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The empirical corporate finance research on defined benefit pension plans

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I certify that all material in this thesis which is not my own work has been identified and that any material that has previously been submitted and approved for the award of a degree by this or any other University has been acknowledged.

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Abstract

This dissertation consists of three main chapters. The first main chapter examines the implications of the defined benefit (DB) pension deficits on firms' expected future growth from a market perspective. I introduce a novel method in estimating a firm's expected growth rate based on all available public information, including companies' financial statements, stock prices and analysts' forecasts of future earnings. The empirical evidence shows that firms' expected growth rates are negatively associated with the funding status of DB pension plans. Theoretically, the mechanism through which markets incorporate a pension plan's funding status into a firm's growth expectation is its pension deficit, which commonly increases its cost of capital and restricts its contemporary investments. As a result, the DB pension plan deficits negatively affect firms' growth ability from the market perspective. I also find that the market tends to consider pension information and other factors – for example, financial constraints, profitability, and the period of growth expectation – to evaluate the overall effect on firms' growth. The evidence suggests that the negative impact of the current pension deficits on a firm's growth expectation stems from investors noting that future investments in operating activities may decline with the DB pension contributions.

To determine whether the market integrates pension information into a firm's growth prediction, I initially examine pension information transformation among various stakeholders. In the second main chapter, I further demonstrate the existence of asymmetric information for the most severely underfunded firms. The empirical evidence supports my hypothesis that pension information is not sufficiently transparent for the most severely underfunded firms. Thus, investors require extra risk compensation, which is reflected in a higher expected stock return. This asymmetric

information hypothesis is supported by a striking post-earning price drift for positive and negative earnings surprises. I also examine a firm's merger and acquisition deal announcement effect. If an acquirer has high asymmetric information, its stock tends to be recognised as overpriced. Therefore, the market will not take an optimistic view of this deal if they use their stock as a payment means. Indeed, the evidence shows that the higher portion of cash in total payment has a higher abnormal return around the announcement date for a target firm's stock price. Notably, this finding seems to be restricted to the most severely underfunded firms.

The natural cash outflow for mandatory pension contributions is predictable for managers. Because managers are inner stakeholders with an information advantage on a DB pension plan's actual status, it is rational to assume they could anticipate subsequent mandatory pension contributions and adopt a suitable liquidity strategy in advance. In the third main chapter, I examine whether firms increase cash holding in response to the anticipated pension contributions. The evidence suggests that when the firm sponsors the most severely underfunded pension plans, the precautionary excess cash holding will increase if the firm is financially constrained. Moreover, the value of excess cash holding is reduced for the most severely underfunded pension plans since the excess cash is mainly held for subsequent pension contributions. If firms need to compensate for severe pension deficits, investors will undervalue the excess cash holdings. The finding further demonstrates the investors determine the value of cash reserves by how the cash reserves will be used.

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1. Introduction

There is a vast literature focusing on corporate defined benefit (DB) pension plans. Due to differences in pension regulation, accounting and funding requirements, my research is based entirely on DB pension plans sponsored by US firms. American pension plans are generally categorised as defined benefit (DB), defined contribution (DC), or hybrid types. DB pension plans' sponsors provide pension promises to their employees, with eventual payments depending on the evolution of employees' wages, mobility, longevity, inflation adjustment and other factors. Because the pension liability is deferred and the exact amount is uncertain, sponsors apply actuarial assumptions to estimate its present value for pension accounting and pension funding. The difference is regarded as the pension deficit if the estimated pension liability value is greater than the pension asset's fair value. In general, sponsors must clear the pension deficit within seven years.[1]

Studies in the DB pension plans are particularly fruitful in the finance and accounting research field. Cocco (2014) provides a comprehensive review of the pension-related research, illustrating the conflict of interests that arises among a firm's various stakeholders regarding pension plans and demonstrating the association between pension policies and corporate financial policies. This thesis, however, focuses on three specific topics: pension plan valuation, pension information transformation and pension plan induced risk management in three main chapters.

Chapter 2 is motivated by Rauh (2006a). Rauh finds that mandatory pension

[1] The Pension Protection Act 2006 requires the pension deficit, less any permissible credit balances must be amortised in annual instalments over seven years. The plan sponsor's minimum required annual contribution is the plan's target normal cost for the plan year, but not less than zero. The 100% funding target will be phased in at 92% in 2008, 94% in 2009, 96% in 2010 and 100% in 2011 and later years. The phase-in will not apply to plans that are already underfunded to the extent that they were subject to the deficit reduction contribution rules in 2007. Those plans will have a 100% funding target beginning in 2008.

contributions reduce a firm's capital expenditure to forgo positive NPV investment opportunities. Campbell, Dhaliwal and Schwartz Jr (2011) provides further evidence that a firm's cost of capital is an intervening variable to explain Rauh (2006a)'s findings. They find the most severely underfunded pension plan sponsors rely more on external funds because the high pension contribution squeezes the internally generated cash flow. Consequently, the higher cost of capital due to the market friction will force the firm to forgo investments in profitable projects. In addition, Shivdasani and Stefanescu (2009) show that incorporating the pension plan into a firm's capital structure can significantly increase its leverage. These findings suggest the severely underfunded DB pension plan will damage the firm's growth in the long term, given that the firms sponsoring severely underfunded plans are likely to incur mandatory pension contributions soon. Franzoni and Marin (2006) argue investors do not understand the persistence in pension contributions so that the share prices of the sponsoring companies react only with a delay when the contributions are finally paid into the plan. To my knowledge, whether current pension deficits affect investors' perspective about a firm's growth is not well addressed. However, the evidence in Franzoni and Marin (2006) shows investors can be shocked by the negative impact of subsequent pension contributions on the firm's earnings.

I introduce a novel method for estimating a firm's long-term growth expectation and provide empirical evidence that markets incorporate the negative impact of pension contributions on a firm's capital expenditure into estimating its expected growth in Chapter 3. It shows that the market integrates its characteristics and pension plan funding status to form its long-term growth expectations. For example, severe financial constraints or insufficient non-operating cash holdings (measured at the end of the fiscal year) increase the expected cash pressure induced by the estimated mandatory pension contributions, thus having a more striking impact on growth expectations. Previous research shows that managers have leeway in timing their pension contributions according to their financial flexibility conditions. Bartram (2018) finds that US sponsors of defined-benefit pension plans integrate their pension plans into their overall financial management. Plan contributions are

smaller and funding levels lower for plan sponsors with less cash, less profitable, and financially distressed. Moreover, plan sponsors make more aggressive pension plan assumptions if they have lower cash holdings and profit margins. Thus, this negative effect is attenuated through adjustments to the timing and amounts in the pension contribution schedule. After considering the horizon of contribution determinations, I find that a firm's profitability only alleviates the negative impact on short-term growth expectations. However, it has a weak effect on long-term growth expectations, indicating that markets account for managers' discretion in pension contributions.

Chapter 3 demonstrates that the market anticipates the negative effect of pension deficits on the firm's long-term growth. This is consistent with the previous papers that find the pension asset and liabilities can explain the sponsoring firms' market value. For instance, early empirical papers find that sponsors of better-funded plans tend to have better debt ratings (Martin and Henderson, 1983; Maher, 1987). These papers suggest a degree of substitutability between pension liabilities and long-term debt. In addition, Jin, Merton and Bodie (2006) confirm that a firm's equity beta and returns reflect its pension plan's risk. Their empirical findings suggest that equity risk reflects the firm's pension plan risk, despite arcane accounting rules for pensions. This finding is consistent with informational efficiency in capital markets. They also posit that the standard procedure of calculating de-leveraged betas is not adjusted for the risk of the pension assets and liabilities. The failure to make this adjustment typically biases upward estimates of the discount rate for capital budgeting.

Due to opaque and complex pension accounting standards, pension information is not always sufficiently transparent. Coronado and Sharpe (2003) suggest that capital markets appear to pay more attention to pension-induced accruals reported in income statements than to the marked-to-market value of pension assets and liabilities reported in the footnotes. Besides, investors appear not to distinguish between the earnings associated with pension accruals and firms' core earnings. Picconi (2006) finds that neither prices nor forecasts fully reflect the quantifiable future earnings effects of changes in pension information when it becomes publicly

available in the firm's 10-K. Instead, the evidence suggests that investors and analysts only gradually incorporate this information into prices and forecasts as they observe the effects of pension plan changes on subsequent quarterly earnings. Additionally, Franzoni and Marin (2006) argue that investors can be shocked by the negative impact of pension deficits on future earnings and cash flows. They find that the market fails to anticipate the severe pension deficits' negative effect on future earnings and cash flows, incorporating it only when the negative impact has been materialised in a firm's financial statements. They argue that analysts may not fully anticipate the effect of pension underfunding on future earnings either because they observe a negative earnings surprise for the most severely underfunded firms.

Managers' manipulation also biases the market reaction to a firm's pension plan funding status. Bergstresser, Desai and Rauh (2006) find that managers appear to manipulate firms' earnings through their characterisations of pension assets to capital markets. Furthermore, they alter investment decisions to justify and capitalise on these manipulations. Managers are more aggressive with assumed long-term return rates when their assumptions significantly impact reported earnings. Firms use higher assumed return rates when they prepare to acquire other firms, near critical earnings thresholds, and when their managers exercise stock options. In turn, changes in assumed returns influence pension plan asset allocations. Further evidence is revealed by An, Lee and Zhang (2014), who find that number of firms that increase the expected rate of return (ERR) on pension plan assets to make their reported earnings meet/exceed analyst forecasts are significantly larger than what would be expected by chance. In the short term, the stock market reacts positively to these firms' earnings announcements which is consistent with Coronado and Sharpe (2003)'s conclusion that investors fail to recognise that earnings benchmarks are achieved by manipulating pension earnings. However, firms that employ this earnings management strategy significantly underperform control firms in stock returns and operating performance in the long term.

The difference between 'accounting value' and 'economic value' creates information asymmetry, especially with the most severely underfunded firms. The

asymmetric information induced by DB pension plans is also discussed in prior literature. For example, Cocco and Volpin (2013) use UK data to show that firms that sponsor a DB pension plan are less likely to be targeted for acquisition. In case of an attempted takeover, they are less likely to be acquired. They suggest that the uncertainty in pension liabilities' value is a source of risk for acquirers of the firm's shares, which works as a takeover deterrent. In addition, they find that these same firms are more likely to use cash when acquiring other firms and that the announcement of a cash acquisition is associated with positive announcement effects.[2]

The mixed evidence raises a question: whether asymmetric information induced by the DB pension plan exists. Picconi (2006) argues the investors can completely process the pension information that has already been recognised in income but fail to fully impound the valuation impact of pension liabilities disclosed in footnotes. Recently, several accounting changes have come into effect, which has made pensions more transparent. In particular, SFAS No.158 (issued in 2006) requires sponsors to report the pension asset and liabilities as on-balance-sheet items. So, in Chapter 4, I try to answer this question with more recent US data.

Firstly, I find the sponsoring the most severely underfunded pension plan will incur a higher expected stock return. Specifically, the regression results show that neither the Fama-French 5 factors plus the momentum factor model, nor the Q-5 factor model, can fully explain this higher expected stock return. Then, I provide empirical evidence to show that firms sponsoring the most severely underfunded pension plans are exposed to asymmetric information, which can be regarded as an additional risk factor. This higher expected stock return could be explained as investors requiring higher risk compensation for holding stocks with severe asymmetric information. The evidence suggests that the market prices pension-induced risk. My evidence also indicates that the implications of asymmetric information are associated with the pension plan funding status. The firms sponsoring the most severely underfunded pension plan are still bothered by asymmetric information. My

[2] Due to different accounting, funding, and regulation requirements for pension funds across countries, the takeover deterrence in the US is explained by agency theory in Rauh (2006b). The evidence suggests that employee ownership is defined contribution plans lowers takeover probabilities.

empirical evidence is taken from the post-earnings-announcement drift (PEAD), DB pension plan freezing strategy, and the announcement effect of M&A deals concerning the DB plan sponsors as the acquirers.

As inner stakeholders, managers have information advantages over external investors regarding the actual pension plan funding status. How managers process, the pension induced risk has been discussed in the extant literature. Studies mainly focus on DB pension asset allocations, where risk-shifting and risk-management incentives are likely to occur. Rauh (2009) find that firms with poorly funded pension plans and weak credit ratings allocate a greater share of pension fund assets to safer securities such as government debt and cash. In contrast, firms with well-funded pension plans and strong credit ratings invest more heavily in equity. The incentive to limit costly financial distress plays a considerably more prominent role than risk-shifting in explaining variation in pension fund investment policies among firms in the US. In contrast, An, Huang and Zhang (2013) report that, for financially distressed firms on the verge of bankruptcy, risk-shifting dominates risk-management, with pension asset allocation shifted to risky assets. The mixed evidence is explained as a matter of financial distress measuring in Cocco (2014). In addition, Anantharaman and Lee (2014) provides an alternative explanation that the compensation incentives for top management affect the extent of risk-shifting versus risk-management behaviour in pension plans. They find that risk-shifting through pension underfunding (and, to a lesser extent, through pension asset allocation to risky securities) is stronger with compensation structures that create high wealth-risk sensitivity (vega) and weaker with high wealth-price sensitivity (delta). These findings are more robust for chief financial officers (CFOs) than chief executive officers (CEOs), suggesting that pension policy falls within the CFO's domain. Risk-shifting through pension underfunding is also lower when the CFO's stake in the pension plan is larger.

Moreover, the pension asset allocation is also associated with the firm's characteristics. Amir, Guan and Oswald (2010) examines the impact of new pension disclosures – and subsequent full pension recognition under SFAS No.158 in the US – on pension asset allocation. Since SFAS No.158 requires recognising the net pension

surplus or deficit on the balance sheet and the actuarial gains or losses in other comprehensive income, this standard introduces volatility into accounting reporting. The empirical evidence shows that, while US companies maintained a stable allocation to equities and bonds before adopting SFAS No.158, these companies, on average, shifted funds from equities to bonds around the adoption of SFAS No.158. The cross-sectional analysis in Amir, Guan and Oswald (2010) suggests that the shift away from equities is related to changes in funding levels, shorter investment horizons, increased financial leverage, and the expected impact of the new standards on shareholders' equity. Furthermore, Phan and Hegde (2013) find that firms with good external and internal corporate governance take more risk by investing heavily in equities and allocating a smaller share of the plan assets to cash, government debt, and insurance company accounts. Besides, the literature also suggests that, in some circumstances, the compensation structure for managers dominates the pension policy. Overall, these findings show that pension policy is a crucial component in managers' integrated firm policies.

Although the prior evidence on pension induced risk management is mixed, it is apparent that managers recognise pension risk as contributing to a firm's overall risk. Thus, they incorporate pension-induced risk into the overall risk-management strategy. A pension-induced risk that has been widely discussed in prior literature is that the mandatory pension contribution can create internal financial constraints. Consequently, internal financial constraints may reduce firms' investments. However, Ballester, Fried and Livnat (2002) find that managers can use DB pension plans to build financial slack. Their empirical evidence suggests that firms with declining contributions after a period of increasing contributions are found to invest more in capital expenditures. Their findings suggest the amount and time of pension contribution is at managers' discretion. They explain the incentive of increasing pension contributions is for future investments. Therefore, how managers process and manage the potential pressure of pension contributions has not been well understood. In Chapter 5, I examine whether managers anticipate and how they manage the cash pressure induced by subsequent mandatory pension contributions.

Chapter 5 examines whether firms' cash holding level is associated with the pension plan's funding status. Since the current funding status determines the amount of subsequent mandatory pension contribution, the most severely underfunded pension plans indicate a higher required pension contribution in the near future. Increasing the cash reserves will be an efficient strategy to buffer the prospective contribution pressure. Moreover, the excess cash holding is most at managerial discretion comparing with total cash holding. Thus, I infer the precautionary cash holding motive will be more pronounced for firms' excess cash holdings. The regression results support my hypothesis that the most severely underfunded pension plans will push sponsors to increase excess cash holding positions. Franzoni (2009) states that the price decrease following a pension-induced drop in cash is magnified for firms that appear a priori more financially constrained. His evidence suggests the firms' financial position significantly affects the implications of pension contribution on firms' value. I further analyse the influence of firms' financial situation and find the increasing effect on excess cash holding is only statistically significant for financially constrained firms. Finally, I examine how the shareholders value the excess cash holdings. The regression results show that the value of excess cash holding is reduced for the most severely underfunded pension plans, demonstrating the conventional idea that the "value of cash reserves" is determined by how investors expect the cash to be used (Dittmar and Mahrt-Smith, 2007).

My thesis is composed of six sections. The second section is the discussion on the institutional background information on the US corporate pensions system. Then, the following three sections are the main chapters in order. The final section is the summary and conclusion for the whole thesis.

2. Institutional Background

A pension plan is an employee benefit that commits the employer to make regular pension contributions to the pension fund set aside to fund payments made to eligible employees after they retire. Companies' pension schemes in the US can be generally categorised as defined benefit (DB) pension plans, defined contribution (DC) pension plans or a hybrid type. Traditional DB pension plans have become increasingly rare in the US private section because of is more costly compared to other types. However, according to the Bureau of Labour Statistics, roughly 15% of private employees in the US are still covered by a DB pension plan today. For a DB scheme, employers promise specific pension benefit payments to employees covered by this pension scheme. This payment takes into account factors such as the estimated final salary, working years and motility ratio. For a DC scheme, employees' pension comes from their person's pension pot, which accumulates the contribution from employees and employers and the investment return of the pension fund. Therefore, the main difference between a DB scheme and a DC scheme is that the former type promises specific pension benefits. The pension payments for the latter types mainly depend on pension charges and the pension fund's investment performance. For my dissertation, I mainly focus on the DB pension scheme.

There are two primary financial issues concerned about the DB pension plan, pension funding and pension accounting. To better secure the retirement promises made by employers to employees, the mandatory pension contribution is required for the underfunded pension plan since Congress tried in 1974 to reinforce the benefits provided by these plans with the adoption of the Employee Retirement Income Security Act (ERISA). The pension funding is governed by the Internal Revenue Code (IRC), which determine the annual cash contribution. Because the pension

contribution is tax deductive, IRC also mandates specific maximum tax-deductible contributions. Generally, the pension contribution amounts over the maximum tax-deductible contribution limitation are not deductible and probably are subject to an excise tax. In addition, the IRC also set a minimum required contribution. The basic minimum required contribution is composed of two aspects. The first aspect is the normal cost (referred to as the service cost for pension accounting). This portion of the required contribution is attributed to the new accrued pension benefits during the current year. The actual amount of normal cost is determined by the applied cost method calculating, which may be based on the expected future salary. The second portion is the amortisation of prior service liability and actuarial gains/losses. The former component arises if the pension plan participants are given credit for time with the employer before they officially enrol as pension participants or the plan is amended. This liability can be amortised over thirty years. The latter component arises when the actual value of pension items do not precisely match the actuarial value. The actuarial value of pension items is based on long-term actuarial assumptions. Suppose the anticipated assumptions, like the expected return of pension asset, mortality or economic ratio, were not met. In that case, the actuarial gains/losses will arise and generally be amortised over five years. Additional pension funding may be charged if the pension asset value is significantly lower than the pension liability. There is a detailed introduction by Rauh (2006a) for the additional pension funding[1]. The purpose of additional pension contribution is to quickly increase the value of pension assets to become at least 90 per cent of the pension liability[2]. The excess amounts will be deposited into a credit balance when annual contributions are over the minimum required contribution. The credit balance grows with interest in future years and can be used for the future mandatory pension

[1] There is a significant accounting leeway in the pension accounting, via intertemporal smoothing and freedom to choose actuarial assumptions, which is not allowed in the computation of additional pension funding.

[2] The Employee Retirement Income Security Act (issued in 1974) requires a 90% funding status for DB pension plans and the deficit needs to be compensated over thirty years. In 1987, Congress subsequently enacted the Pension Protection Act (PPA) of 1987, which requires better overall funding of pension plans by creating deficit reduction contributions for severely underfunded firms. The amount of deficit reduction contribution is between 13.75% and 30% of any under-funding. Then, the Retirement Protection Act of 1994 further increased the lowest deficit reduction contribution rate from 13.75% to 18% and applied the 30% for more plans. This law also specifies that more than 90% funded pension plans are exempted from the deficit reduction contribution.

contribution.

The latest pension funding law is the Pension Protection Act (PPA) of 2006, enacted in August 2006 to require better US DB pension plans funding. The PPA 2006 imposes stringent pension funding requirements by setting a phase-in funding target[3]. Under the PPA 2006, a plan sponsor's minimum required contribution will be based on the plan's target normal cost and the difference between the plan's funding target and the value of the plan's assets. The sponsors are required to fund their funding target fully[4]. The underfunded portion of the funding target must be amortised in annual instalments over seven years. Sponsors of severely underfunded plans that are at risk of defaulting on their obligations will be required to fund their plans according to special rules that will result in higher employer contributions to the plan. Although the PPA 2006 probably does not change the contribution of pension needed, it dramatically accelerates near-term cash shifting into pension plans by shorting the deficit recovery period to seven years.

The second finance issue is pension accounting. The US-based companies disclose pension-related information in a financial statement following the Statements of Financial Accounting Standards (SFAS) stipulations. The primary purpose of pension accounting is to help external investors access pension information. Therefore, the pension accounting principles require clear and consistent disclosure of pension information in sponsors' financial statements. The Statement of Financial Accounting Standard No.87 reaffirms the usefulness of information based on accrual accounting. The Financial Accounting Standards Board's (FASB) SFAS No.87 (issued in 1985) firstly states that companies must recognise and disclose their pension obligations, together with their plans' performance, at the end of each accounting period. Under the guidelines of SFAS No.87, pension information is reported based on the accrual

[3] The 100% funding target will be phased in at 92% in 2008, 94% in 2009, 96% in 2010, and 100% in 2011 and later years. The phase-in will not apply to plans that are already underfunded to the extent that they were subject to the deficit reduction contribution rules in 2007. Those plans will have a 100% funding target beginning in 2008.

[4] The pension obligation companies will have to fund under ERISA rules is closer to the accumulated benefit obligation (ABO) amount. The pension plan's funding target level is based on annual guidance from the Department of Labor and the Internal Revenue Service. According to the introduction of Moody's Investors Service (2006), the projected benefit obligation (PBO) calculated under generally accepted accounting principles (GAAP) is a good proxy for the plan's funding target level.

accounting principle. Sponsors must recognise the annual pension expense in the income statement, recorded as the net periodic pension cost. This annual accounting expense comprises service, interest, expected return on assets, and prior amortisation. Avoiding volatile income statements caused by pension expense, sponsors recorded an expected return on assets instead of an actual return. The difference between actuarial and real gains/losses is accumulated each year and amortised over plan participants' average remaining service year.

Sponsors record the accrued or prepaid pension cost on their balance sheet, equal to the accumulated difference between past net periodic pension costs and plan contributions. Previously, companies were required to report a breakout between over- and underfunded plans on the pension side. This breakout is no longer required under SFAS No.132. SFAS No.132 permits companies to combine their disclosures regarding over- and underfunded accounts in particular circumstances[5]. Previously, the pension plan's funding status was only disclosed in footnotes of financial statements. Effective for fiscal years ending after December 15, 2006, SFAS No.158 requires sponsors to recognise the pension plan's funding status on the balance sheet. The funding status is measured as the difference between plan assets and the projected benefit obligations. Therefore, the balance sheet with the new accounting standards will reflect the previously unrecognised pension expense. For many firms, SFAS No.158 will reduce their shareholder equity on the balance sheet.

[5] The accounting item is crashed into the prepaid/accrued cost (overfunded).

3. Do Pension Deficits Affect Companies' Expected Growth?

3.1 Introduction and relevant literature review

The funding status of defined benefit (hereafter, DB) pension plans in the US and other developed countries has deteriorated recently. About three-quarters of all public companies in the US are in pension deficits in 2018. The increased pension contributions and pension deficits immensely constrain companies' financial flexibility and investment activities and even affect their daily operations[1]. A substantial literature in finance and accounting studies the effects of DB pension plans on corporate valuation and strategic decision-making over the last two decades. Yet, the impact of mandatory DB pension contributions, the deficit reduction plan and the potential distress caused by pension deficits on companies' *expected* growth, a key-value driver, is overlooked in academic research. In this chapter, we address how DB pension deficits affect companies' expected growth.

Our interest is in defined benefit pension plans, which promise a specific payment after an employee retirement.[2] The amount of promised payments is usually determined by an employee's working-age, final salary and the expected longevity. It can be regarded as a long-term debt-equivalent obligation of shareholders to employees. To ensure the solvency of a company's DB pension plans, regulators need to monitor the company's funding status constantly. For the sake of external

[1] Glen A. Barton, the chairman and chief executive of Caterpillar and a member of the Business Roundtable, once wrote, "companies cannot commit to building new plants, launching new research projects or hiring new employees if that cash is needed to fund pensions." (M. W. Walsh, The New York Times, June 22, 2003)

[2] Companies' pension plans can generally be categorized as the defined benefit and defined contribution plans.

investors, pension laws set strict requirements about pension information releasing.[3] The Statement of Financial Accounting Standards (SFAS) No.87 requires companies to disclose the components of net pension costs, projected benefit obligations and the cost of pensions over employee's service periods to help stakeholders to understand pension plans' actual status promptly. Accordingly, pension plan assets are measured in the fair value, and the present value of pension obligations are estimated based on some explicit actuarial assumptions. Pension deficits that reflect a company's pension plan funding status are the difference between the projected benefit obligations and the fair value of pension assets. Therefore, actuarial pension assumptions, mainly the discount rate used in estimating pension liabilities, are among the most critical determinants of pension deficits.

Various measurements of corporate growth have been employed in the extant literature. For instance, individual accounting numbers, such as ex-post asset growth, sales growth, and capital expenditure, are used as proxies for a company's growth. On the one hand, it is understandable that ex-post growth rates have limited explanatory power for predicting future economic outcomes due to unexpected events. On the other hand, pension deficits may affect the ex-post growth and expected future growth through different channels. For example, DB pension deficits may not involve a company's fixed-assets investments depending on its dividend policy and employees' wage bargaining power. High pension deficits do not necessarily mean low capital expenditure since large pension deficits may increase pressure on employees on their pay or wage bargaining. Should wages be reduced, firms may have more capital to invest in expenditure (Benmelech, Bergman and Enriquez, 2012). Cutting current dividend payments is another way of releasing funds to maintain capital expenditure (Liu and Tonks, 2013). However, these corporate decisions may have adverse effects on the market expectation of companies' future growth. While mandatory DB pension benefit contributions may not necessarily restrict companies' current financing and investment activities, there are two main channels through which pension deficits may

[3] The timely source of pension-related information comes from companies' financial statements, though the sponsors of DB pension plans are required to file the Internal Revenue Service Form 5500 with details of pension information. Pension accounting rules require that the relevant financial statements provide complete and up-to-date information for stakeholders' economic decision-making.

affect companies' expected future growth. Firstly, the current pension plan funding status and pension deficit reduction plan can affect a company's future earnings and retained earnings. If a company has DB pension deficits in the current period, it is more likely to be exposed to cash pressure in the near future. It may have an adverse effect on their decisions in investment and operating activities. If a company's DB pension plan is fully funded, sponsors are only required to fund the new pension service costs during the year. However, pension regulators require sponsors of DB pension plans to make a deficit reduction plan and amortize the deficits within the next few years if the market value of pension assets is less than the estimated present value of pension obligations. Their future annual pension contributions must meet minimum legal requirements, which is determined by the current period's pension deficits. While the amortization of pension deficits reduces current period corporate earnings, recurring pension expenses designated in the deficit reduction plan will seriously affect its future earnings and earnings growth if the company has severe DB pension deficits. Secondly, stock price as a leading indicator of a company's future earnings can be depressed by DB pension deficits (Fama and French, 2006; Jin, Merton and Bodie, 2006; Franzoni, 2009). Employee benefit rights are protected under the Employee Retirement Income Act of 1974. The US Pension Protection Act of 2006 reviews mandatory contributions and resets the criterion for fully-funded pension plans. In addition to mandatory pension contributions, the pension plans with severer deficits insured by the Pension Benefit Guaranty Corporation (PBGC) are required to pay a higher insurance premium to the PBGC.[4] While mandatory pension contributions can restrict actual cash available for a company's operating activities and cash outflow is tangible, and pension deficits are implicit capital rationing. In particular large deficits can cause considerable distress to the sponsors of DB pension plans. Therefore, there is a possibility that an employer is under distress termination if the company has severe DB pension deficits. Stock prices may reflect such distress. Pension funding status, therefore, affects companies' growth

[4] The creation of PBGC is supposed to provide timely and uninterrupted pension payments to the retirees. Pension insurance premiums paid by sponsors are determined by the number of participants and the funding status. In 2016, the flat-rate premium was \$64 per participant, and the variable-rate premium is \$30 per \$1000 of unfunded vested benefits. Almost half of the US private single-employer plans are currently insured by the PBGC.

expectations, particularly the expected long-term growth. The expected growth rate is, unfortunately, not observable. This chapter uses reverse engineering to estimate the firm-specific expected growth rate mainly through these two channels. Expressly, the expected growth rate that reflects the market perception of a company's growth is implied from analysts' forecasts of future earnings and stock prices and industry-wide information available at the current period. Investment practitioners have widely used financial analysts' forecasts of earnings. Analysts forecast earnings from continuing operations are expected to reflect the recurring pension expenses designated in a deficit reduction plan. The capital market incorporates pension risk in determining the sponsoring firms' cost of capital and price (Jin, Merton and Bodie, 2006). Since the current stock price reflects all expected future cash flows for a going concern, we view this implied growth rate as a company's average long-term growth rate, which changes every period based on the new information available. After all, the expected future long-term growth rate is one of a company's key value drivers. Therefore, we are interested in the relationship between the DB pension deficits and the expected future growth, particularly the long-term growth.

As an important non-operating activity, the management of DB pension plans has been documented to be integrated into companies' overall investment and financial policies. For instance, prior literature suggests that decisions on capital expenditure, overall capital structure and investment choice are associated with the funding status of a company's DB pension plans. Rauh (2006a) documents that mandatory pension contributions reduce firms' contemporary capital expenditure. He argues that pension contributions reduce the available capital to be used in investments in operating activities. Shivdasani and Stefanescu (2009) find that firms consider their net pension obligations as a debt equivalent liability when they make decisions on the capital structure by incorporating the magnitude of pension assets and liabilities. More recently, Duygun et al. (2018) found that the funding status of the DB plan affects corporate investment choices between diversifying and non-diversifying investments. Jin, Merton and Bodie (2006) suggest that a company's systematic risk (beta) is correlated with its pension asset's risk. Campbell, Dhaliwal and Schwartz Jr (2011)

find that a company's weighted average cost of capital is affected by its pension plan performance. Guan and Tang (2018) also suggest that firms incorporate employees' risk attitudes towards pension obligations into corporate policies. Cocco and Volpin (2013) argue that the uncertainty associated with companies' pension obligations is a source of risk and acts as a deterrent when an acquirer makes a takeover decision.

This chapter examines the impact of DB pension deficits on companies' expected growth rates implied by analysts' forecasts of earnings, stock prices, and industry-wide information. Our results show that pension deficits have a significant and negative effect on companies' expected long-term and short-term growth. We find that the extent to which DB pension deficits affect the expected growth depends on companies' fundamental characteristics. Firstly, since companies with financial constraints have difficulty raising capital from external capital markets, pension contributions and the pressure to reduce the accumulated past deficits may restrict those companies' $NPV > 0$ investments in tangible and intangible assets. We expect and find that the effect of pension deficits on the expected long-term growth for companies with higher-level financial constraints is more severe than for companies with lower-level financial constraints. Secondly, turning into a company's internal funding, if a company has sufficient non-working capital to cover the predicted future mandatory pension contributions, then its pension deficits should have less influence on its normal operating activities and the expected future growth. Our evidence supports that the negative effect of pension deficits on the expected long-term growth is less severe for companies with more non-working cash holdings. Thirdly, the negative impact of pension deficits on the expected short-term growth is less severe for profitable companies. As pension laws allow pension sponsors to make pension deficit recovery plans with some flexibility based on their current financial circumstances, a company's pension deficits could be amortized over the next several years. Profitable companies may rationally use this leeway to delay their deficit contributions and minimize the impact on the current economic activities. In other words, managers of profitable companies could actively take action to manage their pension deficits. Therefore, we should expect that the negative effect of pension

deficits on the expected growth, at least in the short term, is less severe for profitable companies. Our results confirm this intuition. Finally, if an aggressive discount rate in actuarial assumptions is employed, the actual DB pension liabilities will be greater than that is reported in financial statements. This situation is not sustainable in a well-functioning capital market. Our results show that the negative effect of DB pension deficits on the expected long-term growth is resilient even if pension accounting is manipulated or discount rates in determining pension liabilities are artificially raised.

The rest of the chapter proceeds as follows. Section 2 presents a number of hypotheses. Section 3 introduces our research design, the expected growth rate and its estimation procedure. Section 4 describes the data of interest. Section 5 provides empirical results. Section 6 examines the robustness of our analysis. Finally, section 7 concludes the chapter.

