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Impact of Board Composition on Pension De-risking Strategies

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Pension de-risking strategies have been widely adopted by firms with defined-benefit (DB) pension plans to reduce pension risk. This paper investigates the influence of board composition on pension de-risking strategies within the UK, focusing particularly on three strategies: changes to pension asset allocations, switches from DB to defined-contribution (DC) pension plans and pension buy-ins and buy-outs. Our findings suggest that firms with larger boards and more independent directors are less likely to invest their pension assets in equities. Survival analysis shows that firms with larger boards are slower to switch from DB to DC pension plans. This is consistent with stakeholder theory, in that firms with large boards or more independent directors are more likely to protect employees' benefits when de-risking their DB pension plans. However, firms with more female directors are faster to switch fully from DB to DC pension plans and slower to engage in pension buy-in and buy-out transactions. This suggests that female directors encourage fully switching DB pension plans, while they are concerned with the significant costs of pension buy-in or buy-out. This research provides clear evidence that pension de-risking strategies are influenced by board composition. UK pension trustees play a key role in determining switches from DB to DC pension plans, mitigating the impact of independent directors.

Introduction

At the end of 2018, the aggregate pension funding level of FTSE 100 firms saw a surplus following large pension contributions and implementation of various pension de-risking strategies (Lane Clark & Peacock, 2019). With regard to DB pension plans, firms are generally responsible for ensuring that future pension benefits are achieved. Thus, DB pension plans pose a high level of risk and uncertainty for employers, and many firms with DB pension plans have embarked on pension de-risking strategies in order to reduce the risk of such plans to these firms. Lane Clark & Peacock (2014) suggest that FTSE 100 firms' pension assets will continue to be re-allocated from equities to bonds, indicating that firms are investing in safer assets to lower their pension fund risk. Since the 2000s, FTSE 100 firms have been forced to close their DB pension plans to either new or all employees due to rising uncertainty and anticipated costs (Lane Clark & Peacock, 2014). For example, in 2015, Severn Trent and Standard Life announced the closure of their DB pension plans to new employees, and HSBC has closed its DB pension plan to existing members. Firms can not only choose these traditional pension de-risking strategies, but may also pay insurance premiums to enter pension buy-in or buy-out contracts. This new financial tool allows firms to reduce or remove pension obligations risk by transferring it to an insurance firm. This study therefore focuses on three pension de-risking strategies: changes to pension asset allocations, switches from DB to DC pension plans (partial or full switches) and pension buy-ins and buy-outs (BIOs).

However, the three pension de-risking strategies have significantly differing consequences for employees and firms (see Appendix A in the online Supporting Information). Firms invest higher proportions of pension assets in equities to enable them to reduce pension contributions (Bodie, 1990), while investing pension assets in bonds can match the duration of pension liabilities and asset allocations in order to mitigate volatility in DB pension plan funding (Blake, 2001). Partial and full switching from DB pension plans passes investment, longevity and other associated risks from employers to employees (Broadbent, Palumbo and Woodman, 2006). Ippolito (1995, 1997), Munnell *et al.* (2007) and VanDerhei (2006) suggest that switching from DB to DC pension plans allows firms to cut employees' retirement benefits. Firms can engage in BIOs by paying an insurance premium. Pension BIOs reduce, but – depending on the amount of funding provided – do not eliminate risk to the firm, since the financial position of the pension fund has to be kept under review and remains the sponsor's responsibility. Overall, switches from DB to DC pension plans impact on pension beneficiaries more significantly and directly than changes to pension asset allocations. Of the three pension de-risking strategies, pension BIOs are the most costly financial tools to reduce firms' pension obligations owing to their up-front costs.

Top management and boards of directors can significantly influence pension policy-making (Cocco and Volpin, 2007; Vafeas and Vlittis, 2016, 2018). The majority of the literature focuses on DB pension plans for US firms. However, UK pension trustees are responsible for managing and making investment decisions on DB pension plans (Thornton and Fleming, 2011), and are expected to act in the best interests of pension beneficiaries. The UK Pensions Regulator has changed the pension regulations to strengthen pension trustees' independence with regard to pension policy-making and investment strategies. Thus, we investigate and compare differing impacts of board composition – namely board size, percentage of independent and female directors on the boards – on the three pension de-risking strategies in the UK.

This study provides evidence to support stakeholder theory, in that larger and more independent boards are less likely to make risky investment decisions. Also, large boards are more likely to retain DB pension plans for their employees. We find no evidence that board independence impacts on switching decisions, unlike in the USA (Vafeas and Vlittis, 2018); however, as we explain, UK pension trustees mitigate the effect of independent directors. Survival analysis differentiates the impact of partial and full switching on employees and firms. Our evidence also shows that higher percentages of female directors encourage full switches from DB to DC pension plans to reduce firms' pension risk. In addition, we are the first study to investigate the impact of board composition on innovative pension de-risking strategies, in particular BIOs. We report that firms with a high percentage of female directors are also slower to engage in BIOs. This is because female directors weigh the up-front costs of BIOs against the benefits of insuring DB pension plans.

This research makes several contributions to the literature. First, it is the first to explore the impact of board compositions on different de-risking strategies in the UK pensions setting, where UK pension trustees play a significant role in pension policy-making. Second, we contribute to the corporate governance literature by exploring the effects of boards of directors, independent directors and female directors on the pension setting. Third, previous research has not comprehensively examined different pension de-risking strategies, and we incorporate an innovative pension de-risking strategy – BIOs – and apply survival analysis. This paper also contributes to the pension de-risking strategy literature by showing how firms' board composition affects pension policy-making when there is a need to reduce pension risk. Finally, our results may be applicable to other countries with similar pension governance bodies to the UK, such as Europe, Canada and Ireland.

The remainder of this paper is structured as follows. The next section discusses previous literature on board composition and pension de-risking strategies. The third section develops hypotheses, and the fourth section describes the sample selection process and the empirical model. The main tests and results are analysed in the fifth section, and the final section draws some conclusions.

Corporate governance and pension de-risking strategies

Board composition and corporate pension policy

Previous research on the relationship between corporate governance and corporate pension policy (Anantharaman and Lee, 2014; Guan and Tang, 2018; Phan and Hegde, 2013; Vafeas and Vlittis, 2016, 2018; Yu-Thompson *et al.*, 2015) has been based on US data. Phan and Hegde (2013) find that firms with better internal and external corporate governance index tend to allocate more pension assets to equities. This indicates that risk-increasing strategies for pension asset allocations are driven primarily by a desire to achieve higher returns on pension assets, better pension plan funding levels and greater reductions in future pension contributions.

Pension investment strategies may be driven by the interests of top management in US firms. Vafeas and Vlittis (2016) find that independent directors play a key role in determining pension policies. A higher proportion of independent directors relates to better pension funding levels and lower pension asset allocations to equities. They suggest that independent directors adhere to their fiduciary responsibility to forward pension beneficiaries under the Employee Retirement Income Security Act in the USA. However, Vafeas and Vlittis (2018) suggest that independent directors' interests are in line with shareholders' interests in maximizing firm value by closing DB pension plans to employees. They also provide evidence that firms with a higher proportion of independent directors are more likely to close their DB pension plans. This adds to the puzzle of why independent directors act differently towards pension policy-making in relation to allocating pension assets and closing DB pension plans. In addition, long-term investments in equities may outperform investments in bonds. Therefore, it is argued that allocating fewer pension assets to equities may not reduce pension beneficiaries' risk, as it increases the risk of not meeting future benefits obligations.

