Does Economic Policy Uncertainty Affect Corporate Pension Plans?

Fanyu Lu

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Table of Contents

List of Tables

List of Figures

List of Abbreviations

2SLS	Two-stage least squares
BBD	Baker, Bloom and Davis
CEO	Chief executive officer
CSR	Corporate social responsibility
DB	Defined-benefit
DC	Definite contribution
DW-NOMINATE	Dynamic, weighted nominal three-step estimation
EPU	Economic policy uncertainty
ERISA	Employee Retirement Income Security Act of 1974
FEARS	Financial and Economic Attitudes Revealed by Search
GDP	Gross domestic product
GFC	Global financial crisis
IV	Instrumental variable
NBER	National Bureau of Economic Research
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary least squares
PBGC	Pension Benefit Guaranty Corporation
SIC	Standard Industrial Classification
TMT	Top management team
US	United States
VIX	CBOE Volatility Index

Abstract

Prior research shows that corporate pension policies are significantly influenced by tax incentives. While the existing literature extensively focuses on the effect of firm and pension characteristics on corporate defined-benefit (DB) pension plans, it ignores how economic policy uncertainty may affect DB plans. In other words, does an increase in economic policy uncertainty in the political environmental and economic policies weaken firms' capacity to contribute cash to DB pension funds, worsening pension portfolio performance? In this thesis, I examine the effect of economic policy uncertainty on firms' decisions regarding their cash contributions to DB pension plans and the level of underfunding of pension plans. Consistent with risk-shifting theory, I find that the underfunding of DB pension plans increases when economic policy uncertainty rises. This result holds after addressing potential endogeneity issues. The unfavourable effect of economic policy uncertainty on the funding status of corporate pension plans is more pronounced during periods of financial crises and economic recessions. A subsample analysis indicates that this unfavourable effect is also stronger in firms with higher capital expenditure, dividend payouts and executive salaries and weaker in firms with higher corporate social responsibility scores. In addition to reducing cash contributions to corporate pension funds when economic policy uncertainty increases, firms may also use aggressive asset allocation strategies to increase the risk and return of pension assets, again supporting risk-shifting theory. The final part of the empirical analysis is a channel analysis, which finds that the effect of economic policy uncertainty on pension underfunding levels occurs via a tangible channel, financial constraints.

Declaration

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint-award of this degree.

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Chapter 1: Introduction

Donald Trump's 2016 presidential campaign introduced a significant level of uncertainty with respect to the economy, share markets, interest and tax rates, employment and international trade (The Guardian 2016; Time 2016; Bouoiyour & Selmi 2016; BBC 2019). Uncertainty surrounding taxes, monetary policies, regulations and spending is known as economic policy uncertainty (EPU) (Baker, Bloom & Davis 2016), which may affect employee benefits. In addition to employee exploitation in terms of wage inequalities and suppression (The Washington Post 2019, Corporate Justice Coalition 2019), employee retirement benefits have also attracted increasing attention from society and authorities (CNN 2018, Financial Times 2018, Financial Times 2020). Given the severe underfunding status of numerous defined-benefit (DB) pension funds, it is a cruel fact that many employees do not receive sufficient income after retirement. Figure 1 plots the time-series evolution of corporate DB pension underfunding levels from 1985 to 2019. Since 2000, underfunding levels have surged to over 30%, climbing to around $3 trillion in 2019.

Figure 1. Pension Underfunding, 1985–2019.

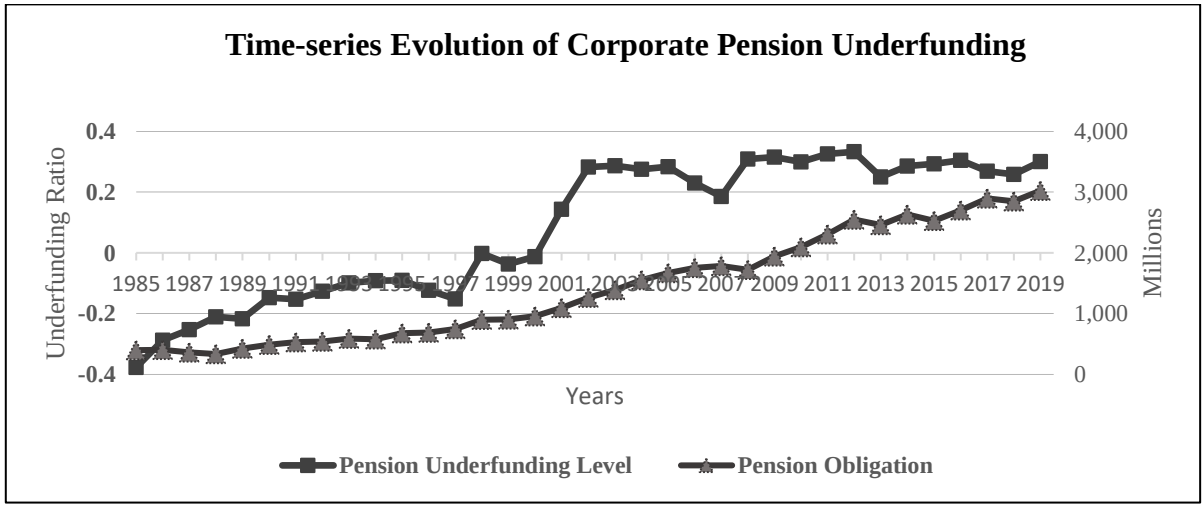

Figure 1 plots the time series evolution of corporate pension underfunding levels over 1985–2019. The corporate pension underfunding level is defined as the difference between pension obligations (the actual pension liability figure) (Compustat item *pbpro*) and pension assets (Compustat item *pplao*), scaled by pension liabilities. The dependent variable $PENSION\_UNDERFUND$ is averaged across each year to plot a time series of corporate pension underfunding over time.

In essence, underfunded DB corporate retirement plans lead to a conflict between debtholders and shareholders. Employees may be likened to 'inside debtholders' because they hold a fixed claim on the firm for their retirement payments (Anantharaman & Lee 2014). Firms that sponsor DB retirement plans are required to contribute a certain amount of cash each period to fulfil their future obligations. However, if a business with inadequate pension assets goes bankrupt, DB pension claimants (i.e. employees) must accept the reduced payouts remaining in the pension fund. Therefore, shareholders effectively hold a put option on DB pension plans (Pedersen 2019). The relationship between employees and shareholders resembles that between debtholders and equity holders. To maximise the value of their pension put options, shareholders are incentivised to increase the risks of corporate pension plans by underfunding them (Jensen & Meckling 1976, Rauh 2009, Anantharaman & Lee 2014, Pedersen 2019).

Up until the 1990s in the United States (US), corporate DB pension plans were generally well funded because of soaring interest rates, fixed-income securities and satisfactory share market returns (Mitchell 2020). However, with the bursting of the dotcom bubble in 2000, returns from both the equity and the bond markets dropped, reducing the returns from pension asset investments and lowering the value of portfolios. A decrease in interest rates further aggravated DB pension plan underfunding because of increased pension obligations (Mitchell 2020). In the past 2 decades, pension fund deficits have led to growing concerns (Christensen 2009; The Retirement Report 2019). Firms' abilities and incentives to contribute to their own corporate pension plans have weakened because of slow domestic economic recovery and intensified international competition along with moral hazards (Ambachtsheer 2011).

Although an increasing number of firms have switched to definite contribution (DC) pension plans,[1] DB plans still cover nearly 40 million beneficiaries in the US (US Department

[1] Firms with DC plans do not have long-term liability for employee retirement payments. DB plans are part of a firm's assets and liabilities, so they are connected to corporate finances. Many academics have shown that the

of Labour 2019). Despite the ongoing reforms of DB plans,[2] pension plans are still on the brink of collapse. For instance, Central States Pension, the largest multi-employer pension plan, is anticipated to collapse in 2025 (CNBC 2019), and the US Social Security Administration (2019) has declared that the public pension fund will run out by 2035. In 2017, the Road Carriers Local 707 Pension Fund went bankrupt, affecting around 4,000 retirees (Forbes 2017, Business Transport Topics 2017). The wave of corporate bankruptcy has drastically levied the financial burden on the Pension Benefit Guaranty Corporation (PBGC).[3] For example, in June 2009, the PBGC assumed the responsibilities of the automotive supplier Delphi's US$6.2 billion pension debt (The New York Times 2011). Moreover, on 19 June 2009, PBGC took over a US$115 million pension obligation to cover nearly 30,000 retirees and beneficiaries (PBGC 2009). Circuit City, a defunct electronics retailer, also shifted its pension obligation of US$64 million to PBGC, with more than 21,000 former workers and retirees being affected. Given these notable pension shortfalls, together with a poor pension asset investment return, the PBGC sank into a shortfall of US$79.2 billion (PBGC 2020) in mid-2020, almost quadruple that in 2010.

With the ongoing underfunding of DB corporate pension plans, the PBGC is unlikely to have sufficient assets to cover its deficits in the long term (Bartram 2018; Guan & Tang 2018; Mitchell 2020). Consequently, this liability will eventually be served by all firms and society as a whole. For example, PBGC may have to increase its premiums for pension plan sponsors.

funding status of DB plans affects firm operations and value (Bergstresser, Desai & Rauh 2006; Franzoni & Marin 2006; Mitchell & Utkus 2002; Rauh 2006).

[2] The government has reformed the regulation of corporate pension plans over time through legislation such as the *Employee Retirement Income Security Act of 1974*, the *Pension Protection Act of 2006*, under which pension insurance was provided by the Pension Benefit Guarantee Corporation, and the *Setting Every Community Up for Retirement Enhancement Act of 2019*.

[3] The PBGC is a federal authority that provides insurance for DB pension plans, protecting approximately 44 million beneficiaries. Under a DB plan, a retiree will receive a retirement income from the sponsor firm, the amount of which depends upon the employee's years of working for the company and wage level. To meet their obligations to retirees, firms must make periodic cash contributions to pension plans to assure their pension assets. If a firm with inadequate assets in its pension fund declares bankruptcy, the PBGC then absorbs the liability to provide retirement payments to pension plan participants. The main income source for PBGC is the premiums paid by pension plan sponsors.

If the income from premiums still fails to cover liability payouts, the government will need to bail out the PBGC, passing on the liability to the taxpayer (Cheng & Swenson 2018; Mitchell 2020). The sheer magnitude of pension deficits coupled with the future burden for taxpayers makes DB pension plans important to academics, firm executives and authorities. Thus, understanding the factors influencing firms' DB plan contribution decisions is imperative. Prior research has dedicated substantial efforts to exploring why DB plans have exhibited substantial underfunding over time.[4] I contribute to this ongoing study by presenting another influential factor in the underfunding of DB pension plans: EPU, defined as the uncertainty of policies related to the economy such as monetary and fiscal policies, government spending, inflation control and tax rates (Baker, Bloom & Davis 2016). EPU exerts an exogenous shock to all companies and is essentially non-diversifiable (Duong et al. 2020).

In the US, fiscal crises, federal elections and political conflicts have led to increasing concerns about the detrimental effects of EPU (Duong et al. 2020). Budding studies have emphasised that EPU influences business operations and corporate behaviours.[5] EPU may also be an important source of risk with regard to the funding conditions in DB plans. This is because EPU heightens uncertainty about firm revenue (Al-Thaqeb & Algharabali 2019), cash inflow from operations (Riddick & Whited 2009), bond value (Brogaard & Detzel 2015; Fang, Yu & Li 2017), market returns (Aye et al. 2018; Boutchkova et al. 2012) and investment portfolio value (Gilchrist, Sim & Zakrajšek 2014; Pástor & Veronesi 2013). These factors can affect a

[4] This includes a reduction in tax rates, which discourages pension contributions (Asthana 1999); a lack of sufficient government direction and oversight, leading to mismanaged and abused pension agreements (Foltin 2018); a lack of employee awareness about the possibility of pension plans defaults and the ripple effects (Hebb 2006); the use of financial instruments that contribute to deficits in corporate pension funds (Franzen 2010; Rauh 2006); economic recessions (e.g. the 2017–2018 Great Recession and the 2020 dotcom recession), leading to a significant drop in asset value (Pino & Yermo 2010); ageing populations and worsening unemployment rates (Ippolito 1986, Samwick & Skinner 2004).

[5] For instance, higher EPU causes a surge in borrowing rates (Kelly, Pástor & Veronesi 2016), increasing the cost of capital for firms. By extension, this leads to reduced capital investment and expenditure (Gulen & Ion 2016; Julio & Yook 2012), employment (Bernanke 1983), merger and acquisition activities (Bonaime et al., 2018; Nguyen & Phan, 2017) and investments in innovation research (Bhattacharya et al., 2017). Such declines in firms' economic engagement may result in negative consequences in the long run for firms, financial markets and, ultimately, the economy.

firm's ability to contribute cash to pension funds as well as the returns from fund investment portfolios. Policymakers and the popular media have publicly speculated about the adverse relationship between EPU and pension funding status. The Organization for Economic Co-operation and Development (OECD) has argued that pension plans require a stable financial market and regulations environment (Blommestein 2001; Wehinger 2011; Yermo & Severinson 2010). In 2015, the Pension Insurance Corporation in the United Kingdom asserted that the coalition formed by David Cameron and Nick Clegg created a stable government from 2010 to 2015, improving the value of assets in DB pension plans. In 2016, the well-known financial newspaper *Financial Times* claimed that an environment with high uncertainty hampers the funding status of DB plans. Greg Mennis, the director of The Pew Charitable Trusts (2020) project Public Sector Retirement Systems wrote that market instability can exert longstanding effects on pension funds. The likelihood that EPU could harm DB plans' funding levels is supported by these anecdotal reports.

I conduct my empirical analysis in three stages. First, I examine whether underfunding levels in corporate DB pension funds worsen in response to higher EPU. Second, I examine specific contexts in which firm characteristics such as capital expenditure moderate the relationship between EPU and DB plan underfunding. Third, I conduct a channel analysis in which I consider information asymmetry and financial constraints as key channels through which EPU may influence the underfunding level of DB pension plans.

A growing number of studies have shown that EPU increases information asymmetry of firms because of opaque policy and macroeconomic changes (e.g. Kabiraj & Mukherjee 2019; Nagar, Schoenfeld & Wellman 2017). An increased level of information asymmetry may reduce market demand and lower firm revenue, decreasing firms' capacity to make cash contributions to DB pension plans (Milevsky & Song 2010; Vafeas & Vlittis 2018). EPU also intensifies firms' financial constraints because of increased capital-raising premiums

(Gungoraydinoglu, Çolak & Öztekin 2017; Pástor & Veronesi 2012) and greater difficulties in securing external financing such as bank loans (Bordo, Duca & Koch 2016; Gilchrist, Sim & Zakrajšek 2014). Previous research on corporate pension plans has shown that if firms have difficulty accessing funds from external sources, they will be more likely to reduce or delay cash contributions to DB pension funds (Campbell, Dhaliwal & Schwartz 2012; Phan & Hegde 2013b; Rauh 2006). These findings suggest that through the intangible channel of information asymmetry (e.g. opaque information) and the tangible channel of financial constraints (e.g. increasing financing costs or constraints on capital), heightened EPU may lead to firms reducing their cash contributions to corporate pension funds.

I use a sample of publicly listed firms in the US from 1985 to 2019 to investigate the relationship between EPU and the underfunding of corporate DB pension plans. I employ Baker, Bloom and Davis's (2020) index (BBD index) as a proxy for EPU. The BBD index is constructed as a weighted average of the following elements: news components, government spending, inflation and tax. In addition to measures of general macroeconomic uncertainty faced by firms, including stock returns (Bali, Brown & Caglayan 2014), output demand (Leahy & Whited 1996), productivity (Bloom & Nicholas 2018) and political elections (Bhattacharya et al. 2017; Jens 2017), [6] the BBD index captures the uncertainty surrounding upcoming fiscal or monetary policies, electoral outcomes and political leadership, thus subsequent regulatory regimes and tax codes (Baker, Bloom & Davis 2016; Gulen & Ion 2016). As demonstrated by Baker, Bloom and Davis[7] and Gulen and Ion (2016), the BBD index largely corresponds with

[6] Previous studies have utilised various measures of overall macroeconomic uncertainty. For example, Bali, Brown and Caglayan (2014) use the dispersion of analysts' forecasts as well as the volatility of stock returns as a second measure of overall economic uncertainty. Leahy and Whited (1996) use the change in input and output prices, and Bloom and Nicholas (2018) use total factor productivity as the measure of macroeconomic uncertainty. With respect to aspects of policy-related uncertainty, Bhattacharya et al. (2017), Jens (2017) and Julio and Yook (2012) employ election years as a proxy for policy uncertainty. Brogaard and Detzel (2015) argue that political elections are discrete events and may not accurately represent uncertainty. The passage of new legislation or reforms following elections will not necessary resolve the uncertainty surrounding regulations and policies. Therefore, in this thesis, I follow Gulen and Ion (2016) and Nguyen and Phan (2017) and use the BBD index as a measure of EPU because it includes uncertainties in both election and non-election periods.

[7] https://www.policyuncertainty.com/methodology.html

events anticipated ex-ante to produce EPU, such as federal elections, financial crises and regional wars. According to eminent academics such as Rauh (2006), Anantharaman and Lee (2014) and Pedersen (2019), the underfunding of corporate pension plans is defined as the difference between pension obligations (Compustat item *pbpro*) and pension assets (Compustat item *pplao*), scaled by pension liabilities.

The relationship between EPU and the underfunding of DB corporate pension plans is positive and statistically significant. With respect to economic significance, a one standard deviation increase in EPU level is associated with a 15.1% increase in the standard deviation of a firm's pension fund underfunding level in the following year. The positive association between EPU and corporate pension underfunding continues to hold after controlling for variations in other macroeconomic factors. I further examine the effects of different components of the BBD index on pension underfunding and find that the news, government spending and inflation components have significant positive effects on corporate pension underfunding levels. The news-based element exerts the largest impact, while the tax component exerts an opposite effect on DB pension plan underfunding levels. Neither observation is surprising. This is because the news-based element occupies the highest fraction (50%) of the aggregated BBD index, while the negative association between tax codes and pension underfunding levels can be largely explained by cash contributions to pension funds creating tax shields for firms. Uncertainty about the expiration of tax codes generally incentivises firms to lock their tax benefits, thus they will allocate more cash to settle their pension liabilities.

One potential concern with the baseline results is that EPU most likely captures the influences of other uncertainties in the overall macroeconomic environment (e.g. sluggish economy recovery) because of the highly positive correlation between EPU and general economic uncertainty. In other words, there is a possible confounding effect (Gulen & Ion,

2016). To address this issue, I follow Nguyen and Phan (2017) and Nguyen and Nguyen (2019) and use a partisan polarisation measure (*POLAR*) as an instrumental variable (IV) for EPU and perform a two-stage least squares (2SLS) regression. This has a number of empirical advantages for exploring firms' responses to underfunding issues in corporate pension plans. First, partisan polarisation may increase uncertainties related to policy gridlocks and variations. Second, the timing of partisan polarisation is heavily exogenous to firms, thus is disentangled from the endogenous nature of firms' decisions and operations (McCarty, Poole & Rosenthal 1997). Further, the staggered nature of legislators' ideological positions in the Senate generates cross-sectional variations in political uncertainty. Therefore, this IV satisfies the relevance condition because partisan polarisation increases the difficulty of passing legislation, leading to greater policy uncertainty, which is associated with higher EPU (McCarty 2004). It also satisfies the exclusion restriction because differences in political ideologies are unlikely to directly affect firms' cash contributions to corporate DB pension plans. The results of the 2SLS test corroborate with the baseline results.

Next, I investigate cross-sectional variations in the association between EPU and underfunding levels in corporate pension plans. I argue that if pension plan underfunding is positively associated with higher EPU, this effect should be stronger during financial crises and economic recessions because of the additional risks, reduced market demand and greater uncertainty in revenue. It should also be stronger in firms that are more committed to ex-ante capital expenditure and dividend payouts because of the conflict between shareholders and debtholders (i.e. employees). Firms that pay their executives excessive salaries are more likely to suffer a higher level of pension underfunding because of the conflict between management and employees; however, this conflict should be alleviated in firms with strong corporate social responsibility (CSR). I find supporting evidence for my prediction that conflicts between

shareholders, employees and executives amplify the effect of EPU on the underfunding of corporate pension plans.