3.2 Developing hypotheses

Pension deficits are measured by the difference between the estimated present value of DB pension obligations and DB pension assets. The higher the pension deficits, the worse a company's pension funding status. Since pension laws require sponsors to contribute their pension plans based on the prior period funding status, the current period pension deficits determine future mandatory pension contributions. Therefore, the higher the current pension deficits, the lower the future potentially available cash for companies' operating and financial investments. The shortfall in pension plan funding has negative effects on companies' economic activities and financial flexibility. DB pension deficits affect a company's expected growth not only because mandatory pension contributions may reduce available cash for future NPV >0 investments and risky R&D projects, but also high deficits can reduce future corporate earnings and may cause distress to investors, managers and some key stakeholders in the capital market[5]. Therefore, current pension deficits may have adverse effects on market

[5] The negative effect of pension deficits on the expected growth is also consistent with behavioural explanations. If management manipulates pension incomes, the company's reported earnings cannot be sustainable. Capital markets would downgrade the expectation of the company's future growth.

perception about a company's future growth. Our first hypothesis follows.

Hypothesis 3.1 *Current DB pension deficits have a negative effect on companies' expected future growth.*

The extent to which DB pension deficits affect a company's expected growth depends on its capability and flexibility of diverting its financial resource and operating efficiency. Mandatory pension contributions to DB pension plans likely reduce companies' available capital for new investments in operating activities and affect their financial and investment decision-making. The diversion of financial resources to non-operating activities potentially causes cash pressure for companies, particularly the sponsors with high DB pension deficits. In comparison, managers in companies with lower financial constraints may raise relatively cheap external capital to satisfy the capital requirements for new investments or invest strategically important tangible and intangible assets. Companies with high financial constraints may have difficulties raising finance from external capital markets when facing cash pressure. Pension deficits have long been considered as one of the financial constraints.(Rauh, 2006a; Almeida and Campello, 2007; Campbell, Dhaliwal and Schwartz Jr, 2010) Hence current pension deficits should have a severer impact on companies' expected growth for companies with high financial constraints.

Hypothesis 3.2 *The effect of DB pension deficits on the expected long-term growth for companies with higher-level financial constraints is more severe than for companies with lower-level financial constraints.*

A company's holding cash is undoubtedly one of the primary funding sources available for the DB pension contributions and deficit reduction plan. Instead of using predicted uncertain free cash flow, the current cash holding position should be more relevant to the company's mandatory DB plan contributions, determined by the prior period's pension plan funding status. Cash holdings are often grouped into two categories in a company's fundamental and practical analysis: the working cash and non-working cash. While there is no formal definition of working cash, it is often viewed as the cash necessary for daily operating activities or ongoing operations.

The non-working cash, also called excess cash, is mainly used to fund non-operation activities and is not directly related to companies' normal daily operations. Hence, the DB pension contributions and deficit reduction plan should be more sensitive to a company's non-working cash than working cash holdings. We compare a company's current non-working cash holdings with the predicted next period mandatory pension contributions based on Moody's Investors Service (2006) prediction method. Suppose the current excess cash holdings are insufficient to cover the mandatory pension contributions in the following year. In that case, we expect that the negative effect of pension deficits on the expected growth is more severe.

Hypothesis 3.3 *The negative effects of DB pension deficits on a company's expected long-term growth rate are more severe if the company's current excess cash holding is not sufficient to cover the predicted mandatory pension contributions.*

The extent to which a company's DB pension deficits affect its future growth is also determined by how profitable the company is, at least in the short term. Operating efficiency is a key to channel tangible and intangible investments to a company's future growth. One marginal dollar investment from more profitable companies will grow quicker than from less profitable ones. On the one hand, pension laws require that the sponsors of DB pension plans with deficits have to pay pension expenses as mandatory pension contributions during the current year and pay annual deficit reduction contributions. On the other hand, management has discretion over the timing and amounts of deficits to be reduced when considering new investments and the expected growth. For instance, managers could examine the trade-off between future investment benefits from new NPV >0 investments or risky R&D projects and costs from delaying to take actions to reduce pension deficits[6]. In other words, managers may consider opportunity costs when they make pension policy.[7] For more profitable companies, managers may have no incentive to adjust their current

[6] External investors may prefer financing physical asset investments to R&D projects since may not be able to understand some strategical risky investments due to asymmetric information fully.(Bartram, 2016)

[7] Carillion was the second-largest construction company in the UK and went into liquidation in 2018. It had prioritized growing earnings and supporting the share price ahead of its pension scheme, though it had a reported pension deficit of about 800 million pounds at the time.

economic activities. It can be in the best interest of profitable companies to delay payments to pension plans and efficiently use scarce capital in investing in profitable projects. Although pension laws allow sponsors to amortize pension deficit reduction contributions in several years, companies are required to retain pension plan fully-funded status in the long term. Therefore, we expect more profitable companies to have less severe negative effects of pension deficits on expected short-term growth. The impact of pension deficits on long-term growth is less dependent on companies' operating efficiency. Furthermore, more profitable companies are also likely to raise cheaper finance in the short term from the external capital market to release the pressure from past DB pension deficits.

Hypothesis 3.4 *Profitable companies have less severe negative impact of DB pension deficits on the expected short-term growth.*

Pension obligations are estimated based on several actuarial assumptions. An artificially increased discount rate in calculating pension liabilities could substantially reduce the number of pension deficits in financial reporting. Managers of companies with severe DB pension deficits have more incentive to manipulate pension accounting to mitigate reported pension deficits and improve reported corporate earnings. (Bergstresser, Desai and Rauh, 2006; Picconi, 2006; An, Lee and Zhang, 2014) For our purpose, we construct a number of benchmark discount rates in estimating pension liabilities. A discount rate is called aggressive if it is higher than the benchmark discount rate. If an aggressive discount rate is employed, the actual funding status will be worse than reported in financial statements. Generally, the market will be concerned about the applied actuarial assumptions. Our estimated expected growth rates reflecting analysts' forecasts of future earnings and stock prices should be able to capture this manipulation in estimating pension obligations.

Hypothesis 3.5 *The negative effects of DB pension deficits on the expected long-term growth are more severe for companies that apply aggressive discount rates in estimating pension liabilities.*

3.3 Research design

3.3.1 Measurement of firm-specific expected growth rate

Capital expenditure (net of replacement of existing assets), among other measures, has been used as a proxy of a company's ex-post growth since growth in fixed assets is supposed to expand and grow the entity and to increase future sales revenues. However, whether capital expenditure is a reasonable proxy for future growth depends on whether the investment has a positive NPV and how the capital is efficiently utilized. It also depends on which industry the company belongs to.[8] In this chapter, we motivate our study from a different angle and aim to answer whether and how DB pension deficits affect a company's expected growth. Since a firm's expected growth rate is unobservable, we use reverse engineering to estimate it based on industry-wide information, in addition to firm-specific characteristics and stock market information.

Our estimation builds on Ashton and Wang (2013), who establish an intrinsic relation between the one-period ahead earnings and fundamental accounting numbers as well as stock prices:

$$E_t[x_{t+1}] = \delta_1 P_t + \delta_2 x_t + \delta_3 b_t + \delta_4 b_{t-1} + \delta_5 P_{t-1}, \tag{3.1}$$

where x_t, b_t and P_t are the firm's earnings, book value and price at time t respectively. At the portfolio level, they show that the implied growth rate (g) and cost of equity capital ($r \equiv R-1$) as well as other valuation parameters, $(\alpha_1, \alpha_2, \lambda)$, can be expressed in terms of above coefficients δ_s (s=1-5):

$$g = \frac{1 + \delta_2 + \delta_3 - \delta_5 + \sqrt{(1 + \delta_2 + \delta_3 - \delta_5)^2}}{2} - 1, \tag{3.2}$$

$$r = (1+g)(1 + \frac{\delta_1 + \delta_5}{1 + g - \delta_2}) - 1, \tag{3.3}$$

$$\alpha_1 = 1 + \frac{\delta_4 + \delta_5}{(1+g) - \delta_2}, \alpha_2 = 1 + \frac{\delta_2 - \delta_4 - \delta_5}{(1+g) - \delta_2}, \lambda = \frac{(1+g)\delta_5}{(1+g) - \delta_2}. \tag{3.4}$$

Following Ashton and Wang (2013), we can use financial analysts' forecasts

[8] For example, Hi-tech companies may have low capital expenditure, but they can have high growth due to investments in intangible assets.

of earnings ($feps_{t+1}$) as a proxy of market expectation of firm's future earnings and regress one-period ahead analysts' consensus forecasts of earnings on current stock price, earnings, book value, lagged book value and lagged price at the industry level. We then estimate industry-level cost of capital and other valuation parameters $(\alpha_1, \alpha_2, \lambda)$ based on the estimated coefficients of $\delta_1 - \delta_5$ as (3.3) and (3.4).

We can further show that one-period ahead stock returns can be written as[9]

$$\begin{aligned} r_{t+1} = g + (1+g)\frac{d_t}{P_t} + \alpha_1 \frac{b_t - (1+g)b_{t-1}}{P_t} \\ + (\alpha_1 + \alpha_2)\frac{x_{t+1} - (1+g)x_t}{P_t} + \lambda(\frac{P_t + d_t - P_{t-1} - x_t}{P_t}) + \frac{\epsilon_{t+1}}{P_t}, \end{aligned} \tag{3.5}$$

where $r_{t+1} = \frac{P_{t+1}+d_{t+1}}{P_t} - 1$ and d_{t+1} is dividends at time t+1. That is, one-period ahead stock returns can be written in terms of growth rate, dividend yield, abnormal growth in companies' book value, and abnormal-growth in forward earnings adjusted by an accounting conservatism term (λ).

We can then use industry-level valuation multiples as a proxy for those of individual firms in the industry for the purpose of valuation. It is not inconsistent with common industry practice. Specifically, we use industry-level valuation parameters, $(\overline{\alpha}_{1,it}, \overline{\alpha}_{2,it}, \overline{\lambda}_{it}, \overline{r}_{it})$ to build a link between firm-level fundamental accounting ratios, one period ahead forecasts of earnings and expected growth as follows[10]:

$$\begin{aligned} \overline{r}_{it} = g + (1+g)\frac{d_t}{P_t} + \overline{\alpha}_{1,it} \frac{b_t - (1+g)b_{t-1}}{P_t} \\ + (\overline{\alpha}_{1,it} + \overline{\alpha}_{2,it})\frac{feps_{t+1} - (1+g)x_t}{P_t} + \overline{\lambda}(\frac{P_t + d_t - P_{t-1} - x_t}{P_t}) - 1, \end{aligned} \tag{3.6}$$

Where $\overline{r}_{it}$ is the implied industry cost of capital. We use $\overline{r}_{it}$ as a proxy of the expected one-period ahead return of individual firms in the industry based on information at time t. We can then estimate the firm-level growth rate (g) based on equation (3.6). We refer to it as the implied firm-level expected long-term growth rate based on information at time t, g_t. To eliminate the impact of extreme values from our

[9] The one-period ahead stock return equation (3.5) is derived from their equations (1) and (7).

[10] This equation reconciles with the well-known Gordon growth model if book value and earnings also grow at rate of g under unbiased accounting.

estimates of expected growth rates, we winsorize the firm-year-specific growth rate based on its distribution[11]. Specifically, we first estimate one standard deviation of the firm-year-specific growth rate, and then retain the estimates if the estimates are in the range of the average value ± one standard deviation, and set all firm-year growth outliers below (above) the one-standard-deviation from its mean to the mean minus (plus) one-standard-deviation.

In our model implementation, we divide both sides of equation (3.1) by stock prices in order to minimize the effect of endogeneity. To increase our sample observations, we use two-year rolling window regressions and Fama and French 5-industry classification.[12] We estimate our short-term expected growth rate based on Fama and French (2006).

3.3.2 Impact of DB pension deficits on the expected growth

To show how a company's expected growth is affected by the company's DB pension deficits, we control for several variables that have been documented to be associated with the future growth of a company in prior literature. First, Tobin's Q is widely used in corporate finance to represent a company's investment opportunities.[13] Second, the Altman Z-score has been used to measure the probability of a company's distress. Distressed firms are expected to be negatively associated with the expected future growth. Anantharaman and Lee (2014) find that a distressed company is more likely to under-fund its pension plans after controlling for the operating cash flows. To improve the solvency condition, a distressed company may have a strong incentive to manipulate the applied actuarial assumptions to underestimate its DB pension deficits.(Amir and Gordon, 1996; Bartram, 2016; Bartram, 2018) Therefore, we take a company's probability of bankruptcy into account. Third, we control for a company's size and age. Small and young firms, in general, grow fast. Firms

[11] We also winsorize the firm-year-specific growth rate based on its industry distribution, the untablulated results are quantitatively similar.

[12] See `https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/det_5_ind_port.html`. Our results are quantitatively similar if we use five-year rolling window regressions based on Fama and French 12-industry classification.

[13] See, for example, Erickson and Whited (2000), Fama and French (2006), Rauh (2006a), Aharoni, Grundy and Zeng (2013) and Campbell, Dhaliwal and Schwartz Jr (2010).

that sponsor DB pension plans tend to be older and larger than firms that do not. (Bartram, 2018) Finally, we also control for accounting accruals (Accr). Fairfield, Whisenant and Yohn (2003) suggest that accounting accruals bias the expectation of future growth. Investors fail to appreciate the difference between accruals and the growth in long-term net operating assets[14]. The primary regression analysis is based on the following equation:

$$g_{i,t} = \beta_1 PD_{i,t} + \beta_2 Q_{i,t} + \beta_3 Z_{i,t} + \beta_4 Size_{i,t} + \beta_5 Age_{i,t} + \beta_6 Accr_{i,t} + \epsilon_{i,t}. \quad (3.7)$$

That is, for company i in year t, we examine how pension deficits (PD) affect the company's expected future growth (g) after controlling for the Tobin's Q, Altman Z-score, size, age and accounting accruals. We also consider industry and year fixed effects in our analysis where appropriate.

Our expected growth rate (g) is estimated based on available information at time t. We argue that the predicted growth rate follows a mean-reverting property, i.e., g evolves towards its long-term average value over time. Therefore, we also use a system GMM method to analyze the following dynamic model:[15]

$$g_{i,t} = \beta_0 g_{i,t-1} + \beta_1 PD_{i,t} + \beta_2 Q_{i,t} + \beta_3 Z_{i,t} + \beta_4 Size_{i,t} + \beta_5 Age_{i,t} + \beta_6 Accr_{i,t} + \epsilon_{i,t}. \quad (3.8)$$

We expect that the lagged expected growth rate has a persistence between zero and one. Since sponsors of the DB pension plans are required to have pension actuaries to re-estimate the pension obligations every three years based on the actuarial assumptions reflecting the latest pension information, we calculate the moving average of pension deficits ($PD_{i,3t}$) in the prior three years for a firm i to capture the historical information on pension funding status. Coronado and Sharpe (2003) and Franzoni and Marin (2006) argue that investors can be slow in impounding pension information into the valuation of companies. Therefore, we also include

[14] The Financial Accounting Standards Board (FASB) Statement No. 87 sets forth a new accrual methodology to calculate pension expenses, which affect companies' total net accruals as the constituent of earnings. If we include R&D as an explanatory variable, then the number of observations will be substantially reduced.

[15] Accordingly, we do not consider time fixed effects.

$PD_{i,3t}$ in our analysis to incorporate historical information about pension funding status and control for the influence of changes in the actuarial assumptions. In addition, the relation between the expected growth rate and current pension deficits may be affected by the volatility of historical pension plan funding status. We therefore also control for the standard deviation of pension deficits in our analysis:

$$g_{i,t} = \beta_{01}PD_{i,3t}+\beta_{02}PD_{i,std}+\beta_1 PD_{i,t}+\beta_2 Q_{i,t}+\beta_3 Z_{i,t}+\beta_4 Size_{i,t}+\beta_5 Age_{i,t}+\beta_6 Accr_{i,t}+\epsilon_{i,t}, \tag{3.9}$$

where $PD_{i,std}$ is the standard deviation of firm i's pension deficits over the last 10 years.

3.4 Data and sample descriptive statistics

Our sample includes all public companies which sponsor DB pension plans in the U.S and covers the period from 1988 to 2016. Due to the time lag of Form 5500, the pension information in the 10-K report is a more direct and timely information source for the capital market participants.[16] The Statement of Financial Accounting Standards (SFAS) No.87 requires the sponsors of DB pension plans to report the pension funding status in the main body of financial statements. It leads to information on DB obligations and pension assets being more accessible for external markets. Our sample period starts from 1988 to ensure that all companies comply with the new requirements and report pension relevant information under SFAS 87.

We collect all relevant pension data items from the Compustat Capital IQ North American Pension Annual database, including the applied pension benefits discount rate (PBARR). There are two structural breaks in the accounting report rules about pension accounting items in estimating the fair values of pension assets and liabilities. The first break is from the reform of SFAS No.87, which changes the pension-related items in Compustat from 1986. The second break is SFAS No.132, which is effective from December 1997.[17] Following Franzoni and Marin (2006), pension assets in our

[16] The sponsors of DB plans are required to file Form 5500 with their pension plan information.

[17] SFAS No.87 requires that the sponsors of defined benefit pension plans report over-funded and under-funded pension plans separately. However, SFAS No.132 amends this requirement and

analysis are the sum of over-funded pension assets (PPLAO) and the under-funded pension assets (PPLAU). At the same time, the projected benefit obligations are the sum of the over-funded pension benefit obligations (PBPRO) and under-funded pension benefit obligations (PBPRU) between 1988 and 1997. After 1997, pension assets were equal to the pension plan assets (PPLAO), and the benefit obligations are equal to the projected benefit obligations (PBPRO)[18]. We scale both pension assets and liabilities by dividing the company's book value of assets (AT). Pension deficits that reflect a company's pension plan funding status are the difference between the projected benefit obligations and the value of pension assets. We delete all observations with missing values in calculating pension deficits.

All other accounting items are collected from the Compustat Capital IQ database. We also collected equity price from the Center for Research in Security Prices (CRSP) and adjusted the price for stock splitting and dividends by using the cumulative adjustment factor from the CRSP. Following prior literature, we use the adjusted price three months after the fiscal year-end to ensure that the financial statement information is fully reflected in prices in our analysis. Analysts' forecasts of earnings are from the I/B/E/S. We use the first available median consensus forecasts of earnings per share after the corresponding I/B/E/S-reported prior-year earnings announcements as one-year ahead earnings ($feps_t$). A firm's market capitalization is the stock price multiplied by the number of shares outstanding. Stock returns are adjusted for firms' delisting. The observations with negative book values (CEQ) or missing values of any used accounting items are deleted from our sample. We also exclude financial firms (SIC 6000-6999) and utilities (SIC 4900-4999). Moreover, we only include companies with at least two-year observations. The Pension Protection Act 2006 regards a DB pension plan as fully funded if the fair value of DB pension assets at least equals the present value of pension obligations. A fully-funded DB plan is only required to fund the new pension service costs during the year. We note that there are about a quarter of firm-year observations with DB pension surplus

requires sponsors to compound these two types of pension plans into one accounting item.

[18] After the adoption of SFAS No.158, sponsors are required to calculate their pension liabilities using the projected benefit obligations instead of the accumulated benefit obligations. For consistency, we omit the potential incremental liabilities recognized in an annual report.

in our sample. For pension plans with a surplus, the pension funding and pension accounting requirement are significantly different. Therefore, we mainly focus on the pension plans with a deficit in this chapter. In constructing our dataset, one percentage at the top and bottom of relevant variables is winsorized to avoid outliers' impact. Table 3.1 reports the sample statistics and the Pearson correlation of main variables used in our analysis.

[Insert Table 3.1 Here]

Panel A of table 3.1 presents the distribution of variables that are used to calculate the firm-specific expected growth rate (g). $feps_t/P_t$, e_t/P_t, b_t/P_t, b_{t-1}/P_t and P_{t-1}/P_t are the one-year ahead forecasts of earnings, current earnings, book value, lagged book value and lagged price, all scaled by current price, respectively. The mean and the median of the expected long-term growth rate are 2.4% and 2.8% respectively.[19] Variables in Panel B describe firms' fundamental characteristics that are used in our regression analysis. The market-to-book ratio of assets measures Tobin's Q, and Z is the Altman Z-score. $Size$ is the log value of companies' total assets, and Age is calculated by the current year minus the year when a company's data is firstly available in the Compustat database. $Accr$ is the company's total accounting accruals, measured by the difference between earnings and operating cash flows scaled by the book value of equity. The distribution of variables is consistent with that reported in prior literature. Panel C reports the statistical distribution of variables related to DB pension plans. PD is the company's pension deficits. PD_3 is the company's average value of pension deficits in the last three years (at least two years). PD_{std} is the company's moving standard deviation of pension deficits over the previous ten years. Panel D reports the Pearson correlation among the main variables used in our analysis. It shows that pension deficits (PD) are significantly negatively related to the expected growth rate (g) with a correlation coefficient of 0.05, the second-highest rank.

[19] The mean and median of U.S GDP growth rates are 2.46% and 2.68% respectively during 1990-2016.

3.5 The empirical results

3.5.1 DB pension deficits and companies' expected long-term growth

In this subsection, we show how companies' expected long-term growth rates are affected by their DB pension deficits.

[Insert Table 3.2 Here]

Results in column 1 in Table 3.2 are based on the entire sample, and the rest columns are based on the sample excluding observations with pension surplus. Columns 1 and 2 show how companies' expected long-term growth rates are affected by their DB pension deficits after controlling for Tobin's Q, Altman Z-score, size, age and accounting accruals. To minimize the issue of sample selection bias, we use the Heckman 2-stage method to estimate the inverse Mills ratio in the first stage and include it in our second stage regressions. As expected, the sample excluding observations with pension surplus shows a much stronger negative relation between the expected growth and pension deficits. Consistent with the prior literature, Tobin's Q and accruals are positively and negatively related to companies' future growth, respectively, while the firm size is negatively associated with future growth. In the third column, we add the volatility of historical pension deficits in our analysis. We find that the volatility of pension deficits is also significantly negatively related to the expected long-term growth after we control for companies' characteristics. The coefficient of the volatility is -0.20 with a t-statistic of -2.27. More importantly, the expected growth rate is still negatively related to the DB pension deficits even if we control for the volatility of the pension deficits. However, the marginal impact is slightly reduced. In the fourth column, we add companies' historical funding status ($PD_{i,3t}$) as an explanatory variable. It shows that pension deficits still negatively impact companies' expected long-term growth after controlling for the historical pension plan funding status and other companies' characteristics. In contrast, the past funding status itself is not statistically significantly related to the expected growth. It suggests that information included in the past funding status is subsumed

in the current pension deficits. The fifth column shows that both current pension deficits and the volatility in our analysis are negatively associated with the expected long-term growth rate when we include both the past funding status and the volatility and other companies' characteristics. In the last column, we use the Arellano-Bond estimator to estimate our dynamic model by incorporating the lagged expected growth (g_{t-1})[20]. Consistent with the mean-reverting property of the expected growth, the persistence of the lagged growth rate is 0.018. We also note that control variables including Tobin's Q, Altman Z and age have changed the signs. It is perhaps because the lagged growth rate subsumes the growth information contained in those control variables. In summary, our regression results show a significant negative relationship between DB pension deficits and the expected long-term growth. Hence our analysis above supports our Hypothesis 1[21].

3.5.2 The impact of DB pension deficits on the expected long-term growth for firms with high financial constraints

While large pension deficits may increase companies' pressure when they make investment decisions in future economic activities, the extent to which DB pension deficits adversely affect their expected growth depends on companies' fundamental characteristics. In the Modigliani and Miller (1958) economy, a company's capital structure is irrelevant to the company's value in a perfect market. Pension deficits should not affect companies' economic activities because companies can always raise capital from the external market without sufficient funds to pay mandatory pension contributions. Alternatively, they can raise capital internally since the cost of raising finance from the external market is the same as the internal cost of capital. In the real world, the cost of raising external capital depends on the riskiness of the

[20] We do not report the R-squared since it is not a reliable proxy for the goodness of fit in this estimation. We also employ the Sargan test to examine the over-identifying restrictions and describe the efficiency of our model by the valid instruments. We use variables in the last 5-period as instrumental variables and find that the Sargan test does not reject the null hypothesis.

[21] The supporting evidence for the expected short-term growth is provided in the subsequent analysis.

company's economic activities, and it can be costly for some companies. Though the pecking order theory suggests that a company should prefer to finance its activities internally through retained earnings in the first place, the company has to consider the external source of capital if the internal capital is unavailable. The internal capital is accordingly companies' first choice when they have to fund their pension plans, especially those with financial constraints. This condition describes the likelihood of companies experiencing difficulties in financing their operations when external financial conditions tighten. Campbell, Dhaliwal and Schwartz Jr (2010) suggest that DB pension deficits may have negative effects on companies' economic activities because companies with pension deficits are likely to be financially constrained. Market frictions prevent companies with high financial constraints from funding some positive NPV investments. Mandatory pension contributions reduce companies' financial flexibility, particularly for firms with large DB pension deficits.[22] Pension deficits as a potential source of financial constraints should harm companies' expected long-term growth.

In this chapter, we use several commonly used methods to measure the degree of a company's financial constraints. First, Kaplan and Zingales (1997) introduce a measure (hereafter, the KZ index), which is based on some fundamental accounting ratios. The higher the KZ index, the higher the probability that a company has financial constraints. Following Kaplan and Zingales (1997), we calculate the KZ index for each company year. A company is said to have a high KZ index or financial constraints in a year if its KZ index is greater than the 70 percentile threshold across all sample companies in the year. Second, a company's liquidity condition is one of the important measurements of financial constraints. Since mandatory pension contributions can create cash pressure for a company, we use the ratio of (the cash and cash equivalents (CHE) - total debt (DLTT+DLC)) divided by the total asset (AT) to measure a company's liquidity condition. The lower the liquidity ratio, the higher the probability that a company has financial constraints. A company has a low liquidity ratio or financial constraints if this ratio is less than the 30 per cent

[22] Bakke and Whited (2012) argue that mandatory pension contributions reducing capital expenditure documented in Rauh (2006a) may be due to companies with severe pension deficits.

threshold across all sample companies in the year. Third, we can use a company's total dividend-to-asset ratio to gauge the company's potential financial constraints. Companies with DB pension plans are generally bigger, older and traditional dividend-paying companies. By total dividends, we mean cash dividends plus common share repurchases since share repurchases have been a popular distribution channel to common shareholders in recent decades. Following Grullon and Michaely, 2002, the common stock repurchase is measured by the total expenditure on the purchase of common and preferred stocks (PRSTKC) minus a redemption value (PSTKRV) on the preferred stocks. Accordingly, the dividend-to-asset ratio is measured by (DVC+DVP+ net repurchase)/lag(AT), where the net repurchase equals (PRSTKC-PSTKRV) if it is positive, zero otherwise. Companies with financial constraints are likely to be low dividend-paying companies. We call a company low dividend-paying or financially constrained if its dividend-to-asset ratio is less than the 30 per cent threshold across all sample companies in the year.[23] Finally, we use a company's investment-grade as a measurement of financial constraints. For this, we use the S&P's long-term domestic issuer credit ratings. Following prior literature, companies with missing credit ratings or lower than BBB are regarded as non-investment grade. The current economic activities in companies with non-investment grades should be more likely to be interrupted by their mandatory pension contributions. Our analysis groups all companies into investment grades (unconstrained) and non-investment grades (constrained).

[Insert Table 3.3 here]

Table 3.3 shows that the adverse effects of DB pension deficits on the expected long-term growth rate are statistically significant for companies with financial constraints based on our four different measurements of financial constraints or companies with high KZ index, low liquidity ratio, low dividend-to-asset ratio and credit ratings lower than BBB. While DB pension deficits have adverse effects on

[23] We note that the concept of financial constraints may be industry-specific. When a company decides its liquidity ratio or dividend-to-asset ratio, it may benchmark its peers in the same industry. We therefore also set our 70 per cent and 30 per cent thresholds on an industry-year basis. Our untabulated results are similar.

both constrained and unconstrained companies, the impact is not significant at the 10 per cent level for companies with less financial constraints after controlling for other companies' characteristics. These findings are also consistent with Campbell, Dhaliwal and Schwartz Jr (2011), who document that an increase in mandatory pension contributions increases the cost of capital, but only for companies facing more significant external financing constraints. Therefore, the results support Hypothesis 2.

3.5.3 The impact of DB pension deficits on the expected long-term growth for firms with high excess cash holdings

We now move to the effect of a company's internal cash holdings on the relation between DB pension deficits and the expected future long-term growth. Mandatory pension contributions can increase a company's cash pressure and restrict its capital expenditure. A sufficient internal cash holding can mitigate the short-term cash pressure caused by mandatory pension contributions and buffer the potential negative implications. Since a company's internal cash holding is a convenient source to fund its pension deficits, we expect the impact of DB pension deficits on companies' expected growth is less severe for companies with sufficient cash holdings. In particular, non-working cash is a more relevant component of cash to fund a company's pension plan, a non-operating activity. However, there is no commonly agreed approach to estimate the non-working cash[24]. Opler et al. (1999) develop a model in determining a company's 'normal' cash holding position. The excess cash holding can then be defined as the difference between the company's total cash and the 'normal' cash holdings. In other words, the residuals in their companies' cash holding determination model can be regarded as the excess cash holdings. Dittmar and Mahrt-Smith (2007) modify the 'normal' cash holding model by extending control variables including

[24] For example, Koller, Goedhart, Wessels et al. (2010) suggest that the working cash is about 2 per cent of companies' annual sales. Accordingly, for each firm year, the non-working or excess cash can be estimated as the minimum of (the total cash and cash equivalence - the 2 per cent of sales, 0). They admit that it is just an approximation, and it omits the significant industry effect in companies' cash holding levels.

companies' investment opportunities. In this subsection, we estimate the excess cash holdings by using their cash holding determination model. Details can be found in the appendix. Since the following year, mandatory pension contributions have been based on current pension funding status. We compare them with the estimates of the current level of excess cash holdings. We follow Moody's Investors Service and Campbell, Dhaliwal and Schwartz Jr (2010) to estimate the amount of one-year ahead mandatory pension contributions.[25]

We expect that the degree of negative effects of DB pension deficits on companies' expected long-term growth depends on the relative magnitude of excess cash holdings and expected mandatory pension contributions. Suppose a company's current excess cash holding is greater than the mandatory pension contribution in the following year. In that case, there may have no immediate pressure for managers to adjust their planned economic activities. In this case, we do not expect the current pension deficits to have a severe negative impact on the expected growth rate. Furthermore, suppose a company's excess cash holdings are greater than its mandatory pension contributions for the past consecutive years. In that case, an even less negative impact of DB pension deficits should be expected. In contrast, if a company's current excess cash holding is less than the predicted mandatory pension contributions, then managers may have to adjust their current economic activities, even if these activities are in the best interest of shareholders. Accordingly, we should expect that the current pension deficits significantly negatively impact the expected growth rate. Therefore, based on a stratified analysis, we sort all observations into two groups depending on whether the excess cash holding is greater or less than the estimated mandatory pension contributions[26]. The regression results are presented below.

[25] Specifically, if the accumulated benefit obligation (ABO) is greater than the fair value of pension plan assets (FVPA), then the mandatory pension contribution equals the service cost plus (ABO-FVPA)/30. If ABO<FVPA, then the mandatory pension contribution equals zero. After adopting the Pension Protection Act 2006, the amortization period of pension deficits can be changed to 7 years. Thus, the expected mandatory pension contributions are (ABO-FVPA)/7 for pension deficits after 2006.

[26] To minimize the selection bias in our grouping, we use Heckman two-stage regression. In the first stage, we use logistic regression to estimate the inverse Mills ratio. The independent variables used in the logistic regression are variables in determining cash holdings as Dittmar and Mahrt-Smith (2007). We then include the inverse Mills ratio in the second stage regression.

[Insert Table 3.4 here]

The first two columns in Table 3.4 show that if companies have no sufficient internal excess cash holdings to cover the expected next period mandatory pension contributions, pension deficits (PD) have significant negative effects on companies' expected long-term growth rate. This result still holds when we include the inverse Mills ratio to control the potential selection bias. The third and fourth columns show consistent results if excess cash is less than the mandatory pension contributions for the past 2- and 3-year, respectively. On the other hand, columns 5 and 6 show that if companies have sufficient excess cash holdings to cover the expected next period mandatory pension contributions, pension deficits PD have no significant negative effects on companies' expected long-term growth rate. Columns 7 and 8 further show that if a company's excess cash holdings are greater than its mandatory pension contributions for the past 2 and 3 consecutive years, the negative impacts are even smaller. It suggests the importance of effective working capital management in pension policy decision-making.

3.5.4 The impact of DB pension deficits on the expected growth for firms with high profitability

Since pension laws allow sponsors to make their pension deficit recovery plans with some degree of flexibility, managers usually amortize the pension deficits over several years and have leeway to adjust their annual contributions during the pension deficit recovery period[27]. In particular, companies with high profitability have no strong incentive to adjust their current economic activities and are more likely to delay the deficit reduction contributions. Because companies are expected to fund their DB pension plans in the long term fully, profitable companies may have a less severe negative impact of pension deficits on the expected short-term growth, not the

[27] After the adoption of the Pension Protection Act 2006, sponsors are required to amortize the pension deficits over seven years. However, in the first year, the minimum contributions to the underfunded pension liabilities are based on min(0.3,0.3-0.25×(funding status-0.6)) and the remainder of the shortfall is amortized over 3-5 years before 1994. The Retirement Protection Act of 1994 changes the minimum pension contributions in first-year to min(0.3,0.3-0.4×(funding status-0.6)).

expected long-term growth.