There is limited evidence on UK DB pensions in relation to firms' board compositions and pension de-risking strategies within this institutional setting. The legal forms of pension funds differ between countries. The term 'trustee' is used in Anglo-Saxon countries, where pension funds are established under trust law and trust deed. Therefore, pension trustees are found in the UK, Ireland and Canada. UK pension trustees have fiduciary responsibility for managing DB pension plans and making decisions on pension policy (Tilba and McNulty, 2013). They are required to work independently and act in the interests of pension beneficiaries. Thus, pension plan governance and trustee independence may determine the likelihood that companies will be able to engineer re-allocations of pension plan assets. However, the USA has an additional feature, as pension governance bodies are commonly sponsoring firms. Cocco and Volpin (2007) provide UK evidence and find that a higher proportion of trustees who are board members of sponsoring firms encourage higher pension asset allocations to equities. They suggest that pension trustees play a significant role in decision-making with regard to pension investment strategies. In addition, firms need to consult with the pension trustees if they are planning to make significant changes to the pension funds.

Pension de-risking strategies

Changes in pension asset allocations. Pension investment strategies determine returns on pension assets, and consequently influence pension funding levels and pension risk where rates of, and variability in, returns vary for different asset classes. Therefore, sponsoring firms tend to alter their pension asset allocations to mitigate pension risk. Lane Clark & Peacock (2014, 2015) indicate that firms have shifted their pension asset allocations from equities to bonds to mitigate pension risk arising from recent changes in accounting standards and financial crises. Similarly, Amir and Benartzi (1999) reveal that UK and US firms have tended to re-allocate pension assets from equities to bonds as a result of adopting IAS 19 and SFAS 158. Mashruwala (2008) provides evidence from the UK that, following the implementation of FRS 17, pension asset allocations have shifted from equities to bonds. Holt (2011) confirms that these shifts were due to the adoption of a new pension accounting standard and increasing pension risk. Therefore, Amir and Benartzi (1999) recommend that firms should allocate pension assets to fixed-income securities in order to match pension assets with the duration of pension liabilities. Overall, allocating pension assets to fixed-income securities may reduce volatility in pension contributions (Bader and Leibowitz, 1988).

However, firms may pursue higher returns from pension investments by allocating pension assets to equities. Investments in equity markets are likely to outperform the bond market in the long term. It can also be argued that allocating pension assets to equities will be more appropriate for firms with longer durations of pension liabilities, as they have longer time horizons and are more able to capture the 'equity premium'. Successful pension investments in equities may benefit firms by lowering pension contributions from sponsoring firms (Bodie, 1990). Liu and Tonks (2013) find a negative relationship between pension contributions and dividend payments. They indicate that pension contributions crowd out or reduce dividend payments to shareholders. Therefore, firms with higher pension asset allocations to equities are expected to have higher investment returns, thereby reducing pension contributions and maintaining levels of dividend payments. In general, changes in pension asset allocations are regarded as pension de-risking strategies.

Switches from DB to DC pension plans. Increased pension contributions and costs have led sponsoring firms to switch from DB to DC pension plans (Clark and Monk, 2007). DC pension plans offer an option to transfer risk from employers to employees. Switches from DB pension plans are regarded as a key pension de-risking strategy in this research. The UK Pensions Regulator (2016) reports that the proportion of members in open DB pension plans declined sharply from 66% to 19% between 2006 and 2016, while the percentage of DB pension plans remaining open to all employees dropped from 43% in 2006 to 13% in 2016. This shows that UK companies are de-risking their DB pension plans by stopping accruals of benefits to new or all employees.

There are two types of switches from DB to DC pension plans. In partial switching, new employees are unable to join the DB pension plan, while existing employees currently in such plans continue to earn benefits as usual (Munnell *et al.*, 2007). In place of DB pension plans for new employees, sponsoring firms tend to offer DC pension plans. Thus, another type of switching is to close a DB pension plan to all employees. This means that the value of pension benefits will stop increasing after the date of the switch. Rauh, Stefanescu and Zeldes (2017) find that switches from DB to DC pension plans help sponsoring firms make substantial savings. Dobbins and Dundon (2017) suggest that switching will reduce pension benefits to employees. Other studies (Choy, Lin and Officer, 2014; Comprix and Muller, 2011; McFarland, Pang and Warshawsky, 2009; Milevsky and Song, 2010) find that full switching of DB pension plans impacts on US firms' risk.

Pension buy-ins and buy-outs. Pension buy-ins and buy-outs provide an opportunity for firms to remove the responsibility for paying pension benefits partially or fully by means of a contract with an insurance company. There are differences between pension buy-ins and buy-outs. Through a buy-in policy, the sponsor firm purchases a group annuity, based on a valuation of future obligations, which is held as an asset within the pension fund (D'Amato *et al.*, 2018). The insurance company makes regular payments to pension trustees to match the pension benefits required to be paid to the relevant former employees. However, the pension scheme continues to administer the benefit payments and the sponsor firm retains responsibility in the event of default by the insurance company. Buy-ins have been popular in the UK, but less so in the USA, where the buy-out is more familiar (Geddes *et al.*, 2014). Pension buy-out was originally used to transfer the pension assets and liabilities of insolvent employers. With a full or partial pension buy-out, a firm transfers all or some of its pension obligations, along with associated assets, to insurers. If a firm completes a full buy-out, on a one-off or phased basis, the DB pension obligations are entirely removed from its financial statements. A firm may choose to engage in a pension buy-in or a partial or full pension buy-out according to its desired level of reduction in pension obligations and its particular circumstances.[1] Lin, MacMinn and Tian (2015), however, highlight that sponsoring firms are required to pay a significant amount of premium to enter a pension buy-in or buy-out insurance.

Since the market is relatively new and data on transactions are limited, there is little empirical literature focusing on pension buy-ins and buy-outs. Given that the longevity risk is one of the largest pension risks faced by DB pension plans (Tilba and Wilson, 2017), other research (Biffis and Blake, 2009; Blake *et al.*, 2008) explores pension buy-ins and buy-outs to investigate how

[1]Lane Clark & Peacock (2018) reports different types of pension buy-in and buy-out transactions: pensioner buy-in, full buy-out, pensioner buy-out and buy-in. The pensioner buy-in (buy-out) is defined as a buy-in (buy-out) that covers payments to current pensioners and their dependents. Full pension buy-out is a buy-out contract covering all known liabilities in a pension plan, usually followed by winding up the pension plan. Buy-in represents a purchase of a bulk annuity contract with an insurance company as an investment to match some or all of a pension plan's liabilities. This research does not take account of different types of pension buy-in and buy-out contracts.

employers transfer mortality risk to insurance companies via this insurance contract.

Hypothesis development

Boards of directors make top-level decisions and oversee firms' operations (Fama and Jensen, 1983), and DB pension de-risking is an important area of firms' strategic decision-making. Prior literature (Cocco and Volpin, 2007; Vafeas and Vlittis, 2016, 2018) suggests that independent directors influence pension policy-making, including changes in pension asset allocations and closures of DB pension plans. Thus, boards of directors are also likely to be associated with any decisions to initiate pension de-risking strategies in order to reduce or remove pension obligation risk.

Effect of board size on pension de-risking strategies

US empirical studies collectively suggest that large boards tend to make less risky investment decisions (Pathan, 2009; Wang, 2012). Cheng (2008) finds that board size is negatively related to a firm's performance, supporting the argument that large boards tend to make more compromises to reach less extreme decisions. A questionnaire survey (McNulty, Florackis and Ormrod, 2013) also provides evidence of a negative relationship between board size and financial risk of UK firms. Studies in the field of economics and psychology (Kogan and Wallach, 1966; Moscovici and Zavalloni, 1969; Sah and Stiglitz, 1986, 1991) provide perspectives on how boards of directors make decisions. Given that directors generally hold diverse opinions and have differing abilities to process information, risky projects are more likely to be rejected. Final decisions represent averages and compromises on group members' opinions.