I then investigate whether information asymmetry and financial constraints are economic channels through which EPU affects corporate pension underfunding status and whether the mediation effect is tangible or intangible. Using the two-step mediation regression approach designed by Zhao et al. (2010), I discover that a higher level of EPU exacerbates corporate pension underfunding via the tangible channel of financial constraints.

My thesis makes several contributions to the existing research. First, it contributes to the literature on corporate DB plans. Although DB plans have gradually diminished in the US over time, they are still widely accepted in almost all developed nations and various developing regions, including the United Kingdom, Canada, Switzerland and China. Specifically, in 2019, DB plans were used in 26 of the 38 OECD nations, and almost US$50 trillion is invested in DB plans.[8] Therefore, the study of DB plans has broad international implications. With respect to the corporate finance literature, DB plans affect firms' capital structure decisions (Shivdasani & Stefanescu 2010), debt ratings (Carroll & Niehaus 1998), merger and acquisition activities (Cocco & Volpin 2013), equity returns (Jin, Merton & Bodie 2006) and managerial risk-taking incentives (Anantharaman & Lee 2014). Therefore, it is important to understand the factors that may exert significant effects on firms' decisions to contribute to corporate DB pension plans.

Second, to the best of my knowledge, no existing literature links EPU and corporate DB pension plans in a unifying framework. Cash contributions to DB plans are an essential factor in influencing the value of pension assets. Much of the prior literature shows that cash contributions to DB plans depend on corporate governance, taxes and insurance premiums (Bicksler & Chen 1985; Chen, Yu & Zhang 2013; Francis & Reiter 1987; Tepper 1981; Tepper & Affleck 1974). Firms (e.g. General Electric Pension Plan, Boeing Company Employee

[8] https://www.oecd.org/daf/fin/private-pensions/Pension-Markets-in-Focus-2020.pdf

Retirement Plans) often adjust their cash contributions to pension plans in different periods. I aim to provide evidence that not only tax but also overall fluctuations in the economic and political environment affect corporate pension management. I empirically illustrate the role of EPU in magnifying the unfavourable impact of corporate pension underfunding. The economic consequences of EPU are also gradually being recognised by authorities and the media (Bank of England 2019, eHarvard Business Review 2019, United Nations 2019, CNBC 2019).

Third, the paper contributes evidence to the ongoing debate around risk-shifting behaviours. Given that DB plan claimants are inside debtholders, a reduction in periodic contributions may be regarded as shifting the risk from shareholders to debtholders. My findings on the existence of risk-shifting behaviours in corporate DB plans align with those of Anantharaman and Lee (2014) but contradicts those of Rauh (2009) and Pedersen (2019). The main discrepancy between these studies lies in the research design and chosen proxy for added risk. Rauh (2009) uses bankruptcy year as a proxy for financial distress, while Anantharaman and Lee (2014) construct financial distress using Black, Scholes and Merton's (1974) model for each firm–year and a distance-to-default metric as a proxy for additional risk. Pedersen (2019) adopts a natural experiment, showing how the National Toxicology Program, which establishes the harmful effects of carcinogens for workers, creates an exogenous shock to firms, dramatically increasing their long-term liability and risks. Similar to Anantharaman and Lee (2014), I employ cross-sectional and within-firm variations to examine the association between corporate DB plan underfunding and firms' exposure to added risks. EPU can act as an exogenous shock to firms, and my results support the risk-shifting hypothesis. Identifying the exogenous factors (e.g. EPU) that drive risk-shifting behaviours will attract the attention of government agencies, regulators, employees and academics, particularly with the abovementioned worsening status of the PBGC's finances.

Fourth, by providing empirical evidence of how EPU affects DB pension plans, I add to the literature on EPU in general. The findings may assist in the understanding of changes in firms' risk-shifting decisions under EPU from the viewpoint of corporate pension management. I also identify and compare the channels through which EPU affects firms' decisions about corporate pension plans, finding that this channel is tangible via financial constraints instead of intangible via information asymmetry. This supports Rauh's (2006, 2009) and Campbell et al.'s (2012) conclusions that it is financial constraints that limit the ability of firms to sufficiently fund their DB plans.

Finally, I identify high capital expenditure, dividend payouts to shareholders and excessive payments to executives as drivers of pension underfunding, while firms with higher CSR scores are less likely to underfund their corporate pension plans. These findings extend the prior work on DB pension governance in terms of conflicts between shareholders, employees and executives. My study provides timely implications for authorities, policymakers and firm executives, which may be valuable given the recent wide swings in EPU and its unfavourable influence on the economy.

The remainder of this thesis is structured as follows. Chapter 2 discusses the related literature. Chapter 3 develops the hypotheses. Chapter 4 presents the methodology, data collection, variable description and descriptive statistics. Chapter 5 interprets the main findings and robustness checks. Chapters 6 and 7 present the results from the five subsample analyses and economic channel analysis, respectively. Chapter 8 provides the policy implications and concludes the thesis.

Chapter 2: Literature Review

2.1 Institutional Features of Corporate Pension Plans

2.1.1 Description of Corporate Pension Plans

Firms in the US have two retirement plans for their employees: DC plans or DB plans (US Department of Labour 2020). The only contractual obligation of firms with DC plans is to make financial contributions in each period to employees' nominated retirement funds. These firms take no responsibility for any unexpected deficits in employees' pension accounts. When employees reach retirement age, they can begin to withdraw any assets that have accrued in their nominated pension funds. If their nominated pension funds are not performing well, employees have the option to switch to another pension fund manager (Poterba et al. 2007).

In contrast, firms that sponsor DB plans pledge certain benefits to retired employees. Companies have a legal obligation to fund DB plans to meet their future pension liabilities, thus manage their asset allocations in consultation with investment experts (US Department of Labour 2020). Remarkably, these firms have a greater degree of discretion with respect to the management of pension funds (Ballester, Fried & Livnat 2002; Bergstresser, Desai & Rauh 2005). For instance, firms are permitted to make minimum mandatory contributions in certain years for earnings management purposes or to overfund pension funds for tax deduction purposes. Firms are also allowed to invest their pension assets in high-risk equities for higher returns to reduce the gap between pension asset value and pension liabilities (Ballester, Fried & Livnat 2002; Bergstresser, Desai & Rauh 2005). Once DB plan participants have reached retirement age, they will receive a pension payment from the firm each month, which continues for the life of the retiree. By law, the payment is a percentage of the retiree's average income combined with other factors such as the duration of work in the firm (US Department of Labour 2020). Therefore, the main difference between DC and DB plans is the party responsible for

investment risks: employers bear the risk in DB plans, while employees bear the risk in DC plans.

Despite the fact that firms with DB plans have a greater obligation to fund employee retirement benefits, DB plans are still favoured by many firms. By mid-2020, DB plans were worth $12 trillion (Bloomberg 2020), an amount considerably larger than that of other off-balance sheet items such as leases. Firms sponsor DB plans mainly because of their tax incentives and discretionary periodic cash contributions. Although cash contributions to DC plans are tax deductible, the amount of the cash contribution is fixed for each period. This means that firms cannot adjust their periodic contributions for income smoothing or tax purposes (Ballester, Fried & Livnat 2002; Samwick & Skinner 2004). In contrast, DB plans provide a source of financial slack because of the discretionary nature of pension contributions and actuarial assumptions (Ballester, Fried & Livnat 2002). For example, if a firm wishes to reduce its tax expenses in a given year, it can choose to overfund its pension plans in that year. Similarly, if it wishes to produce a more satisfactory income statement, it can make minimum contributions for the period. Firms can manipulate the minimum contribution amount because it is affected by actuarial assumptions. Discretion may be utilised in the opportunistic activities of managers and shareholders (Coronado & Sharpe 2003; Bergstresser, Desai & Rauh 2005).

Additionally, when DB plan sponsors invest their pension funds in bonds, they enjoy further tax benefits because of bond leverage. This is because interest income from bond investments in pension plans attracts a much lower tax rate for DB plan sponsors (Samwick & Skinner 2004). Further, taxes on earnings from pension plans are deferred for employees. Employees, especially executives, have lower marginal tax rates in retirement compared with their working years (Samwick & Skinner 2004).

Further, DB plans can enhance employee stability by creating a strong incentive for staff members to continue working for the same firm. If employees leave earlier, they may suffer

severe pension wealth losses (Ippolito 1985). According to the Employee Benefits Security Administration, an employee must stay with a firm for a certain number of periods (known as the vesting period) to receive the benefits of a DB pension plan. If an employee leaves a firm before the end of the vesting period, they may only receive a small portion of the benefits. However, if employees remain with a company until retirement age, they may be eligible to receive a life annuity and supplements.[9]

Unlike the DC plan, which has no relevance to a firm's assets and liabilities, the DB plan is an important source of assets and liabilities for firms. The assets in corporate pension plans, although legally segregated, are owned by firms. Prior research shows that the value of DB pension assets influences firm value and investors' expectations (Barth 1991; Carroll & Niehaus 1998; Rauh 2006; Rubin 2007). The higher the funding levels in a DB plan, the less cash contributions are required by law. Hence, shareholders in the future will not be required to contribute high amounts to pension funds. In addition, firms may provide extra pension benefits in exchange for current lower wage increases. Therefore, the financial slack generated from corporate pension funds can be utilised to rapidly settle debts, pay higher dividends and invest in expansion projects. Firms also have the choice to access pension assets via plan terminations or conversions (Petersen 1992; Comprix & Muller 2011; Harper & Treanor 2014). Thus, pension assets behave as firm assets. However, according to the *Employee Retirement Income Security Act of 1974* (ERISA), firms are liable for employee pension benefits. If a firm declares bankruptcy, its pension liabilities take priority over all other creditor claims. Therefore, liability in DB pension plans is an important type of firm liability.

[9] For example, in General Motors, the basic monthly benefit is $54 multiplied by the employee's working years. Thus, if an employee has worked for 29 years, their monthly retirement benefit from the DB plan will be $1,566. However, if the employee has worked for the firm for more than 30 years, they are awarded a '30 and out' supplement, which boosts the monthly retirement income by nearly 80% to approximately $3,000 (United Auto Workers 2018).

Prior studies also provide evidence that DB plans influence share market and firm investment decisions. For instance, Barth, Beaver and Landsman (1992) find that pension costs determine share prices from the perspective of earnings potential and cash flow. Rauh (2006) shows that large pension contributions affect firms' investment policies. Shivdasani and Stefanescu (2010) show that pensions influence corporate capital structure decisions. Firms that incorporate the magnitude of DB pension plan assets and liabilities are less conservative in the choice of leverage. Cocco and Volpin (2013) state that corporate-sponsored DB plans protect firms from potential bidders for acquisition. Thus, given the risk in the value of liabilities, they serve as a takeover deterrent.

2.1.2 Pension Funding Requirements

DB plan assets and obligations behave as firm assets and liabilities, but they are included in off-balance sheet accounting for sponsor firms. These items are subject to actuarial assumptions (Mohan & Zhang 2014; Sengupta & Wang 2011). In DB plans, pension assets are measured as the fair value of portfolio investments, whereas pension liabilities are measured as the present value of estimated benefit outflow. Estimated benefit outflow is equal to the present value of future obligations according to employees' current wages, tenures and ages. The vested benefit obligation is measured as the present value of pension benefits accumulated by employees, regardless of whether employees continue with the firm's pension plan or not (Shivdasani & Stefanescu 2010). According to the PBGC, the pension funding requirement is based on several important pension characteristics, including pension asset value, estimated liabilities and vested benefit obligations.

In 1974, ERISA was introduced to protect employees who are covered by DB pension plans. Under ERISA, the PBGC was established to provide insurance to guarantee benefits for corporate DB pension plan participants. In the event of firm bankruptcy, the PBGC provides retirement benefits for employees up to a certain level. In return, firms must pay one of two

types of insurance premiums to the PBGC, either a flat rate or a variable rate depending on the amount of unfunded vested benefits. In 1991, the premium was $9 for every $1,000 of unfunded vested benefits. This premium had increased to $34 by 2017 and $45 by 2020. Although firms with a certain level of pension plan underfunding are charged a higher premium, there is a cap on the premium that can be charged for each participant. In 2017, this cap was $517, increasing to $561 in 2020 (PBGC 2020). Therefore, in 2020, the cost of the premium was only 4.5%, which is capped. This means that a firm with a severely underfunded pension plan essentially shifts its default risk to the insurance agent.

To mitigate the effect of risk shifting from DB plan sponsors, the PBGC has implemented policies requiring firms to make additional contributions to severely underfunded DB plans on top of the mandatory amount required by section 430 of the *Internal Revenue Code*. If a firm fails to fulfil its funding obligations, penalties will be triggered under ERISA. ERISA permits the PBGC to file a claim of up to 30% of a firm's net assets to recover the pension shortfall (Lowenstein 2008). However, if a firm is on the brink of bankruptcy, its net assets will be negligible; thus, the PBGC still bears the risks. In contrast, if a firm has already overfunded its pension plan, it will have no minimum contribution obligations (Lowenstein 2008).

In addition to cash contributions, pension asset value and pension underfunding levels depend on risks and returns in the pension investment portfolio (Rauh 2006). Share market downturns and interest rate shocks can severely affect the value of pension assets. For instance, during the internet bubble and global financial crisis (GFC), lower interest rates resulted in a higher pension liability value, whereas the share market disaster resulted in a low pension asset value. However, given that the PBGC has limited control over firms' pension asset allocation strategies, underfunded DB plans with risky investments intensifies the risk shifting to the PBGC.

2.2 Risk Shifting in Corporate Pension Plans

2.2.1 Theories on Risk Shifting in Corporate Pension Plans

Given that a DB pension plan beneficiary is eligible to claim ongoing payments from a firm for the duration of their retirement, DB plans are an obligation for firms akin to long-term debt. Current employees and retirees hold claims on sponsoring firms; thus, they are a firm's debtholders (Anantharamana & Lee 2014; Pedersen 2019). The firm is legally required to reserve and allocate assets to a trust that manages retirement funds and make financial contributions in each period to fund these obligations. However, if a firm enters bankruptcy with insufficient assets in its pension fund, plan participants are bound to accept reduced payments from the existing plan assets. Essentially, the owners of the firm (i.e. the shareholders) hold the right to sell pension assets to pensioners at a set price, which may be exceptionally low. This can be characterised as a put option with a strike price equal to the value of pension liabilities (Sharpe 1976). To boost the value of the pension put option, shareholders are motivated to increase the risk of corporate pension plans (Sharpe 1976; Treynor 1977). In doing so, they are essentially exploiting wealth from pensioners. One way to raise the riskiness of a corporate DB plan is through underfunding.

The existence of PBGC may exacerbate a firm's incentive to shift risk. Without PBGC coverage, employees would be at risk of losing a significant proportion of their promised pension benefits if the firm goes bankrupt. Therefore, these employees would have a strong incentive to monitor the firm in an attempt to decrease the likelihood of the firm defaulting on its pension contributions. However, with PBGC insurance, employees' pension benefits are largely guaranteed. In this case, they may have less incentive to monitor a firm's activities. Even though PBGC charges a premium, the premium is not risk adjusted and is lower than the market commercial insurance rate (Coronado & Liang 2006).

Clearly, the corporate pension funding policy directly affects the value of the pension put option. The put option hypothesis suggests that a firm's shareholders are incentivised to (i) underfund DB plans, (ii) pursue a risky asset allocation strategy and (iii) select aggressive actuarial assumptions. These increase the amount by which the option is in the money. Underfunding pension plans is essentially one way of increasing leverage because it is akin to borrowing from employees, who may be considered inside debtholders. Shareholders have a strong incentive to allocate pension assets to risky investments when a firm is in distress. If the risky investment is successful and the firm survives, shareholders will benefit from contributing less to the pension fund. However, if these investments do not pay off and the firm suffers bankruptcy, the PBGC will bear the cost of the investment failure. Both underfunding and risky asset allocation lead to risk-shifting incentives (Jensen & Meckling 1976; Myers 1977, Anantharamana & Lee 2014). Aggressive actuarial assumptions are indicators of pension manipulation. My thesis mainly focuses on the underfunding levels of corporate pension plans and asset allocation. The rest will be discussed in the section on limitations and future extensions. While the theory suggests that firms facing default have a strong incentive to increase their DB plan risk, the empirical research shows conflicting results on risk-shifting behaviours in corporate DB pension plans.

2.2.2 Empirical Evidence on Risk Shifting in Corporate Pension Plans

As discussed in section 2.1.2, because the PBGC provides insurance for DB plan sponsors but the premium charged is not adjusted for risk, the existence of PBGC exacerbates the moral hazard of risk shifting for firms. Empirically, Hsieh, Chen and Ferris (1994) find that firms whose pension plans are severely underfunded are undercharged by the PBGC, whereas firms with overfunded plans still pay a relatively high premium. This unfairness discourages firms to fully fund their pension plans. Bodie et al. (1987) find that if firms are financially distressed, they have higher pension deficits. Recently, Guan and Lui (2016) find that

financially vulnerable firms with extremely underfunded BB plans engage in risk shifting. While these studies provide some evidence for risk-shifting theory, the overall evidence is mixed.

Many previous empirical studies do not support risk-shifting theory (e.g. Datta, Iskandar-Datta & Zychowicz 1996; Francis & Reiter 1987; Gallo & Lockwood 1995; Thomas 1989; Rauh 2009). Francis and Reiter (1987) investigate the relationship between a firm's funding of DB pension plans and its overall risk, predicting that the higher a firm's risk, the lower its pension funding ratio will be. However, their findings contradict their prediction. They discover that firms exposed to higher risk have, on average, better-funded pension plans, which is inconsistent with risk-shifting theory. Rauh (2009) continues this exploration, discovering that firms in financial distress are more likely to engage in risk aversion than in risk-taking, and their pension investment portfolios have a greater share of fixed-income assets than equities. An, Huang and Zhang (2013) also support Rauh's result that firms with higher pension underfunding levels, on average, tend to invest in safe assets. However, they do find evidence that DB plan sponsors ultimately engage in pension plan freezing, termination or conversion. Although these decisions do not directly shift the risk to the PBGC, they are a means of manipulating pension plans and exploiting employees.

2.3 Economic Policy Uncertainty

2.3.1 Background

The concept of uncertainty originates in the book *The Age of Uncertainty* (Galbraith 1977). Many significant events have shown that uncertainty is a critical issue. The world is evolving rapidly; thus, unemployment, migration and commodity price fluctuation influence not only one nation but the entire world. Geopolitical uncertainties, industry events and firm-level uncertainties such as a change in chief executive officer (CEO) are examples of

uncertainty. All of these may exert great influences on a firm's financial decisions. Abel (1983) defines economic uncertainty as unexpected changes that affect the current economic system. As mentioned previously, EPU acts as an economic risk resulting from future uncertain government policies and regulations.

EPU has become more significant than ever since the political turmoil of the Arab Spring in the Middle East, peaking with the elections of Donald Trump and Joe Biden (Baker, Bloom & Davis 2020). The GFC and partisan political battles in the US have led to policy uncertainty, which has significant economic consequences. For instance, many regions experiencing political uncertainty now have sluggish economic growth. Baker, Bloom and Davis (2016) point out that the 2008–2009 GFC and the subsequent slow recovery is partly because of the adverse effects of EPU on the economy. Because EPU increases risks for both firms and households, they will postpone their investments and spending. If firms are uncertain about future tax and financial policies, borrowing rates, mortgage rates and healthcare budgets, they will be hesitant to invest and offer employment. Therefore, EPU slows economic recovery from recessions because businesses and households delay capital expenditure and consumption (Baker, Bloom & Davis 2016).