We follow Fama and French (2006) to estimate our expected short-term growth rate. They run cross-sectional regression of asset growth on several explanatory variables to obtain the fitted value of firm-specific one-year ahead asset growth (AG_1), detailed in the appendix. We follow their approach to generate out-of-sample 1- and 3-year ahead asset growth rates[28]. We then calculate the corresponding compound annual asset growth rates for company i at time t as below:

$$AG\tau_{i,t} = (AT_{i,t+\tau}/AT_{i,t})^{1/\tau} - 1, \tau = 1, 3, 5. \tag{3.10}$$

We use the return on assets (ROA), return on equity (ROE) and return on investment (ROI) to measure a company's profitability. A company's earnings estimate ROA, ROE and ROI before extraordinary items (IBCOM) divided by the total asset (AT), the book value of equity (CEQ) and total invested capital (ICAPT), respectively. They measure the efficiency of a company is utilizing its invested capital to generate profits. The higher the ratios, the smaller the investment required to generate revenues and, therefore, the higher the company's profitability. These ratios provide insights into the ability of companies to turn available capital into profits from different angles. In each year, we calculate ROA, ROE and ROI for each company. A company is said to have a high ROA (ROE, ROI) in the year if its ROA (ROE, ROI) is greater than the 70 percentile threshold in the cross-section.[29] We use a dummy variable to indicate a company's profitability. The dummy variable equals one if ROA (ROE, ROI) in a year is greater than the threshold in the year, zero otherwise. To examine the role of a company's profitability on the relation between expected growth rates and DB pension deficits, we introduce an interaction term constructed by pension deficits multiplying the dummy variable. It is the variable of our interest in this analysis. The regression results are shown in the following table:

[Insert Table 3.5 Here]

[28] The standard errors in our regressions are corrected for cross-sectional correlation by the White standard errors method.

[29] When we use the median value as the threshold, the results are similar.

First, consistent with Table 3.2, Table 3.5 shows that DB pension deficits have negative impacts on the expected future growth no matter in the long- or short-term after controlling for the interaction term, Tobin's Q, Altman Z-score, size, age and accounting accruals. Second, for all three profitability measurements, our results show that the coefficients of interaction terms are significantly positive at the 5 per cent level for the expected one-year ahead short-term growth rate. It confirms our Hypothesis 4, showing that profitable companies have a less severe negative impact of pension deficits on the expected short-term growth. However, the coefficients of interaction terms for the expected growth rate 3-year ahead and our long-term expected growth rate are not statistically significantly different from zero. It suggests that the impact of pension deficits on long-term growth is less dependent on companies' profitability.

3.5.5 The impact of DB pension deficits on the expected long-term growth when companies manipulate the discount rate in estimating pension liabilities

The sponsors of DB pension plans guarantee employees a specific amount of retirement benefits based on their final salary, years of service and inflation. The pension accounting standards require the sponsors to estimate the present value of deficits and costs associated with their pension plans based on several complex actuarial projections. The discount rate used in calculating pension obligations is one of the most critical applied actuarial assumptions[30]. It is directly related to the reported pension liabilities, but managers can also manipulate them. A slight increase in the projected discount rate can significantly reduce the DB pension liabilities. Therefore, managers could choose a higher discount rate to improve their reported plan funding status[31]. The accounting standards have specific requirements for the applied discount rate. For example, SFAS No.87 use the US 30-year Treasury

[30] The applied actuarial assumptions include the discount rate in estimating pension benefits, expected return on pension assets, expected longevity and rate of compensation increase, etc.

[31] Because pension regulators have set a clear rule on possible discount rates that a company can use, existing studies mainly focus on actuarial assumptions on pension asset returns and view the projected discount rate as an exogenous variable (Cocco, 2014).

bond yield as a discount rate to increase the DB pension sponsors tremendous pressure. The SFAS No.158 accordingly relaxes the requirement to allow companies to apply a yield from investment-grade corporate bonds for financial reporting[32]. The specification of high-quality corporate bond yields leaves managers room for discretion. A certain degree of discretion means that a reasonable range of discount rates will be acceptable. Therefore, there is a need to draw a line between management discretion and manipulations to reduce pension liabilities.

Firstly, we need to examine the managers' discretion on choosing the applied discount rate. Several prior pieces of literature demonstrate that managers can choose applied discount rates according to their target, although the pension regulators have a clear and strict rule on possible discount rates that a company can use. For example, Asthana (1999) finds that the choice of actuarial assumptions is related to the funding status of pension plans, and underfunded plans tend to employ aggressive assumptions to improve funding status. Anantharaman and Lee (2014) also find that the distressed companies manipulate actuarial assumptions by choosing a higher discount rate to improve their reported plan funding status. In this section, to investigate whether the applied discount rates reflect sponsors' pension plan funding status and their business risk, we use the following variables to explain the applied pension discount rates. They are the pension plan funding status (PD), the Altman Z-score (Z), the Moody's seasoned AAA corporate bond yields (AAA), the risk-free rate proxied by the yields of US 10-year treasury bonds (RF), non-pension cash flows (NPCF), measured by the sum of earnings (IB), depreciation and amortization (DP), and pension and retirement expense (XPR) scaled by total assets (AT) as Rauh (2006a), and the percentage of equity in the pension asset allocation (EQP), i.e., equity investment divided by the sum of equity, debt, real estates and others, all collected from Compustat[33].

[32] The IRS publishes rates based on the investment-grade corporate bonds as the baseline of pension discount rates for all private single-employer pension plans, although different DB plans may have different risk associated with their pension asset allocation and pension funding status. (Rauh, 2009) The FASB Retirement Benefits (topic 715) views the discount rate used in a sponsor's accounting reporting as the rate of return on a hypothetical portfolio of high quality fixed income securities that generate cash flows that match the expected amount and timing of payments from the pension plan.

[33] Data for the pension asset allocation is available from 2002. Accordingly, the number of observations decreases to 6257 if we include EQP in our analysis.

[Insert Table 3.6 here]

The first two columns of Table 3.6 indeed show that the applied discount rates are positively related to all our explanatory variables except the Altman Z-score. In particular, the AAA bond yield is the most critical determinant of the applied discount rates as expected. However, the high-quality bond yield is not the only determinant. Companies' other economic characteristics also matter. It is not surprising that the higher the yields of investment-grade corporate bonds (AAA), risk-free rate and non-pension cash flows, the higher the applied discount rate. The higher the Z-score, the lower the applied discount rate. There are other two noteworthy findings. First, the applied discount rate is significantly positively associated with the DB pension deficits. It suggests that managers may be incentivised to use an aggressive discount rate in reporting DB plan obligations. Second, the percentage of equity in the pension asset allocation (EQP) and Z-score have opposite signs. The Z-score is more significantly negatively associated with the applied discount rate when more equity holdings in pension assets. While high EQP is supposed to increase sponsoring companies' overall risk, high EQP also increases pension asset returns as documented in Rauh (2009). Therefore, the applied discount rate in financial reporting reflects the pension plan's specific risk.

To examine whether the applied discount rate affects our findings, we need to determine whether the discount rate is manipulated or reasonable. Firstly, we use four different approaches to construct our benchmark discount rate (BMR) for our purpose. Suppose firms' applied discount rate is higher than its corresponding BMR. In that case, we describe the applied discount rate as an aggressive discount rate and define the reported discount rate in the financial statements is manipulated.

Method 1. We consider company i and assume that companies with similar funding status to company i should apply the same discount rate in estimating pension liabilities in the same year. We first calculate the mean ($\overline{PD_i}$) and standard deviation (σ_{PD_i}) of pension deficits for company i from the start of DB pension plans in our sample period. Then, we create a portfolio, which includes all companies with pension deficits within one standard deviation (σ_{PD_i}) from the mean ($\overline{PD_i}$) of the

company i's pension deficits. We assume that there are $N+1$ companies in the portfolio in year t. We then calculate the average discount rate for all companies except company i in the portfolio as the benchmark discount rate for company i in year t. That is,

$$
\begin{aligned}
BMR_{i,t} &= \frac{1}{N}\sum_{k=1,k\neq i}^{N} DR_{k,t}, \text{where} \\
DR_{k,t} &= \begin{cases} DR_{k,t}, & \text{if } PD_{k,t} \in (\overline{PD}_i - \sigma_{PD_i}, \overline{PD}_i + \sigma_{PD_i}) \\ 0, & \text{otherwise.} \end{cases}
\end{aligned} \tag{3.11}
$$

Method 2. We further consider company i's industry classification and implicitly assume that companies in the same industry (I) with similar funding status should apply the same projected pension benefit discount rate in the same year. We calculate the mean ($\overline{PD}_i$) and standard deviation (σ_{PD_i}) of pension deficits for company i as those in Method 1. We define the benchmark discount rate for company i in year t as the average discount rate applied for all companies ($M+1$ in total in the year) except company i in the same industry (I) in year t. That is,

$$
\begin{aligned}
BMR_{i,I,t} &= \frac{1}{M}\sum_{k=1,k\neq i}^{M} DR_{k,I,t}, \text{where} \\
DR_{k,I,t} &= \begin{cases} DR_{k,I,t}, & \text{if } PD_{k,I,t} \in (\overline{PD}_i - \sigma_{PD_i}, \overline{PD}_i + \sigma_{PD_i}) \\ 0, & \text{otherwise.} \end{cases}
\end{aligned} \tag{3.12}
$$

Method 3. We consider company i's distribution of historical discount rates applied in estimating DB pension liabilities and implicitly assume that the company should use a consistent discount rate in evaluating pension deficits in the normal business environment. We first calculate the mean ($\overline{DR}_i$) and standard deviation ($\sigma_{DR,i}$) of pension benefit discount rates for company i since the start of DB pension plans. We then define a conservative benchmark discount rate as its mean rate plus one standard deviation ($\sigma_{DR,i}$). In other words, company i is not regarded as applying an aggressive pension accounting in determining discount rate if it applies a discount rate lower than one standard deviation above its long-term average ($\overline{DR}_i$).

That is,

$$BMR_{i,t} = \overline{DR}_i + \sigma_{DR,i}. \tag{3.13}$$

Method 4. Finally, prior literature documents that a company's applied discount rate in estimating pension liabilities is associated with pension deficits, default risk, non-pension cash flows (NPCF), the composition of plan assets, the risk-free rate and corporate bond yields. (Asthana, 1999; Anantharaman and Lee, 2014) The percentage of equity investment in pension plan assets (EQP) is the ratio of pension asset invested in equity in total plan assets allocation. We regress the discount rate ($DR_{i,t}$) for firm i at year t on the above independent variable set ($PD_{i,t}, Z_{i,t}, NPCF_{i,t}, EQP_{i,t}, RF_{i,t}, r_{aaa,t}$) from a panel data regression. We also consider state fixed effect and use industry and year dummies in our analysis. We then use the firm-year specific predicted value ($\overline{DR}_{i,t}$) as the benchmark discount rate for company i in year t.

We introduce a dummy variable, which equals one if the applied discount rate is higher than each of the benchmark rates (aggressive) in year t, or zero otherwise[34]. We also introduce an interaction term equal to the product of the dummy variable and pension deficits. Since a distressed company is more likely to apply aggressive pension actuarial assumptions to show a better DB pension plan funding status, we expect a negative sign to be attached to the interaction term. The regression results are reported in Table 3.7.

[Insert Table 3.7 here]

Columns 3 to 5 of Table 3.7 show how the applied discount rates affect the relationship between the DB pension deficits and the expected long-term growth rate corresponding to the benchmark discount rates estimated from Methods 1, 2 and 3, respectively. They show that DB pension deficits are significantly negatively related to the expected long-term growth rates after controlling for the benchmark discount rate dummy and other variables for the three benchmark discount rates. More

[34] Dummy variable equals one for the benchmark portfolio comprise less than two firms when applying Method 2. We implicitly assume that a manager is more likely to use an aggressive discount rate to improve the pension plan funding status in this circumstance.

importantly, all interaction terms have negative signs, although they are marginally significant. They suggest that the negative effects of DB pension deficits on the expected long-term growth are more severe for companies that apply aggressive discount rates in estimating pension liabilities. If an aggressive discount rate is used in estimating DB pension deficits, the market will downgrade the company's future growth expectations.

The predicted applied discount rates based on results in Columns 1 and 2 reflect managers' discretion to deviate from high-grade bond yields when they consider companies' characteristics with or without assessing the riskiness of pension asset investments. Columns 6 and 7 of Table 6 shows how the applied discount rates affect the relation between the DB pension deficits and the expected long-term growth rate, corresponding to the discount rates estimated in Columns 1 and 2, respectively. Unlike results reported in columns 3 and 5, where the benchmark discount rate is based on the cross-sectional or time-series comparisons consistent with the conservative principle in determining DB pension liabilities, the difference between the reported discount rate and the benchmark rate used in columns 6 and 7 is a residual. While a positive residual still indicates aggressive accounting, the applied discount rate can be viewed as reasonable with management discretion. In other words, the application of this aggressive discount rate does not necessarily mean management manipulation. Our results in Columns 6 and 7 demonstrate that the market distinguishes legitimate accounting discretion and financial report manipulations. They show that the expected long-term growth is statistically negatively related to the DB pension deficits but is not sensitive to management discretion in the applied aggressive discount rate. The interaction terms are not statistically significant, although they are still negative.

3.6 Robustness analysis

We have mainly examined the impact of DB pension deficits on companies' expected long-term growth rates, which are implied by companies' fundamentals, stock prices, one-year ahead analysts' forecasts of earnings, and industry-wide information. Biases

in forecasts of one-year ahead earnings and deviation of the stock price from a company's intrinsic value may influence our analysis. Information asymmetry may lead to investors' behavioural biases, such as under/overreaction to the effects of DB pension deficits on future corporate earnings. (Coronado and Sharpe, 2003; Franzoni and Marin, 2006; An, Lee and Zhang, 2014) These may have an impact on the input in estimating our expected growth rate. We use a few alternative measurements of future short-term and long-term growth as a robustness test in this section. In addition, to use the analysts' consensus long-term earnings growth rate forecasts collected from the I/B/E/S database, we also apply the short-term and long-term asset growth estimates discussed in section 3.5.4. We regress these growth proxies on DB pension deficits after controlling for other companies' fundamentals. The results are shown in the following table:

[Insert Table 3.8 here]

The first four columns in Table 3.8 show that DB pension deficits have significant negative effects on companies' future growth measured by analysts' forecasts of long-term growth in earnings and the short- and long-term asset growth.

In all the above analyses, we treat companies' DB pension deficits as an exogenous variable. Note that pension deficits are defined as the difference between pension liabilities and pension assets. Since pension asset value is mainly determined by the return of pension assets in the capital market, sponsors of pension plans have limited control power on the performance of pension assets. Nevertheless, an endogeneity problem in the reported DB pension deficits cannot be ruled out if managers manipulate pension accounting and apply aggressive actuarial assumptions. (Chuk, 2012; Kisser, Kiff and Soto, 2017) On the other hand, the pension deficits of other companies nearby may also affect the expectation of a company's future growth[35]. To eliminate the potential bias, we use the method of instrumental variables (IV) to predict companies' pension deficits. Specifically, we use the average DB pension deficits for all companies in the same state with 2-digit ZIP codes as the

[35] Kedia and Rajgopal (2009) suggest that a company's interaction with nearby companies affects its employee benefit plans. Thus, companies' pension policy decisions are influenced by geographical area.

instrumental variable in the year. We repeat our analysis by using the 2-stage least squares (2SLS) method.

The last two columns of Table 3.8 show the results of 2SLS. Our first-stage results suggest that companies' pension deficits are indeed significantly positively related to our instrumental variable. It indicates the efficiency of the applied instrumental variable and indicates that its pension policy is related to its geographical area. After adopting the predicted values of companies' pension deficits in the second stage, the results show that companies' DB pension deficits have significant negative effects on the expected growth with a coefficient of -0.451 (with t-statistic -3.02).

3.7 Conclusion

Evaluating the impact of pension deficits on companies' expected future growth rates has important implications for strategic management decision-making. It can help management in pension deficits in the best interest of various stakeholders' value. This chapter investigates how companies' current defined benefit pension deficits affect firms' expected growth rate. We recognize that mandatory DB pension benefit contributions may restrict companies' financial flexibility in $NPV > 0$ investments or investment in risky R&D projects. In addition, we study two main channels through which DB pension deficits may affect companies' future growth expectations. A company's future earnings that can be affected by a pension deficit reduction plan and stock prices as a leading indicator of a company's future earnings can be depressed by DB pension deficits. Accordingly, our expected long-term growth rate is estimated from a company's accounting fundamentals, analysts' forecasts of future earnings, current stock prices and industry-wide information. We focus on the expected long-term growth because it is one of the key value drivers and corresponds to the long-term nature of pension obligations. We also estimate a short-term future asset growth rate based on Fama and French (2006) as an alternative growth estimate in our analysis. Our analysis shows that companies' DB pension deficits are significantly negatively associated with their expected long-term as well as short-term growth. The extent to which DB pension deficits affect the expected

growth depends on a company's financial constraints, excess cash holding positions, profitability, and actuarial assumptions that the company applies. Specifically, the effect of pension deficits on the expected long-term growth for companies with higher-level financial constraints is more severe than for companies with lower-level financial constraints. We find that the negative effects of pension deficits on a company's expected long-term growth rate are more severe if the company's excess cash holdings are not sufficient to cover the mandatory pension contributions. We also find that profitable companies have a less severe negative impact of pension deficits on the expected short-term growth. Still, the effect of pension deficits on long-term growth is less dependent on companies' operating efficiency. Finally, we find that the negative effects of pension deficits on the expected long-term growth are more severe for companies that apply aggressive discount rates in estimating pension liabilities. Therefore, a company's pension policy is vital for its future financing, investment and operating decision-making. It can influence the capital market reaction to a company's future performance.

Table 3.1: The descriptive statistics of variables in Chapter 3

This table presents the sample descriptive statistics including the mean, standard deviation, 10th, 25th, 50th, 75th, 90th percentiles and number of observations. The sample period is from 1990 to 2016. Panel A shows the variables that we use to estimate the expected growth rate (g) following Ashton and Wang (2013). $feps_t/P_t$ is one-year ahead I/B/E/S consensus forecasts of earnings per share divided by price. e_t/P_t is the net income per share before extraordinary items divided by price. b_t/P_t is the book-to-market ratio of equity. b_{t-1}/P_t is the lagged book value of equity divided by price. P_{t-1}/P_t is the lagged value of price divided by current value of price. Panel B shows variables that we use to describe companies' characteristics. Q is the Tobin's Q, calculated by the market value of firm (AT+PRCC_C×CSHO-SEQ-TXDB-ITCB+PREF) divided by the book value of firm (AT). Z is the Altman-Z score, calculated by (3.3×(EBIT/AT) +0.99×(SALE/AT) +0.6×(ME/LT) +1.2×(ACT/AT) +1.4×(RE/AT)). Size is the log value of companies' total assets (Log(AT)). Age is calculated by the present year minus the year when a company's data is firstly available in Compustat database. Accruals (Accr) are the difference between earnings and operating cash flows scaled by the book value of equity. Panel C shows variables related to companies' DB pension plans. Pension deficits (PD) are calculated by the difference between the estimated present value of DB pension obligations and the fair value of pension assets scaled by total assets (AT). PD_3 is the average value of pension deficit (PD) in last 3-year. PD_{std} is the moving standard deviation of pension deficit (PD) in the last 10-year. pbarr is the applied pension benefit discount rate. All variables are winsorized at the 1% and 99% levels. Panel D presents the Pearson correlation between the main variables in our analysis. r is the implied industry-year cost of capital. All correlations are computed with the maximum available observations. Correlations in bold are significant at the 10 percent level.

Variable	Mean	std	10%	q1	Median	q3	90%	N
Panel A: Fundamentals and g								
feps_t/P_t	0.068	0.036	0.034	0.049	0.063	0.083	0.109	11747
e_t/P_t	0.044	0.074	-0.016	0.029	0.051	0.073	0.105	11747
b_t/P_t	0.575	0.407	0.204	0.306	0.472	0.711	1.056	11747
b_{t-1}/P_t	0.560	0.434	0.179	0.279	0.441	0.697	1.069	11747
P_{t-1}/P_t	0.998	0.399	0.613	0.753	0.913	1.133	1.465	11747
g	0.024	0.121	-0.077	-0.008	0.028	0.057	0.114	11747
Panel B: Firm characteristics								
Q	1.639	0.736	0.981	1.146	1.425	1.899	2.563	11747
Z	3.856	2.176	1.705	2.446	3.390	4.704	6.494	11747
Size	7.399	1.556	5.361	6.302	7.400	8.479	9.544	11747
Age	3.113	0.793	1.946	2.565	3.296	3.761	3.970	11747
Accr	0.048	0.054	-0.011	0.018	0.045	0.074	0.110	11747
Panel C: Pension characteristics								
PD	0.031	0.036	0.002	0.007	0.019	0.042	0.078	11747
PD_3	0.019	0.041	-0.010	0.002	0.013	0.032	0.060	9231
PD_{std}	0.026	0.025	0.002	0.005	0.016	0.027	0.048	5971
pbarr(%)	5.756	1.437	3.960	4.625	5.800	6.750	7.500	10498
Panel D: Pearson correlation								
	g	r	Q	Z	Size	Age	Accr	PD
g	1.000							
r	**0.097**	1.000						
Q	**0.045**	**-0.049**	1.000					
Z	**0.035**	-0.013	**0.695**	1.000				
Size	**-0.028**	**-0.127**	-0.008	**-0.255**	1.000			
Age	0.008	**-0.071**	**-0.016**	-0.005	**0.339**	1.000		
Accr	-0.013	**-0.030**	**-0.029**	**-0.072**	**-0.022**	-0.013	1.000	
PD	**-0.050**	**-0.081**	**-0.015**	**-0.116**	**0.029**	**0.175**	-0.012	1.000

Table 3.2: The impact of DB pension deficits on the expected growth

This table reports the relationship between the expected growth rate and pension deficits. The firm-level expected growth rate at time t, g_t, is calculated based on Ashton and Wang (2013). Pension deficits (PD) are the difference between the estimated present value of pension obligations and fair value of pension assets scaled by total assets (AT). The Tobin Q is estimated by the market value of firm (AT+PRCC×CSHO-SEQ-TXDB-ITCB+PREF) divided by total asset (AT). The Altman Z score is calculated by (3.3×(EBIT/AT) +0.99×(SALE/AT) +0.6×(ME/LT) +1.2×(ACT/AT) +1.4×(RE/AT)). Size is the log value of companies' total assets (Log(AT)). Age is calculated by the present year minus the year when a company's data is firstly available in Compustat. Accruals (Accr) are the difference between earnings and operating cash flows scaled by the book value of equity. PD_3 is the average value of pension deficits in the last 3-year. PD_{std} is the moving standard deviation of pension deficits in the last 10-year. We run panel regressions with industry and year fixed-effect, except the last column where we report the results of dynamic GMM method. Regress results in column (1) is based on the full sample. Other columns are based on the sample excluding firm-year observations with pension surplus. The sample period is from 1990 to 2016. All variables are winsorized at the 1% and 99% levels. The t-statistics clustered at firm-level are shown in the second line for each variable.

	Dependent variable: the expected growth rate (g)					
	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	0.045	0.031	0.073	0.029	0.071	
	(1.91)	(1.28)	(2.79)	(1.07)	(2.69)	
PD	-0.050	-0.166	-0.132	-0.176	-0.140	-0.015
	(-1.11)	(-3.33)	(-1.98)	(-3.21)	(-2.11)	(-2.24)
Q	0.009	0.009	0.007	0.007	0.007	-0.008
	(3.46)	(3.04)	(1.76)	(2.25)	(1.68)	(-17.77)
Z	-0.001	-0.001	-0.001	-0.001	-0.001	0.002
	(-1.3)	(-0.83)	(-0.85)	(-0.12)	(-0.64)	(10.36)
Size	-0.003	-0.003	-0.005	-0.004	-0.005	-0.003
	(-2.56)	(-2.31)	(-2.99)	(-2.63)	(-2.88)	(-5.48)
Age	0.003	0.006	0.004	0.006	0.004	-0.005
	(1.4)	(2.51)	(0.77)	(2.01)	(0.8)	(-4.5)
Accr	-0.037	-0.047	-0.126	-0.068	-0.131	-0.096
	(-1.51)	(-1.91)	(-3.07)	(-2.31)	(-3.18)	(-38.88)
PD_{std}			-0.212		-0.193	
			(-2.31)		(-2.07)	
PD_3				0.026	0.026	
				(0.85)	(0.73)	
g_{t-1}						0.018
						(16.01)
Industry	Y	Y	Y	Y	Y	
Year	Y	Y	Y	Y	Y	
N	15884	11747	5971	9231	5800	
R^2	0.02	0.02	0.02	0.04	0.04	

Table 3.3: The impact of firm's profitability

Table 3 reports how DB pension deficits affect the short-term and long-term growth rates for firms with different profitability. The sample period is from 1990 to 2016. The expected long-term growth rate (g) is estimated based on Ashton and Wang (2013). 1- and 3-year ahead expected asset growth rates ($AG1, AG3$) are based on Fama and French (2006). Profitability is measured by return on asset (ROA=IBCOM/AT), return on equity (ROE=IBCOM/CEQ) and return on investment (ROI=IBCOM/ICAPT). Pension deficits (PD) are calculated by the difference between the estimated present value of pension obligations and fair value of pension assets scaled by total assets (AT). Dummy variable (Dum.) equals 1 if the value corresponding measure is at the top 30 percent, zero otherwise. The interaction term (Dum.×PD) is the product of pension deficits and the dummy variable. Q is the Tobin's Q, calculated by total assets: (AT+PRCC_C×CSHO-SEQ-TXDB-ITCB+PREF) divided by the book value of firm (AT). Z is the Altman-Z score, calculated by (3.3×(EBIT/AT) +0.99×(SALE/AT) +0.6×(ME/LT) +1.2×(ACT/AT) +1.4×(RE/AT)). Size is the log value of companies' total assets (Log(AT)). Age is calculated by the present year minus the year when a company's data is firstly available in Compustat. Accruals (Accr) are the difference between earnings and operating cash flows scaled by the book value of equity. All variables are winsorized at 1% and 99%. The t-statistics clustered at firm-level are shown in the second line for each variable.

	1-year ahead (AG_1)			3-year ahead (AG_3)			Expected growth rate (g)		
	ROA	ROE	ROI	ROA	ROE	ROI	ROA	ROE	ROI
Intercept	0.188	0.190	0.191	-0.390	-0.387	-0.386	0.044	0.039	0.041
	(14.7)	(14.86)	(14.94)	(27.57)	(-27.33)	(-27.26)	(3.27)	(2.91)	(3.07)
PD	-0.416	-0.440	-0.452	-0.426	-0.463	-0.484	-0.204	-0.162	-0.181
	(-6.18)	(-6.02)	(-6.12)	(-5.17)	(-5.14)	(-5.33)	(-2.84)	(-2.18)	(-2.43)
Dum.	0.003	0.004	0.004	0.009	0.010	0.008	-0.009	-0.017	-0.013
	(0.75)	(1.17)	(1.16)	(2.47)	(2.59)	(2.30)	(-2.16)	(-3.64)	(-2.92)
Dum.×PD	0.141	0.158	0.185	0.071	0.118	0.162	0.019	-0.043	-0.011
	(1.98)	(2.09)	(2.37)	(0.91)	(1.37)	(1.81)	(0.24)	(-0.44)	(-0.13)
Q	0.026	0.026	0.026	0.013	0.012	0.013	0.003	0.006	0.004
	(8.32)	(8.06)	(8.28)	(4.03)	(3.65)	(3.93)	(0.89)	(1.51)	(1.02)
Z	-0.005	-0.004	-0.005	-0.006	-0.005	-0.006	-0.001	-0.001	-0.001
	(-3.78)	(-3.57)	(-3.90)	(-4.4)	(-4.02)	(-4.47)	(-0.48)	(-0.68)	(-0.28)
Size	-0.011	-0.011	-0.011	-0.017	-0.017	-0.017	-0.003	-0.003	-0.003
	(-7.74)	(-8.07)	(-8)	(-10.38)	(-10.82)	(-10.69)	(-1.95)	(-1.52)	(-1.75)
Age	0.001	0.001	0.001	-0.002	-0.002	-0.002	0.006	0.006	0.006
	(0.44)	(0.49)	(0.46)	(-0.83)	(-0.78)	(-0.81)	(1.96)	(2.05)	(2.01)
Accr	-0.049	-0.045	-0.044	0.006	0.010	0.011	-0.025	-0.039	-0.030
	(-1.82)	(-1.72)	(-1.66)	(0.22)	(0.38)	(0.39)	(-0.77)	(-1.2)	(-0.93)
N	5293	5293	5293	5293	5293	5293	5902	5902	5902
R^2	0.10	0.10	0.10	0.14	0.14	0.15	0.01	0.01	0.01

Table 3.4: The impact of firm's financial constraints status

Table 4 reports how the expected growth rate is affected by DB pension deficits when companies have different financial constraints. The sample period is from 1990 to 2016. We apply the KZ index, ratio of (cash minus debt)-to-asset (CD), ratio of dividend-to-asset (DA), and S&P credit rating (RAT) to measure the degree of a company's financial constraints. The KZ index calculation follows Kaplan and Zingales (1997). The ratio of (cash minus debt)-to-asset is calculated by (CHE-DLTT+DLC)/AT. The dividend-to-asset ratio is measured by (DVC+DVP+ net repurchase)/lag(AT). A company is said to have financial constrains (FC) if its KZ index is at the top 70 percent, or ratios of (cash minus debt)-to-asset or dividend-to-asset are at the bottom 30 percent, or credit ratings are lower than the BBB. Otherwise, it is said to be unconstrained (NFC). Pension deficits (PD) are calculated by the difference between the estimated present value of pension obligations and fair value of pension assets scaled by total assets (AT). The Tobin Q is estimated by the market value of firm (AT+PRCC_C×CSHO-SEQ-TXDB-ITCB+PREF) divided by total assets. The Altman-Z score is calculated by (3.3×(EBIT/AT) +0.99×(SALE/AT) +0.6×(ME/LT) +1.2×(ACT/AT) +1.4×(RE/AT)). Size is the log value of companies' total asset (Log(AT)). Age is calculated as the present year minus the year when a company's data is firstly available in Compustat. Accruals (Accr) are the difference between earnings and operating cash flows scaled by the book value of equity. All variables are winsorized at 1% and 99%. The firm-cluster adjusted t-statistics are reported in the second line for each variable.

	Measurements for financial constrain							
	KZ		CD		DA		RAT	
	FC	NFC	FC	NFC	FC	NFC	FC	NFC
Intercept	-0.029	0.509	0.037	0.032	0.045	0.071	0.023	0.022
	(-0.55)	(24.08)	(1.21)	(0.78)	(1.23)	(3.19)	(0.75)	(0.74)
PD	-0.273	-0.005	-0.315	-0.139	-0.368	-0.088	-0.198	-0.091
	(-2.03)	(-0.05)	(-2.39)	(-1.58)	(-2.96)	(-0.85)	(-3.27)	(-1.24)
Q	0.038	0.018	0.028	0.003	0.013	0.006	0.010	0.008
	(2.84)	(2.98)	(3.85)	(0.71)	(2.05)	(1.45)	(3.11)	(1.4)
Z	-0.008	-0.002	-0.013	0.001	-0.002	-0.001	-0.001	-0.001
	(-1.59)	(-0.67)	(-4.23)	(0.56)	(0.96)	(-0.17)	(-0.63)	(-0.42)
Size	-0.003	-0.004	-0.004	-0.003	-0.005	-0.006	-0.001	-0.005
	(-0.68)	(-1.14)	(-1.27)	(-1.65)	(-1.4)	(-2.67)	(-0.68)	(-2.02)
Age	0.01	-0.005	0.006	0.003	0.010	0.001	0.006	0.007
	(1.33)	(-0.99)	(1.51)	(0.81)	(2.25)	(0.22)	(2.46)	(1.75)
Accr	-0.193	-0.158	-0.067	-0.030	-0.117	0.018	-0.050	-0.062
	(-1.79)	(-1.98)	(-1.17)	(-0.77)	(-2.08)	(0.3)	(-1.72)	(-1.4)
Industry	Y	Y	Y	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y	Y	Y	Y
N	688	684	3452	3510	1889	3136	8470	3273
R^2	0.23	0.08	0.05	0.09	0.07	0.08	0.06	0.09

Table 3.5: The sub-sample analysis for firm's different excess cash holdings

Table 5 reports how the expected growth rate is affected by DB pension deficits when companies have different excess cash holding positions. The sample period is from 1990 to 2016. We split the full sample into two sub-samples based on whether the estimated excess cash is less or greater than the predicted one-year-ahead mandatory DB pension contributions during the year. The results are shown in columns 1 and 5 respectively. We also use the Heckman method to calculate inverse Mills ratio in our regressions. The independent variables used in the first-step logistic regression follow Dittmar and Mahrt-Smith (2007). The results are shown in columns 2 and 6. Columns 3 and 7 further show results for firms with consecutive two years excess cash amount being less and greater than the mandatory DB pension contributions respectively. Columns 4 and 8 show results for firms with consecutive three years excess cash amount being less and greater than the mandatory DB pension contributions respectively. The industry and year dummy variables are included in all regressions. All the variables are winsorized at 1% and 99%. The standard error is clustered at firm level and t-statistics are shown in the second line for each variable.