Phan and Hegde (2013) find that US firms with better corporate governance index are more likely to allocate pension assets to equities. However, prior literature reaches no clear conclusion on the effect of board size on pension asset allocations. In addition, successful pension investments in equities may reduce the pension contributions of sponsoring firms (Bodie, 1990). Franzen (2010) suggests that sponsoring firms benefit from contribution holidays if there are higher returns on pension investments. According to agency theory, boards of directors are expected to maximize the interests of shareholders. If large boards result in less firm risk for the benefits of shareholders, they are also likely to be positively related to equity investments in the pension setting. However, investing pension assets in bonds can match between the duration of pension liabilities and asset allocations in order to mitigate volatility in DB pension plan funding (Blake, 2001). Thus, boards of directors may choose to invest pension assets in bonds to generate more secure pension benefits for employees and reduce investment risks of the pension plans. Stakeholder theory suggests that boards of directors should consider the interests of employees. If large boards result in less risk for employees and pension plans, then they are also expected to be negatively related to equity investments. The above discussion leads to a non-directional hypothesis relating to board size and pension asset allocations:

H1a: There is a significant relationship between board size and the percentage of pension assets invested in equities.

Boards of directors can influence the decision to switch from DB to DC pension plans in order to reduce risk. Large boards favour less risk-taking practices and are negatively related to firms' financial risk (Cheng, 2008; Pathan, 2009; Wang, 2012). Again, prior literature provides inconclusive evidence on the impact of board size on the switch decision of pension plans. Rauh, Stefanescu and Zeldes (2017) suggest that reducing employees' pension benefits can save firms money. They find that firms which freeze their DB plans tend to make cost savings of 2–3% of payroll per annum, and in the long run save about 3% of total firm assets. Munnell *et al.* (2007) suggest that motives for firms switching from DB pension plans include reducing future retirement benefits, cutting healthcare costs and avoiding the risks of accounting and regulatory changes. Given the cost-saving incentive, the agency view of boards of directors suggests that they may pursue cost reductions for the benefit of shareholders. Thus, it is expected that larger boards have greater incentive to reduce pension costs, and consequently reduce pension liability risks.

However, Choy, Lin and Officer (2014) find that firms' risk increases in terms of operating activities, research and development and financing strategies following full switches from DB to DC. Hence, firms are likely to take on more risk if managers are compensated through equity-like rather than debt-like incentive mechanisms. In addition, McFarland, Pang and Warshawsky (2009) suggest that it is unclear whether switching from DB to DC pension plans can reduce firms' pension costs, as they must facilitate new pension plans for employees. Switches have a negative effect on human resources, as they significantly reduce employees' benefits. In contrast to the agency view of directors, boards of directors must take account of employees' benefits. The costs of switching may outweigh the benefits, and partial switching from DB to DC may increase firm risk, because it may lead to an increase in firms' costs of providing DB pensions to existing members, as fewer younger employees will be contributing to the plan. We thus develop our second non-directional hypothesis:

H1b: There is a significant relationship between board size and the time taken for firms to switch from DB to DC pension plans.

Pension BIOs are innovative financial tools to help firms offload pension liabilities to insurance companies. Unlike the switching decisions, pension BIOs can entail significant insurance premiums. Firms can remove pension obligations from their financial statements only through pension buy-outs. Lin, MacMinn and Tian (2015) suggest that a careful consideration of firms' financial position is needed before engaging in such insurance contracts. Given that employees' benefits are secured under BIO contracts, boards of directors must take account of the costs of such de-risking strategies. Thus, we argue that firms may have less incentive to engage in pension BIOs owing to the costs of insurance.

H1c: There is a significant negative relationship between board size and the time taken by firms to engage in pension buy-ins or buy-outs.

Effect of board independence on pension de-risking strategies

Vafeas and Vlittis (2016) suggest that independent directors encourage lower pension asset investments in equities when firms are close to going bankrupt in the USA. They argue that inside and outside directors pursue different interests in pension policy-making. Although boards of directors are committed to serving shareholders and pension plan beneficiaries, the interests of inside directors are more aligned with shareholders' wealth, whereas outside directors are more likely to act towards pension plan beneficiaries. In addition, the FCA (2020) requires firms operating workplace pension schemes to establish and maintain independent governance committees (IGCs). These influence pension investment policies. According to stakeholder theory, since firms that allocate fewer pension assets to equities are more likely to provide less volatile and more secured pension benefits to their employees, lower allocations of pension assets to equities are expected to relate to having more independent directors on boards.

H2a: There is a negative relationship between board independence and the percentage of pension assets invested in equities.

In contrast, Vafeas and Vlittis (2018) provide evidence that a higher proportion of independent directors relates to a greater likelihood of firms switching from DB to DC plans. Their findings suggest that independent directors' interests are more aligned with shareholders than pension beneficiaries with regard to pension obligations. As previously discussed, firms benefit from switching through cost reductions and risk-shifting from employers to employees (Broadbent, Palumbo and Woodman, 2006; Ippolito, 1995, 1997; Munnell *et al.*, 2007; Rauh, Stefanescu and Zeldes, 2017).

However, there are institutional differences between UK and US DB pension plans. Munnell *et al.* (2007) suggest that decisions to switch from DB pension plans are determined entirely by firms in the USA. However, labour unions may oppose reductions to employees' benefits. In the UK, the Pensions Regulator requires firms to consult with pension trustees to agree on significant changes to DB pension plans. Therefore, pension trustees play a key role in switching decisions and are expected to safeguard pension beneficiaries' interests when sponsoring firms decide to switch from DB pension plans.

H2b: There is a negative or no relationship between board independence and the time taken for firms to switch from DB to DC pension plans.

There is limited research on the impact of board independence on pension BIO decisions. As previously discussed, firms can benefit from removing pension obligations from financial statements after engaging in pension buy-outs. However, the costs of insurance premiums are a major concern. It is unclear whether independent directors are interested in removing pension obligations through pension BIOs, and whether insurance premium costs outweigh re-insuring pension obligations. Thus, we hypothesize:

H2c: There is a significant relationship between board independence and the time taken for firms to engage in pension buy-ins or buy-outs.

Effect of female board members on pension de-risking strategies

Adams and Ferreira (2009) suggest that female directors' behaviour tends to differ significantly from male directors' behaviour in terms of monitoring and the impact on firm performance. In particular, females are on average more risk-averse than males (Croson and Gneezy, 2009). For example, Faccio, Marchica and Mura (2016) find that a female CEO is associated with a reduction in corporate risk-taking (measured by leverage, return on assets and volatility returns). Similarly, Palvia, Vähämaa and Vähämaa (2015) report that firms with female CEOs and board chairs assess risk more conservatively, hold less equity capital and engage in less risky operations than males. Prior literature provides limited evidence on the impact of female directors on pension investment decisions. Pension investment decisions are made by boards of directors and pension trustees in the UK, presenting the collective view of directors, including female directors. Thus, female directors may influence pension asset allocations. Given that female directors are more risk-averse (Croson and Gneezy, 2009) and make less risky investment decisions (Faccio, Marchica and Mura, 2016) than their male counterparts, firms with more female directors are expected to be less likely to allocate pension assets to equities.

H3a: There is a negative relationship between the percentage of female directors on boards and the percentage of pension assets invested in equities.

Research on the impact of female directors on pension benefits is limited. Vafeas and Vlittis (2018) use the percentage of female directors as a control variable, but find no significant relationship with decisions to switch from DB to DC plans. DB pension plans pose a great risk to firms. Prior literature suggests that firms can make substantial cost savings by switching from DB to DC pension plans (Munnell *et al.*, 2007; Rauh, Stefanescu and Zeldes, 2017). Given that female directors are more risk-averse than male directors (Croson and Gneezy, 2009), they have greater incentives to de-risk DB pension plans. Hence, firms with more female directors are more likely to switch from DB to DC pension plans to reduce firms' pension risk. However, Choy, Lin and Officer (2014) find that switching from DB to DC pension plans increases managerial risk and induces managers to take more risk, thus increasing overall firm risk. Firms with more female directors are therefore less likely to switch from DB to DC. We develop the following non-directional hypothesis:

H3b: There is a significant relationship between the percentage of female directors on boards and the time taken for firms to switch from DB to DC pension plans.