2.3.2 Measurement of Economic Policy Uncertainty

A widely accepted measure of EPU is the CBOE Volatility Index (VIX); however, VIX only captures uncertainties in market sentiment. Similarly, the Financial and Economic Attitudes Revealed by Search (FEARS) index developed by Da, Engelberg and Gao (2014) is also widely used. The FEARS index relies on textual information from the internet to measure investors' sentiments. Another traditional measure is the Federal Reserve Bank of Philadelphia survey, which shows that economic uncertainty in the US has worsened in recent years, but this is limited to the political components of uncertainty. Hassan et al. (2017) design a firm-level political risk measurement based on textual analysis from firms' quarterly conference

transcripts, but this solely focuses on the political component. In the same year, Manela and Moreira (2017) design a news-based uncertainty index based on textual information from *The Wall Street Journal*. The index peaked during the GFC, regional wars and fiscal crises; however, it only considers the news components of uncertainty. All of the above measurements capture partial types of uncertainty.

Baker, Bloom and Davis (2016) developed the BBD index as a proxy for EPU. This index synthesises most of the factors highlighted in earlier works in one simple index, including news, policy, legislation, market, financial and macroeconomic indicators. The BBD index is calculated by the weighted average of three parts: the frequency of newspaper keywords relating to policy uncertainty (e.g. 'economic', 'uncertain', 'regulation', 'White House', 'federal', 'deficit'), the number of federal tax code provisions expiring soon and disagreements between economic professionals. They found that the BBD index and VIX are highly correlated because market volatility increases when firm investments and household consumption decrease.

2.3.3 Influence of Economic Policy Uncertainty on Macro- and Microeconomic Environments

As introduced in section 2.3.1, EPU not only leads to job cuts but also decreases household expenditure and firm spending, especially for costly decisions. Individuals often postpone non-essential expenses during times of uncertainty in income levels and firm profitability (Bernanke 1983; Eberly 1994). Bloom (2009) found that EPU reduces economic growth and the whole economic ecosystem. Foote, Hurst and Leahy (2000), Bloom, Bond and Van Reenen (2007) and Giglio, Kelly and Pruitt (2016) all found that EPU slows gross domestic product (GDP) growth, especially during economic recessions, because households and firms lose interest in upcoming market opportunities. Kelly et al. (2016) use Pástor and Veronesi's (2013) framework to show that political uncertainty is harmful to overall economic prospects.

The uncertainty is priced by the financial market (e.g. higher borrowing rate) and the negative effect is even stronger in weaker economies. This means that EPU increases the risk premiums of financial products, increasing borrowing costs, slowing the hiring process and lowering productivity, ultimately giving rise to weak economic growth, which is consistent with the arguments of Brunnermeier (2009) and Gilchrist, Sim and Zakrajšek (2014). Bloom (2014) and Barrero et al. (2017) also find that EPU and the business cycle have a countercyclical relationship in which EPU is low during economic booms and peaks during economic downturns. Therefore, unpredictable regulatory environments have a longstanding effect on capital expenditures at the firm and macroeconomic levels. Caggiano et al. (2014, 2017) also conclude that EPU leads to a significant rise in unemployment. With looming unemployment volatility, corporate pension plans may face more uncertainty and risk.

2.3.4 Influence of Economic Policy Uncertainty on Capital Markets

The value of assets in corporate pension plans is not only linked to employer contributions but is also affected by fluctuations in the equities and bonds markets. Some financial products are heavily linked to national and global political risks such as equity investments in the energy sector. When EPU increases, these shares generally witness a downturn because their operations are more subject to policy changes, thus experience higher earnings volatility (Boutchkova et al. 2012; Brogaard & Detzel 2015). Firms with high earnings volatility are more likely to cut jobs (Holmes & Maghrebi 2016). Therefore, EPU introduces challenges for pension plan sponsors who heavily invest their pension assets in equities, especially in high-risk sectors. In addition to the share market, EPU may negatively influence the price of corporate bonds because of decreases in corporate productivity and corporate investment activities (Pástor & Veronesi 2013, Gilchrist et al. 2014, Li, Zhang & Gao 2015, Fang, Yu & Li 2017).

2.3.5 Influence of Economic Policy Uncertainty on Firm Behaviour

Julio and Yook (2012) find evidence that corporate capital expenditure drops on average of 5% in election years. Thus, EPU has an adverse effect on corporate capital investments. Gulen and Ion (2015) find a one-third decrease in capital expenditure in the US during the GFC. This effect is more pronounced for firms connected to government contracts and irreversible investments and those with lower profits (Wang, Chen & Huang 2014). EPU also decreases corporate borrowing because banks are more reluctant to offer loans (Kahle & Stulz 2013). Consequently, firms may face a rise in the cost of capital and more uncertainty with their future cash inflow, further reducing capital expenditure. Bhattacharya et al. (2017) find that government policies exert a considerable effect on innovation activities. Technological innovations substantially drop during periods of high EPU (e.g. national elections). However, firms' capital expenditure and innovation activities are crucial for economic recovery and growth (Chung, Wright & Charoenwong 1998; Modebe et al. 2012). Therefore, governments are advised to introduce supporting mechanisms for research and development, especially during periods of heightened uncertainty. In addition, Çolak, Durnev and Qian (2017) discover that firms launch fewer initial public offerings when EPU increases. At the same time, Nguyen and Phan (2017) and Bonaime, Gulen and Ion (2018) find that firms are less interested in merger and acquisition activities.

To sum up, firms behave more conservatively during periods of higher EPU. Corporations and households postpone expenditures and investment decisions because of undefined fiscal policies and market asymmetries. EPU harms the cost of financing, reducing capital expenditures and discouraging initial public offerings and mergers and acquisitions.

2.4 Integration of Economic Policy Uncertainty with Defined-Benefit Pension Plans

DB plans function as regular debts for a firm, and the debtholders are retirees and current employees. As a regular corporate debt, a limited liability policy protects shareholders from transferring their own assets to recompense debtholders if firms declare bankruptcy (Rauh 2009). Sharpe (1976) and Treynor (1977) have established the theory of risk shifting in which shareholders have a strong incentive to underfund corporate pension plans. This risk-shifting incentive is stronger when firms are exposed to a higher level of risks. EPU is a type of risk caused by undefined regulatory frameworks, future government policies and monetary policies. This type of uncertainty increase the risks that firms must face. In response to EPU, firms delay their investment decisions and capital spending. However, how EPU affects a firm's incentives to shift the risk to corporate pension plans remains unknown. Corporate pension plans are an essential element for employee retirement benefits and the social welfare system (Bodie 1989; Bodie et al. 2008; Rauh, Stefanescu & Zeldes 2013). Thus, it is of importance to comprehend how firms respond to changes in EPU. However, there is a paucity of studies on DB pension plan decisions in response to EPU and a lack of direct recommendations to mitigate the pension shortage issue arising from EPU. My objective is to fill this gap in the literature by investigating whether underfunded DB plans deteriorate in response to higher EPU and, if so, the types of firms that are more affected.

Chapter 3: Hypothesis Development

In this chapter, I develop hypotheses about how corporate pension underfunding levels are affected by changes in EPU based on the literature on EPU (e.g. Gulen & Ion 2016, Nguyen & Phan 2017, Duong et al. 2020) and corporate pension plans (Rauh 2006, Rauh 2009, Anantharaman & Lee 2014, Pedersen 2019).

3.1 Agency Hypothesis, Risk Shifting and Economic Policy Uncertainty

The theory of asset substitution suggests that shareholders of high-leverage firms have a greater incentive to take on riskier investment projects because doing so will lead to a transfer of wealth from creditors to equity holders (Jensen & Meckling, 1976; Myers 1977; Rauh 2009; Pedersen 2019). This is a manifestation of classic risk shifting from shareholders to debtholders (Jensen & Meckling, 1976; Myers 1977). DB pension plans create a liability for firms, in which the debtholders are the employees. In the event of default of pension liabilities, employees are bound to receive the funds available in the pension plan. Hence, shareholders may be viewed as put option holders. To maximise the value of the pension put option, shareholders tend to increase the riskiness of DB pension plans sponsored by firms (Rauh 2009; Pedersen 2019).

One way to increase a pension risk is to underfund it. Underfunding DB pension plans amounts to promising future benefits but not providing sufficient funds to fulfil the promise. The underfunding of a pension plan increases its leverage because it is the equivalent of borrowing from employees in the present and promising to pay the benefits later. The higher the underfunding of the DB plan, the more the pension put option is in the money for shareholders. If the DB plan ends up in default, shareholders will bear fewer losses because the limited liability policy protects equity holders from liquidating their personal assets to pay outstanding debts. If the pension plan does not default, shareholders may at least delay their cash contributions to invest the company's money in high-yield opportunities. Rauh (2009) and

Anantharaman and Lee (2014) further point out that risk-shifting incentives are exacerbated by the regulatory environment because the PBGC provides pension insurance for employees. The retirement benefits guaranteed by PBGC dampen the incentives for employees to monitor a firm's pension funding status. Although the PBGC has a strong incentive to monitor the funding of DB pension plans, it has little control over firms' risk-taking strategies in their pension plans. The PBGC also undercharges DB plan sponsors who severely underfund their pension plans. The guaranteed retirement benefits provided by the PBGC combined with the absence of risk-adjusted premiums intensify shareholders' risk-shifting incentives. According to risk-shifting theory, this incentive may be stronger when firms face higher risk, especially those approaching financial distress (Myers 1977; Anantharaman & Lee 2014; Pedersen 2019). Economic policies produce a high level of uncertainty because of the complexity of policy formulation, planning and implementation (Caggiano, Castelnuovo & Figueres 2017). Therefore, EPU represents an exogenous shock and introduces additional risks to firms. When firms face more risk as a result of heightened EPU, shareholders will have a stronger incentive to shift risk to inside debtholders (i.e. employees) via pension underfunding. Thus, my first hypothesis is:

H1: *Higher EPU leads to a higher level of underfunding of corporate pension plans.*

3.2 Global Financial Crisis and Economic Recessions

The evidence for the relationship between firm risk and risk shifting to corporate pension DB plans is mixed. Bodie et al. (1985) and Coronado and Liang (2006) document that financially distressed firms generally have a higher level of pension underfunding, supporting the theory of risk shifting to debt holders. However, Francis and Reiter (1987), Petersen (1996) and Friedman and Light (2008) do not find support for risk shifting to DB pension funds. However, given that these papers were published in different years, they may or may not include periods of economic crisis.

During the GFC, the US economy witnessed its worst economic recession, with rising unemployment and falling prices of assets such as houses and share investments. Therefore, the value of retirement assets dropped significantly (Business Cycle Dating Committee 2010). Many studies (e.g. World Bank 2009) show that firms suffered a lower output demand and operational losses during the GFC. Bricker et al. (2011), Maurer et al. (2012) and Butrica, Johnson and Smith (2012) find that the financial crisis had detrimental effects on household spending and wealth, firm profits and retirement plans. Employees approaching retirement were particularly harmed because of the dual decline in house prices and retirement investment assets in the share market (Coronado & Dynan 2012). Dushi, Iams and Tamborini (2013) find that contributions to DB plans significantly reduced during the GFC. Similarly, the economic recession of the early 1990s and the 2000 dotcom bubble both led to a steep volatility in retirement portfolio values (Eschtruth, Sass & Aubrey 2007; Helppie McFall 2011). During economic recessions, firm output and demand drop, and firms face more expensive external financing, thus may lack access to funds (Kamery 2004; Allen 2016). The GFC and other economic recessions have brought enormous risks to the economy as a whole, and all firms have suffered from the unprecedented uncertainty. During these periods, the incentive to shift risk increases because firms are more likely to face high risks and financial distress. Underfunding corporate pension plans is a means of risk shifting. As a result, I develop my second hypothesis:

H2: *The effect of EPU on corporate pension underfunding is more pronounced during periods of financial crisis and economic recession.*

3.3 Capital Expenditure

Not only do economic recessions and financial crises exacerbate concerns about risk shifting to corporate pension plans, firms with large financial commitments and investment spending may also be motivated to shift risk when additional risks are introduced. According

to Keasey and Moon (1996), firms with higher capital expenditure are more likely to engage in risk-seeking behaviours. Kothari, Laguerre and Leone (2002) and Amir, Guan and Livne (2007) point out that capital investments increase a firms' risk. This indicates that firms that have committed to higher capital expenditure often experience a higher risk than their counterparts. EPU intensifies the risks to which these firms are exposed because of unexpected market conditions. Therefore, firms that have already committed to higher capital expenditure in periods of heightened EPU are expected to be more likely to default their liabilities. According to risk-shifting theory, shareholders in firms with higher capital expenditure will have a stronger incentive to shift the risk imposed by EPU compared with shareholders in firms with lower capital expenditure.

In addition to risk-shifting incentives, firms with higher capital expenditure generally have greater potential growth and investment opportunities (Lang, Ofek & Stulz 1996; Stowe & Xing 2006). Under higher EPU, output demand decreases because consumers delay making non-essential purchases (Eberly 1994), leading to extensive decreases in production, jobs, corporate spending, revenue and cash inflow (Bloom, Nick, Bond & Van Reenen 2007; Phan et al. 2019; Riddick & Whited 2009; Rodrik 1991). EPU also causes firms to suffer from higher borrowing costs and greater difficulty assessing funds (Kelly, Pástor & Veronesi 2016; Pástor & Veronesi 2012). This suggests that in periods of heightened EPU, external financing costs for firms increase drastically. However, capital expenditure for projects typically occurs over years rather than being a one-off cost (McConnell & Muscarella 1985). For example, if a pharmaceutical firm acquires land or a building this year, it will need to invest additional funds to build a biology laboratory next year, then spend more funds to upgrade equipment in the subsequent years. A suspension of capital expenditure may render all previous works worthless. Consequently, when heightened EPU results in more costly external finance, shareholders may

be incentivised to seek internal borrowing, such as shifting pension funds to investment funds. Accordingly, I hypothesise:

H3: *The effect of EPU on corporate pension underfunding is more pronounced in firms with higher capital expenditure commitments.*

3.4 Dividend Payouts

Capital expenditure occurs when undertaking new projects or making new investments, which, in essence, is equivalent to firms building wealth for theirs shareholders (Chung, Wright & Charoenwong 1998; Fliers 2019; McConnell & Muscarella 1985). A direct way for firms to distribute their wealth to shareholders is through dividend payouts (Denis & Osobov 2008). However, the cash outflows associated with dividend payments may harm firms' ability to fully service their debts; therefore, by extension, they shift risk to debtholders (Onali 2014; Pugachev 2019). Hence, firms that pay higher levels of dividends to shareholders may have a stronger incentive to shift the additional risks brought by heightened EPU.

In addition, dividends are rigid over time. Many firms prefer to borrow funds to maintain dividend payouts rather than cutting dividends because shareholders award firms with stable dividends and penalise those that cut dividends (Guttman, Kadan & Kandel 2010). This suggests that firms that pay higher dividends have a higher level of commitment to their shareholders. Managers' decisions about dividend payouts are based on their confidence in the sustainability of future cash flows. Even with a cash flow shock brought by EPU (Riddick & Whited 2009), managers may still be reluctant to cut dividends. Given that external financing becomes much more costly during periods of heightened EPU, managers may shift to 'borrowing' internal funds (i.e. from employees) by reducing contributions to DB pension plans to sustain dividend payments. Therefore, I hypothesise the following:

H4: *The effect of EPU on corporate pension underfunding is more pronounced in firms with a higher level of dividend payouts.*

3.5 Executive Compensation

Employees may be exploited by not only shareholders via risk shifting to corporate pension plans but also firm executives. Vafeas and Vlittis (2018) find that firm executives may engage in employee exploitation via pension freezing. Stefanescu et al. (2018) find strong evidence for the top management team (TMT) extracting rent from employees via employees' DB plans as well as being awarded a one-time increase in their pensionable earnings through higher bonuses in the year before a pension plan freeze or retirement. Firms may also manipulate the actuarial assumptions in pension plans, such as lowering discount rates to reduce pension liabilities when the retiring executives are entitled to a lump-sum payment from their pension plans.

Further, Cheng and Swenson (2018) find that firms that pay their CEOs higher wages make lower cash contributions to DB plans. Pedersen (2019) suggests that underfunding corporate pension plans could benefit firm executives because funds that should have gone towards corporate pension plans are used to shore up the firm's cash position. A better cash position decreases the likelihood of future distress and enhances shareholders' assessment of managers' performance. Cheng and Swenson (2018) explain the association between pension underfunding and excessive CEO pay and highlight the agency problem between managers and employees. Shareholders favour higher firm valuation, estimated in terms of cash flow from operations. Executive compensation also depends on firm valuation. Consequently, executives who are paid more are incentivised to report a high net cash flow from operations in financial statements (Cheng & Swenson 2018; Nwaeze, Yang & Yin 2006). Under conditions of high EPU, firms are likely to experience less cash inflow from operations (Al-Thaqeb & Algharabali 2019; Phan et al. 2019; Riddick & Whited 2009). To meet shareholder expectations of high cash flow from operations and maintain their salaries, highly paid executives may window dress

cash flow statements by reducing contributions to corporate pension funds to delay or decrease cash outflows.

In addition, excessive executive salaries may lead to inequality between managers and employees, not only because it suggests that large amounts of money are going to a small group of individuals at the top of the corporate hierarchy but also because it affects the funds available throughout the corporation (Bandiera, Barankay & Rasul 2007; DiPrete, Eirich & Pittinsky 2010; Lazonick 2014; Wade, O'Reilly III & Pollock 2006). Top executives who request excessive compensation appear to be pursuing personal benefits (Barak, Cohen & Lauterbach 2011; Cronqvist et al. 2009). If executives are excessively paid, it is likely that lower-ranked employees will feel a stronger inequity and firms will have fewer funds for pension contributions, leading to conflicts between managers and employees (Graefe-Anderson, Pyo & Zhu 2018). Benedetti and Chen (2018) suggest that firms with higher-paid executives are less likely to be employee oriented and more likely to harm employee wellbeing. Executive compensation mostly depends on performance, but EPU impedes firm operations, revenue and cash inflow (Kahle & Stulz 2013; Mian & Sufi 2010). In the event of higher EPU, if executives are overpaid, the conflict between lower-ranked employees and executives may become stronger if executives wish to maintain their high salaries. Consequently, they may further extract rent from employees by reducing employee-related expenses and cash contributions towards corporate pension funds. Fewer cash contributions or increased delays lead to higher corporate pension underfunding levels. Therefore, firms with excessively paid executives will have higher pension underfunding levels during periods of increased EPU. Accordingly, I hypothesise the following:

H5: *The effect of EPU on corporate pension underfunding is more pronounced in firms with excess executive compensation.*

3.6 Corporate Social Responsibility

The World Business Council for Sustainable Development (2002) defines CSR as a firm's commitment to the sustainability of economic development, employment and local communities. Via CSR practices, firms meet the needs of a variety of stakeholders to maximise the positive effects of their business operations for society (Waddock, Bodwell & Graves 2002; Yoon, Gürhan-Canli & Schwarz 2006). Harjoto and Laksmana (2020) state that firms with high CSR scores have higher reputations in the labour market. The corporate pension plan is a key metric in the labour market and social welfare system. Hwang and Hong (2020) and Harjoto and Laksmana (2020) provide strong evidence that firms awarded high CSR scores in the category of employee relations are less likely to engage in pension plan freezes.[10] Moreover, with their increased commitments to employees and broader society, firms with higher CSR scores are disinclined to severely underfund their DB plans (Harjoto & Laksmana 2020). They also have more responsible pension actuarial assumptions such as lower discount rates and higher wage increase rates by which to estimate pension liabilities. However, as discussed previously, EPU is associated with increases in the level of pension underfunding. A high CSR score is expected to negatively moderate the effect of EPU on corporate pension underfunding because of the firm's increased commitment to social responsibility and employee relations. Therefore, I hypothesise the following:

> ***H6:*** *The effect of EPU on corporate pension underfunding is more pronounced in firms with lower CSR scores.*

[10] Gelter (2013) and Rauh, Stefanescu and Zeldes (2020) suggest that the freezing of DB pension plans essentially reduces employee benefits because it shifts the risk from employer to employees with regard to employees' future guaranteed pension payouts.