	Excess Cash<Mandatory Contribution				Excess Cash>= Mandatory Contribution			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept	0.055	0.099	0.042	0.047	0.021	0.050	0.027	0.012
	(2.16)	(1.91)	(2.12)	(2.4)	(0.52)	(0.89)	(0.56)	(0.24)
PD	-0.238	-0.303	-0.223	-0.220	-0.131	-0.190	-0.124	-0.115
	(-4.06)	(-2.76)	(-4.13)	(-3.96)	(-1.76)	(-1.47)	(-1.57)	(-1.42)
Q	0.013	0.014	0.010	0.009	0.007	-0.001	0.008	0.009
	(2.73)	(0.86)	(2.59)	(2.37)	(1.88)	(-0.2)	(2.09)	(2.23)
Z	-0.003	-0.005	-0.002	-0.002	0.001	0.002	-0.001	0.001
	(-1.36)	(-1.07)	(-1.08)	(-1.2)	(0.02)	(1.02)	(-0.32)	(0.04)
Size	-0.007	-0.005	-0.004	0.005	-0.001	0.002	-0.002	-0.002
	(-3.48)	(-0.73)	(-2.48)	(1.82)	(-0.89)	(0.36)	(-1.51)	(-1.07)
Age	0.008	0.007	0.004	0.005	0.004	0.003	0.007	0.007
	(2.49)	(1.25)	(1.56)	(1.82)	(1.51)	(0.69)	(2.34)	(2.07)
Accr	-0.129	-0.126	-0.056	-0.050	-0.023	-0.025	-0.044	-0.041
	(-2.98)	(-1.48)	(-1.59)	(-1.63)	(-0.77)	(-0.55)	(-1.27)	(-1.05)
Mills		-0.030				-0.029		
		(-0.24)				(-0.36)		
Industry	Y	Y	Y	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y	Y	Y	Y
N	3623	1029	5304	6321	8124	3495	6363	5361
R^2	0.04	0.01	0.02	0.02	0.02	0.01	0.02	0.03

Table 3.6: Alternate specifications for aggressive pension benefit discount rate

Table 6 shows how expected growth rates are affected by DB pension deficits when companies manipulate pension benefit discount rates. The dependent variable for first-two columns is companies applied projected benefit discount rate (pbarr) and the firm-level expected growth rate (g) for rest of columns. In the first-two columns, we show the regression estimation of applied pension projected discount rate. the regressors include the pension deficit (difference by projected pension benefit obligation and the pension asset value) scaled by total asset (PD), the altman z score which is used to measure the probability of bankruptcy (Z), the Moody seasoned Aaa corporate bond yield, the U.S 10-year treasury yield as risk-free rate, non-pension cash flow (npcf), capital structure in pension asset allocation (p-lev). in the rest of columns, we apply several different measures to define benchmark discount rates by assuming: (i) companies with similar funding status should apply the similar actuary pension assumptions in the same year; (ii) companies in the same industry (classified by Fama-French 49 industry classification) should apply the same actuary pension assumptions in the same year; (iii) a company applies a consistent discount rate based on its own distribution of historical discount rates applied in estimating DB pension liabilities. (vi) the applied discount rate can be explained by related factors. If a company applies a pension obligation discount rate that is higher than the benchmark, the company is said to apply aggressive pension assumptions. Dummy variable equals 1, if a company applies aggressive accounting, zero otherwise. Interaction term is the product of pension deficits and the dummy variable (Dum×PD). State, year and industry fixed effect are considered for first-two columns. The firm-cluster adjusted t-statistics are applied for all regressions and reported in the second row for each variable.

Dependent variable	Applied discount rate(pbarr)		Estimated growth rate (g)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Intercept	-1.810	-0.890	0.032	0.030	0.030	0.047	0.030
	(-8.22)	(-4.53)	(2.95)	(2.71)	(2.62)	(3.16)	(2.66)
PD	0.673	0.771	-0.158	-0.136	-0.167	-0.177	-0.189
	(2.29)	(2.6)	(-3.32)	(-2.65)	(-3.45)	(-3.29)	(-3.8)
Z	-0.025	-0.017	-0.002	-0.002	-0.002	-0.003	-0.002
	(-2.63)	(-1.89)	(-1.92)	(-1.84)	(-1.87)	(-1.95)	(-1.93)
AAA	0.771	0.650					
	(22.4)	(24.74)					
RF	1.017	1.043					
	(15.44)	(14.03)					
Npcf	0.459	0.574					
	(2.06)	(2.77)					
P-Lev	0.676						
	(5.56)						
Dummy			0.003	0.004	0.005	0.009	0.003
			(0.50)	(0.91)	(1.37)	(1.43)	(0.74)
Dum*PD			-0.221	-0.157	-0.162	-0.070	-0.047
			(-1.72)	(-1.86)	(-1.8)	(-0.54)	(-0.5)
Q			0.011	0.011	0.011	0.013	0.011
			(3.79)	(3.81)	(3.76)	(3.1)	(3.72)
Size			-0.004	-0.004	-0.004	-0.007	-0.004
			(-3.11)	(-3.07)	(-2.98)	(-3.86)	(-2.82)
Age			0.006	0.006	0.006	0.008	0.006
			(2.54)	(2.57)	(2.6)	(2.55)	(2.58)
Accr			-0.039	-0.039	-0.040	-0.103	-0.036
			(-1.48)	(-1.45)	(-1.48)	(-2.92)	(-1.34)
N	6257	10297	10498	10444	10459	6257	10297
R^2	0.77	0.83	0.01	0.01	0.01	0.01	0.01

Table 3.7: The impact of aggressive pension benefit discount rate

Table 6 shows how expected growth rates are affected by DB pension deficits when companies manipulate pension benefit discount rates. The sample period is from 1990 to 2016. The dependent variable is the firm-level expected growth rate (g) estimated based on Ashton and Wang (2013). We apply four different measures to define benchmark discount rates by assuming: (i) companies in the same state with similar funding status should apply the same actuary pension assumptions in the same year; (ii) companies in the same state in the same industry should apply the same actuary pension assumptions in the same year; (iii) a company applies a consistent discount rate based on its own distribution of historical discount rates applied in estimating DB pension liabilities. (vi) the applied discount rate can be explained by firms' characteristics. Pension deficits (PD) are calculated by the difference between the estimated present value of pension obligations and fair value of pension assets scaled by total assets (AT). Q is the Tobin Q estimated by the market value of firm (AT+PRCC_C×CSHO-SEQ-TXDB-ITCB+PREF) divided by total assets (AT). Z is the Altman-Z score calculated by (3.3×(EBIT/AT) +0.99×(SALE/AT) +0.6×(ME/LT) +1.2×(ACT/AT) +1.4×(RE/AT)). Size is the log value of companies' total asset (Log(AT)). Age is calculated by the present year minus the year when a company's data is firstly available in Compustat. Accruals (Accr) are the difference between earnings and operating cash flows scaled by the book value of equity. If a company applies a pension obligation discount rate that is higher than the benchmark, the company is said to apply aggressive pension assumptions. Dummy variable equals 1, if a company applies aggressive accounting, zero otherwise. Interaction term is the product of pension deficits and the dummy variable (Dum×PD). Year and industry fixed effect are considered. All variables are winsorized at 1% and 99%. The firm-cluster adjusted t-statistics are reported in the second row for each variable.

	Method1 (1)	Method2 (2)	Method3 (3)	Method4 (4)
Intercept	0.030	0.030	0.030	0.022
	(2.8)	(2.73)	(2.67)	(1.92)
PD	-0.164	-0.157	-0.168	-0.103
	(-2.82)	(-2.74)	(-3.48)	(-1.91)
Dummy	0.002	0.002	0.005	0.010
	(0.47)	(0.54)	(1.32)	(2.33)
Dum×PD	-0.046	-0.061	-0.162	-0.142
	(-0.58)	(-0.76)	(-1.8)	(-1.72)
Q	0.011	0.011	0.011	0.011
	(3.81)	(3.81)	(3.77)	(3.8)
Z	-0.002	-0.002	-0.002	-0.002
	(-1.92)	(-1.92)	(-1.89)	(-1.82)
Size	-0.004	-0.004	-0.004	-0.004
	(-3.09)	(-3.08)	(-3.01)	(-2.82)
Age	0.006	0.006	0.006	0.006
	(2.66)	(2.67)	(2.62)	(2.67)
Accr	-0.039	-0.039	-0.038	-0.038
	(-1.46)	(-1.46)	(-1.42)	(-1.45)
N	10498	10498	10498	10498
R^2	0.01	0.01	0.01	0.01

Table 3.8: The robustness test

The first four columns of Table 7 show how the 1-, 3-, 5-year ahead asset growth rates (AG1-AG5) and the long-term growth rate of earnings from the I/B/E/S consensus forecasts (LTG) are affected by companies' pension deficits. Estimates of the 1-5 years ahead asset growth rates are based on Fama and French (2006). In the last two columns, we show the results of 2SLS on the long-term growth rates based on Ashton and Wang (2013). In the first-stage, we predict companies' pension deficits with instrumental variable, PD_{ave}, which is defined as the average value of pension deficits for companies that are located in the same state. In the second stage regression, we regress companies' expected growth on the predicted value of pension deficits ($\widehat{PD}$). The Tobin Q is estimated by the market value of firm (AT+PRCC_C×CSHO-SEQ-TXDB-ITCB+PREF) divided by total assets (AT). The Altman-Z score is calculated by (3.3×(EBIT/AT) +0.99×(SALE/AT) +0.6×(ME/LT) +1.2×(ACT/AT) +1.4×(RE/AT)). Size is the log value of companies' total assets (Log(AT)). Age is calculated by the present year minus the year when a company's data is firstly available in Compustat. Accruals (Accr) are the difference between earnings and operating cash flows scaled by the book value of equity. NPCF is the non-pension cash flow calculated by the sum of earnings (IB), depreciation and amortization (DP), and pension and retirement expense (XPR) scaled by total assets (AT) (Rauh, 2006a). PD_3 is the average value of pension deficit in the last 3-year. PD_{std} is the moving standard deviation of pension deficits in the last 10-year. We consider year and industry fixed effects. The sample period is from 1990 to 2016. All the variables are winsorized at 1% and 99%. The t-statistics clustered at firm-level are shown in the second line for each variable.

	AG1	AG3	AG5	LTG	2SLS	
Intercept	0.091	-0.482	-0.533	0.157		
	(12.04)	(-60.24)	(-41.9)	(8.34)		
PD	-0.069	-0.093	-0.093	-0.070		
	(-3.13)	(-2.67)	(-2.05)	(-2.33)		
Q	0.018	0.007	-0.001	0.021	-0.001	0.005
	(11.13)	(4.71)	(-0.67)	(9.51)	(-1.06)	(0.64)
Z	-0.001	-0.001	-0.003	-0.004		-0.001
	(-0.05)	(-2.46)	(-3.51)	(-5.33)		(-0.33)
Size	-0.007	-0.013	-0.020	-0.009		-0.006
	(-9.61)	(-15.49)	(-17.35)	(-9.71)		(-2.08)
Age	0.001	-0.003	-0.005	-0.005		0.007
	(1.05)	(-3.09)	(-3.35)	(-3.68)		(0.87)
Accr	-0.129	-0.083	-0.043	-0.048		-0.258
	-10.56	-5.92	-2.43	-3.35		-3.56
PD_{std}					0.648	
					(54.46)	
PD_3					0.344	
					(37.52)	
$\widehat{PD}$						-0.451
						(-3.02)
PD_{ave}					0.266	
					(12.26)	
Npcf						-0.023
						(-2.75)
Industry	Y	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y	Y
N	9424	7117	5293	10805	12082	12082
R^2	0.69	0.75	0.79	0.14	0.45	0.02

4. Asymmetric Information In Defined Benefit Pension Plans

4.1 Introduction and relevant literature review

Asymmetric information caused by opaque and complicated pension accounting has been an interesting subject for the management and investment community since the 1990s, when defined benefit pension schemes (DB) were popularly offered to benefit companies' employees (Treynor, 1977; Pontiff, Shleifer and Weisbach, 1990; Campbell, Dhaliwal and Schwartz Jr, 2011; Cocco and Volpin, 2013). After the turn of the century, the poor investment experience of many pension plans, low-interest rates, and lower mortality rates significantly deteriorate pension plans' funding status. Most active defined benefit pension plans are in deficits now. To better disclose pension risk, the Statement of Financial Accounting Standards (SFAS) No.87 stipulates a series of accounting requirements to standardise pension reporting and help users of financial statements accurately comprehend pension-related information. The SFAS No.158 (issued in 2006) requires plan sponsors to recognise and report funding status in the overall balance sheet and record the pension surplus or pension deficit as a line item on the asset or liability side. These rules set stricter requirements for pension information disclosure and improved the quality of pension information reported in financial statements. In prior corporate finance research, the asymmetric information between managers and investors has been explained through opaque and complicated pension accounting. Therefore, we are curious to know whether asymmetric information associated with DB pension plans is still a challenge to capital market participants now and whether the level of asymmetric information

differs across different DB plans.

Previous pension-related research has explained the generation mechanism of asymmetric information for firms with DB pension plans. Essentially, asymmetric information stems from the opacity of pension accounting, as well as manipulation by managers. For example, accounting standards require sponsors to project the vested and non-vested pension benefits with actuarial assumptions into the present value because pension liability is deferred. Managers have information advantages over external investors regarding the applied actuarial assumptions, such as employee longevity, mobility, and the discount rate. Prior work discusses the probability of managers manipulating pension discount rates to improve the reported funding status or achieve other targets (Amir and Gordon, 1996; Asthana, 1999; Stefanescu et al., 2018). However, the recent pension accounting reforms have set increasingly strict rules surrounding the applied discount rate. Therefore, many recent papers focus on the expected rate of return on pension assets, which is used in income statements[1]. To avoid volatility in firms' earning reporting, managers can use the expected return on pension assets, rather than the actual return, to calculate pension expenses[2]. This smoothing mechanism gives managers discretion in manipulating accounting earnings. This is most likely to occur when managers have an incentive to improve earnings reporting, such as when the reported value is near critical thresholds (Bergstresser, Desai and Rauh, 2006; Rauh, 2009). As a result, this manipulation may change the pension reporting from the actual DB pension plan funding status. Shivdasani and Stefanescu (2009) state that companies may report pension income as part of their operating income when the actual funding status has deteriorated. Focusing exclusively on the balance sheet and income statement creates a distorted image of a pension plan's economic status. In considering this issue, the recent pension

[1] For pension accounting purposes, the interest rate used to discount pension benefits, referred to as the discount rate, should reflect market rates currently applicable for settling the benefit obligation or rates of return on high quality fixed income securities at the measurement date. The expected rate of return on pension assets is the expected future pension asset investment return based on current asset allocation. Both actuarial assumptions changes, often resulting in the volatility of pension accounting from year to year.

[2] The pension expense is recorded in the income statement as the result of service cost or new pensions accrued (newly accrued pension benefit for this year and treated as operating costs) + interest cost (assume pension as debt equivalents) + actuarial loss net of experience gain on plan asset (the non-recurring item) - expected return on assets.

accounting standards aim to improve the quality of pension reporting and provide users with financial statements with more timely and accurate pension information. However, while these changes indeed increase volatility in pension accounting, Amir, Guan and Oswald (2010) show that, since the adoption of SFAS No.158, the net pension surplus or deficit must be recognised on the balance sheet, and actuarial gains or losses must be listed in other comprehensive income. This standard introduces volatility into the comprehensive income and balance sheets for US firms. Thus, investors are challenged in understanding pension information released in financial statements. Other potential sources of information asymmetry include the difference between pension funding and pension accounting, incremental leverage and pension asset allocation (Shivdasani and Stefanescu, 2009).[3]

The prior research found that the market's failure to anticipate pension information stems from investors' behaviour bias. Coronado and Sharpe (2003) find that the market appears to pay more attention to the flow of pension-induced accruals reported in the body of the income statement than to the marked-to-market value of pension assets and liabilities reported in the footnotes. The investors do not seem to distinguish between the earnings associated with pension accruals and a firm's core earnings. Additionally, Franzoni and Marin (2006) find that external investors are shocked by the negative impact of pension deficits on future earnings and cash flows. This finding is further supported by Picconi (2006). Picconi (2006) explores whether investors and analysts fully process publicly available pension information when establishing prices and making earnings forecasts. He finds that prices and analysts' forecasts fail to reflect new pension information when it becomes publicly available. It is only gradually incorporated through its effects on quarterly earnings.

This chapter provides further evidence to confirm the asymmetric information as another explanation channel for the market's failure to anticipate pension information fully. The first evidence about the asymmetric information associated with the DB pension plan is reported in Cocco and Volpin (2013). Their evidence indicates that the asymmetric information issue is an important component of pension-induced risk

[3] The pension contribution can be made either in cash, in stock, or debt. In the US, pension assets can be invested in the firm self stock, limited up to 10 per cent of the total plan assets. The cross-capital holding may deteriorate the asymmetric information (Rauh (2006b)).

for sponsors and may be understood as an anti-takeover strategy by managers.

The asymmetric information in DB pension plans is highly related to pension accounting and has been affected by changes to accounting requirements. The most recent pension law – which dominates the current rules on pension accounting – is SFAS No.158, which was issued in 2006. Because the accounting requirements have clarified the stratified structure of the magnitude of DB pension deficits, we follow Franzoni and Marin (2006) and sort firms that sponsor DB pension plans into 11 portfolios based on the size of scaled pension deficits. The analysis at the portfolio level helps determine whether the effect of asymmetric information is related to the magnitude of pension deficits. As the initial step, we compute several proxies regarded as reasonable indications of asymmetric information, which was used in previous research. The statistical comparison shows that investors have significant opinion divergence regarding firms with deteriorated DB pension plans. We infer that sponsoring a DB pension plan restricts the opinion to agreement among external investors. Further evidence comes from the association between a stock's expected return and information uncertainty. In traditional financial theory, investors require extra compensation for the information risk, which is not offset by diversification. Our regression analysis finds that the portfolios with more outstanding pension liabilities tend to have higher expected stock returns, even after controlling for common risk factors. Jin, Merton and Bodie (2006) confirm that the current risk loading on the market factor (beta) can reflect DB pension plan risk. Our regression analysis is consistent with their findings, showing that the most deteriorated DB pension plan (included in portfolio 1) has a significantly higher loading on the market factor, no matter which pricing model we use. After controlling for the pension-induced risk anticipated in beta, the intercept term (alpha) remains significantly greater for portfolios filled by severely underfunded DB pension plans than for the other portfolios. We explain this phenomenon as investors being reluctant to accept the accuracy of pension information released by underfunded DB pension plan sponsors – therefore, they require extra risk compensation. Our hypothesis is supported by evidence from prior empirical corporate financial policy research, which confirms the

role of pension information risk in post-earnings price drifting, decisions on freezing DB pension plans and payment means of M&A activities. Theoretically, the holding-per-unit pension-projected obligation is more costly for firms exposed to more severe information asymmetry because managers have a stronger incentive to freeze their DB pension plans. Our results support this notion: the coefficient of scaled pension deficits is statistically significant and positive for portfolio 1. Regarding the evidence of M&A activities, we find that cash as a payment means has a positive incremental effect on a target firm's return during the short period of a M&A deal's announcement date. This evidence further supports our hypothesis: the DB pension plans with a deteriorated funding status tend to be exposed to asymmetric information.

This chapter is constructed as follows. In the next section, we introduce pension accounting and pension funding in DB pension plans. Next, we introduce and define the variables used in this chapter and compare several commonly used proxies for asymmetric information among portfolios. We then examine the relationship between a firm's expected stock return and its DB pension plan's funding status. After that, we provide further evidence using the experimental setting of the post-earnings price drifting, DB pension plan freezing strategy and the announcement effect of the M&A deal to examine the existence of asymmetric information for severely underfunded firms. Finally, we discuss our findings and give concluding remarks.

4.2 The pension funding and pension accounting

The US's corporate pension schemes can be generally categorised as defined benefit (DB) or defined contribution (DC) pension plans. The responsibility of an employer sponsoring a DC plan is to fund a constant annual pension contribution, which makes up the operating expense. Unlike sponsors of DC plans, sponsors of DB plans to promise employees a benefit payment after their retirement. The final pension benefit payments are determined by several factors: an employee's final salary, service years, inflation adjustment and longevity expectations. Because this payment will occur in the future and is unobservable in the present, sponsors require actuarial assumptions to project the future expenses into the present value and record them

as pension-projected obligations.

To ensure benefits for DB pension plan participants, sponsors must contribute to their pension plans annually. DB annual funding is ruled by laws described in the Internal Revenue Code. In 1974, the Employee Retirement Income Security Act (ERISA) allowed firms to fund 90% of their underfunded pension liabilities over thirty years. In 1987, Congress subsequently enacted the Pension Protection act of 1987 (PPA 1987), requiring better overall funding of pension plans by creating 'catch-up' contributions for severely underfunded firms. In 2006, Congress enacted the Pension Protection act of 2006 (PPA 2006). The PPA 2006 requires firms to fully fund their pension deficits within seven years, dramatically accelerating near-term cash outflows for all pension sponsors. In general, the annual minimum required contribution is compromised by the normal cost plus the amortisation of the unfunded actuarial liability over seven years. The normal cost is the new accrued pension benefit attributed to the current year of service. This is recorded as a service cost in pension accounting. In addition to the normal cost, the second portion of the minimum required contribution is the amortisation of the underfunded pension liability. When companies fail to make mandatory pension contributions, the Pension Benefit Guaranty Corporation (PBGC) is empowered to file a claim against the company's assets to protect employee benefits.[4]

Pension accounting principles necessitate a clear and consistent disclosure of pension funding information, along with the annual pension costs in financial statements, to satisfy the market's need to access pension-related information. Companies follow the guidance of the Statements of Financial Accounting Standards (SFAS) to report their pension information in their income statements, cash flow statements, and on their balance sheets. The Financial Accounting Standards Board's (FASB) Statement of Financial Accounting Standards No. 87 (issued in 1985) stipulates that companies must recognise and disclose their pension obligations, along with

[4] The Employee Retirement Income Security Act (ERISA, issued in 1974) created the Pension Benefit Guarantee Corporation (PBGC), which was established to protect the pension of American workers and retirees and is managed by the US Department of Labour. When a company terminates its pension plan, the PBGC takes responsibility for the plan. Consequently, the fiscal viability of the government-led PBGC depends on firms' ability to pay their promised pension obligations to retirees.

the performance of their plans, at the end of each accounting period. The values of pension assets and projected benefit obligations must be disclosed in the footnotes of annual financial statements. The SFAS 132 (issued in 1998 and revised in 2003) is intended to enhance the effectiveness of these disclosures and help financial statement users to understand pension-related information. This regulation standardises disclosure requirements. Sponsors must report their plans' funding status, including the amount recognised and not recognised, as well as the actuarial assumptions used in accounting for the pension plans[5]. The FASB adopted SFAS No.158 (issued in 2006) to improve pension accounting disclosures' quality further. SFAS No.158 requires sponsors to report pension plans' funding status on their balance sheets[6].

For pension funding purposes, the IRS requires actuaries of DB plans to select applied assumptions. However, sponsors have discretion in determining the actuarial assumptions for reporting pension information, with guidance from the actuary for pension accounting purposes. However, the applied pension actuarial assumptions generally require review and approval by companies' external auditors in their general auditing of the financial statements.[7] Since pension accounting for DB plans is complicated, and managers have discretion in determining the actuarial assumptions for reporting pension information, managers are conventionally regarded as having information benefits over investors regarding the DB pension plans' actual funding status.

4.3 Data and sample statistics

The target firms are listed on the NYSE, Nasdaq, and AMEX that sponsor DB pension plans. We have selected based on whether the pension projected benefit

[5] The actuarial assumptions used in accounting is reported on a weighted-average basis including the projected benefit discount rate, salary scale and the expected long-term rate of return.

[6] The balance sheet includes two items: the prepaid or accrued pension cost and the occurrence of additional minimum liability. The prepaid or accrued pension cost is used to measure the net accrued pension cost during the year. The occurrence of an additional minimum liability in the event of severe under-funding is added to the accrued pension cost. This is offset by an increase in intangible assets and a charge to the book equity on the balance sheet.

[7] There are two primary types of premises, the economic and demographic assumptions. The economic assumptions deal with current interest rates, salary increases, inflation expectations and investment markets. The demographic assumptions, including the mortality, retirement, and withdrawal assumptions, measure the participants' behaviour and life expectancy.

obligation (PBPRO) in the Compustat database is missing. If so, we currently regard this firm as having no DB pension plan and eliminate it from the base sample, or vice versa. The sample period used in this chapter is from 2008 to 2019. The sample period begins in the fiscal year 2008 to ensure that all DB plan sponsors employ SFAS No.158 to report their pension information and avoid the effect of the financial crisis.

The conventional method of measuring a DB plan's funding status is to measure the difference between the pension projected benefit obligation (PBPRO) and the pension plan assets (PPLAO). These two accounting items are recorded in a firm's financial statement[8]. For the purpose of this chapter, we need to measure the pension plan's funding status each month. Thefore, we first calculate the firm's annual pension plan's funding status according to the pension information disclosed by the annual report. In the next step, we scale the yearly number by the firm's market capitalisation at the prior month. The annual pension funding status is used in the calculation process for 3–14 months after the end of the current fiscal year. In addition to the firm's financial statements, sponsors of DB pension plans must complete Form 5500 and submit it to the Department of Labor and the Internal Revenue Service (the details of pension information are recorded at the plan level through Form 5500). However, Form 5500 is generally only available from the Department of Labor after a significant time lag. The pension information in corporate financial statements constitutes a more timely information source for capital market participants[9]. In this chapter, the regression analysis is performed at the portfolio level, and the rules of portfolio construction are based on the magnitude of pension deficits. From portfolio

[8] The Statement of Financial Accounting Standards (SFAS) No.87 requires the sponsors of defined benefit pension plans to report the pension funding status in the main body of financial statements. Still, the over-funded and under-funded pension plans need to be reported separately. The SFAS No.132, effective from December 1997, amends this requirement and requires sponsors to compound these two types of pension plans into one accounting item. After adopting SFAS No.158 (issued in 2006), sponsors are required to recognise and report the pension plan funded status in their financial statements. The figure between the fair value of pension asset and the projected benefit obligation will be recognised in the balance sheet as one line accounting item on the asset side (pension surplus) or liability side (pension deficit).

[9] Specifically, there is a considerable time lag in the release of Form 5500 data for public consumption. Firms have ten months after year-end to file the forms, and then the data must be compiled, cleaned, and tabulated. As introduced in Campbell, Dhaliwal and Schwartz Jr (2011), because of statutory filing deadlines, Form 5500 data will always be on at least a ten-month lag, and investors will have to use Form 10-K data to estimate funding requirements.

10 to portfolio 1, the scaled pension deficit is increasingly severe, while portfolio 11 only includes firms with a pension surplus. The threshold of decile is based only on the observations listed in the NYSE because Nasdaq and AMEX companies are generally smaller than NYSE companies. To prevent the lower-funding-status portfolios from being entirely populated by small Nasdaq and AMEX companies, we follow the advice of Fama and French (1993) and Franzoni and Marin (2006), basing the calculation of decile only on NYSE observations. The portfolios used in this chapter are updated every year according to pension information in annual reporting. In the first section, we explain the stocks' expected returns with two recently developed asset pricing models: the Fama-French 5 factor plus momentum factor and the Q-5 factor model. The monthly factors' values can be downloaded separately from the authors' websites.

In the next section, we examine post-earnings price-shifting by portfolios. In prior research, the unexpected standardised earnings (SUE) measure is a commonly used momentum indicator. A convenient approach for calculating the SUE is the earnings surprise (the difference between the actual earnings per share and the expected earnings per share) divided by price per share. We follow the methodology outlined in Livnat and Mendenhall (2006) to calculate two SUEs: the Compustat-based SUE and the I/B/E/S-based SUE. The Compustat-based SUE assumes that earnings per share (EPS) follows a seasonal random walk and that the best predicting proxy of the EPS is the reported EPS in the same quarter of the previous fiscal year. The I/B/E/S-based SUE uses the data in the I/B/E/S database and defines the numerator of SUE as the difference between the I/B/E/S-reported actual 'street' earnings and the analysts' expectation of EPS. The analysts' expectation is the latest analyst forecasts are issued within 90 days before the earnings announcement day (EAD). The abnormal return is calculated as the individual stock returns above the market value-weighted index from the CRSP database. Next, we plot the variation of abnormal return at the portfolio level over 50 trading-day after EAD, assuming that the period between the two quarterly earnings reporting dates has around 50 trading days.

We collected related frozen plan information from the Form 5500 file over our sample period. Since 2002, the plan administrators need to answer yes or no as to whether "as of the last day of the plan year, the plan provides that no participant will get any new benefit accrual (whether because of service or compensation)" in Form 5500. So, we can collect data on whether the pension plan is 'hard freezes' from Form 5500. Because Form 5500 files record pension information at the plan level, we match the freezing plan report to plan sponsors (identified by the EIN code).

In the following subsection, we collect details on merger and acquisition (M&A) deals. The acquiring firms are included in our sample of interest from the Securities Data Company (SDC) Platinum. SDC provides the 6-digit CUSIP of acquiring firms and target firms for every deal. We match the data from the SDC platform with the sample of interest-based on the target firm's 6-digit CUSIP.[10] These data include the deal announcement date, the acquiring firm's CUSIP, the target firm's CUSIP, and the portion of cash used in the total payment. Finally, we compute the cumulative abnormal return around the announcement date of the target firm with three days (from day -1 to 1) and five days (from day -2 to 2) event window separately. The abnormal return is defined as the difference between the actual target firm's return and the CRSP value-weighted market return.

The final sample excludes financial firms (SIC 6000 to 6999) and utilities (SIC 4900 to 4999)[11]. Moreover, after deleting the observations with negative book values (CEQ) and those with missing values for any of the study variables, we delete companies with only one year of available observation to reduce the influence of unexpected events. The variables collected from the database are winsorised at 1% and 99% separately to avoid the effect of extreme value. The statistical analysis and

[10] The linkage is from the target firm's 6-digit CUSIP to its PERMNO code. As the information in the first 6-digit relates only to the firm, not the particular security, in most cases, adding 10 to the 6-digit CUSIP will return the common stock. The first equity security issued by a firm issue receives the digit 10, additional issues increment by 10. We firstly convert 6-digit CUSIP to 8-digit by adding 10. If this does not match successfully, try adding 20 instead of 10. After converting from 6-digit to 8-digit, we employ the macro-function provided by WRDS to link it to the PERMNO code.

[11] In empirical finance, excluding the financial firms and utilities is a common approach. Firstly, these two types of companies have a different business model from other companies. Secondly, most utility firms are public firms, which are not profit-orientated and serve public tasks. Therefore, the association between equity performance and DB pension plan's performance probably differ from other companies.

correlation coefficients for the variables used in this chapter are presented below.

[Insert Table 4.1 Here]

[Insert Table 4.2 Here]

4.4 Empirical evidence

4.4.1 A firm's asymmetric information proxies

Asymmetric information is an important research field, and prior research has developed numerous measurement proxies. Based on this literature, in this section, we compute these proxies and compare their statistical differences across portfolios in our sample. The proxies we use can be described as the investors' opinion divergence. Theoretically, if the information is transparent, market participants are more likely to agree on the target firm. Therefore, a broader deviation in investors' opinion indicates that the information transformation channel is not fluent, meaning asymmetric information. Proxies are introduced in the Appendix, and the statistical analysis is listed in the table below.

[Insert Table 4.3 Here]

The investors' opinion divergence proxies directly reflect the market reaction to the degree of a firm's asymmetric information. The first proxy is the bid-ask spread for stock prices (ba). If an investor is willing (bidding) to pay an amount less than what the owner is asking for, it must be because the owner/seller and the potential buyer/shareholder have different information endowments. It indicates information asymmetry, so we follow the construction of Handa, Schwartz and Tiwari (2003) and calculate the bid-ask spread. The second proxy is the unexplained trading volume (suv), introduced by Garfinkel and Sokobin (2006). They explain that the component of volume that is unexplained by prior trading activity is a good indicator of opinion divergence among investors. In previous research, the earnings forecasts dispersion – based on analysts' forecasts provided by the Institutional Brokers' Estimate System

(I/B/E/S) database – is commonly used as a proxy for investors' opinion divergence (Cooper, Day and Lewis, 2001; Johnson, 2004; Diether, Malloy and Scherbina, 2002; Mansi, Maxwell and Miller, 2011). As market participants, analysts' forecasts directly represent investors' opinions. We calculate the analysts' forecast dispersion by the month-end standard deviation of current-fiscal-year earnings estimates across analysts tracked by I/B/E/S. The first measure is scaled by the absolute value of the mean analysts' forecast (d1) and the other scaled by the firm's average monthly stock price (d2) separately. In addition to the conventional proxies, we also collect the available number of forecasts (na). As shown in the above table, we find that the investors' opinion divergence proxies provide consistent results indicating that the most severely underfunded firms (portfolio 1) have the most severe asymmetric information.