The impact of female directors on boards on pension BIO decisions has not previously been explored. Female directors may also balance the costs and benefits of such decisions. Given that Lin, Shi and Arik (2017) suggest that implementing pension BIOs may constrain firms facing poor financial conditions, female directors may worry about the significant costs of such actions. However, since female directors appear to be less traditional (Adams and Funk, 2012) and more risk-averse (Croson and Gneezy, 2009) than male directors, they may be more likely to use new financial tools to help reduce firms' pension obligations.

H3c: There is a significant relationship between the percentage of female directors on boards and the time taken by firms to engage in pension buy-ins or buy-outs.

Sample selection and descriptive statistics

Sample selection

This research focuses on FTSE 350 firms with DB pension plans from 2005 to 2017. FTSE 350 firms account for the majority of DB pension plans in the UK. Given that de-risking DB pension plans significantly affects firms' operations and employees' benefits, any such decisions must represent the interests of both employers and employees. Data on partial and full switches from DB to DC pension plans are hand-collected from FTSE 350 firms' annual reports for the period 2000–2017.

Table 1. Sample selection criteria

Sample selection criteria	Firm-year observations	Unique firms	Number of firms with switches or BIOs in the sample
Initial sample for FTSE 350 during 2005–2017	4,546	650	
Final sample for pension asset allocation during 2005–2017	1,791	257	
Final sample for switches during 2005–2017	1,669	291	123[a]
Final sample for BIOs during 2007–2017	196	33	33[b]

[a] This reports the number of firms either fully switched or partially switched from DB to DC pension plans. Note that four firms engage in both full and part switches.
[b] This includes 33 firms that engage in pension buy-ins or buy-outs.

Pension BIO information is hand-collected from a practitioner research report[2] (Lane Clark & Peacock, 2018). Board composition, pension asset allocation and other accounting information are collected from the Bloomberg database, available for the period 2005–2017. Instrumental variables are collected from BoardEx. The sample selection criteria are reported in Table 1.

The primary sample includes FTSE 350 firms from 2005 to 2017, with unbalanced panel data for 4,546 firm-year observations and 650 unique firms. In order to deal with survivorship bias, we allow firms to freely exit and enter the FTSE 350 index. We exclude firms for which no information is available on board composition data and pension asset allocation information, resulting in 1,791 firm-year observations for the pension asset allocation sample. Merging the data on switches from DB plans and board composition results in 1,669 firm-year observations and 291 firms. Survival analysis allows us to deal with right-censoring of the observations. Given that firms are believed to switch to DC plans to eventually terminate their DB pension plans, survival analysis allows us to include FTSE 350 firms that did not switch their DB pension plans in the sampled years, but will ultimately do so later.

Merging the data on BIOs and board composition results in 196 firm-year observations and 33 unique firms. This sample only includes firms with BIOs, a strategy for de-risking that not all firms chose to adopt. Table 2 provides information on the distribution of firms, partial switches (38), full switches (93) and pension BIO transactions (33) across the years of analysis.

[2]Founded in 1947, Lane Clark & Peacock (LCP) is a major UK-based firm of financial, actuarial and business consultants. It is a leading provider of advice in areas such as pensions, investments and insurance. One of its key activities is the provision of advice to pension plan trustees and corporate sponsors on complex UK and international pensions issues.

Table 2. Sample split according to the partially and fully switches of DB pension plan and BIOs

Year	Partial switch	Full switch	BIO
2005	5	0	N/A
2006	5	4	N/A
2007	4	8	2
2008	3	2	2
2009	3	4	5
2010	1	15	2
2011	3	13	2
2012	4	9	1
2013	6	7	3
2014	4	5	5
2015	0	10	2
2016	0	8	4
2017	0	8	5
Total	**38**	**93**	**33**

Note: This table presents the distribution of the switches of DB pension plans and pension buy-ins and buy-outs by year. There are two types of switches in the sample: partial switching and full switching from DB to DC pension plans. Partial switching is defined as the closure of DB pension plans to new employees. Full switching is defined as the closure of DB pension plans to all employees. The pension buy-ins and buy-outs are not presented separately and regarded as BIO.

Descriptive statistics

Table 3 provides descriptive statistics for the explanatory and control variables used in our empirical analyses. All continuous variables are

Table 3. Descriptive statistics

	Panel A: PA			Panel B: SWITCH			Panel C: BIO		
	Mean	Std dev.	Median	Mean	Std dev.	Median	Mean	Std dev.	Median
EQUITY	42.039	20.377	41.232						
DUR_SWITCH				0.101	0.418	0			
DUR_BIO							0.027	0.163	0
SIZE_BOARD	9.624	2.513	9	9.576	2.534	9	9.576	2.534	9
BOARD_IND	60.328	12.385	60	59.845	12.413	60	59.845	12.413	60
PCT_FEMALE	15.465	10.626	14.286	14.694	10.795	14.286	14.694	10.795	14.286
ROA	7.177	5.873	5.927	7.299	5.985	6.073	7.299	5.985	6.073
LEV	0.637	0.199	0.633	0.631	0.204	0.633	0.631	0.204	0.633
OP_CF	0.282	0.575	0.232	0.282	0.564	0.228	0.282	0.564	0.228
DIV_PAYOUT	66.832	82.504	48.947	67.046	83.299	48.256	67.046	83.299	48.256
SIZE	8.348	1.777	8	8.285	1.777	7.962	8.285	1.777	7.962
PLAN_SIZE	0.329	0.382	0.212	0.308	0.380	0.186	0.308	0.380	0.186
FUND	90.727	14.176	91.22	90.307	15.121	90.78	90.307	15.121	90.78

Note: This table reports descriptive statistics for three pension de-risking strategies (pension asset allocations (PA), switches from DB to DC pension plans (SWITCH) and pension buy-ins and buy-outs (BIO)), board characteristics and other control variables. Information about switches from DB to DC are hand-collected from annual reports. Pension buy-in and buy-out data are hand-collected from a commercial research report (Lane Clark & Peacock, 2018). Pension asset allocations and accounting information are collected from the Bloomberg database. All continuous variables have been winsorized at the top and bottom 1%. All variable definitions are reported in Appendix B.

winsorized (at the top and bottom 1%). More specifically, Panel A shows the variables used to examine the impact of board compositions on pension asset allocations. On average, 42% of pension assets are allocated to equities (*EQUITY*), and there are 9.6 directors on the board (*SIZE_BOARD*), 60% of whom are independent directors (*BOARD_IND*) and 15.5% female directors (*PCT_FEMALE*). The majority of pension funds are underfunded, as the funding level (*FUND*) is 91%. Panels B and C show the variables used to examine the impact of board compositions on switches and BIOs, respectively. The mean of the duration variable, *DUR_SWITCH*, is 0.1. The mean of *DUR_BIO* is 0.027 and that of *PLAN_SIZE* is 0.33, suggesting that projected benefit obligations are equal to 33% of firms' total assets. Pairwise correlation coefficients for the variables used are shown in Table 4. We note no high correlations among the variables; hence, multicollinearity is not an issue in our models.