Chapter 4: Data, Variables and Methodology

4.1 Sample Selection

The initial sample contains all publicly listed US firms in the period 1985–2019.[11] I use Compustat Pension Annual as the data source for pension characteristics and Compustat Fundamental for firm-specific characteristics. Data on equity market returns are obtained from the Center for Research in Security Prices. CEO and TMT compensation data are sourced from the ExecuComp database. I also acquire CSR data from the KLD database.

Following Anantharaman and Lee (2014) and Phan and Hegde (2013), I eliminate firms in the utility industry (Standard Industrial Classification [SIC] code 4900–4999) and financial firms (SIC code 6000–6999). Firms that have negative assets are also excluded. In addition, firm–year observations with missing data on total assets (Compustat item *AT*), cash (*CH*), earnings (*EPSPIY*), net sales (*SALE*), net income (*NI*), short-term debt (*DLC*), long-term debt (*DLTT*), earnings before interest and taxes (*EBIT*), retained profits (*RE*), tangible assets (*PPENT*), market equity (*CSHO*), book equity (*CEQ*) and share price (*PRCC_F*) are also excluded because these data are essential to calculate firm variables in the baseline regression. The final sample contains 17,701 firm–year observations from 2,063 individual firms.

4.2 Main Variable Measurement

4.2.1 Dependent Variable: Underfunding Levels in Corporate Defined-Benefit Pension Plans

Following Anantharaman and Lee (2014) and Pedersen (2019), corporate pension underfunding levels (*PENSION_UNDERFUND*) is defined as the difference between pension

[11] The year 1985 is the first year that data on pension liabilities and the fair value of pension assets became available in Compustat Pension Annual data files.

obligations (Compustat item *pbpro*) and pension assets (Compustat item *pplao*), scaled by pension liabilities.

4.2.2 Key Independent Variable: Economic Policy Uncertainty

The key independent variable is EPU, measured using the EPU index developed by Baker, Bloom and Davis (2016). This is a media-based method that estimates the number of articles from large and influential newspapers containing keywords related to EPU such as 'economic', 'uncertainty', 'regulation', 'Congress', 'Federal Reserve', 'White House', 'deficit' and their synonyms (Baker, Bloom & Davis 2016). The overall EPU index is known as the BBD index, which has shown its ability to capture economic uncertainty in the US each year. For example, the BBD index surged at the time of the Lehman Brothers bankruptcy and during federal elections.

EPU data are obtained from Baker, Bloom and Davis's website.[12] The raw data are given in monthly form. I transform monthly EPU data into annual data by averaging the 12-monthly BBD index in the corresponding year. Following Li (2019) and Duong et al. (2020), I then transfer the annual mean of the BBD index to its logarithmic form, which overcomes concerns about extreme values in certain years.

Baker, Bloom and Davis (2016) also decompose the overall BBD index into four categories: uncertainty related to the news (*EPU_News*), government policy decision disagreements (*EPU_GOV_DIS*), economic forecaster disagreements on inflation (*EPU_CPI*) and the expected expiration of federal tax codes (*EPU_Tax*).

4.2.3 Firm Characteristics

Following Chen et al. (2000), Gulen and Ion (2016) and Balachandran, Duong and Vu (2018), I calculate firm-specific control variables as follows: cash position (*CASH*) is calculated

[12] https://www.policyuncertainty.com/us_monthly.html.

as cash and short-term investments scaled by total assets; earnings volatility (*EARNVOL*) is calculated as the standard deviation of net income in the previous 4 years; firm leverage (*LEVERAGE*) is computed as total debt scaled by total assets; asset tangibility (*ASSET_TANGIBILITY*) is calculated as property, plant and equipment scaled by total assets; market-to-book ratio (*MB*) is calculated as the market value of assets minus deferred taxes divided by the book value of assets; return on assets (*ROA*) is measured as net income over the book value of assets; and firm size (*SIZE*) is defined as the log of total assets. Finally, the proxy for bankruptcy risk *(Z_SCORE*) is calculated using MacKie-Mason's (1990) formula. Detailed definitions can be found in the appendix.

4.3 Baseline Regression Specification

This section has two objectives: first, it provides the econometric model used in the empirical tests; second, it explains why the variables are adopted in the econometric model and how they are calculated.

This thesis mainly focuses on the association between EPU and corporate DB pension underfunding levels. Ordinary least squares (OLS) regression is employed to test this relationship. Following Balachandran, Duong and Vu (2018), I control for other important determinants of corporate pension policies, including firms' cash position (*CASH*), earnings volatility (*EARNVOL*), leverage (*LEVERAGE*), asset tangibility (*ASSET_TANGIBILITY*), bankruptcy risk (*Z_SCORE*), return on assets (*ROA*) and firm size (*SIZE*) in the regressions. In addition, the actual return from corporate pension asset investments (*PENSION_RETURN*) is added as a pension characteristic control variable in the regressions, as suggested by Anantharaman and Lee (2014). Following Duong et al. (2020), I take firm fixed effects and cluster robust standard errors by firm to control for time-invariant firm characteristics and within-firm serial correlations. Thus, the baseline regression is designed as follows:

$$Pension\ underfunding_{i,t+1} = \beta_0 + \beta_1 EPU_{i\,t} + \gamma firm\ control_{i,t} +$$
$$\delta investment\ opportunities\ control + \varphi marcoeconomic\ control_{i,t} + firm\ fixed\ effect + \varepsilon_{i,t} \quad (1)$$

where the dependent variable is $\_UNDERFUND_{i,t+1}$ of firm i in year $t+1$. Firm control variables include firms' cash position (*CASH*), earnings volatility (*EARNVOL*), leverage (*LEVERAGE*), asset tangibility (*ASSET_TANGIBILITY*), Altman Z-score (bankruptcy risk) (*Z_SCORE*), return on assets (*ROA*), firm size (*SIZE*) and actual returns from corporate pension asset investments (*PENSION_RETURN*) of firm i in year t (Anantharaman & Lee 2014; Balachandran, Duong & Vu 2018; Chen et al. 2000; Gulen & Ion 2016). Given that the actual returns from pension investment assets is an important control variable in the regressions, the underfunding of corporate pension plans is more likely driven by insufficient cash contributions from employers. Detailed definitions of variables can be found in the appendix.

The key explanatory variable of interest is EPU (EPU_t). Given that the EPU index is measured as the natural logarithm of the arithmetic average of the monthly BBD index during fiscal year *t*, firms are subject to the same EPU value in the same year *t* (Duong et al., 2020). Therefore, year fixed effects cannot be applied in the model because the EPU index is cross-sectionally invariant (Gulen & Ion 2016, Duong et al., 2020). A change in EPU can be considered an exogenous shock. However, the BBD index is based on time-series data and may capture fundamental economic volatility; thus, an endogeneity concern exists. Therefore, in Chapter 5, macroeconomic variables will be added to the regressions to alleviate such concerns. The endogeneity concern will also be addressed by 2SLS (Wooldridge 2016), which is discussed in the following section. The moderation analysis in Chapter 6 will reveal the types of firms that are more subject to the effects of EPU.

4.4 Endogeneity Problem

EPU is likely to be countercyclical. It is possible that EPU and corporate pension underfunding levels are correlated with some unobservable variables. This leads to a potential

endogeneity issue, which may bias the coefficient estimates of the baseline model. Following guidance from Wooldridge (2016), I use a 2SLS IV regression model to re-examine how EPU affects corporate pension underfunding levels to mitigate endogeneity concerns.

Following Nguyen and Phan (2017) and Nguyen and Nguyen (2019), I employ the partisan polarisation measure (*POLAR*) introduced by McCarty, Poole and Rosenthal (1997) for the instrument for EPU. The key dataset is dynamic, weighted nominal three-step estimation (DW-NOMINATE) scores, which have been used to track legislators' ideological positions over time. Legislators who vote similarly tend to interact, while legislators with different preferred outcomes tend to avoid each other. The difference between two DW-NOMINATE scores shows the distance between two ideological points, thus representing the level of disagreement between two legislators (McCarty, Poole & Rosenthal 1997). Thus, *POLAR* may be calculated as the difference in the first dimension of the DW-NOMINATE scores between the Republican and Democratic parties (Nguyen & Phan 2017; Nguyen & Nguyen 2019).[13]

McCarty (2004) claims that because partisan polarisation makes the passing of legislation more difficult, it can result in policy gridlocks and variations. Therefore, political polarisation functions as a valid instrument for EPU because it directly relates to EPU. Thus, *POLAR* meets the relevance criteria. Whether political polarisation has a direct impact on corporate pension funding status cannot be examined using econometric models; however, it is unlikely that this is the case given that political polarisation refers to the divergence of political attitudes and ideological extremes, thus is not likely to affect firm-level decisions regarding pension funds. Therefore, *POLAR* also satisfies the exclusion requirement. I execute a two-stage regression strategy as shown in Equation (2) (first-stage regression) and Equation (3) (second-stage regression):

[13] Data were collected from https://legacy.voteview.com/dwnomin.htm. The data span the period 1976 to 2014, which provides the maximum availability.

$$EPU_{i,t+1} = \alpha_0 + \beta_1 POLAR_t + \gamma firm\ control_{i,t} + \delta investment\ opportunities\ control + \varphi marcoeconomic\ control_{i,t} + firm\ fixed\ effect + \varepsilon_{i,t} \quad (2)$$

$$Pension\ underfunding_{i,t+1} = \beta_0 + \beta_1 F\_EPU_t + \gamma firm\ control_{i,t} + \delta investment\ opportunities\ control\ + \varphi marcoeconomic\ control_{i,t} + firm\ fixed\ effect + \varepsilon_{i,t} \quad (3)$$

In Equation (2), the IV political polarisation (*POLAR*) is augmented into the regression. Specifications of Equation (3) are the same as in the baseline model (Equation (1)), but the original variable *EPU* is replaced by the fitted value of *EPU* estimated from Equation (2), denoted $FEPU_{i,t}$ in Equation (3). Firm-level controls, macroeconomic controls, firm fixed effects and firm clustering are included in Equation (3).

In the first-stage regression (Equation (2)), the significance of the estimated coefficient for $POLAR_t$ provides an indication of whether the IV meets the relevance requirement. Moreover, the *F*-statistic from Equation (2) can test whether the selected IV is weak (Staiger & Stock 1994, Stock & Yogo 2002). Following Nguyen and Phan (2017), I also adopt the Kleibergen–Paap Wald test and Cragg–Donald Wald test for relevance and weak identification tests. In the second stage (Equation (3)), the coefficient of the instrumented $\widehat{EPU}$ is expected to be positive, confirming the positive association between corporate pension underfunding level and EPU.

4.5 Summary Statistics and Correlation Matrix

Table 1 provides the descriptive statistics of all variables used in the main analysis, including means, standard deviations and minimum, median and maximum values. From 1985 to 2019, there are approximately 17,000 corporate pension–year observations. The dependent variable is corporate pension underfunding levels, and the independent variable of interest is the EPU index. The mean EPU value is 4.657, which is consistent with those reported by Bonaime et al. (2018) and Duong et al. (2020). There are some extreme values for corporate pension underfunding levels and firm characteristics. To avoid bias in key statistics such as

means, medians and results of the OLS regressions, all continuous variables are winsorised at the 1% and 99% levels following the extant literature (e.g. Anantharaman & Lee 2014; Duong & Vu 2018; Duong et al. 2020). If the dependent variable (corporate pension underfunding levels) is positive, this means that the firm's pension assets cannot fully cover its pension obligations, and if it is negative, this means that the value of the firm's pension assets exceeds its pension liabilities. The mean and median values for corporate pension underfunding levels are 0.168 and 0.192, respectively.

Table 1 also shows the descriptive statistics for firm characteristics that are known to affect corporate pension plans and actual returns from corporate pension asset investments (*PENSION_RETURN*). To ensure that corporate pension plan underfunding is mainly attributable to insufficient cash contributions from employers, the regression analysis controls for the actual returns from pension investment assets. Cash and cash equivalent account for an average of 9.1% of the firm's total assets. On average, firms experience annual earnings volatility of 0.827%, with 32.8% of assets being tangible, and an Altman Z-score of 2.006. Firms' DB pension plan asset investment returns are 5.7% on average. These summary statistics are similar to those found in previous studies (e.g. Anantharaman & Lee 2014, Duong & Vu 2018, Pedersen 2019, Duong et al. 2020).

Table 2 presents a correlation matrix, showing that the BBD index is highly correlated with each of its components, especially *EPU_NEWS* (0.901). More importantly, the BBD index is positively correlated with corporate pension underfunding levels (*PENSION_ UNDERFUND*). This observation provides an early indication of the positive influence of EPU on corporate pension underfunding levels.

Table 1. Summary Statistics

This table presents the summary statistics for the main variables in the baseline regression. The data ranges from 1985 to 2019. It presents firm-year observations which do not have missing values.

Summary statistics								
	Obs.	Mean	SD	Min	P25	Median	P75	Max
PENSION_UNDERFUND	17701	0.168	0.419	-0.538	-0.147	0.192	0.492	0.818
EQUITY_ALLOCATION	13041	0.604	0.142	0.270	0.594	0.654	0.644	0.830
EPU	17701	4.657	0.242	4.267	4.480	4.681	4.796	5.148
EPU_NEWS	17701	4.683	0.258	4.206	4.427	4.727	4.927	5.062
EPU_GOV_DIS	17701	4.438	0.383	3.793	4.099	4.377	4.814	5.429
EPU_CPI	17701	4.519	0.204	4.209	4.359	4.469	4.688	5.081
EPU_TAX	17701	4.209	0.432	1.579	4.173	4.299	4.969	7.376
CASH	17701	0.091	0.077	0.005	0.010	0.096	0.113	0.218
EARNVOL	17701	0.827	1.212	0.002	0.028	0.479	0.854	8.076
LEVERAGE	17701	0.291	0.204	0.000	0.145	0.265	0.398	0.895
ASSET_TANGIBILITY	17701	0.328	0.213	0.000	0.160	0.283	0.458	0.952
Z_SCORE	17701	2.006	1.734	-8.941	1.216	1.903	2.977	6.254
MB	17701	1.558	0.730	0.218	1.002	1.376	2.013	2.962
ROA	17701	0.141	0.090	-0.182	0.094	0.139	0.189	0.398
SIZE	17701	8.614	2.374	2.289	7.000	8.605	10.258	13.884
PENSION_RETURN	17701	0.057	0.101	-0.273	0.002	0.072	0.120	0.298

Table 2. Correlation Matrix

Table 2 shows the correlation matrix for the main variables in the baseline analysis. The data ranges from the year 1985 to 2019. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, separately.

Variables	PENSION_UNDERFUND	EPU	EPU_NEWS	EPU_GOV_DIS	EPU_CPI	EPU_TAX	CASH	EARNVOL	LEV-ERAGE	ASSET_TANGIBILITY	Z_SCORE	MB	ROA	SIZE	PENSION RETURN
PENSION_UNDERFUND	1.000														
EPU	0.190***	1.000													
EPU_NEWS	0.144***	0.901***	1.000												
EPU_GOV_DIS	0.155***	0.775***	0.661***	1.000											
EPU_CPI	0.096***	0.551***	0.426***	0.537***	1.000										
EPU_TAX	0.191***	0.864***	0.843***	0.583***	0.571	1.000									
CASH	0.112***	0.083***	0.055***	0.083***	0.040***	0.125***	1.000								
EARNVOL	-0.045***	0.045***	0.033***	0.039***	0.019***	0.049	-0.019***	1.000							
LEVERAGE	0.012	0.002**	0.041***	-0.024***	-0.053***	-0.070***	-0.233***	0.088***	1.000						
ASSET_TANGIBILITY	-0.045***	-0.022***	-0.012***	-0.015***	-0.003***	-0.061***	-0.258***	0.066***	0.116***	1.000					
Z_SCORE	-0.047***	-0.007***	-0.008**	-0.004***	0.001***	-0.008***	-0.035***	-0.014***	-0.321***	0.009***	1.000				
MB	-0.014***	-0.070***	-0.057***	-0.057***	-0.075***	-0.039***	0.181***	-0.101***	0.100***	-0.110***	-0.293***	1.000			
ROA	-0.079***	-0.035***	-0.042***	-0.031*	0.007***	-0.011***	-0.046***	-0.033***	-0.182***	0.070***	0.619***	-0.100***	1.000		
SIZE	-0.022***	0.065*	0.065***	0.051***	-0.020	0.072***	-0.135	0.151***	0.046	0.104***	0.111***	-0.018	0.187***	1.000	
PENSION_RETURN	-0.150***	-0.163***	-0.261	0.049***	-0.107***	0.108***	-0.000***	0.029***	-0.036***	0.002	0.031***	0.041***	0.046***	0.058***	1.000

Chapter 5: Main Results

5.1 Univariate Analysis

The empirical analysis begins with the univariate tests. The sample consists of 17,701 firm–year observations of 2,063 individual firms in the period 1985–2019. The mean *t*-test and Wilcoxon rank-sum test are conducted to test the null hypothesis that the mean effects of EPU on corporate pension underfunding levels are similar for periods of high and low EPU. The low-EPU subsample includes firm–year observations in which the EPU index is below the sample median, while the high-EPU subsample includes firm–year observations in which the EPU index is higher than the sample median.

Panel A of Table 3 divides EPU into quartiles and demonstrates that pension underfunding increases from Quartile 1 to Quartile 4. Panel B reports the results of *t*-tests conducted to compare corporate pension underfunding levels and firm characteristics in periods of high and low EPU. As shown in Panel B, the corporate pension underfunding level is 16.8 points higher in period of high EPU compared with periods of low EPU. This difference is statistically and economically significant. In addition, pension fund investment assets perform better during periods of low EPU (7.4% v. 4.5% return). Given that corporate pension plan values are determined by both investment asset returns and employers' cash contributions, the actual return on pension assets is used as an important control variable. Consistent with the findings of Duong et al. (2020), firms are more cautious during periods of higher EPU, thus hold more cash.

In terms of firm characteristics, it is noteworthy that during periods of higher EPU, firms have higher uncertainty in earnings and returns on assets, with less tangible non-current assets, a higher chance of bankruptcy, higher leverage and a lower market-to-book ratio. This implies that firms in high-EPU periods are more likely to see more serious pension deficit problems.

Table 3. Univariate Analysis

Table 3 Panel A split the EPU by quartiles and shows how pension underfunding increases from quartiles 1 to quartiles 4. Panel B reports the univariate comparisons between firm-level pension underfunding status and firm characteristics in high EPU period and low EPU period. High EPU of those firm-year observations that have a Log (BBD) higher than the sample median. The remaining firm-year observations are categorized as high EPU periods. The sample consists of 17,701 firm-year observations of 2,063 unique firms drawn from the 1985–2019 period. Mean t-test and Wilcoxon rank-sum tests are conducted to test the null hypothesis that the mean effects on the corporate pension funding deficit level are not different between the 2 subgroups which differ in EPU.

Panel A: EPU spitted by quartiles		
EPU	Obs.	Pension Underfunding Level
Quartile 1	3,833	0.144
Quartile 2	4,730	0.198
Quartile 3	4,956	0.224
Quartile 4	4,182	0.235

Panel B: T-tests and Wilcoxon test						
	High EPU Period		Low EPU Period		Tests for difference	
	Mean	Median	Mean	Median	Difference in means	Wilcoxon X^2 test p-value
PENSION_UNDERFUND	0.253	0.174	0.085	0.042	0.168***	0.000***
PENSION_RETURN	0.045	0.056	0.074	0.085	-0.028***	0.000***
CASH	0.113	0.104	0.065	0.070	0.048***	0.000***
EARNVOL	0.851	0.508	0.804	0.452	0.046***	0.000***
LEVERAGE	0.291	0.267	0.290	0.264	0.001	0.392
ASSET_TANGIBILITY	0.317	0.269	0.340	0.294	0.022***	0.000***
Z_SCORE	1.895	1.991	2.113	2.180	-0.217***	0.000***
MB	1.523	1.341	1.590	1.413	-0.067***	0.000***
ROA	0.134	0.133	0.147	0.145	-0.013***	0.000***
SIZE	8.917	8.954	8.324	8.271	-0.593***	0.000***

5.2 Multivariate Analysis

The effect of EPU on underfunding levels in corporate DB pension plans is also investigated using OLS regressions. I use the overall BBD index as well as its main components and control for firm-level characteristics and macroeconomic uncertainty factors that are well known to affect corporate pension asset value such as firm size, firm profit, firm leverage, GDP growth, equity market return and pension assets investment return. Next, the endogeneity issue

is addressed, and additional cross-sectional tests are conducted to further explain the relationship between EPU and corporate pension underfunding levels.