4.4.2 Pension information risk and expected stock return

This section tests the hypothesis by examining the treatment effect of asymmetric information on expected stock returns. Levi and Zhang (2015) and Amihud (2002) explain the inner translation mechanism from asymmetric information to a stock's expected return: because high asymmetry information can dampen liquidity – and because lower liquidity can, in theory, lead investors to ask for higher expected returns. Therefore, if the actual DB plan's status cannot be perfectly understood from accounting information or if investors are suspicious about the accuracy of pension reporting, then the asymmetric information would have an incremental effect on a stock's expected return. Over recent years, stricter pension accounting and reporting requirements have been applied to improve the quality of released pension information. If asymmetric information is still a challenge for investors, they presumably claim risk compensation for the risk that is not fully captured by the accounting statement. Furthermore, it appears that the incremental effect on a stock's expected return should be increasingly related to the magnitude of the DB pension deficits. When the pension deficit assumes a greater proportion of a firm's total size, the DB pension plan's status will have a greater impact on the

firm's financial policy and economic activities. This naturally aggravates the pension plan-induced information asymmetry problem. Therefore, we construct our first hypothesis: conventional risk factors cannot explain abnormal stock returns of firms with severely underfunded DB pension deficits. That is, the DB pension deficit has an incremental effect on expected stock returns. In addition, this incremental effect is increasingly related to the magnitude of pension deficits.

The key step is to estimate the expected stock return accurately. Unlike the realised return, the expected return is unobservable, and its estimation depends significantly on the applied financial theory and models. By comparing the commonly used methodology of estimating expected-return proxies (ERP), Lee, So and Wang (2019) introduce a parsimonious framework for choosing among alternative expected-return proxies when estimating treatment effects. They find that firm characteristics-based ERPs perform better when examining the cross-sectional treatment effect against the flaws of the factor-based model or the financial theory based implied-cost-of-capital method. Hou and Moskowitz (2005), Chordia, Roll and Subrahmanyam (2008) and Li and Zhang (2010) all report that the firm-characteristics-based expected return applies primarily to stocks with high trading costs or arbitrage frictions. Thus, to analyse the cross-sectional treatment effect of pension-induced risk on expected stock returns, we employ a firm-characteristics framework to predict stock returns. Green, Hand and Zhang (2017) test and identify the firm characteristics that can provide independent information about average US monthly stock returns. Based on their work, we select those characteristics that can provide significant and independent explanations about US one-month-ahead stock returns with the data mining method. In the first step, we construct all 94 firm characteristics following their introduction.[12] We run a pooled OLS regression that regresses the US monthly stock returns against the characteristics variables by simultaneously including the 94 characteristics. Based on the output of fitted statistics, we eliminate those variables with a variance inflation factor (VIF) over five or with t-statistics lower than 3-star significance to confirm that the selected characteristics can provide significant and independent information. Next, a subgroup composed of 26 variables is used to predict the one-month-ahead

[12] The replication code:https://sites.google.com/site/jeremiahrgreenacctg/home.

stock return along with the monthly cross-sectional regression. Details on the selected firm characteristics are shown in the Appendix 7.4. Then, the characteristics parameter for each pair of class variables (portfolio and month) is estimated by a cross-sectional regression with the 6-month rolling window Fama-MacBeth regression. Thus, the parameters used to predict the one-month-ahead stock return are taken from the average value of the six months' cross-sectional regression results.

After obtaining the expected stock returns, we examine whether the pension funding status can still explain expected stock returns after controlling for common risk factors at the portfolio level. In asset pricing research, the analysis at the portfolio level is a conventionally used method because it can omit the divergence within a portfolio and directly reflect the association between the portfolio return and the portfolio allocation criteria. It is also commonly used in research that deducts the impact of firms' pension plans on their security performance. Previous research has shown that the quality of accounting information could affect the firm's cost of capital, despite the forces of diversification (Lambert, Leuz and Verrecchia, 2007). So, the portfolio construction cannot fully diversify the impact from pension information. If the quality of pension accounting creates asymmetric information, then the impact on a portfolio's expected return should be observed. The methodology of a portfolio's construction has been introduced in the data section. For extending the available number of observations, the portfolio is constructed monthly. Next, we assume that a stock's expected return follows the factor structure strictly and can be predicted by two classic pricing models: the Fama-French 5 factor plus momentum factor model and the Q-5 factors model[13]. The equal-weighted and market-capitalisation-weighted expected returns within each portfolio are calculated separately. Then the hypothesis is examined by time-series regression at the portfolio level. The regression results are shown below.

[Insert Table 4.4 Here]

[13] Fama and French (2015) extend their classical three factors model (Fama and French, 1993) by adding the profitability and investment factors. However, this model still ignores the effect of momentum, which is widely confirmed that it affects the stock return. So, we use the 6-factor model by adding the momentum factor, which is discussed in Carhart (1997). The another q-5 factor is introduced in Hou et al. (2020) by adding the expected growth factor into their original q-factor model Hou, Xue and Zhang (2015).

[Insert Table 4.5 Here]

As introduced in Jin, Merton and Bodie (2006), the market beta considers the pension-induced risk. This risk comes from pension liabilities and pension asset allocation. In our regression results, the risk factor loading on the market factor is consistent with their findings – the risk factor loading is increasingly related to the magnitude of the pension deficit. It is understandable, considering that the greater magnitude of the pension deficit indicates that the pension liabilities have a higher default risk and uncertainty. Concerning the pension asset part, managers having a deteriorated DB pension plan are assumed to have a strong incentive to take risks in determining pension asset allocation. For example, Bergstresser, Desai and Rauh (2006) suggest that managers change pension asset allocation toward equities to justify a higher assumed rate of return and alleviate the negative effect of the DB pension plan on earnings reporting. The loading on the market factor also offers another explanation channel about the incremental impact on a firm's expected return. That is, firms investing their pension assets in riskier securities should have higher equity betas (all else being equal) after integrating the pension asset returns with the return on other operating assets. Consequently, it generates higher expected stock returns.

Existing literature documents that greater mandatory pension contributions force firms to forego investments to meet pension funding requirements (Rauh (2006a), Franzoni (2009), Campbell, Dhaliwal and Schwartz Jr (2010) and Campbell, Dhaliwal and Schwartz Jr (2011)). The mandatory pension contributions show a nonlinear relationship with the magnitude of pension deficits and increase sharply for severely underfunded firms. Thus, loading on investment factors in the q-5 model is statistically and economically significant for severely underfunded firms[14]. However, after controlling for these common risk factors, the first two portfolios still have a higher alpha term. The higher alpha value indicates that at least part of the pension-induced risk has not been explained by common risk factors but has instead

[14] The risk loading on investment factor CMA in Fama-French 5 factor model is not significant as we expected, this can be explained by the comparison of factor models in Hou, Xue and Zhang (2017). The CMA factor is based on historical investment conditions.

been priced by the market. We argue that this positive alpha can be explained by pension-induced asymmetric information.

Comparing the value of alpha in the above portfolios analysis can not directly provide a statistical reference. To further confirming our hypothesis, we present a panel regression analysis with portfolio and year dummies. The portfolio dummies are constructed at the portfolio level and used to examine the portfolio specific effect on expected return. We assign the first ten portfolios by the decile of pension plan's funding status of NYSE firms. The parameter of each portfolio dummy represents the portfolio's specific implications on expected stock return comparing to the reference group. Avoiding the dummy trap, we exclude the intercept. The final regression specification is:

$$ER_{i,t} = Portfolio\ dummies + Year\ dummies + common\ risk\ factors_t, \quad (4.1)$$

The regression results are shown in the table below.

[Insert Table 4.6 Here]

[Insert Table 4.7 Here]

In columns 2 and 5 of Tables 4.6 and 4.7, the reference group is portfolio 11 with overfunded pension plan. The coefficients of indicators for portfolios 1 and 2 are markedly greater than the reference group. To find further evidence, we separately set portfolios 10 and 1 as the reference group. According to the results of columns 3 and 6, we find the parameter for the first two portfolios' dummies are significantly positive. Moreover, the other portfolios have no statistically significant difference comparing to portfolio 10. Furthermore, we set portfolio one as the reference group. The results of columns 4 and 7 show that parameters for all portfolios' dummies are significantly lower than portfolio 1, except portfolio 2. In summary, this panel regression analysis demonstrates the statistical meaning of higher expected stock return for portfolios 1 and 2, which is observed in portfolio analysis[15].

[15] When we discuss firm-specific expected return, the primary independent variable is the pension

4.4.3 Post-earnings-announcement drift condition

In this section, we provide empirical evidence for the existence of asymmetric information by examining post-earnings price-shifting among DB pension plan sponsors. Because many pension expense-related accounting items, such as the pension service cost or the net pension gain, are part of income statements. A pension plan's contributions and funding status influence corporate earnings reporting[16]. Existing pension-related studies have analysed the impact of DB pension plans on firms' earnings. For example, Franzoni and Marin (2006) find that firms in a deteriorated pension deficit tend to expose negative earnings surprises and post-earnings returns. They explain this phenomenon as the market failing to anticipate the negative effects of a current pension deficit on the firm's future earnings. The price drifts downward when the negative effect is eventually materialised in income statements. The background theoretical logic – also called post-earnings-announcement drift theory – explains the incremental (deterioration) effect of positive (or negative) earnings surprises on subsequent stock returns. Investors adopt the post-earnings announcement drift trading strategy based on the condition of unexpected earnings. The actual earnings release should be immediately priced in an efficient market. However, in practice, this information is not timely reflected in the equity price, which is restricted by the market frictions. Therefore, the upward (or downward) stock price drift after a positive (or negative) earnings announcement is referred to as the post-earnings-announcement drift.

The investors' under-reaction to new information is commonly used to explain previous studies' short-term stock price continuations. Therefore, a more significant

plans' funding status. If we assume that only firms' pension plans' funding status affect their equity's expected return (in practice, it is unreasonable). The random effect model is probably the best choice because it will produce unbiased estimates of the coefficients with minor standard errors. In the spirit of prior pension-related research, we could confirm there are omitted variables that correlate with the pension plans' funding status and the expected stock return. Therefore, we employ the dummy variables to capture the portfolio's specific effect.

[16] The SFAS No.158 targets to address the issue that existing accounting standards can not entirely and timely communicate the pension information. Although this new requirement did not directly affect the original reporting and accounting technique used in the income statement, the series of related off-balance sheet items shifts into the balance sheet, significantly improving the understanding of the information reported in the income statement. For instance, the prior service cost and net gain, as the composition of pension expense, is recorded as accumulated other comprehensive income as a balance sheet item.

price drift should be observed when there is greater asymmetric information. Zhang (2006) provides evidence that supports this hypothesis by observing a greater information uncertainty produces relatively higher expected returns following good news and relatively lower expected returns following bad news. The severe asymmetric information indicates greater information uncertainty for investors. Thus, if the level of asymmetric information is related to the magnitude of pension deficits, we should observe greater post-earnings price drifts for more severe pension deficits due to more significant asymmetric information. Consequently, we observe the post-earnings pricing drift after good news (positive earnings surprise) and bad news (negative earnings surprise) separately over our sample period. In the data section, we have already explained how to define the unexpected standardised earnings (SUE). Adhering to the definitions given above, we measure the negative or positive earnings surprise based on the I/B/E/S-based and the Compustat-based SUE separately. The analysis window for the price-continuous variation is until 50 days after the earnings announcement date. For the readability of figures, each figure contains only a two-pair comparison: the positive or negative earnings surprise for portfolio one against portfolio ten and portfolio two against portfolio 9. The post-earning price drifting of I/B/E/S-based SUE is shown below.

Figure 4.1: The cumulative abnormal returns (CARs) following earnings announcement date (EAD) with I/B/E/S-based standardised unexpected earnings (SUE) (portfolio 1 vs. portfolio 10)

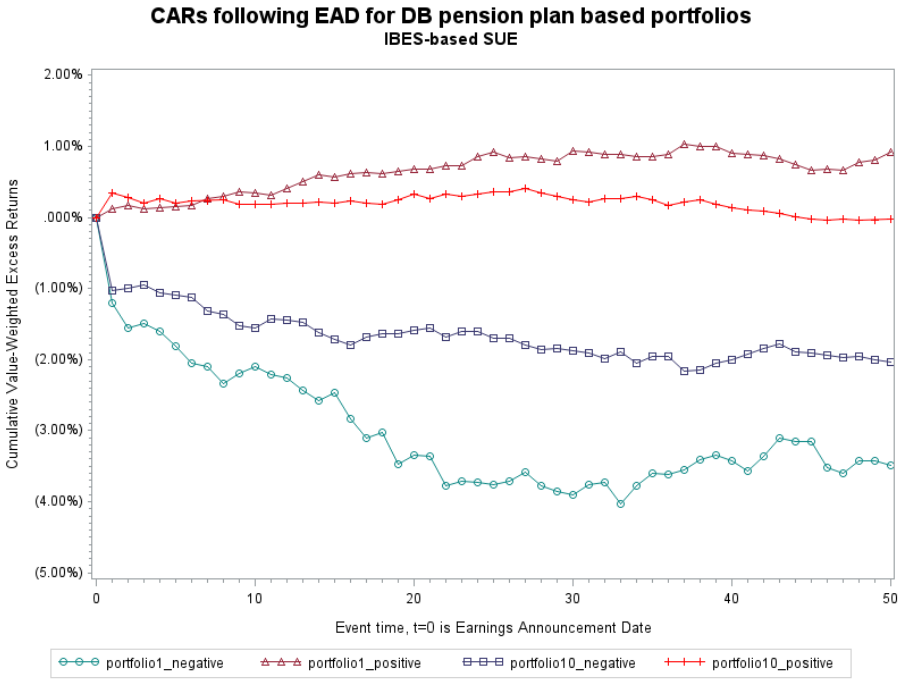
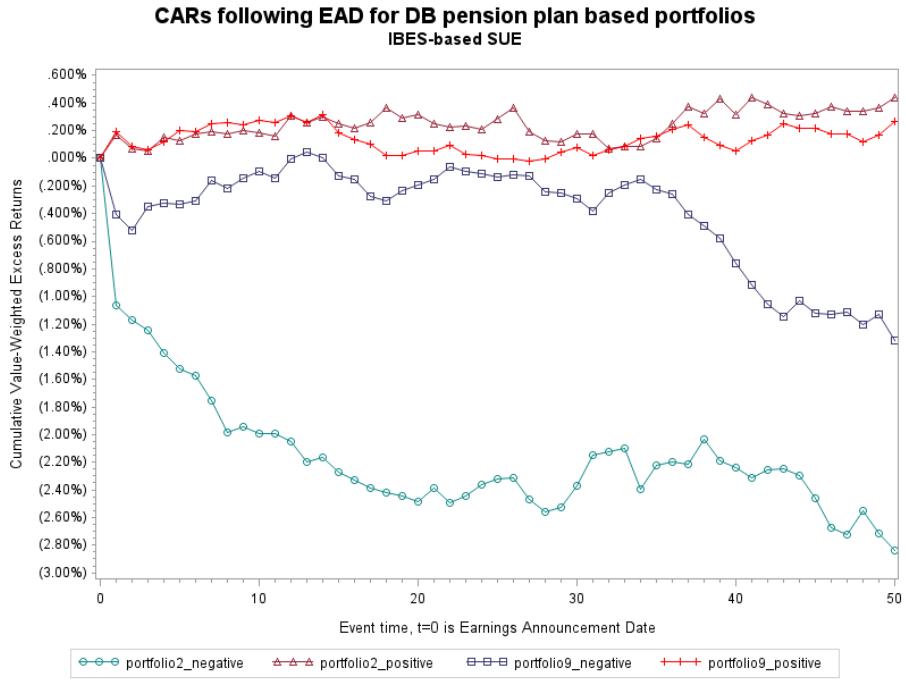


Figure 4.2: The cumulative abnormal returns (CARs) following earnings announcement date (EAD) with I/B/E/S-based standardised unexpected earnings (SUE) (portfolio 2 vs. portfolio 9)



It is logical to assume that the positive (or negative) earnings surprise has an incremental (or decremental) effect on price after the earnings announcement date over the short term, although the volatility and revision of price-shifting make the change in price unpredictable in the long time. The results in Figures 4.1 and 4.2 indicate that the effect of negative earnings surprises is much more significant, which is consistent with the conventional financial theory: markets are more sensitive to bad news and have an immediate reaction reflected in the price. In addition to these same trends, we further compare the different variation statuses for a pair of portfolios that separately represent the least underfunded and the most underfunded DB pension plans. The observation supports our hypothesis and is consistent with the conclusion of Zhang (2006). Portfolios 1 and 2, which are assumed to encompass more severe information asymmetry, have more significant post-earnings price drift regardless of the type of earnings surprise. This finding is also consistent with that of Franzoni and Marin (2006). Suppose investors' and analysts' forecasts fail to anticipate the effect of DB pension contributions on future earnings. In that case, they will be shocked when the adverse impact is finally materialised in income statements. Therefore, the treatment effect of negative earnings surprise on price-shifting is sharper, although the magnitude of the pension deficit determines the degree of reduction. In addition to the earnings forecasts produced by analysts, the prior same quarter's earnings are often used as a proxy for this quarter's earnings. Thus, we describe the post-earning price drifting with the Compustat-based SUE.

Figure 4.3: The cumulative abnormal returns (CARs) following earnings announcement date (EAD) with Compustat-based standardised unexpected earnings (SUE) (portfolio 1 vs. portfolio 10)

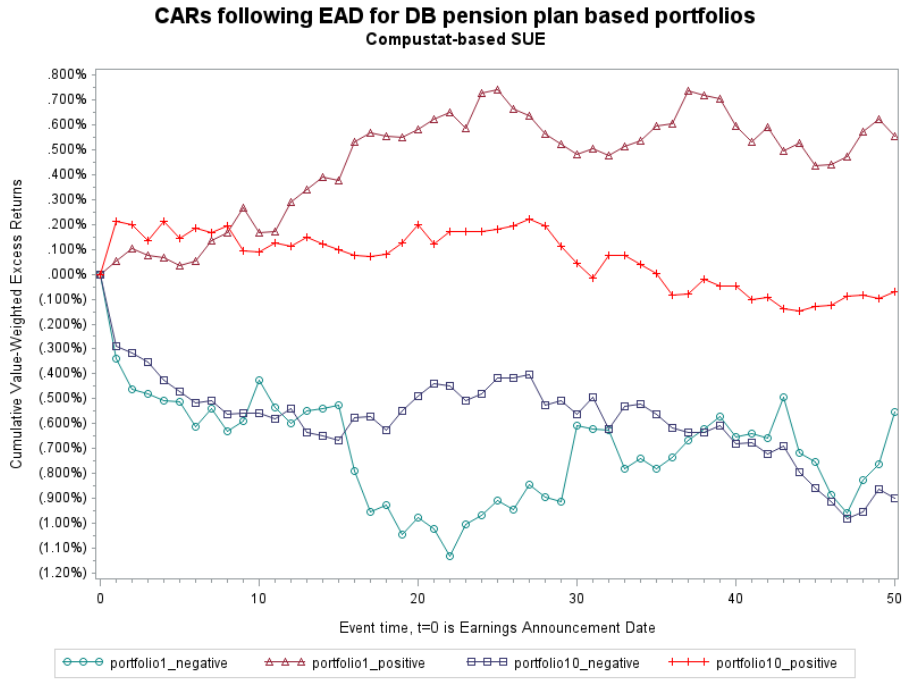
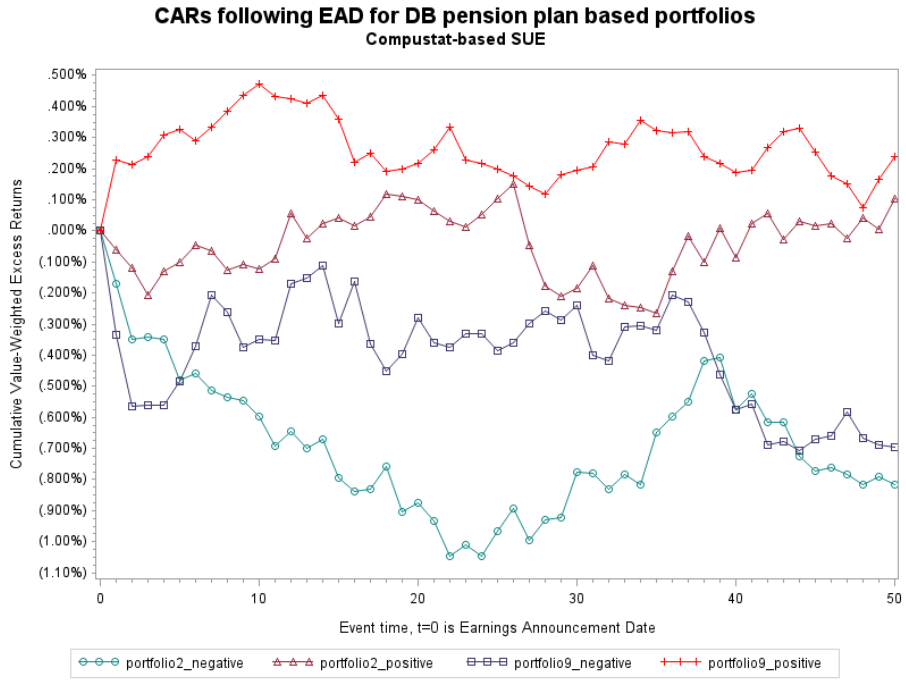


Figure 4.4: The cumulative abnormal returns (CARs) following earnings announcement date (EAD) with Compustat-based standardised unexpected earnings (SUE) (portfolio 2 vs. portfolio 9)



The figures 4.3 and 4.4 show the price-drift conditions with the Compustat-based SUE. Compared to the I/B/E/S-based SUE, this measurement barely involves investors' opinions. Rather, it assumes that EPS follows a seasonal random walk, and the best predicting proxy of the EPS is the firm's reported EPS in the same quarter of the last fiscal year. By comparing these two proxies, we find the degree of downward price-drifting after the negative Compustat-based SUE is sharply alleviated for portfolios 1 and 2. In addition, it is sensitive only for portfolios 1 and 2 after a negative SUE. In theory, if information in a firm's financial statements is transparent, the difference between these two proxies should not be significant. We assert that this phenomenon results from asymmetric information that misleads investors and analysts' forecasts diverging from financial statement-based forecasts around earnings.

4.4.4 Pension plan freezing

Since the early 2000s, managers commonly freeze their DB pension plan to reduce firms' costs. Generally, the freezing strategy is categorised into "hard", "soft" and "partial" types. When a DB pension plan is "hard" freezing, the future accrual of pension benefits is ceased, and enrolment is closed to new employees.[17] The Rauh, Stefanescu and Zeldes (2020) confirm that cost savings mainly motive the DB pension plan freezing decision. The most direct cost savings stem from the cancelling of future pension accruals. Although the "hard" freezing of a DB pension plan does not relieve firms of their responsibilities for pension benefits already accrued, it could reduce the pension benefit associated with future accruals[18]. Thus, the excess of projected benefit obligation (PBO) over the accumulated benefit obligation (ABO) is essentially the cost savings from DB pension plan "hard" freezes[19]. In this section,

[17] In contrast, the "soft" freezing allows the pension benefit to increase with growth in wages but not to increase with the additional service years. Finally, if managers take the "partial" freezing strategy, there are different assignments to benefit accruals for different employees.

[18] It is inconclusive whether freezing a pension plan reduces the pension-induced risk. Choy, Lin and Officer (2014) find that freezing a DB pension plan has two potentially offsetting effects: while it directly reduces the DB plan-induced risk, it causes firms to take on more risk. This incentive effect outweighs the direct impact.

[19] Yu, 2016 finds the amount of cancelled future pension benefit accruals (PBO-ABO) affects the "hard" freezing decision.

we explain the incentive behind this strategy in light of asymmetric information.

Pension accounting only requires a pension plan to recognise the cost that is attributed to the past service. Suppose the actuarial liability reflects the expected future salary increase because most DB pension payments are based on the final salary at retirement. In that case, this is referred to as the PBO. If the actuarial liability only recognises benefits accrued to date, it is referred to as the ABO. The estimation of PBO involves more actuarial assumptions for future conditions. If firms have server information asymmetry, the market tends to doubt the accuracy of reported PBO and overestimates it. So, we posit that the impact of PBO on the "hard" freezes decision should be associated with the level of the firm's information asymmetry. The regression results are shown below:

[Insert Table 4.8 Here]

The Panel A of Table 4.8 shows the results with pension deficit which is calculated as the PBO minus the fair value of pension asset. In Panel B of Table 4.8, we calculate the pension deficit as the ABO minus the fair value of pension assets. We find the coefficients of pension deficit, measured by ABO, are statistically significant for all portfolios. This regression result suggests that managers take the pension benefit accrued to date (ABO) into account when deciding to take the "hard" freezing strategy. However, only portfolio 1 in Panel A shows a consistent result. As we discussed above, the estimation of PBO needs the actuarial assumptions for future salary increases. If a firm has severe asymmetric information, the "actual" value of PBO from the investors' perspective will be significantly greater than its reported "accounting" value. So, the per unit of reported PBO will have more significant negative implications on the firm's value. In this context, managers have a stronger incentive to "hard" freeze their DB pension plan. Panel C shows the ratio coefficients, ABO divided by PBO, which is statistically significant for portfolios 1 and 2. Economically, the cost savings are the main incentive for managers choosing to freeze their DB pension plan (Rauh, Stefanescu and Zeldes, 2020). Since the "hard" freezing stops the pension benefit from increasing with future accruals, the PBO is equal to the ABO after "hard" pension freezing. The lower ratio value, ABO

divided by PBO, describes the more potential cost savings from the "hard" freezing. If the firm is exposed to asymmetric information problems, the proportion of PBO associated with future accruals is severely overestimated by investors. Therefore, the higher proportion of PBO associated with already accrued to date will weaken the incentive of "hard" freezing. In Panel C, the coefficients of PD_{DIF} for portfolio 1 and 2 are -0.07 (t-value 7.36) and -0.12 (t-value 2.07) separately. In contrast, the coefficients are not statistically significant for other portfolios. This finding suggests that the most severely underfunded DB pension plan will cause an asymmetric information problem.

4.4.5 M&A deal announcement effect on target firm

In this section, we use mergers and acquisitions (M&A) activity to provide further evidence that firms with the most severely underfunded DB pension plan tend to be exposed to asymmetric information. Cocco and Volpin (2013) find that firm's DB pension plans can be used as a takeover deterrence because acquirers may be suspicious about the target firm's value if they sponsor a DB pension plan. In contrast, if acquirer firms sponsor a DB pension plan, the target firm may be reluctant to accept stock as the payment means in acquisitions.[20] In this chapter, we focus instead on the announcement effects of a M&A for the target firm. We propose that if acquirers are exposed to information asymmetry, then cash used as a payment method will have an incremental effect on the target firm's price around the announcement period.

The target firm's cumulative abnormal returns (CARs) is calculated separately around a 3-day event window (from day -1 to day 1) and a 5-day event window (from day -2 to day 2). The risk adjustment is based on a value-weighted index from the CRSP database. In addition to the portion of cash used as a M&A payment means (ccash), the dummy variable DB indicates whether the target firm sponsors a DB pension plan. If the target firm has a DB pension plan in the current year, it

[20] The pension system in the US is different from that in the UK, and the mechanism by which DB pension plans serve as a takeover deterrence in the US is explained by agency theory (Rauh, 2006b).

equals one—otherwise, 0. The size is the total asset's log value, and the leverage (lev) is computed as the total debt holdings divided by the total asset. Restricted by the number of available observations, the announcement effect is not examined for every portfolio. Instead, we re-build three new portfolios. The first new portfolio is composed of the original portfolio one to five, representing the most severely underfunded DB pension plan. The second new portfolio comprises the original portfolio six to ten, which means the least severely underfunded DB pension plan. The final new portfolio is composed of only overfunded DB pension plans. The regression results are shown below.

[Insert Table 4.9 Here]

After regressing the CARs on exposure variables, we find that cash used as a payment means has a significant incremental effect on the target firm's CARs around the calculation window for the first portfolio. However, there is no such significant incremental effect for the other two portfolios. The treatment effect of the M&A payment method (for acquirers sponsoring a DB pension plan) on the target firm's price, introduced in Cocco and Volpin (2013), is only consistent with the severely underfunded DB pension plan in the US. It suggests that the information asymmetry only significantly affects the firms with severely underfunded DB pension plans. The regression results also show that when the acquirer and target firms both have DB pension plans, the incremental effect of cash as payment means on the target firm's return is reduced. It seems to suggest that this type of M&A deal does not diversify the pension-induced risk since they sponsor the DB pension plan.

4.5 Conclusion

In this chapter, we examine whether asymmetric information remains an un-omitted problem for DB pension plan sponsors. In prior literature, the asymmetric information induced by opaque pension accounting leads investors and analysts astray. After a series of changes to pension accounting standards, the quality of pension information has undoubtedly been improved. Recently, SFAS No.158 requires that funding

status be reported on the balance sheet and that the deferred pension obligation be recognised immediately. These standards ensure that investors obtain timely pension information through financial statements and reduce the managers' leeway for manipulation. However, according to the findings presented in this chapter, asymmetric information still exists for firms with severely underfunded DB pension plans, although these plans adopt stricter pension funding and accounting requirements. We demonstrate that asymmetric information still plays a vital role in explaining the market reaction to severely underfunded DB pension plans.

Table 4.1: Sample descriptive statistics of variables in Chapter 4

This table describes the statistics of variables used in this chapter. Panel A shows the firm's and pension plan's characteristics for sample firms. Pension deficit (pd) is defined as the difference between the projected benefit obligation (PBPRO) and the pension asset (PPLAO), divided by the prior-month market capitalization. DB pension plan size (psize) is the log value of projected benefit obligation (PBPRO). Firm size is the log value of a firm's total asset (AT). Leverage (lev) is the firm's total debt (DLTT+DLC) scaled by the total asset (AT), and operating cash flow (ocf) is the cash flow from the firm's operating activities (OANCF) scaled by the total asset (AT). Panel B shows the statistics of proxies for asymmetric information. Appendix 7.2 introduces the variables' definition in detail. Panel C shows the statistics of variables used to predict stock return. Appendix 7.4 introduce how we construct these variables. All variables are winsorized at 1% and 99% percentage.