Empirical analyses and results

Impact of board composition on pension asset allocations

In order to examine the impact of board compositions on pension asset allocations, the following firm and industry fixed-effects model is used:

$$\begin{aligned} EQUITY_{\mathrm{i}} = \beta_0 + \beta_1 SIZE\_BOARD_{\mathrm{i,t}} \\ + \beta_2 BOARD\_IND_{\mathrm{i,t}} + \beta_3 PCT\_FEMALE_{\mathrm{i,t}} \\ + \beta_4 ROA_{\mathrm{i,t}} + \beta_5 LEV_{\mathrm{i,t}} + \beta_6 OP\_CF_{\mathrm{i,t}} \\ + \beta_7 DIV\_PAYOUT_{\mathrm{i,t}} + \beta_8 SIZE_{\mathrm{i,t}} \\ + \beta_9 PLAN\_SIZE_{\mathrm{i,t}} + \beta_{10} FUND_{\mathrm{i,t}} \\ + \sum \beta_{\mathrm{s}} Year\_dummy \\ + \sum \beta_{\mathrm{r}} Industry\_dummy + \sigma \end{aligned} \quad (1)$$

The dependent variable *EQUITY* is a continuous variable measuring the percentage of pension assets allocated to equities. The definition of the independent variables is given in Appendix B in the online Supporting Information. Table 5 presents the results of estimating Eq. (1).

There is a significant negative relationship between *SIZE_BOARD* and *EQUITY* at the 10% significance level. This indicates that firms with larger boards are less likely to allocate pension assets to equities, and are hence more likely to make less risky pension investments. These results are consistent with H1a, supporting that firms with larger boards are less likely to take extreme decisions (Cheng, 2008). Firms with larger boards reduce

Table 4. Correlation matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) *EQUITY*	1.000												
(2) *DUR_SWITCH*	0.023	1.000											
(3) *DUR_BIO*	0.137*	0.051*	1.000										
(4) *SIZE_BOARD*	−0.088*	−0.010	−0.067*	1.000									
(5) *BOARD_IND*	−0.280*	0.030	−0.059*	0.085*	1.000								
(6) *PCT_FEMALE*	−0.305*	0.029	−0.079*	0.133*	0.369*	1.000							
(7) *ROA*	0.048*	−0.038*	−0.073*	−0.155*	−0.050*	0.003	1.000						
(8) *LEV*	−0.016	0.056*	0.044*	0.243*	0.057*	0.103*	−0.220*	1.000					
(9) *OP_CF*	0.066*	−0.008	−0.042*	0.021	−0.015	0.037*	0.181*	0.088*	1.000				
(10) *DIV_PAYOUT*	0.015	0.021	0.025	0.021	0.105*	0.090*	−0.203*	0.131*	−0.000	1.000			
(11) *SIZE*	−0.217*	0.017	−0.074*	0.618*	0.365*	0.216*	−0.281*	0.313*	−0.031*	0.054*	1.000		
(12) *PLAN_SIZE*	−0.012	0.032	−0.020	−0.182*	0.049*	0.007	0.114*	0.190*	0.096*	0.017	−0.244*	1.000	
(13) *FUND*	−0.290*	0.005	−0.089*	0.078*	0.126*	0.174*	0.053*	0.005	−0.005	0.021	0.125*	0.067*	1.000

*Significance at the 0.05 level.

Table 5. The impact of board composition on pension asset allocations

$$EQUITY_{i} = \beta_0 + \beta_1 SIZE\_BOARD_{i,t} + \beta_2 BOARD\_IND_{i,t} + \beta_3 PCT\_FEMALE_{i,t} + \beta_4 ROA_{i,t} + \beta_5 LEV_{i,t} + \beta_6 OP\_CF_{i,t} + \beta_7 DIV\_PAYOUT_{i,t} + \beta_8 SIZE_{i,t} + \beta_9 PLAN\_SIZE_{i,t} + \beta_{10} FUND_{i,t} + \sum \beta_s Year\_dummy + \sum \beta_r Industry\_dummy + \sigma$$

Dependent variable	*EQUITY*
	(1)
VARIABLES	OLS
SIZE_BOARD	−7.737*
	(4.4650)
BOARD_IND	−0.179**
	(0.0802)
PCT_FEMALE	−0.053
	(0.0784)
ROA	0.246
	(0.1526)
LEV	1.723
	(5.4927)
OP_CF	1.965*
	(1.0463)
DIV_PAYOUT	0.020***
	(0.0068)
SIZE	−1.327*
	(0.7513)
PLAN_SIZE	−0.876
	(3.3045)
FUND	−0.248***
	(0.0700)
Constant	121.491***
	(11.7720)
Observations	1,791
Number of firms	257
Industry dummy	YES
Year dummy	YES
Adjusted R^2	0.288

Note: This table reports the results of a year and industry fixed-effects regression that examines the impact of board composition on pension asset allocations. The dependent variable is percentage of pension assets allocated to equities (*EQUITY*). Robust standard errors are reported in parentheses. *, ** and *** represent significance levels of 10%, 5% and 1%, respectively (two-tailed). Standard errors clustered by firm. All variable definitions are reported in Appendix B.

investment risks relating to pension funds and provide secure pension benefits for their employees.

There is a negative relationship between *BOARD_IND* and *EQUITY* at the 5% significance level. This finding supports H2a and suggests that firms with more independent directors on boards are less likely to invest pension assets in risky investments. Our evidence is consistent with Vafeas and Vlittis's (2016) finding that outside directors are more committed to protecting the interests of pension beneficiaries. Thus, the more independent directors, the less likely that pension assets will be allocated to risky asset classes.

However, there is an insignificant relationship between *PCT_FEMALE* and *EQUITY*. We find no evidence that having more female directors on boards encourages less risky pension investments. Thus, H3a is rejected.

In summary, our evidence for the impact of board composition on pension asset allocations reveals that firms with larger boards and more independent directors are less likely to allocate pension assets to equities. This finding is consistent with stakeholder theory.

Impact of board composition on DB pension plan switches

The following Cox proportional hazards model is used to explore whether board composition impacts the survival of DB pension plans:

$$\begin{aligned} h_i\ (DUR\_SWITCH) = {} & h_0(t)\exp\{\beta_0 \\ & + \beta_1 SIZE\_BOARD_{i,t} + \beta_2 BOARD\_IND_{i,t} \\ & + \beta_3 PCT\_FEMALE_{i,t} + \beta_4 ROA_{i,t} + \beta_5 LEV_{i,t} \\ & + \beta_6 OP\_CF_{i,t} + \beta_7 DIV\_PAYOUT_{i,t} \\ & + \beta_8 SIZE_{i,t} + \beta_9 PLAN\_SIZE_{i,t} \\ & + \beta_{10} FUND_{i,t} \\ & + \sum \beta_r Industry\_dummy + \sigma\} \end{aligned} \tag{2}$$

The dependent variable is a duration variable referring to the time taken (in years) from the start of the sample period for the firm to switch from DB pension plans (*DUR_SWITCH*). All other control variables are as previously defined. The Cox proportional hazards model enables the determination of the length of time it takes for firms to switch from DB to DC pension plans. Compared with other parametric models (such as Weibull and exponential), the Cox model (which is a semi-parametric model) does not impose any structure on the baseline hazard and may result in more accurate estimations. Therefore, *DUR_SWITCH* is used to measure the duration of switches from DB to DC pension plans. Each firm is assumed to have a probability of switching from a DB pension plan, called the hazard rate. The coefficients and hazard ratios are reported in Table 6. A significant positive value of the β parameter indicates that an increase in the corresponding variables leads to faster switching from DB pension plans. The hazard rate is interpreted as the extent to which the hazard of the event increases for a unit change in the independent variables. A hazard rate larger than 1 suggests that the corresponding variable is negatively associated with the length of survival, whereas a hazard rate of between 0 and 1 suggests a positive association.