5.2.1 Baseline Results

Columns (1) and (2) in Table 4 show the results from the regression model. Specifically, EPU and firm fixed effects are specified in Column (1), while firm-level control variables are included in Column (2). The coefficients of EPU in Columns (1) and (2) are 0.140 and 0.109, respectively, and they are statistically significant. The results indicate that higher EPU is associated with higher DB pension underfunding levels in the following year.

5.2.2 Addressing the Confounding Effects of Economic Policy Uncertainty

As previously mentioned, the BBD index may strongly correlate with other sources of macroeconomic uncertainty such as economic recessions, financial crises, wars and regional conflicts (Baker, Bloom & Davis 2016). These sources may confound the positive relationship between EPU and DB pension underfunding levels. This concern is addressed by adding control variables that take into account economic uncertainties (Bloom 2009). These proxies are widely used in the literature on EPU (e.g. Gulen & Ion 2016; Nguyen & Phan 2017; Nguyen & Nguyen 2020).

The first proxy is expected GDP growth (*EX_GDPGROWTH*), which is the mean percentage change between GDP forecasts in the year before and the current GDP. Data are obtained from the Federal Reserve Bank of Philadelphia's biannual Livingstone Survey. The second proxy is real GDP growth rates (*REAL_GDPGROWTH*), obtained from the World Bank's World Development Indicators database. The third proxy is *ECONOMIC_INDEX*, which is the year-by-year log change reported in the Conference Board Leading Economic Index, which summarises macroeconomic indicators that are recognised as having predictive powers regarding future GDP growth. The fourth proxy is the University of Michigan

Consumer Confidence Index (*CONSUMER_CONFIDENCE*), which captures consumer expectations about the future growth of the economy. The fifth variable is a dummy variable for election year (*ELECYEAR*), an essential macroeconomic uncertainty element (Julio & Yook 2012) that equals 1 in presidential election years and 0 in non-election years. Sixth, GDP forecast dispersion is calculated as the coefficient of the variation of GDP forecasts (*GDPDIS*). Data are obtained from the biannual GDP forecasts from Federal Reserve Bank of Philadelphia's biannual Livingstone Survey and are used as the proxy for expected economic growth uncertainty. To capture variations in firms' future profitability, the annual cross-sectional standard deviation of growth in firm profit (*SDPROFIT*) is also included. The growth in a firm's profit is measured as the change in net income divided by sales revenue. In addition to controlling for uncertainties in share markets, the yearly standard deviation of stock returns (*SDRETURN*) and the index of implied volatility (*VXO*) from the Chicago Board Options Exchange are added into the regression. Finally, the index designed by Jurado, Ludvigson and Ng (2015) (*JLN*) measures the conditional volatility of the unforecastable components of a multitude of economic data series. The index is based on the co-movement of unpredictable elements from 132 macroeconomic indices and 147 financial market data series. Following Nguyen and Phan (2017), I transform all economic uncertainty proxies (apart from the election year variable) to their natural logarithms. In Column (3) of Panel A in Table 4, the baseline specifications are augmented by adding these 10 macroeconomic uncertainty factors into the model in Equation (1). The results confirm the positive association between EPU and corporate pension underfunding levels.

Following Gulen and Ion (2016) and Duong et al. (2020), all variables in Column (3) of Panel A in Table 4 are normalised by their standard deviations to estimate the coefficients. The purpose is to compare the economic magnitudes across covariables. The normalised coefficients are reported in Table 4. Each coefficient should be interpreted as a one standard

deviation change in the independent variable associated with a percentage change of standard deviation in the dependent variable. A normalised coefficient of 0.151 for EPU indicates that when EPU increases by one standard deviation, the firm's pension underfunding level increases by an average of 15.1% relative to its standard deviation. This suggests a 633 basis point (0.151 × 0.419) increase, which is equivalent to a 37.678% (= 633 bps/0.168) increase in average corporate DB pension underfunding in the sample.

The BBD index is then decomposed to news, fiscal and monetary policy, inflation and tax uncertainties. The effects of these on corporate pension underfunding vary. Columns (4) to (6) show the results of each component of policy uncertainty: news (*EPU_NEWS*), government fiscal and monetary policies (*EPU_GOV*), inflation (*EPU_CPI*) and tax (*EPU_TAX*). Similar to the BBD index, these components are also in the log transformation form. The estimated coefficients for EPU vary across these components. The news-based component is the strongest metric affecting corporate pension underfunding, which meets my expectations given that the BBD index uses the newspaper text method to capture uncertainties in almost all categories of economic policy-related events. Therefore, the news component encompasses uncertainties associated with government fiscal and monetary policies, inflation and tax. Baker, Bloom and Davis (2016) argue that the news-based element constitutes the greatest proportion (50%) in the overall BBD index; therefore, it is not surprising that *EPU_NEWS* is positively associated with the underfunding of firms' DB plans.

Uncertainties related to government disagreements about fiscal and monetary policies and inflation are also positively associated with corporate pension underfunding. This suggests that these types of uncertainty negatively influence firms' decisions about cash contributions to corporate pension plans because they may hinder output demand, thereby leading to job cuts and increasing borrowing costs (Gulen & Ion 2016; Nguyen & Phan 2017).

Interestingly, the results shown in Column (7) of Panel A in Table 4 show a negative coefficient for *EPU_Tax*. This indicates that uncertainty related to the expiration of tax codes exerts a negative influence on corporate pension underfunding levels, meaning that the tax-related component is positively associated with cash contributions to corporate pension funds. Nguyen and Phan (2017) explain that the expiration of tax codes may reduce tax benefits for businesses. Therefore, this creates an incentive for businesses to contribute more cash to corporate pension plans to reduce their taxable profits prior to the expiration of the tax code. For example, the expiration of the surtax to support Obamacare would have effectively decreased tax rates for businesses. Therefore, prior to the expiration of the Obamacare surtax, employers would have been motivated to contribute more cash to pension funds to reduce the potential increase in tax payments from profits for the year. Another example is the *Tax Cuts and Jobs Act (TCJA)* signed by the President Trump, which provides incentives for firms to accelerate their cash contributions to DB pension plans in a given tax year. Given the deductions related to corporate DB plans, the effective tax rate for corporations has significantly decreased. As a result of this tax code, deductions related to pension contributions are more valuable if large cash contributions to pension plans are executed in 2017 rather than 2018. In short, given the uncertainty of the expiration of these provisions, firms may have an incentive to accelerate cash contributions to pension funds before these provisions expire.

Table 4. Baseline Regression

Table 4 regresses the underfunding level of firm pension plans (the difference between pension liabilities and pension assets, scaled by pension liabilities, *PENSION_UNDERFUND*) on Economic Policy Uncertainty (EPU, log of BBD index) in Column (1) and include firm-level controls such as firm's cash position (*CASH*), earnings volatility (*EARNVOL*), leverage (*LEVERAGE*), asset tangibility (*ASSET_TANGIBILITY*), Altman Z-score (*Z_SCORE*), ROA (*ROA*), firm size (*SIZE*), and actual return from corporate pension asset investments (*PENSION_RETURN*) in Column (2). In Column 3, general macroeconomic uncertainty variables, including expected GDP growth (*EX_GDPGROWTH*), real GDP growth (*REAL_GDPGROWTH*), leading economic index (*ECONOMIC_INDEX*) and consumer confidence (*CONSUMER_CONFID*), GDP forecast dispersion (*GDPDIS*), a standard deviation of cross-sectional profit growth (SDPROFIT), a standard deviation of cross-sectional real returns (*SDRETURN*), implied volatility (*VXO*), Jurado et al. (2015)'s index (*JLN*) and election year dummy (*ELECYEAR*) are added following Gulen & Ion (2016), Nguyen & Phan (2017), and Nguyen & Nguyen (2020). In Columns (4) through (6), the overall EPU measure is replaced by each of its four components (news (*EPU_NEWS*), disagreement on government fiscal and monetary policies (*EPU_GOV_DIS*), inflation (*EPU_CPI*), and tax (*EPU_TAX*)). All continuous variables are winsorized at 1% levels. In all regressions, I include firm fixed effects and firm clustering effects, following Duong et.al (2020). Robust firm clustered standard errors is reported in the parentheses. I ease year fixed effect to avoid the multicollinearity issue since EPU is measured at the yearly level. The effect of EPU holds if the regression is cluster by year (unreported). *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, separately.

Panel A: Regression results							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	EPU	EPU	EPU	EPU_News	EPU_GOV	EPU_CPI	EPU_Tax
Variables	PENSION UNDERFUND (t+1)	PENSION UNDERFUND (t+1)	PENSION UNDERFUND (t+1)	PENSION UNDERFUND (t+1)	PENSION UNDERFUND (t+1)	PENSION UNDERFUND (t+1)	PENSION UNDERFUND (t+1))
EPU	0.140***	0.109***	0.561***				
	[0.000]	[0.000]	[0.000]				
EPU_NEWS				0.405***			
				[0.000]			
EPU_GOV_DIS					0.025***		
					[0.000]		
EPU_CPI						0.109***	
						[0.000]	
EPU_TAX							-0.004**
							[0.050]

CASH	1.316***	0.805**	0.742**	0.909***	0.933***	0.917***
	[0.000]	[0.013]	[0.022]	[0.007]	[0.006]	[0.006]
EARNVOL	-0.060	-0.048	-0.039	-0.070	-0.073	-0.070
	[0.628]	[0.704]	[0.759]	[0.582]	[0.570]	[0.587]
LEVERAGE	-0.536	2.278	1.826	3.582**	3.949**	3.636**
	[0.725]	[0.187]	[0.290]	[0.040]	[0.024]	[0.038]
ASSET_TANGIBILITY	-3.259*	-2.413	-2.985	-0.613	0.288	-0.476
	[0.057]	[0.534]	[0.442]	[0.875]	[0.941]	[0.903]
Z_SCORE	-0.099	-0.106	-0.114	-0.112	-0.116	-0.114
	[0.434]	[0.358]	[0.305]	[0.365]	[0.352]	[0.360]
MB	-0.668**	-0.376	-0.389	-0.761**	-0.825**	-0.786**
	[0.019]	[0.235]	[0.216]	[0.019]	[0.012]	[0.016]
ROA	-1.246***	-0.894***	-0.770***	-0.947***	-0.928***	-0.922***
	[0.000]	[0.002]	[0.003]	[0.001]	[0.001]	[0.001]
SIZE	1.558***	1.368**	1.295**	1.232**	1.118*	1.217**
	[0.007]	[0.024]	[0.033]	[0.043]	[0.065]	[0.046]
PENSION_RETURN	-0.250***	-0.229***	-0.208***	-0.376***	-0.376***	-0.376***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
EX_GDPGROWTH		0.550***	0.822	0.842***	0.883***	0.765***
		[0.000]	[0.666]	[0.000]	[0.000]	[0.000]
REAL_GDPGROWTH		-0.199***	-0.195***	-0.091***	-0.108***	-0.070***
		[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
ECONOMIC_INDEX		0.193***	0.226***	0.170***	0.192***	0.169***
		[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
CONSUMER_CONFID		1.455***	0.280***	1.026***	0.778***	1.269***
		[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
GDPDIS		-0.182***	-0.146***	-0.102***	-0.129***	-0.114***
		[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
SDPROFIT		-0.054***	-0.056***	0.010***	0.008***	0.011***
		[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
SDRETURN		-0.786***	-0.628***	-0.101***	-0.163***	-0.077***
		[0.000]	[0.000]	[0.000]	[0.000]	[0.000]

VXO			0.332***	0.201***	0.053***	0.101***	0.042***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
JLN			0.309***	0.393***	0.199***	0.047	0.068
			[0.000]	[0.000]	[0.000]	[0.289]	[0.128]
ELECYEAR			0.011***	0.013***	0.028***	0.019***	0.035***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
CONSTANT	-0.608***	-0.367***	-6.067***	-2.411***	1.285***	0.267*	1.940***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.054]	[0.000]
Obs.	17701	17701	17701	17701	17701	17701	17701
Adj. R^2	0.023	0.104	0.241	0.247	0.187	0.190	0.187
Firm FE	YES	YES	YES	YES	YES	YES	YES
Firm Cluster	YES	YES	YES	YES	YES	YES	YES

Panel B: Normalized all variables (Column 3)

Variables	Coefficients	Robust standard errors
EPU	0.151***	0.005
CASH	0.007**	0.003
EARNVOL	-0.001	0.002
LEVERAGE	0.005	0.003
ASSET_TANGIBILITY	-0.005	0.008
Z_SCORE	-0.005	0.005
MB	-0.004	0.003
ROA	-0.009***	0.003
SIZE	0.026**	0.011
PENSION_RETURN	-0.021***	0.001
EX_GDPGROWTH	0.019***	0.001
REAL_GDPGROWTH	-0.031***	0.001
ECONOMIC_INDEX	0.036***	0.002
CONSUMER_CONFID	0.071***	0.004
GDPDIS	-0.028***	0.001
SDPROFIT	-0.054***	0.002

5.2.3 Corporate Pension Underfunding in Different Periods

As demonstrated in Figure 1 (see Chapter 1), the underfunding of corporate pension plans has gradually increased. Table 5 shows the effects of EPU on DB pension plan underfunding. Column (1) shows the baseline results, Column (2) compares the results for recession v. non-recession periods, and Column (3) compares the results for GFC v. non-GFC periods. The years of expansion and recession are based on US business cycle expansions and contractions together with recession and GFC years sourced from the National Bureau of Economic Research (NBER),[14] which is commonly used by academics and policymakers (Claessens & Kose 2018; Jens 2017; Morley & Piger 2012). The NBER identifies the years 1990–1991 (the early 1990s recession), 2001 (the dotcom bubble) and 2007–2009 (the GFC) as recession periods. The variable *RECESSION* is a dummy variable equal to 1 if in economic recession years. The variable *GFC* is a dummy variable equal to 1 during the years 2007–2009.

The results in Table 5 show that during periods of economic recession and the GFC, the effect of EPU on corporate DB pension underfunding levels increases ($0.434 + 0.340 = 0.774$). This suggests that in periods of high economic volatility, policymakers and pension insurance providers should be more cautious about funding health in corporate pension plans.

[14] https://www.nber.org/cycles.html.

Table 5. EPU and Corporate Pension Underfunding Levels for Different Periods

In table 5 additional analyses are conducted to further examine the cross-sectional variations of the relation between EPU and corporate pension underfunding levels for different periods. Panel A compares the result of EPU on corporate pension underfunding level during recession periods and non-recession periods, and Panel B shows the result of the GFC period and non-GFC period. The years of expansion and recession depend upon the U.S. business cycle expansions and contractions, together with the years of economic recessions and GFC periods, for which the National Bureau of Economic Research (NBER) provides guidance. This source has been popularly used by academics and policymakers (Claessens & Kose 2018; Jens 2017; Morley & Piger 2012). According to the NBER, the year 1990 to 1991 (Early 1990s recession), 2001 (The internet crisis), and 2007 to 2009 (The Great Recession) are identified as recessionary periods. The variable RECESSION is a dummy variable equal to 1 if in the recession years. The variable GFC is a dummy variable equal to 1 during the years 2007-2009. This source has been popularly used by academics and policymakers (Claessens & Kose 2018; Jens 2017; Morley & Piger 2012). According to the NBER, the year 1990 to 1991 (Early 1990s recession), 2001 (The dot-com bubble), and 2007 to 2009 (Global Financial Crisis) are identified as recessionary periods. The variable RECESSION is a dummy variable equal to 1 if in the recession years. The variable GFC is a dummy variable equal to 1 during the years 2007-2009. All continuous variables are winsorized at 1% levels. Robust firm clustered standard errors is reported in the parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, separately.

	Baseline regression	Recession periods vs. Non-recession periods	GFC periods vs. Non-GFC periods
	(1)	(2)	(3)
Variables	PENSION UNDERFUND (t+1)	PENSION UNDERFUND (t+1)	PENSION UNDERFUND (t+1)
EPU	0.561***	0.434***	0.540***
	[0.000]	[0.000]	[0.000]
RECESSION		1.336***	
		[0.000]	
RECESSION×EPU		0.340***	
		[0.000]	
GFC			0.167***
			[0.000]
GFC×EPU			0.013***
			[0.000]
CASH	0.742**	0.625*	0.562*
	[0.022]	[0.055]	[0.083]
EARNVOL	-0.039	-0.018	-0.030
	[0.759]	[0.886]	[0.810]
LEVERAGE	1.826	1.752	1.795
	[0.290]	[0.302]	[0.292]
ASSET_TANGIBILITY	-2.985	-3.298	-3.236
	[0.442]	[0.391]	[0.401]
Z_SCORE	-0.114	-0.141	-0.141
	[0.305]	[0.177]	[0.182]

MB	-0.389	-0.303	-0.323
	[0.216]	[0.342]	[0.308]
ROA	-0.770***	-0.619**	-0.583**
	[0.003]	[0.016]	[0.025]
SIZE	1.295**	1.501**	1.318**
	[0.033]	[0.014]	[0.030]
PENSION_RETURN	-0.208***	-0.162***	-0.190***
	[0.000]	[0.000]	[0.000]
EX_GDPGROWTH	0.822	0.638***	1.199***
	[0.666]	[0.000]	[0.000]
REAL_GDPGROWTH	-0.195***	-0.294***	-0.476***
	[0.000]	[0.000]	[0.000]
ECONOMIC_INDEX	0.226***	-0.098***	0.333***
	[0.000]	[0.000]	[0.000]
CONSUMER_CONFID	0.280***	0.829***	1.948***
	[0.000]	[0.000]	[0.000]
GDPDIS	-0.146***	-0.307***	-0.178***
	[0.000]	[0.000]	[0.000]
SDPROFIT	-0.056***	-0.048***	-0.079***
	[0.000]	[0.000]	[0.000]
SDRETURN	-0.628***	-0.676***	-0.978***
	[0.000]	[0.000]	[0.000]
VXO	0.201***	0.264***	0.386***
	[0.000]	[0.000]	[0.000]
JLN	0.393***	0.322***	0.378***
	[0.000]	[0.000]	[0.000]
ELECYEAR	0.013***	0.011***	-0.008***
	[0.000]	[0.000]	[0.000]
CONSTANT	-2.411***	-4.215***	-7.565***
	[0.000]	[0.000]	[0.000]
Obs.	17701	17701	17701
Adj. R^2	0.241	0.268	0.261
Firm FE	YES	YES	YES
Firm Cluster	YES	YES	YES

5.3 Robustness Checks

5.3.1 Instrumental Variable Approach

I employ the IV approach and run a 2SLS regression to mitigate potential endogeneity issues. Following Nguyen and Phan (2017) and Nguyen and Nguyen (2019), the IV is partisan polarisation of US senators (*POLAR*). As discussed in section 5.3.1, this instrument is valid because it is correlated with the endogenous variable but is not directly related to the dependent

variable (i.e. pension underfunding levels). Figure 2 illustrates the time-series evolution of party polarisation (*POLAR*), defined as the difference in the first dimension of DW-NOMINATE scores between the Republican and Democratic parties (Zingher 2018).

Figure 2. A Time-series Evolution of Party Polarisations (POLAR)

Figure 2 demonstrates a time-series evolution of Party Polarisations (POLAR). POLAR is defined as the difference in the first dimension of the DW-NOMINATE scores between the Republican (code: 200) and Democratic (code: 100) parties.