Variables	Mean	St.dev	Q1	Median	Q3
Panel A: variables used in fundamental regressions					
pd	0.07	0.25	0.01	0.03	0.09
psize	0.2	0.71	0.01	0.02	0.09
size	8.81	1.78	7.59	8.8	10.07
lev	0.27	0.15	0.16	0.26	0.36
ocf	0.09	0.05	0.06	0.09	0.12
Panel B: proxies for asymmetric information					
ba($\times 10^2$)	0.12	0.44	0.02	0.03	0.07
suv($\times 10^2$)	31.54	176.54	-71.74	-7.67	85.59
d1($\times 10^2$)	9.02	29.71	1.04	2.18	5.35
d2($\times 10^2$)	0.43	1.59	0.06	0.14	0.34
na	10.02	6.25	5	9	14
Panel C: variables used in predicting monthly expected stock returns					
ret	0.02	0.09	-0.03	0.01	0.06
p_ret	0.02	0.04	-0.01	0.01	0.03
aeavol	0.93	1	0.28	0.69	1.3
bm_ia	-0.05	30	-0.22	0.11	0.76
cash	0.10	0.09	0.03	0.08	0.14
cfp	0.11	0.09	0.06	0.09	0.14
chatoia	-0.02	0.14	-0.07	-0.01	0.05
chempia	-0.17	0.50	-0.16	-0.07	-0.01
chpmia	1.41	11.44	-1.51	-0.01	1.38
chtx	0.01	0.01	-0.01	0.01	0.01
pchcapx_ia	0.98	11.98	-0.91	-0.40	-0.04
pchsale_pchrect	-0.01	0.21	-0.08	0.01	0.07
idiovol	0.04	0.02	0.02	0.03	0.04
ill($\times 10^7$)	0.46	3.89	0.01	0.01	0.01
indmom	0.11	0.26	-0.06	0.1	0.24
mom1m	0.01	0.09	-0.03	0.01	0.06
ms	4.80	1.59	4	5	6
nanalyst	12.32	8.05	5	12	19
nincr	0.82	1	0.00	1	1
roic	0.11	0.08	0.07	0.10	0.14
rsup	-0.01	0.08	-0.02	0.01	0.02
sgr	0.02	0.16	-0.05	0.01	0.08
sp	1.38	1.49	0.55	0.94	1.61
std_dolvol	0.41	0.17	0.30	0.37	0.46
tang	0.41	0.12	0.31	0.41	0.50
turn	1.78	1.30	1.00	1.48	2.16
zerotrade	0.02	0.24	0.01	0.01	0.01

Table 4.2: Correlation matrix of variables in Chapter 4

This table presents the correlation among variables used in this chapter. The correlation coefficients in the upper diagonal are Spearman's rank correlation, and the downside of the diagonal are Pearson correlation. Pension deficit (pd) is defined as the difference between the projected benefit obligation (PBPRO) and the pension asset (PPLAO), divided by the prior-month market capitalization. DB pension plan size (psize) is the log value of projected benefit obligation (PBPRO). Firm size is the log value of a firm's total asset (AT). Leverage (lev) is the firm's total debt (DLTT+DLC) scaled by the total asset (AT), and operating cash flow (ocf) is the cash flow from the firm's operating activities (OANCF) scaled by the total asset (AT). The bid-ask spread (ba), standardized unexplained volume (suv), daily trading volume (vol), two measures for analyst's forecasts dispersion (d1, d2), the number of analysts forecast in a given month (na), stock return (ret) and the predicted stock return (pret) are used to measure information asymmetry. Appendix 7.2 introduces the variables' definition in detail. All the bold value is significant at a 0.01 level.

	pd	psize	size	lev	ocf	ba	suv	d1	d2	na	ret	pret
pd	1	**0.46**	**-0.03**	**0.11**	**-0.08**	**0.09**	-0.01	**0.11**	**0.16**	**-0.09**	-0.01	**0.07**
psize	**0.27**	1	**-0.76**	**-0.04**	**-0.01**	**0.50**	**0.01**	**0.16**	**0.17**	**-0.61**	**-0.01**	**0.08**
size	**-0.04**	**-0.43**	1	**0.14**	**-0.09**	**-0.54**	**-0.02**	**-0.13**	**-0.07**	**0.69**	**-0.01**	**-0.07**
lev	**0.06**	**-0.13**	**0.15**	1	**0.10**	**-0.13**	-0.01	**-0.02**	**-0.03**	**0.07**	**-0.01**	**-0.04**
ocf	**-0.07**	**-0.10**	**-0.09**	**0.09**	1	**-0.24**	**0.01**	**-0.22**	**-0.23**	**0.15**	**0.03**	**0.01**
ba	**0.06**	**0.38**	**-0.31**	**-0.09**	**-0.13**	1	**-0.01**	**0.34**	**0.37**	**-0.52**	**-0.04**	**0.05**
suv	-0.01	0.01	**-0.02**	0.01	**0.01**	**-0.01**	1	0.01	-0.01	**-0.02**	-0.01	**-0.01**
d1	**0.12**	**0.13**	**-0.07**	**0.06**	**-0.13**	**0.09**	**-0.01**	1	**0.95**	**-0.05**	**-0.02**	**0.03**
d2	**0.24**	**0.16**	**-0.03**	**0.05**	**-0.11**	**0.14**	-0.01	**0.36**	1	**-0.03**	**-0.03**	**0.03**
na	**-0.06**	**-0.28**	**0.67**	**0.05**	**0.13**	**-0.23**	**-0.03**	**-0.04**	**-0.05**	1	**-0.01**	**-0.07**
ret	0.01	**-0.01**	**-0.02**	**-0.02**	**0.03**	**-0.01**	-0.01	0.01	**-0.05**	**-0.02**	1	**0.32**
pret	**0.06**	**0.03**	**-0.07**	**-0.03**	**0.01**	**0.02**	**-0.01**	**0.04**	**0.02**	**-0.07**	**0.32**	1

Table 4.3: Proxies of asymmetric information at firm level

This table presents statistics of the asymmetric information proxies. It shows the monthly value-weighted mean value. The weighting is based on the firm's market capitalization in the prior month. Bid-ask spread (ba) is calculated as the difference between the bid and ask price scaled by their mean value. If the bid or ask price is zero or the calculated bid-ask spread is greater than 0.5, then delete the observation. Standardized unexplained volume (suv) is the difference between the turnover ratio and the predicted value of turnover ratio divided by the root mean square of errors in the fitted model. Analyst's forecasts dispersion is calculated by the standard deviation of the latest stock forecasts in a given month, scaled by the absolute value of the mean analysts' forecast (d1) or the firm's average monthly stock price (d2) for a given (ticker, year, month, analyst forecast) combination. We keep only records with the closest fiscal period end. The monthly analysts forecast estimate is carried forward to either the next estimate issue date or the date which is 105 days ahead or the next actual earnings announcement days, whichever comes sooner. The last proxy is the number of available analysts' forecast in a given month (na). The table presents the statistic difference test results compared to portfolio 1 with the t-test in parentheses. All variables are winsorized at 1% and 99% percentage.

	Statistics of proxies for asymmetric information										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
ba	0.05	0.05	0.04	0.04	0.03	0.04	0.04	0.03	0.04	0.04	0.06
		(1.22)	(4.15)	(4.27)	(11.11)	(10.42)	(10.67)	(11.88)	(8.59)	(9.15)	(-3.42)
suv	26.60	33.20	23.20	40.70	34.20	28.60	25.40	16.80	19.10	28.60	13.80
		(-2.74)	(1.5)	(-5.78)	(-2.94)	(-0.84)	(0.48)	(4.05)	(3.14)	(-0.81)	(5.67)
d1	7.72	6.23	5.23	5.73	5.61	5.88	4.53	4.99	6.32	6.07	8.53
		(3.69)	(7)	(5.97)	(6.17)	(5.67)	(10.98)	(8.27)	(3.89)	(5.51)	(-1.58)
d2	0.70	0.34	0.31	0.32	0.32	0.32	0.28	0.27	0.28	0.27	0.44
		(10.33)	(11.9)	(12.44)	(12.85)	(12.79)	(14.81)	(15.83)	(15.51)	(16.94)	(9.44)
na	13.25	12.77	12.72	13.28	14.10	13.26	14.34	15.82	15.76	15.98	16.37
		(6.21)	(6.62)	(-0.46)	(-9.98)	(-0.2)	(-12.14)	(-25.38)	(-25.75)	(-28.99)	(-32.81)

Table 4.4: Portfolio analysis with equal-weighted expected returns

This table shows the regression results by regressing equal-weighted expected stock returns on various risk factors at the portfolio level. The firms' expected one-month-ahead stock returns are estimated by the firm-characteristics based model. The 6-month rolling window Fama-MacBeth regression by a pair of class variables (the portfolio and month date) is used to estimate the parameter of characteristics. After obtaining the firms' expected stock return, we calculate the equal-weighted expected stock return at the portfolio level. When controlling for the Fama-French 5 factors plus momentum factor, our portfolio level regression equation is:

$$ER_{i,t} = \alpha_i + \beta 1 * mkt + \beta 2 * smb + \beta 3 * hml + \beta 4 * rmw + \beta 5 * cma + \beta 6 * umd. \tag{4.2}$$

When controlling for the q-5 factors, the regression equation is:

$$ER_{i,t} = \alpha_i + \beta 1 * r\_mkt + \beta 2 * r\_me + \beta 3 * r\_ia + \beta 4 * r\_roe + \beta 5 * r\_eg. \tag{4.3}$$

The sample period is from 2008 to 2019. For the readability, the coefficient is shown in percentage value and the number in parentheses is t-statistic value.

	Portfolios by magnitude of pension deficit										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Panel A: control for the Fama-French 5 factors plus umd											
α	1.24	1.31	0.58	1.01	0.68	0.50	0.61	0.82	0.78	0.46	0.84
	(3.21)	(3.71)	(1.88)	(3.85)	(2.02)	(1.73)	(1.93)	(4.97)	(3.23)	(1.54)	(3.71)
mkt	0.57	0.39	0.37	0.30	0.49	0.41	0.48	0.20	0.30	0.43	0.31
	(5.56)	(4.08)	(4.36)	(4.25)	(5.49)	(5.33)	(5.73)	(4.47)	(4.66)	(5.4)	(5.07)
smb	0.01	0.14	0.01	0.02	-0.12	-0.16	-0.10	-0.06	-0.08	-0.09	0.02
	(0.07)	(0.95)	(-0.01)	(0.17)	(-0.85)	(-1.32)	(-0.73)	(-0.87)	(-0.81)	(-0.69)	(0.24)
hml	-0.01	0.01	0.12	0.13	-0.15	-0.05	-0.14	0.13	-0.05	-0.09	0.02
	(-0.04)	(-0.02)	(0.66)	(0.88)	(-0.78)	(-0.32)	(-0.79)	(1.33)	(-0.36)	(-0.51)	(0.12)
rmw	-0.01	0.07	-0.13	-0.07	-0.16	-0.16	-0.14	0.01	-0.12	-0.13	0.01
	(-0.05)	(0.27)	(-0.65)	(-0.38)	(-0.71)	(-0.84)	(-0.67)	(-0.03)	(-0.72)	(-0.64)	(0.1)
cma	0.01	-0.19	-0.10	0.11	0.09	0.19	0.01	0.01	0.16	0.23	0.16
	(0.01)	(-0.62)	(-0.37)	(0.45)	(0.32)	(0.77)	(0.05)	(0.03)	(0.75)	(0.88)	(0.79)
umd	-26.24	-25.87	-9.13	-10.81	-7.73	-3.34	-7.63	11.09	4.46	2.71	-2.12
	(-2.94)	(-3.14)	(-1.29)	(-1.77)	(-1)	(-0.5)	(-1.05)	(2.89)	(0.8)	(0.39)	(-0.4)
N	124	124	124	124	124	124	124	124	124	124	124
R^2	0.46	0.39	0.33	0.35	0.34	0.30	0.36	0.20	0.21	0.29	0.31
Panel B: control for Q-5 factors											
α	1.56	1.39	0.55	0.95	1.09	0.49	0.82	0.87	0.92	0.63	1.05
	(4.44)	(4.31)	(1.97)	(3.83)	(4.3)	(1.78)	(2.78)	(5.54)	(4.09)	(2.35)	(5.45)
r_mkt	0.47	0.39	0.37	0.31	0.39	0.38	0.39	0.17	0.26	0.37	0.24
	(5.18)	(4.6)	(5.07)	(4.86)	(5.91)	(5.36)	(5.09)	(4.24)	(4.37)	(5.29)	(4.75)
r_me	-0.12	-0.03	-0.03	-0.04	-0.22	-0.12	-0.13	-0.05	-0.08	-0.10	-0.08
	(-0.79)	(-0.22)	(-0.28)	(-0.39)	(-2.03)	(-1.01)	(-0.99)	(-0.71)	(-0.84)	(-0.83)	(-0.96)
r_ia	-0.04	-0.21	0.03	0.09	-0.27	-0.04	-0.33	-0.03	-0.12	-0.13	-0.06
	(-0.18)	(-1.05)	(0.18)	(0.55)	(-1.73)	(-0.21)	(-1.82)	(-0.35)	(-0.86)	(-0.75)	(-0.51)
r_roe	-0.65	-0.60	-0.43	-0.36	-0.18	-0.15	-0.26	0.04	-0.05	-0.07	-0.21
	(-3.72)	(-3.76)	(-3.14)	(-2.92)	(-1.41)	(-1.08)	(-1.77)	(0.53)	(-0.47)	(-0.55)	(-2.21)
r_eg	-0.11	0.01	-0.02	-0.08	-0.45	-0.22	-0.28	-0.15	-0.27	-0.30	-0.18
	(-0.48)	(0.01)	(-0.11)	(-0.5)	(-2.65)	(-1.22)	(-1.41)	(-1.4)	(-1.77)	(-1.64)	(-1.37)
N	124	124	124	124	124	124	124	124	124	124	124
R^2	0.43	0.39	0.39	0.39	0.44	0.34	0.37	0.20	0.27	0.34	0.36

Table 4.5: Portfolio analysis with value-weighted expected returns

This table shows the regression results by regressing value-weighted expected stock returns on various risk factors at the portfolio level. The firms' expected one-month-ahead stock returns are estimated by the firm-characteristics based model. The 6-month rolling window Fama-MacBeth regression by a pair of class variables (the portfolio and month date) is used to estimate the parameter of characteristics. After obtaining the firms' expected stock return, we calculate the value-weighted expected stock return at the portfolio level. When controlling for the Fama-French 5 factors plus momentum factor, our portfolio level regression equation is:

$$ER_{i,t} = \alpha_i + \beta 1 * mkt + \beta 2 * smb + \beta 3 * hml + \beta 4 * rmw + \beta 5 * cma + \beta 6 * umd. \tag{4.4}$$

When controlling for the q-5 factors, the regression equation is:

$$ER_{i,t} = \alpha_i + \beta 1 * r\_mkt + \beta 2 * r\_me + \beta 3 * r\_ia + \beta 4 * r\_roe + \beta 5 * r\_eg. \tag{4.5}$$

The sample period is from 2008 to 2019. For the readability, the coefficient is shown in percentage value and the number in parentheses is t-statistic value.

	Portfolios by magnitude of pension deficit										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Panel A: Fama-French 5 factor + umd										
α	0.90	1.09	0.56	0.93	0.21	0.38	0.33	0.67	0.54	0.10	0.42
	(2.51)	(3.34)	(1.93)	(3.23)	(0.65)	(1.39)	(1.13)	(4.25)	(2.43)	(0.32)	(2.12)
mktrf	0.54	0.40	0.39	0.31	0.49	0.37	0.47	0.19	0.32	0.43	0.30
	(5.64)	(4.56)	(4.91)	(4.03)	(5.75)	(5.05)	(6.07)	(4.38)	(5.31)	(5.24)	(5.58)
smb	0.02	0.13	-0.02	0.02	-0.13	-0.21	-0.13	-0.07	-0.11	-0.15	-0.01
	(0.11)	(0.95)	(-0.18)	(0.19)	(-0.98)	(-1.78)	(-1.07)	(-1.12)	(-1.18)	(-1.14)	(-0.13)
hml	0.04	-0.04	0.10	0.14	-0.07	-0.08	-0.15	0.10	-0.03	-0.04	0.05
	(0.2)	(-0.19)	(0.58)	(0.86)	(-0.4)	(-0.51)	(-0.88)	(1.1)	(-0.24)	(-0.24)	(0.44)
rmw	0.01	0.09	-0.10	-0.03	-0.16	-0.19	-0.14	0.01	-0.09	-0.16	-0.02
	(0.03)	(0.41)	(-0.5)	(-0.13)	(-0.75)	(-1.04)	(-0.71)	(0.02)	(-0.57)	(-0.77)	(-0.18)
cma	-0.05	-0.13	0.06	0.10	-0.03	0.21	0.01	0.08	0.16	0.22	0.20
	(-0.17)	(-0.46)	(0.23)	(0.39)	(-0.11)	(0.88)	(0.1)	(0.57)	(0.84)	(0.84)	(1.12)
umd	-22.04	-19.36	-6.61	-14.90	-5.38	-3.92	-5.41	12.18	-0.37	8.93	2.74
	(-2.63)	(-2.55)	(-0.98)	(-2.24)	(-0.73)	(-0.61)	(-0.8)	(3.31)	(-0.07)	(1.26)	(0.59)
N	124	124	124	124	124	124	124	124	124	124	124
R^2	0.46	0.39	0.35	0.36	0.36	0.27	0.38	0.20	0.28	0.25	0.33
	Panel B: Q-5 model										
α	1.27	1.24	0.61	0.81	0.66	0.32	0.57	0.76	0.65	0.30	0.69
	(3.86)	(4.15)	(2.28)	(3.08)	(2.69)	(1.19)	(2.04)	(5.03)	(3.13)	(1.09)	(4.03)
r_mkt	0.44	0.37	0.37	0.34	0.38	0.38	0.38	0.15	0.27	0.36	0.22
	(5.18)	(4.79)	(5.29)	(5.03)	(6.03)	(5.46)	(5.25)	(3.87)	(5.11)	(5.1)	(4.94)
r_me	-0.08	-0.03	-0.07	-0.05	-0.22	-0.15	-0.13	-0.08	-0.11	-0.13	-0.08
	(-0.59)	(-0.21)	(-0.59)	(-0.43)	(-2.13)	(-1.32)	(-1.04)	(-1.3)	(-1.19)	(-1.11)	(-1.13)
r_ia	-0.04	-0.23	0.07	0.24	-0.30	-0.02	-0.34	-0.03	-0.05	-0.13	-0.04
	(-0.18)	(-1.23)	(0.43)	(1.49)	(-1.97)	(-0.15)	(-1.99)	(-0.32)	(-0.41)	(-0.76)	(-0.35)
r_roe	-0.56	-0.47	-0.32	-0.45	-0.14	-0.11	-0.13	0.09	-0.12	0.04	-0.07
	(-3.45)	(-3.21)	(-2.45)	(-3.53)	(-1.17)	(-0.83)	(-0.97)	(1.19)	(-1.17)	(0.31)	(-0.84)
r_eg	-0.17	-0.08	-0.13	0.05	-0.46	-0.20	-0.34	-0.22	-0.20	-0.37	-0.31
	(-0.78)	(-0.38)	(-0.69)	(0.28)	(-2.82)	(-1.14)	(-1.8)	(-2.17)	(-1.42)	(-2)	(-2.66)
N	124	124	124	124	124	124	124	124	124	124	124
R^2	0.44	0.39	0.39	0.40	0.45	0.32	0.36	0.18	0.33	0.30	0.38

Table 4.6: The panel analysis with equal-weighted expected return

This table shows the regression results at the portfolio level, which are estimated by fixed effects regression. The dependent variable is the portfolio's equal-weighted expected return. The firms' expected one-month-ahead stock returns are estimated by the firm-characteristics based model. The 6-month rolling window Fama-MacBeth regression by a pair of class variables (the portfolio and month date) is used to estimate the parameter of characteristics. After obtaining the firms' expected stock return, we calculate the equal-weighted expected stock return at the portfolio level. In addition to common risk factors, the independent variables also include 11 portfolio dummies, indicating which portfolio the firm belongs to. To avoid a dummy trap, we present regression results based on three models. Firstly, the intercept term is omitted, and the coefficient for every dummy shows an independent-unique effect for each portfolio. Secondly, we set portfolio 10 as the base portfolio. The coefficients of dummies describe extra effect comparing to portfolio 10. In this context, the intercept represents the independent-unique effect of portfolio 10. Finally, we set portfolio 1 as the base portfolio and repeat the same analysis process. The sample period is from 2008 to 2019. The number in parentheses is the t-statistic value.

	FF6 model			Q-5 model		
	noint	ref10	ref1	noint	ref10	ref1
$portfolio1$	0.014	0.010	0.014	0.016	0.010	0.016
	(4.93)	(2.33)	(4.93)	(6.59)	(2.89)	(6.59)
$portfolio2$	0.013	0.008	-0.001	0.015	0.008	-0.002
	(4.49)	(2.02)	(-0.31)	(5.97)	(2.45)	(-0.44)
$portfolio3$	0.005	0.001	-0.009	0.006	0.000	-0.010
	(1.85)	(0.16)	(-2.17)	(2.48)	(-0.04)	(-2.93)
$portfolio4$	0.010	0.005	-0.004	0.010	0.004	-0.006
	(3.41)	(1.25)	(-1.08)	(4.09)	(1.11)	(-1.79)
$portfolio5$	0.007	0.003	-0.007	0.010	0.004	-0.006
	(2.56)	(0.65)	(-1.68)	(4.08)	(1.1)	(-1.8)
$portfolio6$	0.005	0.000	-0.009	0.005	-0.001	-0.011
	(1.69)	(0.03)	(-2.3)	(2.15)	(-0.28)	(-3.17)
$portfolio7$	0.007	0.002	-0.008	0.008	0.002	-0.008
	(2.35)	(0.5)	(-1.83)	(3.36)	(0.58)	(-2.31)
$portfolio8$	0.007	0.002	-0.008	0.008	0.002	-0.008
	(2.23)	(0.41)	(-1.92)	(3.38)	(0.6)	(-2.3)
$portfolio9$	0.007	0.002	-0.008	0.008	0.002	-0.008
	(2.29)	(0.46)	(-1.88)	(3.44)	(0.64)	(-2.25)
$portfolio10$	0.005	0.005	-0.010	0.006	0.006	-0.010
	(1.65)	(1.65)	(-2.33)	(2.54)	(2.54)	(-2.89)
$portfolio11$	0.008	0.003	-0.007	0.010	0.004	-0.006
	(2.68)	(0.73)	(-1.6)	(4.06)	(1.08)	(-1.81)
$FF\_factors$	Y	Y	Y	N	N	N
$Q\_factors$	N	N	N	Y	Y	Y
$Year\ fixed$	Y	Y	Y	Y	Y	Y
N	1363	1363	1363	1363	1363	1363
R^2	0.33	0.33	0.33	0.37	0.37	0.37

Table 4.7: The panel analysis with value-weighted expected return

This table shows the regression results at the portfolio level, which are estimated by fixed effects regression. The dependent variable is the portfolio's value-weighted expected return. The firms' expected one-month-ahead stock returns are estimated by the firm-characteristics based model. The 6-month rolling window Fama-MacBeth regression by a pair of class variables (the portfolio and month date) is used to estimate the parameter of characteristics. After obtaining the firms' expected stock return, we calculate the value-weighted expected stock return at the portfolio level. In addition to common risk factors, the independent variables also include 11 portfolio dummies, indicating which portfolio the firm belongs to. To avoid a dummy trap, we present regression results based on three models. Firstly, the intercept term is omitted, and the coefficient for every dummy shows an independent-unique effect for each portfolio. Secondly, we set portfolio 10 as the base portfolio. The coefficients of dummies describe extra effect comparing to portfolio 10. In this context, the intercept represents the independent-unique effect of portfolio 10. Finally, we set portfolio 1 as the base portfolio and repeat the same analysis process. The sample period is from 2008 to 2019. The number in parentheses is the t-statistic value.

	FF6 model			Q-5 model		
	noint	ref10	ref1	noint	ref10	ref1
$portfolio1$	0.011	0.010	0.011	0.013	0.010	0.013
	(3.95)	(2.55)	(3.95)	(5.56)	(3.15)	(5.56)
$portfolio2$	0.011	0.010	0.000	0.013	0.011	0.000
	(4.01)	(2.59)	(0.04)	(5.62)	(3.19)	(0.04)
$portfolio3$	0.006	0.005	-0.005	0.007	0.004	-0.006
	(2.14)	(1.27)	(-1.27)	(2.91)	(1.26)	(-1.88)
$portfolio4$	0.009	0.008	-0.002	0.009	0.007	-0.004
	(3.23)	(2.04)	(-0.51)	(3.94)	(1.99)	(-1.16)
$portfolio5$	0.003	0.002	-0.008	0.006	0.003	-0.007
	(1.03)	(0.48)	(-2.07)	(2.43)	(0.91)	(-2.23)
$portfolio6$	0.003	0.002	-0.008	0.004	0.001	-0.010
	(1.14)	(0.56)	(-1.99)	(1.51)	(0.25)	(-2.89)
$portfolio7$	0.004	0.003	-0.007	0.005	0.003	-0.008
	(1.33)	(0.69)	(-1.85)	(2.29)	(0.81)	(-2.33)
$portfolio8$	0.005	0.004	-0.006	0.007	0.004	-0.006
	(1.75)	(0.99)	(-1.56)	(2.87)	(1.22)	(-1.92)
$portfolio9$	0.005	0.004	-0.006	0.006	0.004	-0.007
	(1.69)	(0.94)	(-1.6)	(2.73)	(1.12)	(-2.02)
$portfolio10$	0.001	0.001	-0.010	0.003	0.003	-0.010
	(0.35)	(0.35)	(-2.55)	(1.15)	(1.15)	(-3.15)
$portfolio11$	0.004	0.003	-0.007	0.006	0.003	-0.007
	(1.28)	(0.65)	(-1.89)	(2.49)	(0.95)	(-2.19)
FF_factor	Y	Y	Y	N	N	N
Q_factor	N	N	N	Y	Y	Y
$Year\_fixed$	Y	Y	Y	Y	Y	Y
N	1363	1363	1363	1363	1363	1363
R^2	0.33	0.33	0.33	0.36	0.36	0.36

Table 4.8: The experimental evidence from freezing DB pension plan

This table shows the result of probit regression analysis. The binary dependent variable equals to one if the DB pension plan is "hard" freezing or already in "hard" freezing status, otherwise zero. We calculate the pension deficit with three methods. The pension deficit Pd_{PBO} in Panel A is calculated as the projected benefit obligation (PBPRO) minus the pension asset (PPLAO), then divided by the prior month's market capitalization. In Panel B, we use the accumulated benefit obligation to replace the the projected benefit obligation and calculate the scaled pension deficit, Pd_{ABO}. In Panel C, we use the ratio of the accumulated benefit obligation divided by the projected benefit obligation to measure pension deficit ($Pd_{PBO-ABO}$). The firm size (Size) is the logarithm value of firm's total asset (AT). The free cash flow (Fcf) is calculated as cash flows from operating and investing operations ($OIBDP - XINT - TXT - DVC$) scaled by the book value of equity (CEQ). The financial leverage (Lev) is calculated as long-term debt (DLTT) divided by total assets (AT). The return on assets (ROA) is calculated as income before extraordinary items (IB) divided by total assets (AT). The model is:

$$prob(event = freezing) = \alpha_i + \beta_1 * PD + \beta_2 * Size + \beta_3 * Fcf + \beta_4 * Lev + \beta_5 * ROA + \alpha_{year} + \epsilon. \quad (4.6)$$

All regressions include year dummies (α_{year}). The negative two times the log-likelihood values (-2LL) are reported as the model fitness. All variables are winsorized at 1% and 99% separately and the number in parentheses is Wald Chi-Square value.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Panel A: pension deficit is calculated by projected benefit obligation (PBO)											
Inter	-0.09	-4.64	-4.30	0.51	0.63	-3.61	1.37	0.53	0.96	-2.64	-5.40
	(0.01)	(0.01)	(0.01)	(0.41)	(0.44)	(0.01)	(2.73)	(0.29)	(0.99)	(0.01)	(0.01)
PD_{PBO}	0.30	0.22	-0.55	-0.52	-0.66	-4.78	1.14	0.39	1.52	13.69	0.40
	(16.36)	(0.57)	(2.10)	(0.35)	(0.55)	(8.08)	(2.26)	(1.02)	(0.49)	(0.66)	(0.46)
Size	0.01	-0.08	-0.09	-0.10	-0.04	-0.17	-0.22	-0.03	-0.11	-0.18	0.04
	(0.09)	(2.58)	(4.24)	(5.25)	(0.74)	(10.67)	(19.91)	(0.34)	(4.49)	(6.91)	(0.93)
Fcf	-0.24	0.31	1.29	1.15	0.48	2.73	-1.09	-0.12	0.06	0.89	0.83
	(1.44)	(0.90)	(9.16)	(4.23)	(1.42)	(10.03)	(3.96)	(0.11)	(0.01)	(1.10)	(7.76)
Lev	0.03	0.80	-2.81	-1.58	-1.52	-1.37	-0.09	-0.68	-0.92	-2.26	-1.43
	(0.01)	(1.79)	(20.02)	(6.61)	(5.69)	(4.31)	(0.02)	(1.19)	(1.95)	(7.32)	(5.77)
ROA	-1.54	-0.46	-2.81	-1.55	-3.39	-5.40	0.16	-2.87	-2.60	-4.53	-0.98
	(2.86)	(0.11)	(2.65)	(1.22)	(4.41)	(10.45)	(0.01)	(4.67)	(2.33)	(6.10)	(0.43)
-2LL	495.1	386.8	335.6	385.9	352.6	321.2	351.7	315.0	300.4	208.1	364.5
Panel B: pension deficit is calculated by accumulated benefit obligation (ABO)											
Inter	-0.13	-4.63	-4.30	0.43	0.42	-3.47	1.32	0.46	1.01	-1.72	-5.37
	(0.02)	(0.01)	(0.01)	(0.29)	(0.23)	(0.01)	(2.52)	(0.22)	(1.09)	(0.01)	(0.01)
PD_{ABO}	0.35	0.54	-0.37	1.07	-0.19	-1.00	1.98	6.53	2.83	56.84	1.23
	(17.32)	(2.56)	(2.65)	(1.52)	(0.34)	(0.57)	(4.51)	(3.43)	(1.58)	(10.66)	(3.32)
Size	0.02	-0.07	-0.09	-0.08	-0.04	-0.15	-0.21	-0.02	-0.11	-0.16	0.04
	(0.24)	(2.16)	(4.12)	(3.46)	(0.70)	(9.47)	(18.14)	(0.23)	(4.43)	(5.05)	(1.06)
Fcf	-0.26	0.15	1.10	0.43	0.29	0.81	-1.33	-0.82	-0.21	0.26	0.77
	(1.63)	(0.22)	(8.14)	(0.67)	(0.81)	(1.43)	(6.13)	(2.25)	(0.13)	(0.08)	(6.78)
Lev	-0.01	0.75	-2.79	-1.75	-1.51	-1.31	-0.04	-0.63	-0.86	-2.03	-1.49
	(0.01)	(1.56)	(19.91)	(8.08)	(5.63)	(4.04)	(0.01)	(1.00)	(1.70)	(5.78)	(6.29)
ROA	-1.45	-0.50	-2.87	-1.71	-3.52	-5.22	0.28	-2.73	-2.29	-2.83	-0.79
	(2.49)	(0.13)	(2.83)	(1.53)	(4.88)	(10.13)	(0.03)	(4.06)	(1.75)	(1.97)	(0.28)
-2LL	492.5	384.5	337.8	384.8	353.7	330.0	348.9	310.9	299.0	188.6	361.3
Panel C: the accumulated benefit obligation divided by projected benefit obligation (ABO/PBO)											
Inter	-0.16	-4.61	-4.37	0.48	0.29	-3.53	1.35	0.52	0.94	-2.55	-5.41
	(0.03)	(0.01)	(0.01)	(0.37)	(0.09)	(0.01)	(2.72)	(0.28)	(0.96)	(0.01)	(0.01)
PD_{DIF}	-0.07	-0.12	0.09	0.10	-0.01	0.32	-0.07	-0.10	-0.01	0.13	0.12
	(7.36)	(2.07)	(1.93)	(0.34)	(0.04)	(1.31)	(0.20)	(0.92)	(0.01)	(0.05)	(2.20)
Size	0.01	-0.08	-0.08	-0.10	-0.04	-0.15	-0.23	-0.03	-0.11	-0.19	0.03
	(0.06)	(2.91)	(3.39)	(4.74)	(0.62)	(8.97)	(21.29)	(0.37)	(4.52)	(7.83)	(0.72)
Fcf	0.01	0.16	1.09	1.00	0.14	0.78	-0.51	-0.14	0.37	1.01	1.20
	(0.01)	(0.23)	(6.61)	(6.37)	(0.18)	(2.94)	(2.15)	(0.11)	(0.48)	(1.41)	(11.89)
Lev	-0.13	0.80	-2.77	-1.58	-1.46	-1.15	-0.25	-0.66	-0.90	-2.02	-1.41
	(0.07)	(1.80)	(19.66)	(6.67)	(5.33)	(3.04)	(0.18)	(1.13)	(1.87)	(6.39)	(5.67)
ROA	-1.72	-0.18	-2.84	-1.52	-3.53	-5.01	0.01	-2.76	-2.73	-4.53	-1.40
	(3.75)	(0.02)	(2.77)	(1.18)	(4.90)	(9.48)	(0.01)	(4.34)	(2.57)	(5.99)	(0.88)
-2LL	508.3	385.2	338.9	385.9	354.0	328.6	353.9	315.9	300.9	208.7	363.1
Year fixed	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
N	397	341	361	361	361	327	323	276	247	193	350

Table 4.9: The announcement effect of M&A deal on target firm's stock

This table shows the regression analysis of M&A deal announcement effect on target firm's stock price. The calculation window of cumulative abnormal return is 3 days (-1,1) and 5 days (-2,2) separately with value-weighted return from CRSP database as benchmark. The main independent variable is the percentage value of cash as payment means in total $M\&A$ deal size (ccash). The dummy variable DB equals to 1 if target firm has a DB pension plan, otherwise 0. The firm size (size) is the logarithmic firm's total asset. The leverage ratio (lev) is calculated as the total debt (DLCC+DLC) divided by total asset(AT). The accounting items' value are collected from the firm's annual report in the prior fiscal year. The regression equation is:

$$CAR_{-t,t} = \beta_1 + \beta_2 * ccash + \beta_3 * DB + \beta_4 * size + \beta_5 * lev + \epsilon, \quad t = 1, 2. \tag{4.7}$$

For ensuring the sufficient amount observations for each portfolio analysis, the portfolios are re-classified as the most severely underfunded firms (composed of original portfolio 1 to portfolio 5), the least severely underfunded firms (composed by original portfolio 6 to portfolio 10) and overfunded firms (composed by original portfolio 11). The announcement effect is analysed at portfolio level. All variables are winsorized at 1% and 99% level and the number in parentheses is t-statistics value.