In Table 6, columns (1) and (2) show a negative and significant coefficient of *SIZE_BOARD* at the 10% significance level, and a hazard ratio between 0 and 1. This suggests that firms with a larger board are slower to switch from DB to DC pension plans. These results support H1b, and are consistent with previous studies (Choy, Lin and Officer, 2014; McFarland, Pang and Warshawsky, 2009). Choy, Lin and Officer (2014) find that firms which switch from DB pension plans are more likely to experience increased firm risk as managers are incentivized to take more risk when pension obligations are reduced. Therefore, given that larger boards favour less risk-taking (Cheng, 2008; Pathan, 2009; Wang, 2012), firms with a larger board are associated with slower switching from DB pension plans in order to prevent managers from increasing firm risk. In addition, boards of directors may worry about the negative impact of switching on employees (McFarland, Pang and Warshawsky, 2009) and the increased costs of providing DB pension plans for existing employees, as fewer young employees will contribute. This may support stakeholder theory, in that firms with larger boards protect employees' benefits and are slower to switch from DB to DC pension plans.

However, there is no evidence of a significant relationship between *BOARD_IND* and *DUR_SWITCH*. This rejects H2b. Our evidence differs from that of Vafeas and Vlittis (2018), who find that firms with more independent directors are more likely to switch from DB to DC pension plans. They suggest that independent directors' interests are aligned with those of shareholders, believing that switching from DB to DC pension plans may decease firms' costs. However, there are institutional differences between UK and US pension plans. UK pension trustees play a significant role in pension decision-making, and firms must consult with pension trustees when deciding on significant changes to pension plans. Therefore,

Table 6. The impact of board composition on switches of DB pension plans

$$h_i(DUR\_SWITCH) = h_0(t)\exp\{\beta_0 + \beta_1 SIZE\_BOARD_{i,t} + \beta_2 BOARD\_IND_{i,t} + \beta_3 PCT\_FEMALE_{i,t} + \beta_4 ROA_{i,t} + \beta_5 LEV_{i,t} + \beta_6 OP\_CF_{i,t} + \beta_7 DIV\_PAYOUT_{i,t} + \beta_8 SIZE_{i,t} + \beta_9 PLAN\_SIZE_{i,t} + \beta_{10} FUND_{i,t} + \sum \beta_r Industry\_dummy + \sigma\}$$

Dependent variable	*DUR_SWITCH* Full and partial switches		Partial switches		Full switches	
VARIABLES	(1) Coefficient	(2) Hazard ratio	(3) Coefficient	(4) Hazard ratio	(5) Coefficient	(6) Hazard ratio
SIZE_BOARD	−0.810*	0.445*	−0.162	0.850	−0.918*	0.399*
	(0.4610)	(0.2050)	(0.7660)	(0.6510)	(0.5520)	(0.2200)
BOARD_IND	−0.007	0.993	−0.020	0.980	−0.006	0.994
	(0.0092)	(0.0091)	(0.0164)	(0.0161)	(0.0105)	(0.0105)
PCT_FEMALE	0.016	1.016	0.0009	1.001	0.022*	1.022*
	(0.0108)	(0.0109)	(0.0164)	(0.0164)	(0.0126)	(0.0129)
ROA	0.013	1.013	0.0134	1.013	0.000233	1.000
	(0.0167)	(0.0169)	(0.0387)	(0.0392)	(0.0174)	(0.0174)
LEV	0.096	1.100	−0.394	0.674	0.528	1.695
	(0.5050)	(0.5560)	(1.3070)	(0.8810)	(0.5470)	(0.9280)
OP_CF	−0.010	0.990	0.058	1.059	0.077	1.080
	(0.1440)	(0.1430)	(0.2110)	(0.2230)	(0.1780)	(0.1920)
DIV_PAYOUT	2.04e−05	1.000	0.002	1.002	7.00e−05	1.000
	(0.0009)	(0.0009)	(0.0017)	(0.0017)	(0.0011)	(0.0011)
SIZE	0.104	1.110	0.273*	1.314*	−0.036	0.964
	(0.0872)	(0.0968)	(0.1590)	(0.2090)	(0.1030)	(0.0993)
PLAN_SIZE	0.468**	1.597**	1.233**	3.432**	0.196	1.217
	(0.2240)	(0.3580)	(0.5110)	(1.7550)	(0.2460)	(0.3000)
FUND	0.004	1.004	−0.0003	1.000	0.004	1.004
	(0.0058)	(0.0058)	(0.0110)	(0.0110)	(0.0065)	(0.0065)
Industry dummy	YES		YES		YES	
Observations	1,669		1,979		1,857	
Number of firms	291		291		291	
Number of firms to switch	123		38		93	
Wald chi-square	30.78		20.95		22.69	

Note: This table reports the results of survival analysis for the impact of board composition on switch decisions of DB pension plans. The dependent variable is the time in years to switch DB to DC pension plans. Columns (3) and (5) report the survival analysis for partial switches and full switches independently. Columns (1), (3) and (5) report the coefficient results. Columns (2), (4) and (6) report the hazard ratios. The positive coefficient indicates that as the independent variables increase, the time-to-event decreases (event is faster to happen). Robust standard errors are reported in parentheses. *, ** and *** represent significance levels of 10%, 5% and 1%, respectively (two-tailed). Standard errors clustered by firm. All variable definitions are reported in Appendix B.

pension trustees' roles may mitigate the influence of independent directors on decisions to switch from DB to DC pension plans. In addition, as discussed earlier, IGCs may play a role in pension investment policy when firms decide to close DB pension plans.

Our results reveal the differing impacts of board independence on two pension de-risking strategies (pension asset allocations and switches from DB to DC pension plans). Independent directors appear to have a significant influence on pension asset allocations, but no or less influence on switching decisions. This may be because the latter significantly affect employees' benefits and may attract greater attention from pension trustees and independent committees. This may be more likely to mitigate independent directors' influence on switching than on pension asset allocations. We find no evidence for the impact of the percentage of female directors on boards (*PCT_FEMALE*) on switches from DB to DC pension plans.

Full and partial switches have differing impacts on pension beneficiaries. Partial switches only impact on new employees, whereas full switches impact on all employees. Therefore, we conduct further survival analysis focusing on the separate impacts of board compositions on partial switches (columns (3) and (4) of Table 6) and full switches (columns (5) and (6) of Table 6).

We find no evidence that the number of directors (*SIZE_BOARD*), the percentage of independent directors (*BOARD_IND*) or the percentage of female directors on boards (*PCT_FEMALE*) impact on partial switches from DB to DC pension plans. However, we find a negative and significant coefficient of board size (*SIZE_BOARD*) at the 10% significance level for full switches, with a hazard ratio between 0 and 1. This suggests that larger boards are slower to take such decisions, as they impact significantly on employees and pension beneficiaries. We detect a positive and significant coefficient for the percentage of female directors (*PCT_FEMALE*) on boards at the 10% significance level, with a hazard ratio greater than 1. This suggests that firms with a higher proportion of female directors on boards are faster to switch fully from DB to DC pension plans. This supports H3b and confirms the risk-aversion of female directors. Thus, firms with more female directors are encouraged to switch fully from DB to DC pension plans.

Overall, our evidence suggests that firms with larger boards are slower to switch from DB to DC pension plans. We find no evidence of any impact of independent directors on switching decisions, as UK pension trustees and other committees may mitigate independent directors' influence. In addition, we highlight that independent directors' impact on switches from DB to DC pension plans differs from pension asset allocations. This is due to the differing nature of these pension de-risking strategies, as firms must consult with pension trustees when planning to switch pension plans.

Further tests show that the impact of board size is more significant in full than in partial switching decisions. This is consistent with the fact that full switches have a more significant impact on pension beneficiaries than partial switches (Choy, Lin and Officer, 2014; Comprix and Muller, 2011); hence, boards of directors exert more influence over full switching decisions. Finally, we find that firms with a higher percentage of female directors are faster to fully switch from DB pension plans, as more female directors sitting on boards may encourage de-risking on DB pension plans.