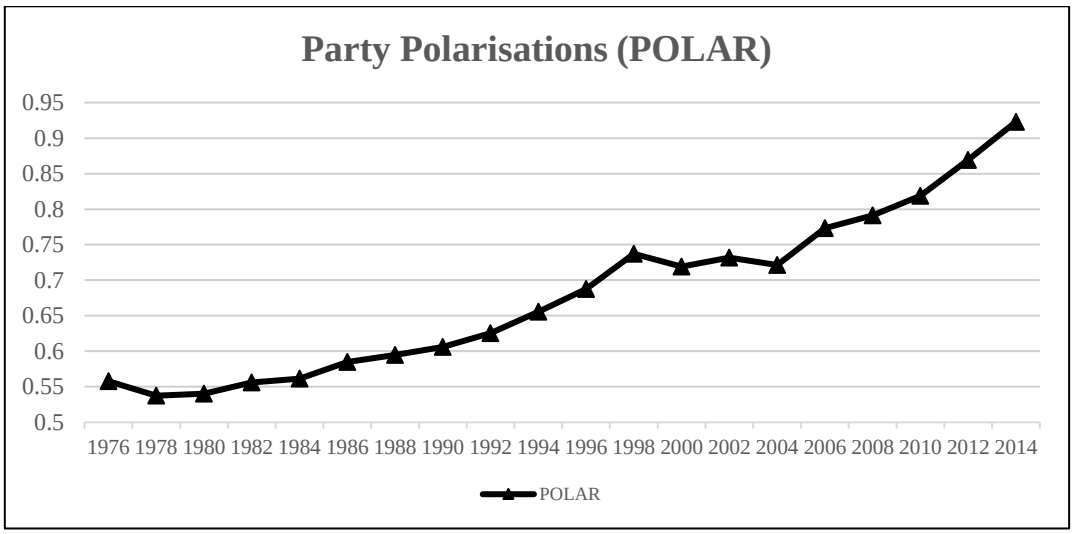

Table 6. 2SLS Regressions (Political Polarization IV): Addressing endogeneity in corporate pension underfunding level regressions

The table presents the 2SLS regression results. EPU maybe an endogenous variable. The party polarisations for the members in the Senate (POLAR) acts as the instrument variable. Column (1) reports the first-stage regression result, and Column (2) reports the second-stage regression result. The dependent variable in Column (2) is the underfunding levels in corporate DB pension plans. The sample contains 14,826 firm-year observations between 1985 and 2019. P-value is reported in parentheses, is adjusted for heteroscedasticity. It is clustered by firm. All regressions control for the firm fixed effects. ***, **, and * indicate significant level at the 1%, 5% and 10%, separately.

	(1)	(2)
	First Stage	Second Stage
Variables	EPU	PENSION UNDERFUND (t+1)
POLAR	0.441***	
	[0.000]	
EPU_HAT (Instrumented)		3.043***
		[0.000]
CASH	0.229	0.700
	[0.807]	[0.815]

EARNVOL	-0.003	-0.171
	[0.921]	[0.188]
LEVERAGE	2.186***	-0.440***
	[0.000]	[0.005]
ASSET_TANGIBILITY	1.052	3.376
	[0.134]	[0.228]
Z_SCORE	-0.060*	0.110
	[0.099]	[0.308]
MB	-0.527***	0.910***
	[0.001]	[0.000]
ROA	1.164	-1.257***
	[0.209]	[0.000]
SIZE	0.203*	-1.681***
	[0.073]	[0.000]
PENSION_RETURN	-0.241***	0.359***
	[0.000]	[0.000]
EX_GDPGROWTH	0.899***	-0.199**
	[0.000]	[0.017]
REAL_GDPGROWTH	0.543***	-1.251***
	[0.000]	[0.000]
ECONOMIC_INDEX	-0.433***	0.972***
	[0.000]	[0.000]
CONSUMER_CONFID	-4.629***	1.059***
	[0.000]	[0.000]
GDPDIS	0.247***	-0.702***
	[0.000]	[0.000]
SDPROFIT	0.351***	-0.487***
	[0.000]	[0.000]
SDRETURN	1.353***	1.440***
	[0.000]	[0.000]
VXO	-0.493***	2.267***
	[0.000]	[0.000]
JLN	-0.802***	-0.206***
	[0.000]	[0.000]
ELECYEAR	0.081***	-0.874***
	[0.000]	[0.000]
Underidentification test Kleibergen-Paap Wald F-statistic	445.946***	
Weak identification test Cragg-Donald Wald F-statistic	461.240***	
Obs.	14826	14826
Adj. R^2	0.968	
Firm FE	YES	YES
F-Statistic	96.637	

Table 6 presents the 2SLS regression results. Column (1) reports the first-stage regression results for EPU on the IV (*POLAR*), controlling for firm-specific characteristics and macroeconomic factors. Column (1) shows that the coefficient (0.441) on the IV is positively significant at the 1% level, suggesting that the IV meets the relevance criterion. These findings align with Bloom et al. (2016) that policy variations and policy gridlocks are reflected in the EPU index. In addition, the *F*-statistic from the first-stage regression is greater than 10, rejecting the null hypothesis of a weak instrument (Staiger & Stock 1994). The Kleibergen–Paap under-identification test statistic and the Cragg–Donald weak identification test statistic further suggest that the IV is not a weak instrument, thus is relevant (Nguyen & Phan 2017). Given that no previous study has documented a strong link between party polarisation and corporate pension underfunding levels, the selected IV also satisfies the exclusion criteria.

Column (2) reports the second-stage regression results. The dependent variable is underfunding levels in corporate DB pension plans. Consistent with the results reported in the baseline regression, the coefficient for the instrumented EPU (3.043) is positively significant at the 1% level. This indicates a positive association between EPU and corporate DB pension underfunding levels.

To conclude, the results from the 2SLS regression analysis provide assurance that the association between EPU and DB pension underfunding levels is robust to endogeneity corrections. These results are consistent with those reported in the baseline regression, suggesting a positive causal connection between a firm's exposure to EPU and corporate DB pension underfunding levels.

5.3.2 Test for Multicollinearity

In this section, I test for the existence of multicollinearity in the baseline regression model. Table 7 reports the variance inflation factors among firm characteristics. The results

imply that there is little multicollinearity at the firm level because the values for each variable are less than 2.

Table 7. Multicollinearity Analysis

Table 7 reports the variance inflation factor (VIF) for each variable. The results indicate multicollinearity is not a problem in the model at the firm level, because the VIF values for each explanatory variable are less than 2.

Variables	VIF	1/VIF
EPU	1.050	0.951
CASH	1.200	0.836
EARNVOL	1.050	0.950
LEVERAGE	1.170	0.854
ASSET_TANGIBILITY	1.100	0.909
Z_SCORE	1.500	0.668
MB	1.140	0.878
ROA	1.430	0.698
SIZE	1.090	0.914
PENSION_RETURN	1.040	0.965
Mean VIF	1.180	

5.3.3 Alternative Measures

In Table 8, I replicate the baseline regression with alternative measures of the logit model. The dependent variable $PENSION\_UNDERFUND\_PROB_{i,t+1}$ is a dummy variable equal to 1 if a firm's DB pension fund is underfunded and 0 otherwise. Other control variables are the same as the baseline variables. The logit regression results largely reinforce the OLS baseline model in Table 4. Most importantly, firms in higher EPU periods were more likely to underfund their pension plans.

Table 8. Alternative Measures: Logit Model

The panel logit regression is further employed to regress the relation between EPU and corporate pension underfunding levels. The dependent variable PENSION_UNDERFUND_PROB is a dummy variable equals to 1 if the firm's DB pension fund is underfunded, and 0 if the firm's DB pension fund is overfunded. The sample contains 17,701 firm-year observations between 1985 and 2019. P-value is reported in parentheses and is adjusted for heteroscedasticity. ***, **, and * indicate significant level at the 1%, 5% and 10%, separately.

Panel A: Logit model							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	EPU	EPU	EPU	EPU_News	EPU_GOV	EPU_CPI	EPU_Tax
	PENSION UNDERFUND_PROB (t+1)	PENSION UNDERFUND_PROB (t+1)	PENSION UNDERFUND_PROB (t+1)	PENSION UNDERFUND_PROB (t+1)	PENSION UNDERFUND_PROB (t+1)	PENSION UNDERFUND_PROB (t+1)	PENSION UNDERFUND_PROB (t+1)
EPU	1.742***	2.539***	9.554***				
	[0.000]	[0.000]	[0.000]				
EPU_NEWS				7.154***			
				[0.000]			
EPU_GOV_DIS					0.291*		
					[0.091]		
EPU_CPI						0.773	
						[0.170]	
EPU_TAX							-0.063
							[0.248]
CASH		4.073***	2.667***	2.446***	2.008***	2.415***	2.303***
		[0.000]	[0.001]	[0.002]	[0.000]	[0.000]	[0.000]
EARNVOL		-0.923	-3.280	-3.443	-3.327	-3.385	-3.386
		[0.772]	[0.370]	[0.347]	[0.338]	[0.329]	[0.328]
LEVERAGE		3.900	1.284***	1.072***	1.819***	1.953***	1.985***
		[0.165]	[0.002]	[0.004]	[0.000]	[0.000]	[0.000]
ASSET_TANGIBILITY		-5.630***	-1.445	-9.790	-5.196	-4.151	-2.224
		[0.006]	[0.764]	[0.800]	[0.887]	[0.909]	[0.951]
Z_SCORE		2.326	3.253*	3.077*	3.642*	3.627*	3.668*

		[0.201]	[0.089]	[0.097]	[0.066]	[0.065]	[0.064]
MB		-6.753*	-0.564	-0.862	-3.547	-3.670	-3.830
		[0.089]	[0.910]	[0.862]	[0.419]	[0.400]	[0.379]
ROA		-2.680***	-2.343***	-2.192**	-2.706***	-2.428***	-2.219***
		[0.000]	[0.004]	[0.011]	[0.001]	[0.001]	[0.001]
SIZE		15.151***	3.982	2.938	3.274	3.083	2.949
		[0.000]	[0.370]	[0.513]	[0.442]	[0.468]	[0.489]
PENSION_RETURN		-4.174***	-3.543***	-3.193***	-5.639***	-5.644***	-5.707***
		[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
EX_GDPGROWTH			6.821***	-1.623	16.764***	16.410***	16.594***
			[0.000]	[0.402]	[0.000]	[0.000]	[0.000]
REAL_GDPGROWTH			-3.196***	-3.042***	-2.711***	-2.377***	-2.394***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
ECONOMIC_INDEX			3.843***	4.641***	4.748***	4.755***	4.556***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
CONSUMER_CONFID			1.350***	-1.027	-2.812***	-1.872***	-2.113***
			[0.000]	[0.663]	[0.000]	[0.000]	[0.000]
GDPDIS			-3.954***	-4.012***	-3.095***	-3.164***	-3.180***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
SDPROFIT			-0.871***	-0.927***	0.421***	0.491***	0.468***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
SDRETURN			-1.894***	-1.804***	-1.017**	-0.037	-0.688
			[0.000]	[0.000]	[0.020]	[0.963]	[0.109]
VXO			6.084***	4.423***	1.222***	0.897***	1.350***
			[0.000]	[0.000]	[0.000]	[0.004]	[0.000]
JLN			6.874***	6.253***	4.255***	3.663**	3.458**
			[0.000]	[0.000]	[0.003]	[0.021]	[0.024]
ELECYEAR			-0.323***	0.136*	0.492***	0.629***	0.514***
			[0.001]	[0.088]	[0.000]	[0.000]	[0.000]
CONSTANT	-6.961***	-9.146***	-9.452***	-3.852***	4.665***	5.618***	4.372***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
lnsig2u	2.091***	1.750***	1.886***	1.913***	1.797***	1.796***	1.795***

	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Obs.	17701	17701	17701	17701	17701	17701	17701
p	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Chapter 6: Moderation Analysis

6.1 Capital Expenditures

Table 9 shows the moderating effect of firms' capital expenditures on the relationship between EPU and corporate DB pension underfunding levels. Capital expenditure (*CAPEX*) is calculated as capital expenditure (Compustat item *CAPX*) to lagged total assets (Compustat item *AT*) (Pedersen 2019; Duong et al. 2020). *CAPEX_HIGH* is applied when capital expenditure is higher than the industry median at the two-digit SIC code level. I regress corporate pension underfunding (*PENSION_UNDERFUND*) on EPU, a dummy variable (*CAPEX_HIGH*), and the interaction term *EPU* × *CAPEX_HIGH*.

The results in Table 9 suggest that firms with higher capital expenditure have lower corporate pension underfunding levels, which is consistent with Rauh (2006), who finds that firm capital expenditure is positively associated with corporate pension total contributions (but negatively associated with corporate pension mandatory contributions). This thesis focuses on the interaction term between high capital expenditure and EPU (*EPU* × *CAPEX_HIGH)*. This interaction term shows the moderating role of capital expenditure on the association between EPU and corporate DB pension underfunding levels. As seen in Table 9, the coefficient on the term *EPU* × *CAPEX_HIGH* is significantly positive at the 1% level, which suggests that a rise in EPU is linked with an increase in corporate pension underfunding, and this effect is more pronounced for firms with a higher level of capital expenditure.

Table 9. Subsample Analysis: Capital Expenditure and Dividend Payout

In this table, I run additional regressions to examine the role of capital expenditure and dividend payout in moderating the relation between EPU and corporate DB pension underfunding status. Capital expenditures (*CAPEX*) is calculated as capital expenditure (Compustat item "CAPX") to lagged total assets (Compustat item "AT"), according to Rauh (2006) and Pedersen (2019). *CAPEX_HIGH* of the firm-year observations with a *CAPEX* higher than the respective contemporaneous industry median at the two-digit SIC code level. As for another set of subsample analysis of the moderation role of dividend payout in EPU and pension underfunding, *Dividend* is calculated as common stock dividends (Compustat item "DVC") plus stock repurchases (Compustat item "PRSTKC" minus "PSTKRV") divided by lagged total assets (Compustat item "AT"), according to Boudoukh et. al (2007) and Srivastav, Armitage & Hagendorff (2014). *DIVIDEND_HIGH* of the firm-year observations with a *DIVIDEND* higher than the respective contemporaneous industry median at the two-digit SIC code level. I regress corporate pension underfunding (*PENSION_UNDERFUND*) on EPU, a dummy variable (*CAPEX_HIGH*), or a dummy variable (*DIVIDEND_HIGH*), and the interaction term *EPU×CAPEX_HIGH* or the interaction term *EPU×DIVIDEND_HIGH* in Table 9. All continuous variables are winsorized at 1% levels. P-value is reported in parentheses, is adjusted for heteroscedasticity, clustered by firms. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, separately.

	Capital Expenditure	Dividend Payout
Variables	PENSION_UNDERFUND (t+1)	PENSION_UNDERFUND (t+1)
EPU	0.080***	0.169***
	[0.000]	[0.000]
EPU*CAPEX_HIGH	0.034***	
	[0.001]	
CAPEX_HIGH	-0.176***	
	[0.000]	
EPU×DIVIDEND_HIGH		0.032***
		[0.007]
DIVIDEND_HIGH		-0.168***
		[0.003]
CASH	1.788**	1.223***
	[0.018]	[0.002]
EARNVOL	-0.137	-0.096
	[0.293]	[0.454]
LEVERAGE	2.782	3.022*
	[0.108]	[0.083]
ASSET_TANGIBILITY	0.118	-1.847
	[0.976]	[0.640]
Z_SCORE	-0.103	-0.095
	[0.346]	[0.463]
MB	-0.553*	-0.570*
	[0.083]	[0.072]
ROA	-0.857***	-10.302***
	[0.002]	[0.000]
SIZE	1.070*	1.995***

	[0.076]	[0.001]
PENSION_RETURN	-0.313***	-0.378***
	[0.000]	[0.000]
EX_GDPGROWTH	0.701***	0.872***
	[0.000]	[0.000]
REAL_GDPGROWTH	-0.006	-0.167***
	[0.572]	[0.000]
ECONOMIC_INDEX	0.060***	0.213***
	[0.000]	[0.000]
CONSUMER_CONFID	-0.835***	-0.321***
	[0.000]	[0.000]
GDPDIS	-0.114***	-0.126***
	[0.000]	[0.000]
SDPROFIT	-0.001	-0.007***
	[0.606]	[0.000]
SDRETURN	-0.204***	-0.142***
	[0.000]	[0.000]
VXO	0.109***	0.3324***
	[0.000]	[0.000]
JLN	3.871***	1.483***
	[0.000]	[0.000]
ELECYEAR	0.028***	-0.000
	[0.000]	[0.929]
CONSTANT	0.548***	-0.540***
	[0.000]	[0.004]
Obs.	17701	17701
adj. R^2	0.197	0.201
Firm FE	YES	YES
Firm Cluster	YES	YES

6.2 Dividend Payout

Table 9 also examines how firms' dividend payouts moderate the relationship between EPU and DB pension underfunding levels. Following Boudoukh et. al (2007) and Srivastav, Armitage and Hagendorff (2014), *DIVIDEND* is calculated as common stock dividends (Compustat item *DVC*) plus stock repurchases (Compustat item *PRSTKC* minus *PSTKRV*), divided by lagged total assets (Compustat item *AT*). *DIVIDEND_HIGH* is equal to 1 when *DIVIDEND* is higher than that of the industry median at the two-digit SIC code level, otherwise 0. I regress corporate pension underfunding (*PENSION_UNDERFUND*) on EPU, a dummy variable (*DIVIDEND_HIGH*) and the interaction term *EPU* × *DIVIDEND_HIGH*.

The variable of interest in this section is *EPU* × *DIVIDEND_HIGH*. The interaction term shows the moderating role of dividend payouts on the association between EPU and DB plan underfunding levels. As shown in Table 9, the coefficient of the interaction term *EPU* × *DIVIDEND_HIGH* is significantly positive at the 1% level, indicating that firms with a high dividend payout ratio contribute less to corporate pension plans during periods of high EPU.

6.3 Executive Compensation

In this section, I discuss whether employees are further exploited during periods of high EPU by firm executives via lower cash contributions to corporate pension plans. Previous research shows that firms can manipulate corporate pension plans, shifting the risk to employees (e.g. Anantharaman & Lee 2014, Begley et. al 2015; Thompson 2015; Stefanescu et. al 2018; Cheng & Swenson 2018, Vafeas & Vlittis 2018). On average, firms that pay their executives excessively contribute less cash to DB plans (Cheng & Swenson 2018). Executive compensation data were sourced from the Compustat ExecuComp database. I follow the literature (Bushman, Dai & Zhang 2016 and Bebchuk, Cremers & Peyer 2011) and remove firms that have reported compensation for fewer than five executives in a given year. If a firm has reported information for more than five executives, only the information for the top five highest-paid executives is used.