	Portfolios 1 to 5		Portfolios 6 to 10		Portfolio 11	
	Car(-1,1)	Car(-2,2)	Car(-1,1)	Car(-2,2)	Car(-1,1)	Car(-2,2)
ccash($\times 10^2$)	0.111	0.112	-0.018	-0.013	-0.025	-0.027
	(2.4)	(2.38)	(-0.53)	(-0.37)	(-1.58)	(-1.67)
DB	-0.100	-0.104	-0.104	-0.101	0.033	0.036
	(-2.07)	(-2.12)	(-2.71)	(-2.58)	(1.61)	(1.75)
size	0.005	0.006	0.018	0.017	0.009	0.009
	(0.88)	(0.93)	(3.99)	(3.78)	(4.18)	(4.29)
lev	0.189	0.206	0.168	0.167	0.076	0.068
	(2)	(2.14)	(2.07)	(2.03)	(2.26)	(2)
N	129	129	230	230	512	512
R^2	0.25	0.26	0.22	0.22	0.19	0.19

5. Excess Cash Holding, Financial Constraints And Defined Benefit Pension Plans

5.1 Introduction

Assuming the mandatory pension contribution is an exogenous shock, the prior literature commonly employs defined benefit (DB) pension plan to examine financial frictions' treatment effect on the firm's investment decisions (Rauh, 2006a; Franzoni, 2009; Campbell, Dhaliwal and Schwartz Jr, 2011). The logic is that managers passively reduce investment under the unexpected cash pressure created by compulsory pension contributions. Existing evidence also confirms that the reduction of investment negatively affects firms' values. In this contest, increasing cash holdings ahead of the cash pressure can be valuable to alleviate the investment reduction. However, it is inconclusive on this topic in prior literature. This chapter attempts to examine whether firms sponsoring a DB pension plan will actively increase the cash holding level for the prospective pension contribution pressure.

When a firm sponsors a DB pension plan, it promises to pay participants a pension after retiring. The Internal Revenue Service (IRS) requires sponsors to fund an annual mandatory pension contribution to security DB pension plans' solvency. As this pension benefit payment will happen in the future, the sponsors need actuarial assumptions to project the deferred payment into the present value for pension funding. In general, pension contributions are service costs plus the amortisation of the prior unfunded actuarial liability. Among the composition, the

service cost is the new accrued pension benefit attributed to the current year's service. In addition to the service cost, the sponsors need to contribute extra to amortise the underfunded pension liability, which is the difference between the actuarial pension liability and the fair value of assets. Although the exact amount of subsequent pension contributions is not observable, the persistent pension contributions are partially predictable based on the current information.

Whether the firm's value reflects the continual implications of sponsoring the DB pension plan has received much attention. Franzoni and Marin (2006) demonstrate that the market fails to predict the natural cash outflow induced by future mandatory pension contributions. Their evidence suggests that investors can not fully anticipate the persistence of pension contribution implied in current accounting statements, although publicly available. The common explanation attributes the miss-pricing for the DB pension plan to the opaque pension accounting. Because pension accounting is complicated, so investors fail to distinguish the 'accounting value' and 'economic value' (Coronado and Sharpe, 2003; Franzoni and Marin, 2006; Picconi, 2006). Though previous literature that employs the DB pension plan to examine the implication of market frictions on a firm's economic activities is inconclusive on whether the sponsoring firm can anticipate this persistent pension contribution before it is materialised, it provides useful insights (Rauh, 2006a; Campbell, Dhaliwal and Schwartz Jr, 2011). The main finding is that managers reduce investment because contemporary mandatory pension contribution consumes the internal financial resource. This finding suggests that managers also fail to fully anticipate the future implications associated with sponsoring DB pension plans as managers do not effectively take actions to mitigate this implication. This conflicts with the conventional idea that managers have information advantages on the DB pension plan.

Since managers can access essential pension information, including pension asset allocation and the pension obligation estimation, managers have the necessary information to predict the future cash pressure created by subsequent mandatory pension contributions. So, we raise the first question: whether firms sponsoring

an underfunded pension plan tend to have higher cash holding. In the traditional static trade-off model, the firm's optimal cash holding level is at the point where the marginal cost equals the marginal benefit of holding cash. When the future cash pressure is predictable for managers, the benefits of precautionary cash holding will increase. Then, a firm will have strong incentives to hold more cash, especially when the firm has difficulty raising finance from capital markets. This question can be extended by considering the magnitude of the pension deficit. The different extent of pension deficits could affect the firm's cash holding motivation from two aspects. First and foremost, the mandatory pension contribution is determined by the current pension plan's funding status. The severely underfunded DB pension plan can bring more significant cash pressure for sponsoring firms under the same recovery plan period. The benefit of cash holding accordingly increases. Secondly, previous studies find that firms supporting a severely underfunded DB pension plan usually have financial constraints (Campbell, Dhaliwal and Schwartz Jr, 2011; Bakke and Whited, 2012). Therefore, these firms will bear negative implications from funding mandatory pension contributions because raising capital markets finance is costly. These aspects will make the incentive of raising cash holding stronger for firms sponsoring a severely underfunded DB pension plan. We, therefore, consider the magnitude of the pension deficit.

To answer our questions, we focus on a firm's cash holding policy. The cash holdings are a valuable tool for future financial slack. Unlike property, stocks, or bonds, holding cash will not have any actual interest revenue. However, maintaining a certain level of cash can minimise the transaction costs associated with raising external funds or liquidating assets and finance projects in case of financing constraints. Corporate finance usually explains a firm's cash holdings by transaction, speculative, or precautionary motives. Among these three cash holding motivations, precautionary motivation plays a central role in explaining the firm's cash holding. Precautionary saving refers to the cash holding for unforeseen challenges in the future. Han and Qiu (2007) and Bates, Kahle and Stulz (2009) demonstrate that managers increase their cash holdings in response to increasing cash flow volatility. Due to market

frictions, internally generated cash is less costly than external capital. Thereby, a sufficient cash-holding is valuable for maintaining firms' ongoing operations and continued growth, especially when the firms have difficulties raising finance from capital markets. A firm's cash holding is an aggregated variable associated with the firm's investment and daily operations. The portion of cash reserves held for financing day-to-day operations and investments are least at management's discretion. As a non-operating activity, the cash reserves for subsequent pension contributions should be associated with the excess cash holding. Therefore, we estimate cash reserves held over those needed for operations and investments. In the corporate finance literature, the excess cash holding is commonly estimated through the residual in the firm's cash holding prediction model. In two early papers, Kim, Mauer and Sherman (1998) and Opler et al. (1999) argue that firms have an optimal level of cash holdings. Managers trade off the costs and benefits of holding cash to determine the appropriate cash holding level. The recent research further discusses the regression specifications for an optimal cash holding (Dittmar, Mahrt-Smith and Servaes, 2003; Dittmar and Mahrt-Smith, 2007; Harford, Mansi and Maxwell, 2008). In this paper, we follow the Dittmar and Mahrt-Smith (2007)'s improved cash determination model to estimate a firm's excess cash holding.

Firstly, we investigate whether the severely underfunded DB pension plans will encourage firms to increase their cash holdings. The evidence shows a positive relationship when we examine the implications of pension plan funding status on total cash holding level. This finding is consistent with the conventional idea that pension policy is significantly affected by a firm's financial position (Bartram, 2018). When firms can generate sufficient internal financial resources, managers tend to fund their DB pension plans. At the same time, firms are more likely to hold more cash reserving that stems from the internally generated cash flows. The excess cash holding is most at managers' discretion and directly reflects management strategies comparing to aggregated cash holding. We, therefore, further examine whether severely underfunded DB pension plans are positively related to firms' excess cash holdings. The regression results show that firms sponsoring a severely underfunded

DB pension plan will hold less cash but more excess cash. Our results suggest the importance of distinguishing the excess cash from total cash holding in analysing the impacts of non-operation activities, like sponsoring pension plans.

Next, we consider a firm's financial position. The precautionary motive for cash holdings has been well documented (Opler et al., 1999; Mikkelson and Partch, 2003; Bates, Kahle and Stulz, 2009). The studies suggest that firms use internally generated funds to hedge against future cash flow uncertainty. Moreover, the evidence shows that the amount of cash holdings in precautionary motive depends on financial constraints. The marginal value of cash holdings for firms with greater financing constraints is higher than firms that can easily raise funds from capital markets. Faulkender and Wang (2006) find that the marginal value of cash holdings for financially constrained firms is higher than financially unconstrained firms. The marginal value of cash is from \$0.27 to \$0.63, depending on different constrained criteria. So, we investigate whether only financially constrained firms increase excess cash holdings in response to the subsequent pension contributions. Our sub-sample analysis shows that the positive relationship between low pension plan funding status and excess cash holdings is only statistically significant for financially constrained firms. It seems to support the high excess cash holding results from the precautionary motive for subsequent pension contributions. Thereby, the financially constrained firms have a strong incentive to increase cash reserve because of the higher cost of raising finance.

This chapter also contributes to the literature on what determines the value of cash holding. Faulkender and Wang (2006) find the value of one dollar of cash holding is about \$0.94. This finding raises a question: why the cash holding will destroy firm value. In fact, Pinkowitz, Stulz and Williamson (2006) and Dittmar and Mahrt-Smith (2007) provide an explanation about this question. They find that corporate governance is a crucial factor in explaining the low value of cash holding. They show that the value of cash, and thus firm value, is partially determined by how investors expect the cash to be used. In general, managers prefer to hold cash because a higher level of cash holding can reduce uncertainty and increase

managers' discretion. As introduced in Opler et al. (1999): "The greater preference for cash will lead managers to place too much importance on the precautionary motive for holding cash." Therefore, the cash holding at managers' discretion will damage the firm's value. The excess cash holding motivation is explained as the precautionary motive for subsequent pension contributions throughout this chapter. Thus, it conflicts with the perspective of maximisation shareholder wealth because pension contribution is the benefits allocated to employees. Our findings provide alternative empirical evidence about why the cash holdings reduce the firm value from stakeholders' perspectives.

Note that managers have other options to take a future pension contribution holiday. In pension funding practice, the actual pension contribution is tax-deductible[1] and managers could use the overfunding in future pension contribution. Therefore, if firms have no good investment opportunities or face a high corporate tax rate during the current period, managers could increase their annual pension contribution in exchange for future financial slack. However, the proportion of overfunding will be saved in the credit balance account and only used for future contributions. The sponsors can not withdraw the overfunding to finance other economic activities. Besides this shortfall, the regulator also sets the upper bound for the tax-deductive contribution. In this context, increasing cash holding is a desirable strategy for future financial slack.

The rest of this chapter is structured as follows. In section 2, we discuss pension accounting and pension funding requirements. In section 3, we build up our hypotheses. In section 4, we discuss sample selection and introduce variable definitions. In section 5, we discuss the findings. Section 6 conducts the robustness analysis. Section 7 concludes this chapter.

[1] In US-based companies, the real pension contribution instead of the pension expense recorded in financial statements is tax-deductible.

5.2 The US pension funding requirement

US pension schemes generally can be categorised as defined contribution, defined benefit, or hybrid types. DB pension plans promise participants a pension payment after their retirement, with the amount determined by the employee's final salary, working years, mobility and longevity expectations, and inflation adjustment. As deferred liabilities, sponsors need actuary assumptions to discount the final pension benefits into the present value for pension accounting and funding purposes. The US-based companies disclose pension-related information in a financial statement following the Statements of Financial Accounting Standards (SFAS) stipulations. The Financial Accounting Standards Board's (FASB) SFAS No.87 (issued in 1985) firstly states that companies must recognise and disclose their pension obligations, together with their plans' performance, at the end of each accounting period. The value of pension assets and projected benefit obligations are reported in the footnotes to the balance sheet[2].

The purpose of pension accounting is to disclose the time and exact pension information to the users of financial statements. So, the pension accounting valuation is based on the short-term 'snapshot' rate. Differently, the principles of pension funding are to ensure the solvency of pension plans by receiving adequate cash contributions. The Internal Revenue Code (IRC) allows the plan's actuary to select long-term stable assumptions to calculate minimum pension contribution. If the fair value of pension assets is greater than the pension liabilities, sponsors only need to fund the pension benefit accruals attributed to the employee's service during this year. Otherwise, if the fair value of pension assets is less than the pension liabilities, Internal Revenue Service (IRS) requires additional funding charges to compensate pension deficit within the next several years. In 1974, the Employee Retirement Income Security Act (ERISA) allowed firms to fund 90% of their underfunded pension liabilities over thirty years. In 1987, Congress subsequently enacted the Pension Protection Act (PPA) of 1987, which requires better overall funding of

[2] The SFAS No.158 (issued in 2006) further improved pension accounting disclosures by changing pension assets and liabilities as on-balance sheet items. SFAS No.158 dominates the pension accounting standards over our sample period. We, therefore, do not consider the implications of pension accounting standards change.

pension plans by creating 'catch-up' contributions for severely underfunded firms. Recently, Congress enacted the PPA 2006 (issued in 2006), which dramatically accelerates near-term cash outflows for all pension firms and requires firms to fund their pension deficits within seven years fully. The excess will be deposited into a credit balance if the annual pension contribution is over the mandatory pension contribution. This credit balance grows with interest and can fund future pension contributions, although employees cannot withdraw the overfunding.

During our sample period, the pension funding is ruled by the PPA 2006. Under the PPA 2006, a plan sponsor's minimum required contribution will be based on the plan's target normal cost and the difference between the plan's funding target and the value of the plan's assets. The plan's target normal cost is the present value of all benefits plan participants will accrue during the year. The funding target is the current value of all benefits, including early retirement benefits, already accrued by plan participants at the beginning of the plan year. If a plan's assets are less than the funding target, the plan has an unfunded liability. This liability, less any permissible credit balances, must be amortised in annual instalments over seven years. The plan sponsor's minimum required annual contribution is the plan's target normal cost for the plan year, but not less than zero. The 100% funding target will be phased in at 92% in 2008, 94% in 2009, 96% in 2010 and 100% in 2011 and later years. The phase-in will not apply to plans that are already underfunded to the extent that they were subject to the deficit reduction contribution rules in 2007. Those plans will have a 100% funding target beginning in 2008.

5.3 Hypothesis development

Existing studies demonstrate that sponsoring a DB pension plan will significantly impact the firm's other economic activities, particularly when the plan size is large relative to the firm size. Early empirical papers find that sponsors of better-funded plans tend to have better debt ratings (Martin and Henderson, 1983; Maher, 1987). These papers suggest a degree of substitutability between pension liabilities and long-term debt. Subsequently, Shivdasani and Stefanescu (2010) provide further

evidence showing that managers incorporate pension liabilities into a firm's capital structure decision and quantify the substitutability between pension liabilities and conventional financial debt. These papers confirm the sponsoring DB pension plan will affect the firm's cost of debt. Another type of literature focuses on the impacts on the firm's cost of equity. Jin, Merton and Bodie (2006) document that sponsoring firms' equity beta and stock returns reflect the pension induced risk. They also show the importance of adjusting the cost of capital for the pension plan's presence. These results suggest that a firm's cost of capital is an intervening variable that explains the implication of the DB pension plan on the firm's other economic activities. Rauh (2006a) documents a negative relationship between mandatory pension contributions and the firm's capital expenditures. His empirical evidence suggests that managers are forced to reduce investment because of cash pressure created by compulsory pension contributions. In a recent paper, Campbell, Dhaliwal and Schwartz Jr (2011) explain the investment reduction observed in Rauh (2006a) results from the increasing cost of capital. When the firm's cost of capital is increased by reducing internal financial resources, managers may passively forgo investments, eventually damaging the firm's value. In this context, a high level of cash reserving ahead of compulsory pension contributions can mitigate this prospective cash pressure. Moreover, the proportion of cash used for daily operation and investment is less at the manager's discretion. As non-operation activities, we expect that the implications on excess cash holding should be more pronounced. So, we build our first hypothesis:

Hypothesis 5.1 *Firms sponsoring severely underfunded DB pension plans are likely to increase their excess cash holdings.*

As the crucial component in a firm's capital structure, determining firms' cash holding is always a key research topic in the corporate finance field. Opler et al. (1999) use the static trade-off theory to explain the firm's cash holding position. Their evidence suggests whether a firm is easy to access capital markets will affect its cash holding level. This finding is consistent with the conventional idea that financially constrained firms tend to hold more cash because of the relatively higher cost of raising finance from the capital market.

The firms' financial position has been well discussed in pension-related literature. For example, Franzoni (2009) finds that the price decreasing following a pension-induced drop in cash is magnified for firms that appear a priori more financially constrained, suggesting a negative effect of financing frictions on investment. In addition, Campbell, Dhaliwal and Schwartz Jr (2011) find an increase in mandatory pension contributions increases the cost of capital, but only for firms facing more significant external financing constraints. This evidence suggests that compulsory pension contributions as internal financing constraints could result in foregone investment because of costly raising finance from the capital market. However, when the firm is accessible to raising finance from the capital market, this negative implication disappears. Furthermore, firms sponsoring a severely underfunded DB pension plan are more likely to have financial constraints (Rauh, 2006a; Campbell, Dhaliwal and Schwartz Jr, 2011; Bakke and Whited, 2012). So, we develop our second hypothesis by considering the firm's financial position.

Hypothesis 5.2 *The incremental effect of severely underfunded DB pension plans on excess cash holdings is more pronounced for financially constrained firms.*

5.4 Data section

This paper forms the sample from publicly traded US firms listed on the NYSE, Nasdaq and AMEX. Our sample period is from 2008 to 2019. Since we use pension information disclosed in accounting statements to measure pension plan funding status, this sample period considers the latest change of pension accounting rule, the SFAS No.158. The sample starts from 2008 to ensure that all DB plan sponsors employ SFAS No.158 to report their pension information.[3] We collect pension-related variables and other accounting variables from the COMPUSTAT database. Suppose

[3] The SFAS No.87 requires the sponsors of defined benefit pension plans to report the pension funding status in the main body of financial statements, but the over-funded and under-funded pension plans need to be reported separately. The SFAS No.132, effective from December 1997, amends this requirement and requires sponsors to compound these two types of pension plans into one accounting item. After adopting SFAS No.158 (issued in 2006), sponsors are required to recognize and report the pension plan funded status in their financial statements. The figure between the fair value of pension assets and the projected benefit obligation will be recognized in the balance sheet as one line accounting item on the asset side (pension surplus) or liability side (pension deficit).

the value of a firm's project benefit obligation (PBPRO) is missing. In that case, the firm is recognized as having no DB pension plan and is eliminated from the final sample.[4]

The firm's financial position is a crucial variable in our paper. We calculate the HP index (Hadlock and Pierce, 2010) and the WW index (Whited and Wu, 2006) to measure the firms' financial positions. The higher the value of these two proxies, the more difficult firms are to raise funds from external capital markets[5]. To measure a firm's financial position over time t, we average the value of two proxies at time t-1 and time t. The HP index is calculated as $0.737 \times Assets + 0.043 \times Assets^2 - 0.040 \times Age$, where assets are the log value of inflation-adjusted book assets and are capped at (the log value of) 4500 (million), and age is the number of years a firm's data is available in Compustat database (capped at 37 years). All variables are inflation-adjusted using the CPI index and converted into real values in 2008. The WW index is originally calculated using quarterly data in Whited and Wu (2006). For simplicity, we compute the WW index using Compustat annual data. The calculation formula is: $WW =$ –$0.091 * CF$–$0.062 * DIVPOS$+$0.021 * TLTD$–$0.044 * LNTA$+$0.102 * ISG$–$0.035 * SG$, where CF is the ratio of cash flow to total assets (IB+DP)/AT, DIVPOS is an indicator that takes the value of one of the firm pays cash dividends (DVC), TLTD is the ratio of the long-term debt to total assets (DLTT/AT), LNTA is the natural log of total assets (AT), ISG is the firm's three-digit SIC industry sales growth, and SG is the firm's sales growth ($SALE_t/SALE_{t-1}$). After sorting the annual value of proxies, the top 30% firms are defined as financially constrained firms.

[4] Sponsors of DB pension plans are required to complete Form 5500 and submit it to the Department of Labor. The details on pension information are recorded at the plan level in Form 5500. However, this form is generally available from the Department of Labor after a significant time lag. Specifically, there is a considerable time lag in the release of Form 5500 data for public consumption. Firms have ten months after year-end to file the forms, and then the data must be compiled, cleaned, and tabulated (Buessing and Soto, 2006). As introduced in Campbell, Dhaliwal and Schwartz Jr (2011), because of statutory filing deadlines, Form 5500 data will always be on at least a ten-month lag, and investors will have to use Form 10-K data to estimate funding requirements. File 2020 returns/reports for plan years that began in 2020. All required forms, schedules, statements, and attachments must be filed by the last day of the 7th calendar month after the end of the plan year (not to exceed 12 months in length) that began in 2020. - INSTRUCTIONS OF FORM 5500

[5] In addition, we also calculate the Kaplan and Zingales (1997) index as an alternative measurement of financial constraints. Still, this index is weakly correlated with the other measures and is argued by much prior literature about its efficiency (not easy to follow this, please rewrite), so we will not apply this index.

We exclude observations of financial firms (SIC 6000–6999) and utilities (SIC 4900–4999). Moreover, we also employ several other selection criteria. Firstly, we only include a firm's data till it has at least two years' available accounting information in the COMPUSTAT database. Then, we correct the outliers' effect by dropping observations for each year in which the funding status variable is more than five standard deviations away from the annual mean (Franzoni and Marin, 2006). For other non-pension related accounting variables, we winsorize them at 1% and 99% levels. Moreover, we delete the observations with the missing value of any used variables, and all non-ratio variables are deflated by the net asset (AT-CHE). The table below presents the summary statistics of the final sample.

[Insert Table 5.1 Here]

Table 5.1 shows the descriptive statistics of variables used in the primary regression model. We present their statistics in full-sample and sub-samples separately. The first sub-sample is only composed of firms sponsoring the most severely underfunded DB pension plans. Another sub-sample is only composed of firms sponsoring the least underfunded DB pension plans. Panel A of table 5.1 is the results based on the total sample. Panels B and C of table 5.1 are statistics of variables based on two sub-samples, respectively. Comparing the two sub-sample results, we find the firms sponsoring the least underfunded DB pension plans have greater firm size, lower financial leverage and the book-to-market ratio. The characteristic statistics indicate the pension plan funding status is a proxy for a firm's status. This result is consistent with Bartram (2018) who shows that a firm's pension policy is significantly associated with its financial position.

[Insert Table 5.2 Here]

Table 5.2 shows the correlation coefficient, and the bold font indicates the p-value lower than 0.01. The correlation is also measured in different samples. Panel A in table 5.2 shows the correlation statistics in the total sample. Furthermore, panel B in table 5.2 shows the correlation in the sub-sample, which is only composed of firms sponsoring the most severely underfunded DB pension plan. Panel C in table 5.2

shows the correlation in the sub-sample, which is only composed of firms sponsoring the least severely underfunded DB pension plan. The sign of the correlation between pension plan funding status and a firm's cash holding is inverse in two sub-samples. This finding indicates the implication of DB pension plan funding status on the firm's cash reserves is systematically different for the most severely underfunded and the least underfunded DB pension plans.

5.5 The empirical evidence

5.5.1 The incremental implications on cash holdings

This section provides empirical evidence for our first hypothesis that a firm sponsoring the most severely underfunded DB pension plan has a higher level of excess cash holding. First, we follow Opler et al. (1999)'s method to measure a firm's liquid asset holdings, which is the ratio of cash and marketable securities to total assets minus cash and marketable securities. The higher value of this ratio indicates the firm holds a higher proportion of cash in total capital. Then, we estimate the firm's excess cash holding. Excess cash holding is the cash that is not used in the firm's daily operation and investments. In our paper, it is defined as the residuals of optimal cash holding fitting model (Dittmar and Mahrt-Smith, 2007). The details are introduced in the appendix 7.3.

To define the most severely underfunded DB pension plan, we sort firms by their pension plan funding status (Fs) annually and determine the bottom 30% as firms with the most severely underfunded DB pension plan. Correspondingly, the dummy variable, Lfs, equals one, otherwise zero. Similarly, we introduce a dummy variable, Hfs, to represent the top 30% firms. Besides the dummy variables, we also include pension plan funding status (Fs) as a control variable. Because the pension plan's funding status is a proxy for a firm's characteristics and financial position, including pension plan funding status (Fs) could partially eliminate the implications of other unobserved factors related to its characteristics and financial situation.

In addition to pension-related variables, our model also includes other control

variables related to the firm's cash holding position. The first non-pension related control variable is the firm's size, which is calculated as the total asset's logarithm value (AT). The other one is the firm's financial leverage. Shivdasani and Stefanescu (2010) show that firms incorporate the magnitude of their pension assets and liabilities into their capital structure decisions, and the pension deficit has an accumulative effect on the firm's financial leverage. If pension assets and liabilities are incorporated into leverage calculation, the severely underfunded pension liabilities will significantly increase the sponsoring firm's leverage. In this context, more cash may be needed for the increased default risk. The corporate pension-related papers usually exploit 'consolidated' leverage by incorporating pension assets and liabilities. In our model, the purpose of including leverage is to eliminate the implications from the non-pension related capital structure. Therefore, we use conventional financial leverage as a control variable. Then, we calculate the book-to-market ratio of equity. If its market value is greater than its book value, this suggests the firm has a greater growth opportunity. So, the book-to-market ratio of equity is used to control the unobserved investment opportunity. The next two control variables are the firm's payout ratio ($Pay_{i,t}$) and capital expenditure ($Capx_{i,t}$). The pension contribution significantly affects contemporary economic activities by reducing internal financial resources (Rauh, 2006a; Liu and Tonks, 2013), including these two economic activities eliminates the implications on cash reserving from other non-pension cash expenditures. Last but not least, we calculate the net working capital $Wcap_{i,t}$ as a measure of liquid asset substitutes (Opler et al., 1999). Our fundamental regression model is shown below.

$$\begin{aligned} ch_{i,t} \text{ or } ex\_c_{i,t} =& \beta_1 + \beta_2 * Fs_{i,t} + \beta_3 * Size_{i,t} + \beta_4 * Lev_{i,t} + \beta_5 * BM_{i,t} + \beta_6 * Pay_{i,t} + \beta_7 * Wcap_{i,t} \\ &+ \beta_8 * Capx_{i,t} + \beta_9 * Fs\ dummy_{i,t} + \alpha_{industry} + \alpha_{year} + \epsilon_{i,t}. \end{aligned} \tag{5.1}$$

Where the $ch_{i,t}$ is the natural logarithm of cash and equivalents (CHE) deflated by the non-cash assets (AT-CHE), the estimation of excess cash holding $ex\_c_{i,t}$ is introduced in Dittmar and Mahrt-Smith (2007)'s appendix and regarded as the residuals of optimal cash holding fitting model. The $Fs_{i,t}$ is the difference between projected benefit pension obligation (PBPRO) and fair value of pension

asset (PPLAO) deflated by the market value of equity in December of last year. The $Size_{i,t}$ is the logarithm value of the firm's total asset (AT). $Lev_{i,t}$ is the financial leverage which is calculated as total debt (DLTT+DLC) divided by book value of equity (SEQ). The book-to-market ratio of equity $BM_{i,t}$ is the book value of the asset (SEQ+TXDB+ITCB-PREF) divided by the market value of equity in December of last year. The $Pay_{i,t}$ is the firm's payout ratio (PRSTKC+DVC+DVP) divided by the income before extraordinary items (IB). $Wcap_{i,t}$ is the working capital (WCAP) divided by net asset (AT-CHE). $Capx_{i,t}$ is the capital expenditure (CAPX) divided by net asset (AT-CHE). The $Fs\ dummy_{i,t}$ includes two dummy variables. The first one, low funding status (Lfs), represents the bottom 30% observations after sorting by annual pension plan funding status (Fs). High funding status (Hfs) is used to represent the top 30% observations. The industry (Fama-French 48 industry classification) and year fixed effect are included to control the unobserved constant bias at industry classification and time level. The regression results are shown below.

[Insert Table 5.3 Here]

Columns (1), (2) and (3) in table 5.3 show the results using total cash holding as the dependent variable. Although the coefficient of Lfs is positive as we expect, it is not statistically significant from zero (with a t-value of 0.78). On the other hand, the coefficient of Hfs indicates that firms sponsoring the least underfunded pension plans hold more cash reserving at the end of the fiscal year. As we discussed before, the pension plan funding status reflects the firm's financial position. The dummy variable Hfs is a proxy indicating the firm is well operated and could generate sufficient cash flow from operating activities. Therefore, there is a more outstanding total cash holding stemming from internal funds.

Columns (4), (5) and (6) in table 5.3 show the results using excess cash holding as the dependent variable. The result of column (4) suggests that the most severely underfunded pension plans will increase firms' excess cash holding, supporting our first hypothesis that firms increase excess cash holding in response to the subsequent mandatory pension contribution. However, we find no statistically significant influence for firms that sponsor the least underfunded pension plans.

5.5.2 The effect of financial constraints

This section provides empirical results on our second hypothesis to test whether a firm's financial position further affects managers' incentive to increase cash reserves. An alternative view of the trade-off model of cash holding is that a firm has no optimal cash holding. The argument is that the cash holdings react passively to changes in the firm's internal funds. Firms can accumulate cash from internally generated cash flow unless it is constrained in investment. Hence, internal financial constraints will reduce cash reserve and eventually force firms to raise funds from capital markets. The different costs of raising finance from capital markets will distinguish the negative implications on investment across firms. Franzoni (2009) states that the price decreasing following a pension-induced drop in cash is magnified for firms that appear a priori more financially constrained. Restricted by costly raising funds from capital markets, the financially constrained firms prefer to use internal funds in economic activities. Consequently, the firm's financial position significantly changes its cash reserve at the end of the fiscal year. More importantly, previous literature provides extensive evidence that firms sponsoring the most severely underfunded DB pension plans usually are financially constrained(Rauh, 2006a; Rauh, 2009; Bartram, 2018; Anantharaman and Lee, 2014; Bakke and Whited, 2012). Therefore, when a firm has difficulty raising finance from the capital market, the pension contributions' squeezing effect on internal cash resources will be more striking. Finally, firms have more incentive to increase cash reserves for the subsequent pension contributions.

To test our hypothesis, we first need to measure a firm's financial position. The proxies used to measure firms' financial positions are the HP-index (Hadlock and Pierce, 2010) and the WW-index (Whited and Wu, 2006). To measure a firm's financial position pre- and post-decision of cash reserving, these finally used proxies for time t are the average value of time t and t-1. The details of proxies' construction are introduced in the data section. After obtaining the proxies for the firm's financial position, we sort the proxies in ascending order each year. The top 30% of observations are regarded as severely financially constrained, and the bottom 30% have no financial constraints. Then, we form two sub-samples: the first

one is composed of financially constrained firms, and the second one is composed of financially non-constrained firms. We run our basic regression with excess cash holding as the dependent variable in two sub-samples in the final step. The regression results are shown in table 5.4.

[Insert Table 5.4 Here]

Columns (1) and (2) of table 5.4 show the regression results with financial constraints measured by the WW index. In the first two columns, we find that the low funding status dummy variable (Lfs) coefficient is only statistically significant for financially constrained firms. This result suggests that precautionary cash reserving will not be necessary for the manager's consideration if firms can quickly raise finance from the capital market. We also find the other contemporary cash expenditure activities affect final excess cash holding only for financially non-constrained firms, like paying dividends to shareholders ($Pay_{i,t}$) or investments ($Capx_{i,t}$). Accounting numbers calculate these two variables and mainly aim to provide recent historical financial information. So, the excess cash holding is primarily motivated by predicated future conditions for financially constrained firms. This evidence further demonstrates that firms increase excess cash holding resulting from precautionary motives for the subsequent pension contributions.

5.5.3 The value of excess cash holding

While the precautionary cash holding attributed to funding pension contribution can reduce a firm's risk, the increase in excess cash holding may not align with shareholders' interest. In this section, we discuss how investors value the firm's excess cash holding.

The "value of cash" has been well discussed in extant literature (Dittmar, Mahrt-Smith and Servaes, 2003; Faulkender and Wang, 2006; Pinkowitz, Stulz and Williamson, 2006; Dittmar and Mahrt-Smith, 2007). Faulkender and Wang (2006) argue that a firm's cash holding policy follows a continued strategy, so the cash holding in the prior fiscal year is the best proxy for estimating the cash holding during the current fiscal year. Consequently, the variation in cash holdings is an

unexpected shock for the market. The cumulative effect on abnormal stock returns can be regarded as the marginal value of cash holdings. However, the changes regression is not suitable for valuing excess cash holdings. The changes method is not straightforward to interpret a change in excess cash since this may be caused either by a change in total cash or a change in some of the optimal cash determinants. Dittmar and Mahrt-Smith (2007) employ a level regression to calculate the marginal value of a firm's excess cash holding. In this section, we follow Dittmar and Mahrt-Smith (2007)'s method and use a value regression akin to Fama and French (1998) to calculate the impact of the DB pension plans' funding status on excess cash reserves. The value regression model is shown below.

$$\begin{aligned}\frac{MV_{i,t}}{NA_{i,t}} =&\beta_1 + \beta_2\frac{E_{i,t}}{NA_{i,t}} + \beta_3\frac{d\,E_{i,t}}{NA_{i,t}} + \beta_4\frac{d\,E_{i,t+2}}{NA_{i,t}} + \beta_5\frac{RD_{i,t}}{NA_{i,t}} + \beta_6\frac{d\,RD_{i,t}}{NA_{i,t}} + \beta_7\frac{d\,RD_{i,t+2}}{NA_{i,t}} + \beta_8\frac{D_{i,t}}{NA_{i,t}} + \beta_9\frac{d\,D_{i,t}}{NA_{i,t}} \\ &+ \beta_{10}\frac{d\,D_{i,t+2}}{NA_{i,t}} + \beta_{11}\frac{I_{i,t}}{NA_{i,t}} + \beta_{12}\frac{d\,I_{i,t}}{NA_{i,t}} + \beta_{13}\frac{d\,I_{i,t+2}}{NA_{i,t}} + \beta_{14}\frac{d\,NA_{i,t}}{NA_{i,t}} + \beta_{15}\frac{d\,NA_{i,t+2}}{NA_{i,t}} + \beta_{16}\frac{d\,MV_{i,t+2}}{NA_{i,t}} \\ &+ \beta_{17}Fs\ Dum._{i,t} + \beta_{18}\frac{XCash_{i,t}}{NA_{i,t}} + \beta_{19}Fs\ Dum._{i,t} * \frac{XCash_{i,t}}{NA_{i,t}} + Yr\ Dum. + Firm\ Fixed\ Effects + \epsilon_{i,t},\end{aligned} \tag{5.2}$$

where $d\ X_t$ indicates a change in X from time t-2 to t and, Compustat codes in parentheses, $MV_{i,t}$ is the stock price ($PRCC_C$) times shares outstanding (CSHO) plus total liabilities (LT), $NA_{i,t}$ is net assets (AT-CHE) at time t, $E_{i,t}$ is earnings before extraordinary items (IB+XINT+TXDI+ITCI) from year t-1 to t,$RD_{i,t}$ is the R&D expenses (XRD), which equals zero if missing from year t-1 to t, $D_{i,t}$ is common dividends (DVC) from year t-1 to t, $I_{i,t}$ is interest expenses (15) from year t-1 to t, $XCash_{i,t}$ is excess cash at time t from appendix, $Fs\ Dum._{i,t}$ is the funding status dummy, Lfs and Hfs, with same definition before. The firm-fixed effect and year dummy variable are also included in the model. The regression results are shown below.