Table 7. The impact of board composition on pension buy-ins and buy-outs

$$h_i(DUR\_BIO) = h_0(t)\exp\{\beta_0 + \beta_1 SIZE\_BOARD_{i,t} + \beta_2 BOARD\_IND_{i,t} + \beta_3 PCT\_FEMALE_{i,t} + \beta_4 ROA_{i,t} + \beta_5 LEV_{i,t} + \beta_6 OP\_CF_{i,t} + \beta_7 DIV\_PAYOUT_{i,t} + \beta_8 SIZE_{i,t} + \beta_9 PLAN\_SIZE_{i,t} + \beta_{10} FUND_{i,t} + \sum \beta_r Industry\_dummy + \sigma\}$$

Dependent variable	*DUR_BIO*	
	(1)	(2)
VARIABLES	Coefficient	Hazard ratio
SIZE_BOARD	−3.090	0.046
	(3.418)	(0.156)
BOARD_IND	0.009	1.009
	(0.0352)	(0.0355)
PCT_FEMALE	−0.107*	0.899*
	(0.0576)	(0.0517)
ROA	0.005	1.005
	(0.0596)	(0.0599)
LEV	0.457	1.579
	(2.592)	(4.092)
OP_CF	0.416	1.515
	(0.4230)	(0.6410)
DIV_PAYOUT	0.002	1.002
	(0.0054)	(0.0054)
SIZE	0.351	1.421
	(0.8640)	(1.2280)
PLAN_SIZE	7.436**	1,695**
	(3.531)	(5,986)
FUND	−0.126	0.882
	(0.0768)	(0.0677)
Industry dummy	YES	
Observations	196	
Number of firms	33	
Number of firms to BIO	29	
Wald chi-square	28.70	

Note: This table reports the survival analysis for the impact of board composition on the decision of pension buy-ins and buy-outs. The dependent variable is the time in years to engage in pension buy-ins and buy-outs. Columns (1) and (2) report the coefficient and hazard ratios, respectively. The positive coefficient indicates that as the independent variables increase, the time-to-event decreases (event is faster to happen). Robust standard errors are reported in parentheses. *, ** and *** represent significance levels of 10%, 5% and 1%, respectively (two-tailed). Standard errors clustered by firm. All variable definitions are reported in Appendix B.

Impact of board composition on pension buy-ins and buy-outs

This section explores whether board composition impacts on pension BIO decisions, using the

Table 8. First and second stage of IV regressions: impact of board composition on pension asset allocations

Dependent variables:	*EQUITY*	*SIZE_BOARD*	*BOARD_IND*	*PCT_FEMALE*
	(1)	(2)	(3)	(4)
VARIABLES	Second stage	First stage	First stage	First stage
SIZE_BOARD	−25.390*			
	(12.44)			
BOARD_IND	−2.492***			
	(0.2030)			
PCT_FEMALE	0.380			
	(0.4810)			
BMEET		−0.104***	1.102	−1.005
		(0.0173)	(1.0610)	(0.6190)
AMEET		0.068***	1.744	0.570
		(0.0182)	(1.0020)	(0.5570)
PCTATTEND		−0.008***	0.059	0.081
		(0.0014)	(0.0850)	(0.0517)
LAGPCTFEMALE		0.0001	0.327***	0.815***
		(0.0005)	(0.0297)	(0.0176)
Control variables	YES	YES	YES	YES
Constant	312.0	2.099***	154.0***	−24.37
	(219.0)	(0.418)	(23.74)	(14.80)
Observations	1,455	1,455	1,455	1,455
Shea partial R^2		0.0471	0.0040	0.0274
R^2/partial R^2	−0.168	0.0444	0.0863	0.6405
F(4, 1,435)		16.00	34.19	615.06
P-value		0.0000	0.0000	0.0000
Firm FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Under-identification	7.326**			
Cragg–Donald (CD) Wald F-statistic	2.081			
Endogeneity test	12.19***			

Note: This table reports the results of first and second-stage 2SLS regression with board composition instrumented in the first stage. The dependent variable is percentage of pension asset invested in equities (*EQUITY*) in the second stage. Instrument variables are discussed in the main text. We report F-statistics of excluded instruments, SW F-statistics for weak instrument tests. We report SW chi-square for under-identification tests. Robust standard errors are reported in parentheses. *, ** and *** represent significance levels of 10%, 5% and 1%, respectively (two-tailed). Standard errors clustered by firm. All variable definitions are reported in Appendix B.

following equation:

$$\begin{aligned} h_i\ (DUR\_BIO) = {} & h_0(t)\exp\{\beta_0 \\ & + \beta_1 SIZE\_BOARD_{i,t} + \beta_2 BOARD\_IND_{i,t} \\ & + \beta_3 PCT\_FEMALE_{i,t} + \beta_4 ROA_{i,t} \\ & + \beta_5 LEV_{i,t} + \beta_6 OP\_CF_{i,t} \\ & + \beta_7 DIV\_PAYOUT_{i,t} + \beta_8 SIZE_{i,t} \\ & + \beta_9 PLAN\_SIZE_{i,t} + \beta_{10} FUND_{i,t} \\ & + \sum \beta_r Industry\_dummy + \sigma\} \end{aligned} \quad (3)$$

The dependent variable is the time taken by firms (in years) from the year of availability of pension BIOs to the year they engage in them (*DUR_BIO*). All other control variables are as previously defined.

The survival analysis in Table 7 shows a significant and negative coefficient of *PCT_FEMALE* at the 5% significance level (column (1)), with a hazard ratio lower than 1 (column (2)). This indicates that firms with a higher percentage of female directors on boards are slower to engage in pension BIO transactions, supporting H3c. Female directors' impact on pension BIO decisions differs from that on switching decisions. This is explained by the nature of the two pension de-risking strategies: pension BIOs require significant upfront payments of cash premiums, whereas Choy, Lin and Officer (2014) suggest that switches from DB to DC pension plans do not incur any immediate costs. Therefore, our evidence indicates that female directors exert an influence on pension BIO decisions, but they tend to place greater weight

Table 9. First and second stage of IV regressions: impact of board composition on switches of DB pension plans

Dependent variables:	*SWITCH*	*SIZE_BOARD*	*BOARD_IND*	*PCT_FEMALE*
	(1)	(2)	(3)	(4)
VARIABLES	Second stage	First stage	First stage	First stage
SIZE_BOARD	−1.338*			
	(0.673)			
BOARD_IND	0.081			
	(0.0428)			
PCT_FEMALE	−0.019			
	(0.0168)			
BMEET		−0.115***	0.480	−0.821
		(0.0160)	(0.9530)	(0.5510)
AMEET		0.076***	2.220*	0.375
		(0.0169)	(0.9440)	(0.5150)
PCTATTEND		−0.008***	0.052	0.074
		(0.0013)	(0.0768)	(0.0474)
LAGPCTFEMALE		0.0002	0.318***	0.829***
		(0.0004)	(0.0272)	(0.0164)
Control variables	YES	YES	YES	YES
Constant	−11.490	2.329***	143.100***	−18.220
	(6.9690)	(0.3940)	(22.0500)	(12.2200)
Observations	1,846	1,846	1,846	1,846
Shea partial R^2		0.0500	0.0039	0.0289
R^2/partial R^2	−1.553	0.0468	0.0835	0.6524
F(4, 1,826)		20.91	38.96	709.75
P-value		0.0000	0.0000	0.0000
Firm FE		YES	YES	YES
Year FE		YES	YES	YES
Under-identification	6.603**			
Cragg–Donald (CD) Wald F-statistic	1.652			
Endogeneity test	19.25***			

Note: This table reports the results of first and second-stage 2SLS regression with board composition instrumented in the first stage. The dependent variable is indicator variable (*SWITCH*) in the second stage, coded as 1 if the firm partially switches from DB to DC pension plans, 2 if the firm fully switches from DB to DC pension plans and 0 otherwise. Instrument variables are discussed in the main text. We report F-statistics of excluded instruments, SW F-statistics for weak instrument tests. We report SW chi-square for under-identification tests. Robust standard errors are reported in parentheses. *, ** and *** represent significance levels of 10%, 5% and 1%, respectively (two-tailed). Standard errors clustered by firm. All variable definitions are reported in Appendix B.

on the significant costs of pension BIOs than on the benefits of removing or reducing pension obligations.