To estimate whether employees' benefits are negatively affected by firm executives with excessive compensation packages during periods of high EPU, I use the approaches of Core et al. (2008) and Canil, Karpavičius and Yu's (2019), who calculate executive overpayments as actual total compensation minus optimal total compensation. The benchmark for total optimal compensation is determined by regressing the natural logarithm of total pay on the following firm and managerial characteristics: CEO tenure (*CEO_TENURE*) and age (*EXECUTIVE_AGE*), sales (*SALES*), return on assets (*ROA*), stock returns (*RET*), market

returns (*S&P500_RET*) and market-to-book ratio (*MB*). The model for executives' optimal pay is shown in Equation (4) and that for excessive pay is shown in Equation (5):

$$ln(Optimal\ TOTAL\ PAY)_t = \beta_0 + \beta_1 ln(1 + CEO\ TENURE)_t + \beta_2 S\&P500\_RET_{t-1} + \beta_3 ln(SALES)_{t-1} + \beta_4 MB_{t-1} + \beta_5 ROA_t + \beta_6 ROA_{t-1} + \beta_7 RET_t + \beta_8 RET_{t-1} + \beta_9 ln(EXECUTIVE\ AGE)_{t-1} + \epsilon_t \quad (4)$$

$$ln(Residual\ Compensation)_{i,t} = ln(Executive\ Total\ Pay)_{i,t} - ln(Optimal\ Total\ Pay)_{i,t} \quad (5)$$

In Equation (4), the dependent variable is in the natural logarithm form of total compensation that is considered reasonable or optimal executive compensation. This is determined by the executive's characteristics and firm performance. Following Canil, Karpavičius and Yu (2019), *CEO_TENURE* is CEO tenure in years, computed as the respective financial year minus the year in which the CEO became the firm's CEO. *S&P500_RET* is the annual return on the S&P 500 index (e.g. Boudoukh et. al 2007). *SALES* is the natural logarithm of a firm's sales revenue. *MB* is market-to-book ratio. *ROA* is computed as the net income over a book value of a firm's assets. *RET* is the equity return in the last fiscal year. *EXECUTIVE_AGE* is the log transformation form of data extracted from ExecuComp (item *AGE*). All variables are defined in the appendix. With respect to the top five executives' optimal compensation, $\ln(1 + CEO\ TENURE)_t$ is not considered due to data unavailability. The results of the two regressions for CEO and TMT are reported in Table 10.

Table 10. Optimal Executive Compensation

I follow Canil, Karpavičius & Yu's (2019) measure to calculate optimal CEO and TMT compensations respectively. It is noted that TMT refers to the top management team members in a firm and thus it includes CEOs and non-CEO executives. Following Canil, Karpavičius & Yu (2019), I thus also include all observations in the sample period to Column (2). If Execucomp has reported more than five executives' information, then only the top five highest-paid executives' information is used (Bebchuk, Cremers & Peyer 2011; Bushman, Dai & Zhang 2016; Peyer et. al 2007). The dependent variable here is the natural log of total compensation (*ln(EXECUTIVE_TOTAL_PAY)*). *CEO_TENURE* refers to CEO tenure in years. *S&P500_RET* refers to the annual return on S&P 500 Index. *RET* represents the stock return in the last financial year. *ln(SALE)* is the natural logarithm of sales. *MB* is the market-to-book ratio. *ROA* is net income over the book value of assets. All continuous variables are winsorized at 1% levels. I include firm fixed effects and firm clustering effects. P-value is reported in parentheses, is adjusted for heteroscedasticity. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, separately.

	(1)	(2)
Variables	ln(CEO_OPTIMAL_ TOTAL_PAY) (t+1)	ln(TMT_OPTIMAL_ TOTAL_PAY) (t+1)
CEO_TENURE^{+1}	0.031**	
	[0.035]	
SALES	0.481***	0.522***
	[0.000]	[0.000]
MB	0.050***	0.090***
	[0.000]	[0.005]
ROA	−0.293***	-0.250***
	[0.002]	[0.004]
ROA^{+1}	−0.089	-0.121*
	[0.618]	[0.063]
RET	0.001***	0.001***
	[0.000]	[0.000]
RET^{+1}	0.200***	0.019***
	[0.002]	[0.000]
$EXECUTIVE\_AGE^{+1}$	−0.023	0.085***
	[0.496]	[0.000]
$S\&P500\_RET^{+1}$	−0.209	0.136***
	[0.260]	[0.000]
CONSTANT	0.276*	0.319**
	[0.058]	[0.045]
Obs	8067	30993[15]
Adj. R^2	0.413	0.460
Industry FE	YES	YES
Year FE	YES	YES

[15] The exceptional large number of observations here is because the top management team members in a firm includes not only the CEOs and but also non-CEO executives. Following Canil, Karpavičius & Yu (2019), I include all observations in the sample period to Column (2) separately. If Execucomp has reported more than five executives' information, then only the top five highest-paid executives' information is used (Bebchuk, Cremers & Peyer 2011; Bushman, Dai & Zhang 2016; Peyer et. al 2007).

In Table 11, Column (1) shows the results for the interaction term *EPU* × *CEO_OVERPAY*, while Column (2) shows the results for the interaction term *EPU* × *TMT_OVERPAY*, both of which are positively significant. The results suggest that firms that overpay their executives, on average, have higher corporate pension underfunding levels, which is consistent with the findings of Cheng and Swenson (2018). This indicates that when EPU increases, firms with overpaid executives contribute less to employee pension plans.

Table 11. Subsample Analysis: Excessive Executive Compensation

In this table, I conduct analyses to examine the role of CEO and TMT excessive compensation in moderating the relation between EPU and corporate DB pension plan underfunding status. CEO_OVERPAY and TMT_OVERPAY are dummy variables equal to 1 if a firm paying their CEO and/or TMT excessively, and zero otherwise. To determine whether firms pay their executives excessively, we refer to Table 10 to obtain the optimal pay. The optimal pay is determined by the regression result of the natural logarithm of executive pay on proxies for financial performance determinants of executive compensation, such as firm size and sales revenue. Excess pay is the residual from an optimal compensation and actual total compensation. For CEO, if the figure of excessive pay is higher than CEO sample mean, then the dummy variable CEO_OVERPAY equals 1 and zero otherwise. For TMT, I first check whether this executive has above-sample-mean excess pay, and if it is a yes, then this executive is counted as an over-paid executive. Then I calculate the ratio of over-paid executives within the TMT team of each firm. If this over-paid executive ratio is higher than the sample mean ratio, then TMT is identified as an over-paid TMT. All continuous variables are winsorized at 1% levels. I include firm fixed effects and firm clustering effects. P-value is reported in parentheses, is adjusted for heteroscedasticity. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, separately.

	(1)	(2)
	CEO	TMT
Variables	PENSION UNDERFUND (t+1)	PENSION UNDERFUND (t+1)
EPU	0.114***	0.273***
	[0.000]	[0.000]
CEO_OVERPAY	0.054	
	[0.162]	
EPU×CEO_OVERPAY	0.280*	
	[0.069]	
TMT_OVERPAY		0.266***
		[0.000]
EPU×TMT_OVERPAY		0.701***
		[0.000]

CASH	0.740**	0.705**
	[0.028]	[0.030]
EARNVOL	-0.086	-0.150
	[0.470]	[0.307]
LEVERAGE	2.991*	2.809
	[0.073]	[0.130]
ASSET_TANGIBILITY	-1.482	-0.609
	[0.791]	[0.897]
Z_SCORE	-0.127	-0.104
	[0.383]	[0.356]
MB	-0.678**	-0.796**
	[0.035]	[0.031]
ROA	-0.985***	-0.964***
	[0.000]	[0.000]
SIZE	1.091*	0.971
	[0.084]	[0.136]
PENSION_RETURN	-0.324***	-0.316***
	[0.000]	[0.000]
EX_GDPGROWTH	0.708***	0.590***
	[0.000]	[0.000]
REAL_GDPGROWTH	-0.002	0.021
	[0.771]	[0.301]
ECONOMIC_INDEX	0.051***	0.051***
	[0.000]	[0.000]
CONSUMER_CONFID	-0.868***	-0.894***
	[0.000]	[0.000]
GDPDIS	-0.120***	-0.120***
	[0.000]	[0.000]
SDPROFIT	-0.001	-0.000
	[0.607]	[0.718]
SDRETURN	-0.212***	-0.169***
	[0.000]	[0.000]
VXO	0.116***	0.107***
	[0.000]	[0.000]
JLN	0.680***	0.609***
	[0.000]	[0.000]
ELECYEAR	0.034***	0.019***
	[0.000]	[0.000]
_cons	0.453***	0.523***
	[0.000]	[0.000]
Obs.	5096	4839
Adj. R^2	0.208	0.201
Firm FE	YES	YES
Firm Cluster	YES	YES

6.4 Corporate Social Responsibility

Corporate pension funds are closely associated with employee benefits. Reduced employee benefits and retirement securities are likely to affect employee morale and productivity. In this section, I further examine how firm-level CSR activities, particularly firms' commitment to employee relations, moderate the association between EPU and DB plan underfunding. Although an abundance of research has shown that CSR activities reduce management opportunism such as earnings management (Benabou & Tirole 2010, Y. Kim et al. 2012), few have shown that firms with higher total CSR scores have lower DB plan underfunding levels (e.g. Cox, Brammer & Millington, Hwan & Hong 2020). Nevertheless, Hwan and Hong (2020) find evidence that firms with better CSR scores in the employee relations category are far less likely to manipulate DB pension plans.

CSR information was sourced from the KLD database (Chatterji et al. 2009; Hwang & Hong 2020), which provides seven CSR categories: community, diversity, employee relations, environment, human rights, products and corporate governance (MSCI 2015). This thesis examines the effect of total CSR score (*TOTAL_CSR*) and employee relations score (*EMPLOYEE_RELATION*). Following Servaes and Tamayo (2013) and Di Giuli and Kostovetsky (2014), the total CSR score for each firm is measured as the sum of scores in seven categories. Each category score is calculated as the difference between the sum of strengths (a positive score) minus the sum of deficiencies (a negative score), divided by the total number of indicators for each firm in each year. Scaling the total number of indicators retains the same weight over the seven categories. Similarly, the employee relations score is computed as the sum of positive indicators minus the sum of negative indicators from the employee relations category.

In the regression, I use dummy variables for the total CSR and employee relations scores. *TOTAL_CSR_HIGH* and *EMPLOYEE_RELATION_HIGH* are equal to 1 when the total

CSR and employee relations scores, respectively, are higher than the industry median at the two-digit SIC code level, otherwise 0. Table 12 shows the regression results for corporate pension underfunding (*PENSION_UNDERFUND*) on EPU, a dummy variable (*TOTAL_CSR_HIGH*) or (*EMPLOYEE_RELATION_HIGH*) and the interaction term (*EPU* × *TOTAL_CSR_HIGH*) or (*EPU* × *EMPLOYEE_RELATION_HIGH*), firm control variables and macroeconomic variables. The results in Table 12 show that CSR activities have a positive influence on corporate pension plans. The negative coefficients for *TOTAL_CSR_HIGH* and *EMPLOYEE_RELATION_HIGH* (significant at the 5% and 10% levels, respectively) indicate that CSR activities reduce corporate pension underfunding levels. For the moderation effect, the interaction term *EPU* × *TOTAL_CSR_HIGH* is not significant. However, the interaction term of EPU and employee relations (*EPU* × *EMPLOYEE_RELATION_HIGH*) is negative and significant, suggesting that firms that heavily engage in positive employee relations programs have lower underfunding levels in their corporate pension plans during periods of high EPU.

Table 12. Subsample Analysis: Corporate Social Responsibility

According to Servaes & Tamayo (2013) and Di Giuli & Kostovetsky (2014), the total CSR score for each firm is measured as the sum of scores in seven categories, where each category score is calculated as the sum of strengths (positive score) minus the sum of concerns (negative score), divided by the total number of indicators for each firm as at each year. The CSR score relating only to employee relations is calculated as the sum of positive indicators minus the sum of negative indicators from the employee relations category. *TOTAL_CSR_HIGH* (*EMPLOYEE_RELATION_HIGH*) of those firm-year observations that have a TOTAL_CSR (EMPLOYEE_RELATION_HIGH) scores higher than the respective contemporaneous industry median at the two-digit SIC code level. I regress corporate pension underfunding (PENSION_UNDERFUND) on EPU, a dummy variable (TOTAL_CSR_HIGH) or (EMPLOYEE_RELATION_HIGH) and the interaction term (EPU×TOTAL_CSR_HIGH) or (EPU×EMPLOYEE_RELATION_HIGH) in Table 12. All continuous variables are winsorized at 1% levels. In all regressions, the firm fixed effects and firm clustering effects are included. Robust firm clustered p-values are reported in the parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, separately.

	(1)	(2)
	TOTAL_CSR	EMPLOYEE_ RELATION
Variables	PENSION UNDERFUND (t+1)	PENSION UNDERFUND (t+1)
EPU	0.265***	0.168***
	[0.000]	[0.000]
TOTAL_CSR_HIGH	-0.204**	
	[0.032]	
EPU×TOTAL_CSR_HIGH	0.017	
	[0.845]	
EMPLOYEE_RELATION_HIGH		-0.615*
		[0.072]
EPU×EMPLOYEE_RELATION_HIGH		-0.247*
		[0.092]
CASH	-2.336	-4.384
	[0.596]	[0.351]
EARNVOL	-0.355	-0.545**
	[0.123]	[0.039]
LEVERAGE	1.564	0.771
	[0.645]	[0.830]
ASSET_TANGIBILITY	1.463**	1.497*
	[0.012]	[0.064]
Z_SCORE	-0.083	-1.111
	[0.916]	[0.226]
MB	0.561	0.181
	[0.485]	[0.823]
ROA	-1.426***	-1.004**
	[0.000]	[0.032]
SIZE	-1.475	-1.825
	[0.192]	[0.112]

PENSION_RETURN	-0.140***	-0.254***
	[0.000]	[0.000]
EX_GDPGROWTH	1.813***	1.492***
	[0.000]	[0.000]
REAL_GDPGROWTH	0.296***	0.334***
	[0.000]	[0.000]
ECONOMIC_INDEX	-0.101***	-0.352***
	[0.000]	[0.000]
CONSUMER_CONFID	-1.943***	-1.401***
	[0.000]	[0.000]
GDPDIS	-0.072***	0.027**
	[0.000]	[0.048]
SDPROFIT	-0.249***	0.044***
	[0.000]	[0.001]
SDRETURN	-0.148***	-0.255***
	[0.000]	[0.000]
VXO	-0.142***	-0.049***
	[0.000]	[0.000]
JLN	0.684***	0.381***
	[0.000]	[0.001]
ELECYEAR	-0.065***	0.043***
	[0.000]	[0.000]
CONSTANT	1.857***	2.593***
	[0.000]	[0.000]
N	5868	5214
adj. R^2	0.405	0.409
Firm FE	YES	YES
Firm Cluster	YES	YES

6.5 Equity Investments in Corporate Pension Funds

Cash contributions and investment returns jointly affect the value of corporate pension funds. As discussed in Chapter 2, shareholders have the right to sell pension assets to employees at a price equal to the value of the pension's liabilities when DB pension plan sponsors are approaching default. Thus, shareholders may be considered put option holders on corporate DB pension assets (Sharpe 1976). Sharpe (1976) and Treynor (1977) state that the value of put options is maximised when equity holders raise the pension risk.

The previous sections have discussed insufficient contributions and corporate pension underfunding. However, reducing cash contributions to corporate pension plans is only one way of increasing pension risk. Higher DB pension plan underfunding levels generally imply

that pension plans are being leveraged because employees are debtholders. Another way to increase the value of pension put options is to increase the plan's underlying asset risks by investing in riskier instruments such as equities (Anantharaman & Lee 2014).

The results in sections 6.1–6.4 show that different types of firms may have different incentives for risk-taking or risk management in their corporate pension plans. According to Rauh (2009), a risk-taking strategy involves heavily investing pension assets in riskier asset classes such as equities. In contrast, a risk-management strategy allocates a more significant fraction of assets into safe asset classes such as government debts. Rauh (2009) suggests that firms that enjoy a better credit rating usually fund their DB pension plans well but are more likely to invest a greater share of pension assets in equities, while firms with a poor credit rating and whose pension plans are underfunded shift pension assets to government debts and cash. However, whether heightened EPU causes firms to shift more assets to equity is unknown. Bali, Brown and Tang (2017) argue that when uncertainty increases, shareholders require higher returns as an economic uncertainty premium. With the economic uncertainty premium brought by heightening EPU, firms may increase their tendency to take risks, allocating more pension fund assets to equity as a means of shifting risk.

In this section, I investigate how EPU influences the allocation of corporate pension assets. In the regression, I control for pension underfunding levels, firm characteristics and macroeconomic factors. The proportion of pension assets allocated to equity provides a unique setting in which to examine the association between EPU and risk-taking in pension plans. The level of pension underfunding (*UNDERFUNDED_HIGH*) is a dummy variable, which equals 1 if the underfunding level is higher than the industry median at the two-digit SIC code level, otherwise 0. According to Anantharaman and Lee (2014), *EQUITY_ALLOCATION* is measured as the proportion of pension assets invested in equity securities. The dependent

variable is equity allocation (*EQUITY_ALLOCATION*), and the variable of interest is the interaction term *EPU* × *UNDERFUNDED_HIGH*.

Table 13. Subsample Analysis: Equity Allocation

This table shows the result of the regression of asset allocation in corporate pension funds and EPU. The dependent variable is equity allocation (EQUITY_ALLOCATION) and the variable of interest is the interaction term of EPU and pension underfunding. The pension underfunding level (UNDERFUNDED_HIGH) is a dummy variable equals to 1 and zero otherwise if the firm's pension underfunding level is higher than the respective contemporaneous industry median at the two-digit SIC code level. All continuous variables are winsorized at 1% levels and defined in the Appendix. In all regressions, the firm fixed effects and firm clustering effects are included. Robust firm clustered p-values are reported in the parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, separately.

Variables	EQUITY_ ALLOCATION (t+1)
EPU	0.312***
	[0.000]
EPU×UNDERFUNDED_HIGH	0.041***
	[0.003]
UNDERFUNDED_HIGH	-0.164**
	[0.013]
CASH	-2.679
	[0.428]
EARNVOL	-0.110
	[0.482]
LEVERAGE	-0.509***
	[0.005]
ASSET_TANGIBILITY	1.856
	[0.608]
Z_SCORE	0.317**
	[0.014]
MB	-0.017
	[0.956]
ROA	-0.809**
	[0.010]
SIZE	0.309
	[0.672]
PENSION_RETURN	0.044***
	[0.001]
EX_GDPGROWTH	0.871***
	[0.000]
REAL_GDPGROWTH	-0.076***
	[0.000]
ECONOMIC_INDEX	-0.303***
	[0.000]
CONSUMER_CONFID	0.800***
	[0.000]

GDPDIS	-0.107***
	[0.000]
SDPROFIT	-0.064***
	[0.000]
SDRETURN	-0.585***
	[0.000]
VXO	0.082***
	[0.000]
JLN	3.221***
	[0.000]
ELECYEAR	-0.001
	[0.597]
CONSTANT	-3.189***
	[0.000]
Obs.	13041
Adj. R^2	0.262
Firm FE	YES
Firm Cluster	YES

Table 13 shows the regression results. The coefficient of *UNDERFUNDED_HIGH* is negatively significant, suggesting that firms with poorly funded DB plans allocate a larger proportion of pension assets to safer assets such as fixed-income securities. This is consistent with the results of Rauh (2009). The interaction term *EPU* × *UNDERFUNDED_HIGH* is also positive and significant at the 1% level, suggesting that although managers of poorly funded pension plans prefer safer asset classes, heightened EPU increases the likelihood of risk-taking behaviours such as allocating more pension fund assets to equities. This finding highlights the potential risk-shifting behaviours in the presence of high EPU. According to Bali, Brown and Tang (2017), investors pay attention to not only the mean and variance of stock returns but also the uncertainty of future events and policies under which future return distributions will occur. EPU measures the uncertainty of the future economy and events. When EPU increases, investors will demand extra compensation such as higher returns to stay in the share market. Therefore, firms with pension plans that are already highly underfunded may be willing to invest more in equities for a potential higher return to close the gap between pension asset value

and pension obligations. However, firms with overfunded or less underfunded pension plans may instead pursue safer investment strategies.

Chapter 7: Mediation Analysis

7.1 Mediation Models

In this section, I perform a mediation analysis to explore the underlying channels through which EPU influences corporate pension plan underfunding. Specifically, following the two-step mediation regression approach designed by Zhao et al. (2010), the mediation models are formulated as follows:

$$M_{i.t} = \beta EPU + \gamma firm\ control_{i,t} + \delta investment\ opportunities\ control + \varphi marcoeconomic\ control_{i,t} + firm\ fixed\ effect + \varepsilon_{i,t} \quad (6)$$

$$Pension\ underfunding_{i,t+1} = \beta EPU_{i\,t} + \alpha M_{i.t} + \gamma firm\ control_{i,t} + \delta investment\ opportunities\ control + \varphi marcoeconomic\ control_{i,t} + firm\ fixed\ effect + \varepsilon_{i,t} \quad (7)$$

where *M* denotes the mediators.

