006/07. To make comparison easy to follow, we also assume capital growth is 0%.

Pre-2006 DB and DC pension		Post-2006 DB and DC pension		Cash-in-lieu of pension	
Incremental pension pay	£100,000	Incremental pension pay	£100,000	Incremental cash pay	£100,000
Income tax on pension contribution (tax exempt)*	£0	Annual allowance charge at the highest income tax rate (40%)	£40,000	Income tax at highest income tax rate (40%)	£40,000
Pension contributed after tax	£100,000	Pension contributed after tax	£60,000		
Income tax on pension benefits (40%)**	£40,000	Lifetime allowance charge at 25%	−£15,000		
		Pension after lifetime allowance charge	£45,000		
		Income tax on pension benefits at highest tax rate (40%)	−£18,000		
Incremental pay after tax	£60,000	Incremental pay after tax***	£27,000	Incremental pay after tax	£60,000

*Based on 1989 occupational pension scheme, employer contributions are tax exempt.

**Earnings Cap can be avoided if the CEO's pension benefits come from different pension regimes.

***This LTA example is based on technical instruction titled 'Pension Tax Manual' produced by HMRC. The instruction is available online at https://www.gov.uk/hmrc-internal-manuals/pensions-tax-manual/ptm080000

First, a CEO in the pre-2006 era would pay far less income tax on pension. For £100,000 gross pay, a CEO would be triple taxed (AA charge, LTA charge and also income tax) and pay 73% in total tax in the post-2006 era. On the other hand, the same amount of £100,000 gross pay would be only taxed once and pay 40% in total tax in the pre-2006 era. This is because Earnings Cap rules are laxer in tax reliefs. CEOs have a range of flexibility to manoeuvre incomes to avoid Earnings Cap.

Second, cash-in-lieu of pension is more tax efficient than DB and DC pension in the post-2006 era. The tax treatment for DB and DC pension is the same in the post-2006 era, so we do not distinguish DB and DC in the above table. As soon as the CEO's pension exceeds either AA or LTA, an additional tax bill will be triggered. Cash-in-lieu of pension, on the other hand, is just normal cash salary with a different name. So it would be taxed as regular income. Based on the 40% income tax rate, £100,000 incremental pay in cash-in-lieu would generate £60,000 take-home pay. Therefore, paying cash-in-lieu is far better than paying DB or DC pension in terms of tax treatment in the post-2006 era.

Third, DB and DC pension are more tax efficient than cash-in-lieu in the pre-2006 era while in both cases, a CEO would receive £60,000 net of tax for £100,000 incremetal pay. It is still better to be paid in DB or DC pension as income tax on pension does not arise until a CEO starts receiving benefits. When the capital growth rate is not zero (we assume 0% for simplification), a CEO would receive even more after-tax pay than the same amount paid in cash-in-lieu. This may explain why the use of cash-in-lieu is so rare before the 2006 pension reform.

Finally, Unfunded Retirement Benefit Schemes (UFRBS) and later the Employer Financed Retirement Benefit Scheme (EFRBS) could be used to avoid AA and LTA. However, rules regarding those schemes are very complex. It

is also very expensive to run those schemes due to heavy management expenses. Many of those schemes have to use offshore operation in a different tax jurisdiction to achieve tax efficiency.

In summary, the most tax efficient way in the post-2006 era is awarding CEOs with DB or DC pension up to the AA and LTA limit. Then CEOs could be paid in cash-in-lieu to top up further benefits. That is why we expect a big increase in the use of cash-in-lieu, while the decline of DB and DC pension after pension reforms.