Survival analysis shows no support for any significant relationship among board size, independent of boards and the timing of pension BIOs.

Overall, evidence for the impact of board composition on pension BIO decisions shows that firms with a higher percentage of female directors are slower to engage in pension BIOs. We highlight that the costs of pension BIOs are a major concern for female directors. Female directors' impact on pension BIO decisions differs from their impact on switching decisions owing to the differing nature of the two pension de-risking strategies.

Robustness checks

We aim to address any endogeneity concerns in our models. Two-stage least-squares (2SLS) regression analysis serves as a robustness test to support the impact of board composition on pension de-risking strategies. We adopt several instrumental variables[3] for board composition from prior literature (Boone *et al.*, 2007; Linck, Netter and Yang,

[3]We selected four instruments that affect board composition and have no effect on pension de-risking strategies. In the UK pension setting, pension plans are managed by pension trustees. Thus, these candidate instruments are unlikely to affect decisions on pension de-risking strategies. Vafeas (1999) documents that board meeting frequency impacts on board operations and hence on board composition. Therefore, the number of board meetings,

Table 10. First and second stage of IV regressions: impact of board composition on pension buy-ins and buy-outs

Dependent variables: VARIABLES	*BIO* (1) Second stage	*SIZE_BOARD* (2) First stage	*BOARD_IND* (3) First stage	*PCT_FEMALE* (4) First stage
SIZE_BOARD	−0.115			
	(0.197)			
BOARD_IND	0.025**			
	(0.0080)			
PCT_FEMALE	−0.007*			
	(0.0029)			
BMEET		−0.117***	−0.214	−0.765
		(0.0161)	(0.9480)	(0.5470)
AMEET		0.076***	2.701**	0.227
		(0.0170)	(0.9540)	(0.5140)
PCTATTEND		−0.008***	0.009	0.073
		(0.0013)	(0.0755)	(0.0467)
LAGPCTFEMALE		0.001	0.301***	0.837***
		(0.0004)	(0.0268)	(0.0157)
Control variables	YES	YES	YES	YES
Constant	−0.714*	2.098***	55.100***	−3.012
	(0.3400)	(0.1790)	(9.8570)	(6.0860)
Observations	1,846	1,846	1,846	1,846
Shea partial R^2		0.0608	0.0110	0.0840
R^2/partial R^2	−0.884	0.0578	0.0831	0.6662
F(5, 1,833)		20.34	30.77	627.52
P-value		0.0000	0.0000	0.0000
Firm FE		YES	YES	YES
Year FE		YES	YES	YES
Under-identification	19.52***			
Cragg–Donald (CD) Wald F-statistic	3.735			
Endogeneity test	19.03***			

Note: This table reports the results of first and second-stage 2SLS regression with board composition instrumented in the first stage. The dependent variable is buy-ins and buy-outs (*BIO*) in the second stage, coded as 1 if the firm engages in BIOs and 0 otherwise. Instrument variables are discussed in the main text. We report F-statistics of excluded instruments, SW F-statistics for weak instrument tests. We report SW chi-square for under-identification tests. Robust standard errors are reported in parentheses. *, ** and *** represent significance levels of 10%, 5% and 1%, respectively (two-tailed). Standard errors clustered by firm. All variable definitions are reported in Appendix B.

2008; Vafeas, 1999), including numbers of board meetings (*BMEET*), numbers of audit meetings (*AMEET*), board meeting attendance rate (*PCTATTEND*) and lag 1 year of percentage female directors on board (*LAGPCTFEMALE*).

As shown in Table 8, after controlling for endogeneity issues, the results show a significant relationship between *BOARD_IND* and *EQUITY* at the 1% significance level. This is consistent with the main results and supports H2a. The significance level is lower for *SIZE_BOARD* but remains significantly negative. This is also consistent with our main results, and provides evidence that firms with larger boards are less likely to allocate pension assets to equities.

Table 9 reports the 2SLS regression for the impact of board composition on switches from DB to DC pension plans. Again, we find a negative and significant coefficient for *SIZE_BOARD*, supporting the results of the survival analysis.

Table 10 reports the 2SLS regression for the impact of board composition on BIOs. We find a negative coefficient for *PCT_FEMALE* at the 10% significance level, supporting the results of the survival analysis.

number of audit meetings and board meeting attendance rate may be valid instrumental variables. Boone *et al.* (2007) and *Linck et al*. (2008) employ the lagged value of board compositions as an instrumental variable. Thus, we used the lagged value of the percentage of female directors on board as an instrumental variable.

Conclusions

This paper examines the impact of board composition on pension de-risking strategies, namely changes to pension asset allocations, switches from DB to DC pension plans and pension BIOs. Our findings suggest that firms with larger boards and more independent directors tend to allocate fewer pension assets to equities. These results support previous findings that larger boards (Pathan, 2009; Wang, 2012) and more independent directors (Vafeas and Vlittis, 2016) encourage less risk-taking in pension asset allocations as they are more likely to take account of the benefits to their employees.

The findings suggest that firms with larger boards are slower to switch from DB to DC pension plans. This is because boards of directors may be concerned about the impact of this de-risking strategy. First, reducing debt-like pension obligations may incentivize managers to take more risk and hence increase firm risk (Choy, Lin and Officer, 2014). Second, it is unclear whether switching from DB to DC pension plans reduces firms' overall pension risk, as it may impact on employees' productivity (McFarland, Pang and Warshawsky, 2009) and reduce future contributions to existing pension funds. Thus, boards of directors consider the benefits to employees and the potential risk of switching. Unlike US studies, we find no evidence of independent directors' impact on switches from DB pension plans. We interpret this as being because UK pension trustees and other committees may play a role in decisions to switch, mitigating the impact of independent directors. In addition, we find that a higher percentage of female directors is associated with being faster to fully switch from DB to DC pension plans. This indicates that female directors tend to encourage full switching to reduce the pension risk, and is consistent with female directors' risk-aversion.

Further evidence shows that firms with a higher percentage of female directors are slower to engage in pension BIO transactions. This may be because female directors are concerned with the significant up-front insurance premiums necessary for this pension de-risking strategy.

The main empirical implication of this research is that larger boards and greater board independence should be established to encourage less risk-taking in pension investments in the UK. This is consistent with the FCA's requirement for firms to establish ICGs in the interests of pension beneficiaries. Greater independence in pension fund management may reduce firms' influence over pension policy-making, and may grant pension beneficiaries greater protection. Our study of the UK pension setting allowed us to examine the impact of board composition on different pension de-risking strategies, and will help to address the importance of such settings in other countries.

Some limitations of this research should be noted. It focused only on three main pension de-risking strategies. So, future research might examine other de-risking strategies. In addition, our research is limited by the availability of pensions data. Pension de-risking decisions may also be influenced by pension fund investment consultants. The CMA (2017) has recently investigated the disproportionate power of investment consultants over trustee strategic decision-making. Future studies may want to incorporate the role of consultants into decisions on pension de-risking strategies.

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