The first step is to examine the relationship between EPU and information asymmetry or financial constraints. Corporate pension underfunding levels are then regressed on EPU, the mediating variables, firm characteristics, investment opportunities, control variables and general macroeconomic control variables in the second step. If the coefficients of corporate pension underfunding levels are positively significant in both regressions and the mediating variables are also statistically significant, the mediating effect holds.

7.2 Mediators

Cocco and Volpin (2013), Rauh (2006) and Campbell et al. (2012) find that firms with high information asymmetry or opacity are more likely to hold more cash for secure investment opportunities and precautionary purposes, which may contribute to higher levels of pension underfunding. Meanwhile, Nguyen and Phan (2017) show that EPU exacerbates financial

constraints, which also limit a firm's ability to make cash contributions to its DB pension plans (Rauh 2006, 2009, Campbell et al. 2012).

Following Cai et al. (2015) and Wu and Lai (2020), an information asymmetry index is constructed from multidimensional elements such as firm size (Diamond & Verrecchia 1991, Krishnaswami, Spindt & Subramaniam 1999), Tobin's Q (McLaughlin, Safieddine & Vasudevan, 1998), research and development expenses (Aboody & Lev 2000), number of shareholders (Armstrong et al. 2011; Li et. al 2006), analyst coverage (Chemmanur & Paeglis 2001; Li 2020) and analyst earnings forecast errors (Krishnaswami & Subramaniam 1999). The starting point is to calculate the percentile ranking for each select variable over the entire sample period. Next, I calculate the average of the percentile rankings of all components. A higher score in the information asymmetry index indicates a greater degree of information asymmetry.

The proxy for financial constraints is the index designed by Hadlock and Pierce (2010) (HP Index). A higher HP Index represents a higher degree of financial constraints. The HP Index is defined as follows:

$$HP\ Index = -0.737 \times SIZE + 0.043 \times SIZE^2 - 0.040 \times FIRM\_AGE \quad (8)$$

where *SIZE* is the log transformation of total assets of a firm, and *AGE* is computed as the year 2019 minus the year of the firm's initial public offering.

7.3 Results and Analysis

Table 14 shows the results of the mediation models. Column (1) repeats the baseline regression, showing that EPU has a positive and significant association with corporate DB pension underfunding levels. Column (2) shows that EPU has a positive relationship with the information asymmetry index, significant at the 1% level. This finding indicates that EPU is linked with a higher degree of information asymmetry because of a high level of uncertainty.

Column (3) reports that EPU has a positive association with financial constraints, significant at the 1% level. This finding indicates that EPU is associated with a high degree of financial constraints because of higher uncertainty and risk. In Column (4), both mediating variables are added into the one regression to investigate the relative explanatory power of the two potential underlying channels. There is no evidence supporting the mediating effect of information asymmetry. However, the coefficient for the HP Index is positive and significant, indicating that the mediating effect mostly arises from financial constraints ($99.54\% = \frac{0.433}{0.002+0.433}$). This suggests that EPU affects corporate pension plan underfunding mainly through increased financial constraints.

Table 14: Mediation Models

This table shows the mediating role of financial constraints in the relation between EPU and corporate DB pension underfunding level for a sample of U.S. listed firms from 1985 to 2019. The dependent variable is PENSION_UNDERFUND, which is calculated as Pension liabilities minus the fair value of pension assets, divided by pension liabilities. The dependent variables in Columns (2) and (3) are information asymmetric and financial constraints. Information asymmetric is the information asymmetry index proposed by Wu & Lai (2020). Financial constraint is measured by the HP index designed by Hadlock & Pierce (2010). The main explanatory variable EPU is the log transformation of the BBD Index. Other control variables include firm's cash position (CASH), earnings volatility (EARNVOL), leverage (LEVERAGE), asset tangibility (ASSET_TANGIBILITY), Altman Z-score (Z_SCORE), ROA (ROA), firm size (SIZE), and actual return from corporate pension asset investments (PENSION_RETURN). The general macroeconomic uncertainty control variables are also added, including expected GDP growth (*EX_GDPGROWTH*), real GDP growth (*REAL_GDPGROWTH*), leading economic index (*ECONOMIC_INDEX*) and consumer confidence (*CONSUMER_CONFID*), GDP forecast dispersion (*GDPDIS*), standard deviation of cross-sectional profit growth (SDPROFIT), standard deviation of cross-sectional real returns (*SDRETURN*), implied volatility (*VXO*), Jurado et al. (2015)'s index (*JLN*) and election year dummy (*ELECYEAR*). All continuous variables are winsorized at 1% levels and defined in Appendix. The firm fixed effects and firm clustering effects are included. Robust firm clustered standard errors are reported in the parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, separately.

	(1)	(2)	(3)	(4)
Variables	PENSION_ UNDERFUND (t+1)	IA_INDEX	HP_INDEX	PENSION_ UNDERFUND (t+1)
EPU	0.561*** [0.000]	3.243*** [0.000]	0.310** [0.013]	0.421*** [0.000]

IA_INDEX				0.002
				[0.914]
HP_INDEX				0.433***
				[0.000]
CASH	0.742**	3.029***	1.571***	1.125
	[0.022]	[0.004]	[0.000]	[0.786]
EARNVOL	-0.039	-6.731	0.361***	-0.342*
	[0.759]	[0.239]	[0.000]	[0.066]
LEVERAGE	1.826	-8.787	-0.681	4.978
	[0.290]	[0.282]	[0.472]	[0.159]
ASSET_TANGIBILITY	-2.985	-4.476***	-1.912***	1.085
	[0.442]	[0.001]	[0.000]	[0.101]
Z_SCORE	-0.114	6.123**	-0.104	-0.363
	[0.305]	[0.047]	[0.356]	[0.642]
MB	-0.389	1.462***	0.327*	0.202
	[0.216]	[0.000]	[0.051]	[0.669]
ROA	-0.770***	2.963	-2.883*	-1.453**
	[0.003]	[0.110]	[0.065]	[0.022]
SIZE	1.295**	3.512***	5.930***	0.107
	[0.033]	[0.000]	[0.000]	[0.915]
PENSION_RETURN	-0.208***	2.296***	0.102***	-0.313***
	[0.000]	[0.000]	[0.000]	[0.000]
EX_GDPGROWTH	0.822	-3.650***	-2.300***	0.793***
	[0.666]	[0.000]	[0.000]	[0.000]
REAL_GDPGROWTH	-0.195***	-1.468***	-0.326***	0.236***
	[0.000]	[0.000]	[0.000]	[0.000]
ECONOMIC_INDEX	0.226***	1.709***	0.481***	-0.044***
	[0.000]	[0.000]	[0.000]	[0.005]
CONSUMER_CONFID	0.280***	2.850***	0.289***	-0.110
	[0.000]	[0.000]	[0.000]	[0.364]
GDPDIS	-0.146***	-6.175***	-0.216***	0.058***
	[0.000]	[0.000]	[0.000]	[0.000]
SDPROFIT	-0.056***	-0.765***	0.040***	-0.062***
	[0.000]	[0.000]	[0.000]	[0.000]
SDRETURN	-0.628***	-9.409***	-0.089***	-0.659***
	[0.000]	[0.000]	[0.000]	[0.000]
VXO	0.201***	3.045***	0.216***	0.106***
	[0.000]	[0.000]	[0.000]	[0.000]
JLN	0.393***	2.470***	-1.359***	2.375***
	[0.000]	[0.000]	[0.000]	[0.000]
ELECYEAR	0.013***	-1.598***	-0.033***	-0.003
	[0.000]	[0.000]	[0.000]	[0.309]
CONSTANT	-2.411***	-1.162***	-0.263***	-1.831***
	[0.000]	[0.000]	[0.000]	[0.000]
Obs.	17701	17701	17701	17701
Adj. R^2	0.247	0.609	0.716	0.419
Firm FE	YES	YES	YES	YES
Firm Cluster	YES	YES	YES	YES

Figure 3 illustrates the mediation channels. The baseline model shows that the overall effect of EPU on corporate DB pension underfunding is 0.561. According to Zhao et al. (2010), the indirect effect of EPU through information asymmetry on corporate pension underfunding levels is $0.0007\ (= 0.343 \times 0.002)$. This intangible channel accounts for $1.247\% \left(= \frac{0.343 \times 0.002}{0.561}\right)$ of the total effect. Similarly, the indirect effect of EPU on corporate pension underfunding through financial constraints is $0.134\ (= 0.310 \times 0.433)$. This tangible channel accounts for $23.886\% \left(= \frac{0.310 \times 0.433}{0.561}\right)$ of the total effect. Compared with Columns (1) and (4) in Table 13, the significance level of the relationship between corporate pension underfunding and EPU remains unchanged, whereas the coefficient of EPU drops from 0.561 to 0.421.

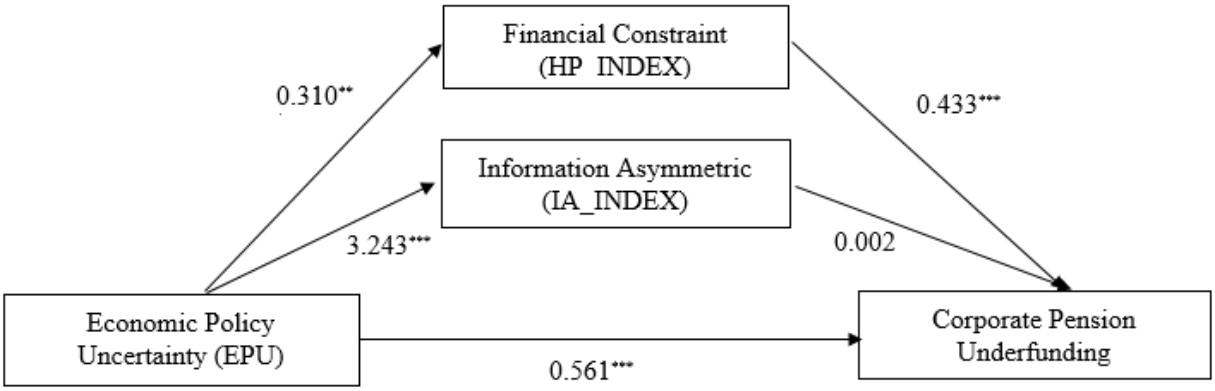

Figure 3: Demonstration of the Mediation Effect

Chapter 8: Discussion and Conclusion

In this thesis, I explore the association between EPU and corporate DB pension funds. I use the BBD index developed by Baker, Bloom & Davis (2016) to measure EPU, which captures uncertainty about upcoming fiscal, monetary, tax and regulatory regimes or political leadership.

I find a significant positive association between EPU and corporate DB pension underfunding levels for US firms from 1985 to 2019. This result is robust to controlling for other macroeconomic variables. I also find consistent results when using the 2SLS approach and a logit regression model. These results support the risk-shifting theory. From the put option perspective, shareholders are incentivised to maximise risk in corporate pension funds. Increased EPU increases firms' uncertainty about their future prospects; thus, shareholders are more likely to shift the risk to pension beneficiaries.

In the subsample analysis, I investigate the moderation effects of EPU on corporate pension underfunding levels from the perspectives of capital expenditure, dividend payouts, CEO and TMT compensation, CSR activities and corporate pension asset allocation strategies. I find that the effect of EPU on corporate pension underfunding levels is more pronounced in firms with higher capital expenditure and higher dividend payout ratios. More importantly, firms that pay their executives excessive salaries are more likely to underfund DB pension plans during periods of high EPU. In contrast, firms with better CSR scores have lower pension underfunding levels. These findings suggest that employees may be exploited by executives when uncertainty increases, while those working in firms with higher CSR engagement generally have better retirement securities. Finally, firms with higher corporate pension underfunding allocate more assets to riskier equity instruments during high EPU periods, again confirming the existence of risk shifting in corporate pension plans.

I then examine the underlying economic channels through mediator analysis. I use two mediators, information asymmetry and financial constraints. I find that the positive effect of EPU on the corporate pension underfunding levels occurs mainly through the tangible channel of financial constraints rather than through the intangible information asymmetry channel.

The thesis contributes to the growing research on EPU. By linking internal corporate pension contributions to external uncertainty, particularly EPU, this paper extends the research on corporate pension plans and confirms that EPU has value implications and can decrease the benefits of corporate employees.

Second, the findings presented in the thesis may help policymakers and regulatory bodies to better recognise how macroeconomic policies can affect DB plan deficits, which has significant policy implications. For example, governments can open new funding channels and premium social security support for DB plan sponsors. After all, pensions are the responsibility of society as a whole rather than individual firms' finance departments. With assistance from government funding channels, DB plans may become more sustainable. Regularity bodes may also act as guarantors for funding or loans to DB plan sponsors to a certain extent. Another implication may be tax incentives, such as further tax exemptions for contributions to DB plans.

I also acknowledge that this thesis has some limitations. First, there is no perfect measure of EPU. I use the BBD index as a proxy for EPU, which is largely based on the frequency of keywords in 10 leading US newspapers. Although the BBD index has withstood detailed human audits and checks, it may not be a perfect measure of EPU because the data are not perfect (Gulen & Ion 2016). Second, errors could exist in the disclosed pension asset and liability measures (Barth 1991; Stefanescu 2006) such as using book value or market value on balance sheets. Thus, market value is subject to actuarial assumptions and accounting manipulation.

The work of this thesis could be extended in several directions. For example, future research could examine and compare the effects of EPU on the pension policies of public versus private firms or firms in developed versus developing countries. In addition, my thesis mainly focuses on underfunding levels of DB plans. However, employees may also be exploited via pension conversions and freezes. These variables may also be considered in the study of employee exploitation. In my future research, I aim to address some of these limitations to enhance the understanding of corporate pension plans.

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Appendix

Variable Codes, Names and Definitions

Code	Name	Definition	Data Source
Dependent Variable			
PENSION_UNDERFUND	Corporate pension underfunding level	Pension liabilities minus fair value of pension assets divided by pension liabilities: $(PBPRO_t - PPLAO_t)/PBRPO_t$	Compustat
Main Independent Variable			
EPU	Economic Policy Uncertainty (Overall)	Log transformation of BBD Index (Overall)	www.policyuncertainty.com/us_monthly.html
EPU_NEWS	Economic Policy Uncertainty (News)	Log transformation of BBD Index (News)	
EPU_GOVDIS	Economic Policy Uncertainty (Government disagreement on fiscal and monetary policies)	Log transformation of BBD Index (Government disagreement on fiscal and monetary policies)	
EPU_CPI	Economic Policy Uncertainty (Inflation)	Log transformation of BBD Index (Inflation)	
EPU_TAX	Economic Policy Uncertainty (Tax Codes)	Log transformation of BBD Index (Tax Codes)	
Pension Characteristics Variable			
PENSION_RETURN	Pension actual return on plan assets	Compustat item "*PBARAT"*	Compustat
Firm Characteristics Variable			
CASH	Firm's cash position	Cash divided by total assets: CH_t/AT_t	Compustat

EARNVOL	Earnings volatility	Standard deviation of quarterly earnings (Compustat item "*EPSPIY"*) in the previous four years	Compustat
LEVERAGE	Leverage	Total debt divided by total assets: $(DLTT_t + DLC_t)/AT_t$	Compustat
ASSET_TANGIBILITY	Asset tangibility	Tangible assets divided by total assets: $PPENT/AT_t$	Compustat
Z_SCORE	Bankruptcy risk	Z_SCORE=3.3 × $\left(\frac{EBIT_t}{AT_t}\right)$ + 1.0 × $\left(\frac{SALES_t}{AT_t}\right)$ + 1.4 × $\left(\frac{RE_t}{AT_t}\right)$ + 1.2 × $[\frac{(ACT_t - LCT_t)}{AT_t}]$	Compustat
MB	Market-to-Book Ratio	Market value of assets (book value of assets – book value of equity (*CEQ*)+market value of equity (common shares outstanding (*CSHO*)×closing share price at the end of the fiscal year (*PRCC_F*) – deferred taxes (*TXDB*) over book value of assets	Compustat
ROA	Return on assets	Net income over book value of assets: NI/AT_t	Compustat
SIZE	Firm size	Natural logarithm of the book value of total assets: Log (AT_t)	Compustat
Macroeconomic Control Variables			
EX_GDPGROWTH	Expected GDP Growth	The percentage change between the annual mean one-year-ahead GDP forecasts from the Philadelphia Federal Reserve's biannual Livingstone survey	https://www.philadelphiafed.org/surveys-and-data/real-time-data-research/livingston-survey

ECONOMIC_INDEX	Leading Economic Index	The Conference Board's monthly Leading Economic Index, which is based on ten macroeconomic indicators	https://conferenceboard.org/data/bcicountry.cfm?cid=1
REAL_GDPGROWTH	Real GDP Growth Rates	The real GDP growth rates from the World Bank's World Development Indicator	https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG
CONSUMER_CONFID	Consumer Confidence	The Michigan Consumer Confidence Index from the University of Michigan	https://data.sca.isr.umich.edu/data-archive/mine.php
ELECYEAR	Election Year Dummy	Dummy variable indicating the presidential election years	https://history.house.gov/Institution/Election-Statistics/
GDPDIS	GDP Dispersion	Log transformation of GDP Dispersion, the coefficient of variation of GDP forecasts	https://www.philadelphiafed.org/surveys-and-data/real-time-data-research/livingston-survey
SDPROFIT	Profit Volatility	Log transformation of profit growth, the annual cross-sectional standard deviation of the growth in firm profit	Compustat
VXO	Implied Volatility	Log transformation of VXO index, the implied volatility from the Chicago Board Options Exchange	https://finance.yahoo.com/quote/%5EVXO/history/
SDRETURN	Return Volatility	The yearly historical stock return volatility, i.e., the standard deviation of monthly stock returns in previous twelve months	Compustat
JLN	Jurado et al. (2015)‘s Index	Log transformation of JLN aggregate uncertainty index	https://www.sydneyludvigson.com/data-and-appendixes
Subsample Analysis Variables			

GFC	Global financial crisis	GFC=1 if in year 2007, 2008 and 2009	
RECESSION	Economic recession	RECESSION=1 if in year 1990, 1991, 2007, 2008 and 2009	https://www.nber.org/cycles.html
CAPEX	Capital expenditure	Capital expenditures divided by lagged total assets: $CAPX_t/AT_{t-1}$	Compustat
DIVIDEND	Dividend payout, including cash dividend and share repurchase	Common stock dividends plus stock repurchases divided by lagged total assets: $(DVC_t + Stock\ repurchase_t)/AT_{t-1}$.	Compustat
FIRM_AGE	The history of a firm	Log transformation of The number of years since the year of a firm's incorporation or founding	Compustat
TOTAL_PAY	CEO or TMT total annual compensation	Total compensation (*TDC1*) adjusted for inflation using GDP deflator (in 1000 s of 2009 USD)	Execucomp
EXECUTIVE_AGE	Executive age	Log(*AGE*)	Execucomp
SP500 Return	Market Return	Value-Weighted Return incl. dividends, CRSP data item "VWRETD ").	CRSP
SALES	Sales Revenue	Natural logarithm of sales (Compustat item "*SALE"*)	Compustat
RET	Stock Return	Stock return over the last fiscal year ((*PRCC_F*/*AJEX* + *DVPSX_F*/ *AJEX*)/(lag(*PRCC_F*)/lag(*AJEX*))-1)	Compustat
CEO_TENURE	CEO Tenure	Natural logarithm of CEO tenure: Log (*TENURE*). The difference between the year	ExecuComp

		of the observation and the year in which the executive became CEO. CEO tenure calculated as the fiscal year minus the year the CEO became the company's CEO (ExecuComp data item "*BECAMECEO*"). CEOs are identified using the ExecuComp variable '*CEOANN'*.	
HP INDEX	Financial Constraint Index	HP = – 0.737×log(*AT*) – 0.043×[log(*AT*)]^2 – 0.040× "FIRM_AGE"	Compustat