[Insert Table 5.5 Here]

Columns 2 and 3 show the regression results without pension-related variables. After including the pension funding status dummy, we find that the most severely underfunded pension plans reduce excess cash holding values[6]. We present this

[6] Chaudhry, Au Yong and Veld (2017) also find the investors value an additional dollar lower

phenomenon as investors expect that the excess cash holding will be used to fund the pension plans. So, the benefits being eventually allocated to employees reduce the market value of equity. Moreover, we find the value of excess cash holding is generally lower than those reported in previous studies (for example, Dittmar and Mahrt-Smith (2007)). Because our sample is only composed of firms sponsoring the DB pension plans, the excess cash holding will be partially used to cover the subsequent pension contributions. This finding further suggests that investors' expectations for using cash will determine cash reserving value.

5.6 Robustness test

In the main body of this paper, we define the most severely underfunded DB pension plans as the bottom 30% after annually sorting observations by pension plan funding status. This setting could retain an adequate amount of observations in the group of interest. To avoid potential bias from selecting criteria, we change the critical values for the interest groups and present the regression results with new standards. In our initial setting, the first group of interest is the firms sponsoring the most severely underfunded pension plan, which is proxied by a low funding status dummy (Lfs). This dummy variable equals one if a firm's funding status is located at the bottom 30%, zero otherwise. For the robustness of our conclusion, we change the critical value to 20% and 40%. Correspondingly, we change the crucial value for the firms sponsoring the least underfunded pension plan to 80% and 60% separately. The new regression results are shown below.

[Insert Table 5.6 Here]

The regression results are largely consistent with those presented in the main body of this chapter. The coefficients of excess cash holding on Lfs are 0.97 (t-value 3.35) and 0.62 (t-value 3.2) for new critical value, 20% and 40% separately. Comparing the value of coefficient on Lfs with original criterion 30%, we find the increasing impact on excess cash holding is more pronounced while firms are sponsoring a more

as pension deficit increases. They focused on the value of total cash holding and explained the reduction effect with managers' overinvestment.

severely underfunded pension plan. According to the robustness test results, we further confirm that the most severely underfunded firms increase their excess cash holdings in response to the subsequent pension contributions. It suggests that the main results are robust to choosing the critical value of the most severely underfunded pension plan.

5.7 Conclusion

This chapter analyses the interaction between a firm's cash holdings and pension plan funding status. Our evidence suggests that firms with severely underfunded DB pension plans tend to hold more excess cash in response to the subsequent mandatory pension contributions. Most importantly, the impact of the most severely underfunded pension plans on excess cash holdings depends on the firm's financial constraints. A financially constrained firm increases its excess cash holdings in response to an increasing mandatory pension contribution. In contrast, unconstrained firms do not find any causal relationship between pension plan funding status and excess cash holdings. The implication of financial constraints provides further evidence that holing higher excess cash is at the precautionary motive for the subsequent mandatory pension contributions. Due to easily raising finance from the capital market for financially unconstrained firms, they will have a weak incentive to hold a large amount of excess cash.

This chapter contributes to the extant literature in several critical dimensions. First, we further analysis the precautionary cash holding in response to subsequent pension contribution. We demonstrate that firms will increase excess cash holding for future cash pressure if they sponsor the most severely underfunded DB pension plans. Second, it provides evidence that a firm's pension plan is mainly associated with excess cash holdings instead of total cash holdings. As pension plans are non-operation activities, their funding status has weak implications on cash holdings used in daily operation and investment. Our evidence also suggests that precautionary cash holdings for subsequent pension contributions mainly result from the costly external fund-raising. Financial constraints play an important role in a firm's cash

holding policy. Finally, we also discuss how investors value the excess cash holding. We find that cash value is determined by how investors expect the usage of cash holdings by pension sponsoring firms.

We acknowledge that agency theory is important in this analysis since managers have a greater preference for cash because it not only reduces firms' risk but increases their discretion. This greater preference for cash can lead managers to place too much importance on the precautionary motive for holding cash. Therefore, agency problems and precautionary cash reserving can be thought of as substitutes. The optimal precautionary cash holdings in response to pension funding should equal the predicted mandatory pension contributions next year. The potential solution to eliminate the agency problem's impact is to consider the firm's governance. We leave it for our future research.

Table 5.1: The descriptive statistics of variables in Chapter 5

This table presents the summary statistics of variables used in chapter 5. The sample period is from 2008 to 2019. Panel A shows the statistics based on a complete sample. The total cash holding (ch) is the logarithm value of (CHE) deflated by the non-cash asset (AT-CHE). The excess cash holding (ex_c) is the firm's cash holding fitting model's residuals. The fitting model follows the introduction in Dittmar and Mahrt-Smith (2007)'s appendix. The funding status (Fs) is the difference between the projected benefit pension obligation (PBPRO) and the fair value of pension asset (PPLAO) deflated by the market value of equity in December of last year. $Size$ is the logarithm value of a firm's total asset (AT). Lev is the leverage which is calculated as total debt (DLTT+DLC) divided by book value of equity (SEQ). The book-to-market ratio of equity (BM) is the book value of the asset (SEQ+TXDB+ITCB-PREF) divided by the market value of equity in December of last year. The Pay is the firm's payout ratio (PRSTKC+DVC+DVP) divided by the income before extraordinary items (IB). $Wcap$ is the working capital (WCAP) divided by net asset (AT-CHE). $Capx$ is the capital expenditure (CAPX) divided by the net asset (AT-CHE). Panel B is the statistics based on a sub-sample composed of firms sponsoring the most severely underfunded DB pension plans. Panel C is the statistics based on a sub-sample composed of firms sponsoring the least severely underfunded DB pension plan.

Variable	N	Mean	q1	Median	q3
Panel A: full-sample					
ch	5311	-2.554	-3.316	-2.431	-1.712
ex_c	5311	-7.324	-12.757	-4.845	-2.572
Fs	5311	-0.059	-0.064	-0.020	-0.005
Size	5311	7.942	6.835	7.933	9.021
Lev	5311	1.426	0.314	0.674	1.298
BM	5311	0.617	0.284	0.476	0.773
Pay	5311	0.577	0.000	0.420	0.949
Wcap	5311	0.092	-0.003	0.078	0.182
Capx	5311	0.048	0.022	0.037	0.060
Panel B: sub-sample of low funding status (Lfs)					
ch	1482	-2.658	-3.342	-2.524	-1.884
ex_c	1482	-7.150	-12.757	-4.421	-2.669
Fs	1482	-0.176	-0.205	-0.121	-0.081
Size	1482	7.933	6.807	7.904	8.940
Lev	1482	2.113	0.430	0.920	1.999
BM	1482	0.784	0.355	0.617	0.988
Pay	1482	0.477	0.000	0.268	0.804
Wcap	1482	0.087	-0.006	0.074	0.176
Capx	1482	0.047	0.024	0.038	0.059
Panel C: sub-sample of high funding status (Hfs)					
ch	1380	-2.374	-3.171	-2.233	-1.418
ex_c	1380	-7.308	-12.757	-4.753	-2.476
Fs	1380	-0.006	-0.009	-0.005	-0.002
Size	1380	8.064	7.007	8.025	9.125
Lev	1380	1.108	0.245	0.589	1.192
BM	1380	0.443	0.230	0.364	0.569
Pay	1380	0.698	0.078	0.551	1.077
Wcap	1380	0.087	-0.007	0.080	0.165
Capx	1380	0.047	0.020	0.036	0.059

Table 5.2: Correlation matrix of variables in Chapter 5

This table presents the correlation coefficients for variables used in chapter 5. The sample period is from 2008 to 2019. The correlation coefficients in the upper diagonal are Spearman's rank correlation, and the correlation coefficients in the downside of the diagonal are Pearson correlation. All the bold value are significant at a 0.01 level. The total cash holding (ch) is the logarithm value of (CHE) deflated by the non-cash asset (AT-CHE). The excess cash holding (ex_c) is the firm's cash holding fitting model's residuals. The fitting model follows the introduction in Dittmar and Mahrt-Smith (2007)'s appendix. The funding status (Fs) is the difference between the projected benefit pension obligation (PBPRO) and the fair value of pension asset (PPLAO) deflated by the market value of equity in December of last year. *Size* is the logarithm value of a firm's total asset (AT). *Lev* is the financial leverage which is calculated as total debt (DLTT+DLC) divided by book value of equity (SEQ). The book-to-market ratio of equity is the book value of the asset (SEQ+TXDB+ITCB-PREF) divided by the market value of equity in December of last year. The *Pay* is the firm's payout ratio (PRSTKC+DVC+DVP) divided by the income before extraordinary items (IB). *Wcap* is the working capital (WCAP) divided by net asset (AT-CHE). *Capx* is the capital expenditure (CAPX) divided by the net asset (AT-CHE). Panel B is the statistics based on a sub-sample composed of firms sponsoring the most severely underfunded DB pension plans. Panel C is the statistics based on a sub-sample composed of firms sponsoring the least severely underfunded DB pension plan.

	ch	*ex_c*	Fs	Size	Lev	BM	Pay	Wcap	Capx
Panel A: full-sample analysis									
ch	1	**0.77**	**0.09**	**-0.14**	**-0.35**	**-0.15**	0.02	-0.01	**0.07**
ex_c	**0.68**	1	-0.01	**-0.1**	**-0.24**	**0.08**	**-0.04**	0.02	**0.08**
Fs	**0.09**	0.02	1	**-0.03**	**-0.2**	**-0.21**	**0.11**	-0.02	-0.01
Size	**-0.13**	**-0.05**	**0.04**	1	**0.36**	**-0.19**	**0.3**	**-0.44**	**-0.05**
Lev	**-0.14**	**-0.09**	**-0.17**	**0.12**	1	**-0.24**	0.02	**-0.34**	**-0.05**
BM	**-0.15**	**0.04**	**-0.29**	**-0.16**	**-0.13**	1	**-0.31**	**0.14**	0.01
Pay	0.008	**-0.04**	**0.05**	**0.13**	0.01	**-0.12**	1	**-0.1**	-0.02
Wcap	**-0.04**	0.01	-0.01	**-0.42**	**-0.2**	**0.08**	**-0.05**	1	**-0.09**
Capx	0.02	**0.05**	0.02	**-0.03**	0.01	**0.04**	**-0.05**	**-0.16**	1
Panel B: sub-sample of low pension plan funding status									
ch	1	**0.84**	**0.06**	-0.03	**-0.26**	**-0.18**	0.06	-0.05	0.03
ex_c	**0.74**	1	0.04	-0.04	**-0.17**	-0.05	0.02	-0.03	**0.07**
Fs	**0.11**	**0.07**	1	**0.09**	**-0.07**	**-0.25**	**0.2**	**-0.06**	0.01
Size	-0.01	0.01	**0.11**	1	**0.35**	**-0.2**	**0.3**	**-0.42**	-0.04
Lev	**-0.15**	**-0.06**	**-0.13**	**0.17**	1	**-0.28**	-0.06	**-0.28**	0.02
BM	**-0.16**	-0.04	**-0.32**	**-0.17**	**-0.18**	1	**-0.27**	**0.13**	-0.06
Pay	0.03	0.01	**0.07**	**0.13**	-0.01	**-0.09**	1	**-0.11**	0.02
Wcap	**-0.07**	-0.04	-0.05	**-0.42**	**-0.18**	**0.08**	-0.04	1	**-0.17**
Capx	-0.04	0.04	0.01	-0.01	0.05	-0.02	0.03	**-0.24**	1
Panel C: sub-sample of high pension plan funding status									
ch	1	**0.7**	0.01	**-0.19**	**-0.38**	**-0.17**	0.02	0.02	**0.12**
ex_c	**0.62**	1	-0.05	**-0.11**	**-0.26**	**0.14**	**-0.06**	0.05	**0.1**
Fs	-0.02	**-0.07**	1	-0.02	-0.02	**-0.16**	0.02	-0.03	0.02
Size	**-0.16**	**-0.06**	-0.01	1	**0.39**	**-0.15**	**0.25**	**-0.44**	**-0.08**
Lev	**-0.13**	**-0.13**	-0.03	**0.13**	1	**-0.27**	**0.09**	**-0.38**	**-0.14**
BM	**-0.15**	**0.1**	**-0.15**	**-0.13**	**-0.19**	1	**-0.28**	**0.15**	0.02
Pay	0.01	**-0.08**	0.02	**0.08**	0.04	**-0.15**	1	**-0.1**	-0.02
Wcap	-0.03	0.03	-0.02	**-0.43**	**-0.25**	**0.13**	-0.03	1	0.02
Capx	0.05	**0.08**	-0.01	-0.03	-0.05	**0.06**	**-0.07**	-0.05	1

Note: bold font represents significance: $p < 0.01$,

Table 5.3: The fundamental regression analysis

This table shows the results of fundamental regression. The sample period is from 2008 to 2019. The dependent variable for the first three columns is the firm's total cash holdings (ch), calculated as the natural logarithmic of cash (CHE) divided by the net assets ($AT - CHE$). The dependent variable for columns (4), (5) and (6) is excess cash holding (ex_c). The estimation of excess cash holding is introduced in Dittmar and Mahrt-Smith (2007)'s appendix and regarded as the residuals of optimal cash holding fitting model. The Lfs is a dummy variable used to represent the bottom 30% observations after sorting by annual pension plan funding status (Fs). Oppositely, the Hfs is a dummy variable used to describe the top 30% observations. The funding status (Fs) is the difference between the projected benefit pension obligation (PBPRO) and the fair value of pension asset (PPLAO) deflated by the market value of equity in December of last year. The $Size$ is the logarithm value of the firm's total asset (AT). Lev is the financial leverage which is calculated as total debt (DLTT+DLC) divided by book value of equity (SEQ). The book-to-market ratio of equity (BM) is the book value of the asset (SEQ+TXDB+ITCB-PREF) divided by the market value of equity in December of last year. The Pay is the firm's payout ratio (PRSTKC+DVC+DVP) divided by the income before extraordinary items (IB). $Wcap$ is the working capital (WCAP) divided by net asset (AT-CHE). $Capx$ is the capital expenditure (CAPX) divided by the net asset (AT-CHE). Our model also includes industry and year dummy variables. The fundamental regression model is,

$$\begin{aligned} ch_{i,t} \text{ or } ex\_c_{i,t} =& \beta_1 + \beta_2 * Fs_{i,t} + \beta_3 * Size_{i,t} + \beta_4 * Lev_{i,t} + \beta_5 * Bm_{i,t} + \beta_6 * Pay_{i,t} + \beta_7 * Wcap_{i,t} \\ &+ \beta_8 * Capx_{i,t} + \beta_9 * Fs\ Dum._{i,t} + Industry\ Dum. + Year\ Dum. + \epsilon_{i,t}. \end{aligned} \tag{5.3}$$

All variables used in regression analysis are winsorized at 1% and 99% separately, and the number in parentheses is t-statistics.

	$ch_{i,t}$			$ex\_c_{i,t}$		
	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	-2.41	-2.44	-2.38	-7.19	-7.04	-7.07
	(-15.19)	(-15.31)	(-15.06)	(-10.05)	(-9.79)	(-9.9)
Lfs	0.03			0.56		
	(0.78)			(2.82)		
Hfs		0.07			-0.15	
		(2.11)			(-1)	
$Fs_{i,t}$	0.54	0.37		2.46	1.14	
	(2.91)	(2.5)		(2.94)	(1.69)	
$Size_{i,t}$	-0.11	-0.11	-0.11	-0.11	-0.10	-0.11
	(-10.99)	(-11.02)	(-11.04)	(-2.41)	(-2.35)	(-2.4)
$Lev_{i,t}$	-0.05	-0.05	-0.06	-0.17	-0.17	-0.18
	(-9.39)	(-9.3)	(-10.2)	(-6.76)	(-6.71)	(-7.12)
$BM_{i,t}$	-0.31	-0.30	-0.33	0.24	0.24	0.20
	(-10.39)	(-10.07)	(-11.71)	(1.84)	(1.81)	(1.58)
$Pay_{i,t}$	0.01	0.01	0.01	-0.08	-0.08	-0.08
	(1.17)	(1.14)	(1.23)	(-1.93)	(-1.92)	(-1.91)
$Wcap_{i,t}$	-1.38	-1.39	-1.38	-0.71	-0.71	-0.72
	(-11.21)	(-11.26)	(-11.2)	(-1.27)	(-1.28)	(-1.3)
$Capx_{i,t}$	1.12	1.11	1.13	5.90	5.90	5.91
	(2.82)	(2.8)	(2.85)	(3.31)	(3.31)	(3.31)
$Industry$	Y	Y	Y	Y	Y	Y
$Year$	Y	Y	Y	Y	Y	Y
N	5311	5311	5311	5311	5311	5311
R^2	0.24	0.24	0.24	0.02	0.02	0.02

Table 5.4: The impact of firm's financial constraints status

We calculate two commonly used proxies that reflect whether firm is financially constrained. The WW index is introduced by Whited and Wu (2006). The calculation formula is:

$$WW = -0.091 * CF - 0.062 * DIVPOS + 0.021 * TLTD - 0.044 * LNTA + 0.102 * ISG - 0.035 * SG \quad (5.4)$$

Where CF is the ratio of cash flow to total assets (IB+DP)/AT. $DIVPOS$ is an indicator that takes the value of one of the firm pays cash dividends (DVC), zero otherwise. $TLTD$ is the ratio of the long-term debt to total assets (DLTT/AT). $LNTA$ is the natural log of total assets (AT). ISG is the firm's three-digit SIC industry sales growth, and SG is the firm's sales growth. All variables are deflated by the net asset (AT-CHE). The HP index is introduced by Hadlock and Pierce (2010) and the calculation formula is:

$$HP = 0.737 * Assets + 0.043 * Assets^2 - 0.040 * Age \quad (5.5)$$

Where assets are the logarithm value of inflation-adjusted book assets and capped at (the log value of) 4500 (million), age is the number of years a firm's data is available Compustat database and is capped at 37 years. The variables are inflation-adjusted by the CPI index and converted into real value of year 2008. To measure the firm's financial position over the time t, the proxy in time t is the average value of time t-1 and time t. After sorting the proxies annually, we define the top 30% firms are financially constrained (Fc). Oppositely, the firms situated in the bottom 30% are financially unconstrained (Non-Fc). The basic model including the Lfs dummy variable is analyzed at two sub-samples separately. The number in parentheses is the t-statistics value.

	WW index		HP index	
	Fc	Non-Fc	Fc	Non-Fc
	(1)	(2)	(3)	(4)
Intercept	-10.87	-8.33	-8.51	-6.13
	(-6.05)	(-4.85)	(-4.45)	(-3.37)
Lfs	0.91	0.34	0.88	0.43
	(2.05)	(0.77)	(2.10)	(0.95)
$Fs_{i,t}$	1.23	2.15	3.44	1.56
	(0.54)	(1.26)	(1.64)	(0.87)
$Size_{i,t}$	0.03	0.02	-0.15	-0.12
	(0.18)	(0.11)	(-0.94)	(-0.83)
$Lev_{i,t}$	-0.15	-0.29	0.01	-0.23
	(-2.57)	(-5.08)	(0.12)	(-3.54)
$BM_{i,t}$	0.10	0.48	0.12	0.14
	(0.26)	(1.92)	(0.33)	(0.54)
$Pay_{i,t}$	-0.05	-0.28	-0.04	-0.24
	(-0.59)	(-2.69)	(-0.49)	(-2.26)
$Wcap_{i,t}$	0.65	1.52	-0.54	0.14
	(0.42)	(1.52)	(-0.34)	(0.14)
$Capx_{i,t}$	5.69	8.85	5.35	5.45
	(1.41)	(2.34)	(1.33)	(1.48)
$Industry$	Y	Y	Y	Y
$Year$	Y	Y	Y	Y
N	1794	1792	1885	1792
R^2	0.09	0.09	0.07	0.07

Table 5.5: The marginal value of firm's excess cash holding

This table shows the results for the value regression. This model is estimated as fixed effects regression. The regression model is:

$$\begin{aligned}\frac{MV_{i,t}}{NA_{i,t}} =&\beta_1 + \beta_2\frac{E_{i,t}}{NA_{i,t}} + \beta_3\frac{d\,E_{i,t}}{NA_{i,t}} + \beta_4\frac{d\,E_{i,t+2}}{NA_{i,t}} + \beta_5\frac{RD_{i,t}}{NA_{i,t}} + \beta_6\frac{d\,RD_{i,t}}{NA_{i,t}} + \beta_7\frac{d\,RD_{i,t+2}}{NA_{i,t}} + \beta_8\frac{D_{i,t}}{NA_{i,t}} + \beta_9\frac{d\,D_{i,t}}{NA_{i,t}} \\ &+ \beta_{10}\frac{d\,D_{i,t+2}}{NA_{i,t}} + \beta_{11}\frac{I_{i,t}}{NA_{i,t}} + \beta_{12}\frac{d\,I_{i,t}}{NA_{i,t}} + \beta_{13}\frac{d\,I_{i,t+2}}{NA_{i,t}} + \beta_{14}\frac{d\,NA_{i,t}}{NA_{i,t}} + \beta_{15}\frac{d\,NA_{i,t+2}}{NA_{i,t}} + \beta_{16}\frac{d\,MV_{i,t+2}}{NA_{i,t}} \\ &+ \beta_{17}Fs\ Dum._{i,t} + \beta_{18}\frac{XCash_{i,t}}{NA_{i,t}} + \beta_{19}Fs\ Dum._{i,t} * \frac{XCash_{i,t}}{NA_{i,t}} + Yr\ Dum. + Firm\ Fixed\ Effects + \epsilon_{i,t},\end{aligned} \tag{5.6}$$

where $d\ X_t$ indicates a change in X from time t-2 to t and, Compustat item in parentheses, $MV_{i,t}$ is the stock price (PRCC$_C$)$times shares outstanding(CSHO) plus total liabilities(LT)$,NA$_{i,t}$ is net assets (AT-CHE) at time t, $E_{i,t}$ is earnings before extraordinary items (IB+XINT+TXDI+ITCI) from year t-1 to t,$RD_{i,t}$ is the R&D expenses (XRD), which equals zero if missing from year t-1 to t, $D_{i,t}$ is common dividends (DVC) from year t-1 to t, $I_{i,t}$ is interest expenses (XINT) from year t-1 to t, $XCash_{i,t}$ is excess cash at time t from appendix 7.3, $Fs\ Dum._{i,t}$ is the funding status dummy, Lfs and Hfs, with same definition before. All regressions include year dummies. The number in parentheses is the t-statistics value.

	Coef.	T-Value	Coef.	T-Value	Coef.	T-Value
$XCash_{i,t}/NA_{i,t}$	1.37	(9.16)	1.48	(9.43)	1.24	(7.51)
Lfs			-0.10	(-2.22)		
Lfs*$XCash_{i,t}/NA_{i,t}$			-0.93	(-2.41)		
Hfs					0.16	(4.85)
Hfs*$XCash_{i,t}/NA_{i,t}$					0.32	(1.14)
$E_{i,t}/NA_{i,t}$	1.73	(7.35)	1.66	(7.02)	1.69	(7.21)
$d\ E_{i,t}/NA_{i,t}$	-0.09	(-0.82)	-0.08	(-0.76)	-0.09	(-0.83)
$d\ E_{i,t+2}/NA_{i,t}$	0.18	(1.41)	0.19	(1.52)	0.15	(1.25)
$RD_{i,t}/NA_{i,t}$	8.12	(6.77)	8.12	(6.79)	8.02	(6.73)
$d\ RD_{i,t}/NA_{i,t}$	0.55	(0.37)	0.59	(0.4)	0.51	(0.34)
$d\ RD_{i,t+2}/NA_{i,t}$	1.64	(1.57)	1.64	(1.57)	1.6	(1.55)
$D_{i,t}/NA_{i,t}$	5.89	(6.34)	5.83	(6.3)	5.92	(6.42)
$d\ D_{i,t}/NA_{i,t}$	0.35	(0.54)	0.37	(0.57)	0.34	(0.54)
$d\ D_{i,t+2}/NA_{i,t}$	1.41	(2.06)	1.35	(1.98)	1.48	(2.18)
$I_{i,t}/NA_{i,t}$	-1.54	(-0.77)	-0.19	(-0.1)	-0.47	(-0.24)
$d\ I_{i,t}/NA_{i,t}$	-0.68	(-0.51)	-1.2	(-0.91)	-0.87	(-0.66)
$d\ I_{i,t+2}/NA_{i,t}$	-0.55	(-0.38)	-0.18	(-0.12)	-0.29	(-0.2)
$d\ NA_{i,t}/NA_{i,t}$	-0.09	(-1.73)	-0.08	(-1.57)	-0.09	(-1.85)
$d\ NA_{i,t+2}/NA_{i,t}$	-0.06	(-1.72)	-0.07	(-1.84)	-0.07	(-1.91)
$d\ MV_{i,t+2}/NA_{i,t}$	0.18	(11.64)	0.18	(11.73)	0.18	(11.76)
$Firm$	Y		Y		Y	
$Year$	Y		Y		Y	
N	2456		2456		2456	
R^2	0.60		0.62		0.62	

Table 5.6: The robustness test results

This table shows the results of the robustness test. We reset the critical value for two pension plan funding status dummies (Lfs and Hfs). The fundamental model is:

$$ch_{i,t} \text{ or } ex\_c_{i,t} = \beta_1 + \beta_2 * Fs_{i,t} + \beta_3 * Size_{i,t} + \beta_4 * Lev_{i,t} + \beta_5 * Bm_{i,t} + \beta_6 * Pay_{i,t} + \beta_7 * Wcap_{i,t} + \beta_8 * Capx_{i,t} + \beta_9 * Fs\ Dum._{i,t} + Industry\ Dum. + Year\ Dum. + \epsilon_{i,t}. \quad (5.7)$$

The first dependent variable is the firm's total cash holdings (ch), calculated as the natural logarithmic of cash (CHE) divided by the net assets ($AT - CHE$). Another dependent variable is the excess cash holding (ex_c). The estimation of excess cash holding is introduced in appendix 7.3. In columns (1), (2), (3) and (4), the dummy variable, Lfs (Hfs), equals one if the observation is located at the bottom 20% (top 20%). Otherwise, this dummy variable equals to zero. In columns (5), (6), (7) and (8), the critical value changes to 40%. The funding status (Fs) is the difference between the projected benefit pension obligation (PBPRO) and the fair value of pension asset (PPLAO) deflated by the market value of equity in December of last year. The $Size$ is the logarithm value of the firm's total asset (AT). Lev is the financial leverage which is calculated as total debt (DLTT+DLC) divided by book value of equity (SEQ). The book-to-market ratio of equity (BM) is the book value of the asset (SEQ+TXDB+ITCB-PREF) divided by the market value of equity in December of last year. The Pay is the firm's payout ratio (PRSTKC+DVC+DVP) divided by the income before extraordinary items (IB). $Wcap$ is the working capital (WCAP) divided by net asset (AT-CHE). $Capx$ is the capital expenditure (CAPX) divided by the net asset (AT-CHE). All regressions include industry and year dummies. The number in parentheses is the t-statistics value.

	$Lfs < 20\%, Hfs > 80\%$				$Lfs < 40\%, Hfs > 60\%$			
	ch	ex_ch	ch	ex_ch	ch	ex_ch	ch	ex_ch
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept	-2.40	-7.81	-2.40	-7.62	-2.41	-7.90	-2.43	-7.71
	(-15.15)	(-9.61)	(-15.11)	(-9.33)	(-15.19)	(-9.71)	(-15.24)	(-9.41)
Lfs	0.07	0.97			0.05	0.62		
	(1.29)	(3.35)			(1.28)	(3.20)		
Hfs			0.01	-0.48			0.05	-0.21
			(0.27)	(-2.63)			(1.61)	(-1.28)
$Fs_{i,t}$	0.64	3.58	0.44	1.47	0.57	2.64	0.38	1.37
	(3.12)	(3.40)	(3)	(1.94)	(3.31)	(2.97)	(2.53)	(1.76)
$Size_{i,t}$	-0.11	-0.10	-0.11	-0.10	-0.11	-0.11	-0.11	-0.10
	(-11.03)	(-2.09)	(-11)	(-2.04)	(-11.03)	(-2.1)	(-11.07)	(-1.97)
$Lev_{i,t}$	-0.05	-0.19	-0.05	-0.19	-0.05	-0.19	-0.05	-0.19
	(-9.38)	(-6.67)	(-9.34)	(-6.69)	(-9.39)	(-6.69)	(-9.29)	(-6.64)
$BM_{i,t}$	-0.30	0.31	-0.30	0.28	-0.31	0.29	-0.30	0.30
	(-10.33)	(2.02)	(-10.21)	(1.85)	(-10.35)	(1.94)	(-10.02)	(1.95)
$Pay_{i,t}$	0.01	-0.09	0.01	-0.09	0.01	-0.09	0.01	-0.09
	(1.17)	(-1.97)	(1.17)	(-1.92)	(1.19)	(-1.93)	(1.16)	(-1.96)
$Wcap_{i,t}$	-1.38	-0.80	-1.38	-0.79	-1.38	-0.81	-1.38	-0.80
	(-11.2)	(-1.26)	(-11.2)	(-1.24)	(-11.21)	(-1.28)	(-11.2)	(-1.26)
$Capx_{i,t}$	1.09	6.41	1.10	6.65	1.11	6.65	1.10	6.56
	(2.76)	(3.15)	(2.79)	(3.27)	(2.81)	(3.27)	(2.79)	(3.23)
$Industry$	Y	Y	Y	Y	Y	Y	Y	Y
$Year$	Y	Y	Y	Y	Y	Y	Y	Y
N	5311	5311	5311	5311	5311	5311	5311	5311
R^2	0.24	0.02	0.24	0.02	0.24	0.02	0.24	0.02

6. Conclusion

The corporate DB pension plans provide an experimental setting to examine the conflicts and interactions between various stakeholders. Despite the vast literature concerning the market reaction to enormous deficits in DB pension plans in finance and accounting research, there are many unanswered questions due to the changes in the economic environment, accounting rules and regulatory requirements.

6.1 Contributions

The DB pension plan sponsors are concerned with two primary financial issues: pension accounting and pension funding. This thesis contributes to the literature in these two aspects separately. Chapters one and two examine the value relevance of pension accounting. In chapter 3, I establish a relationship between the pension plans' funding status and the growth component embeds in equity price. My findings contribute to the stock market efficiency literature. Since the conventional accounting disclosure about pension information has some problems, whether the market is efficient enough to react pension information is an unsettled question. Some early researches provide evidence that stock price can reflect the pension plan's information, such as Feldstein and Seligman (1981) and Jin, Merton and Bodie (2006). In contrast, Coronado and Sharpe (2003), Coronado et al. (2008) and Franzoni and Marin (2006) argue that market misinterpret the footnotes disclosed pension information which is not recognized in balance sheet. My evidence shows that investors can utilize both recognized and disclosed pension information to evaluate a firm's future growth expectations. Although the conventional accounting measure might not fully reflect pension information, investors accept pension accounting

as the best available information source and reduce the growth expectation by a corresponding pension deficit.

In chapter 4, I examine the market reactions to available pension information disclosed in financial statements. This chapter contributes to the literature discussing whether pension accounting is transparent. Before the fiscal year 2006, sponsors recognized and reported pension information under the guidelines of SFAS No.87. This accounting standard requires the sponsor to record the accrued or prepaid pension cost on the balance sheet. For the severely underfunded DB pension plan, sponsors need to record a liability on a balance sheet equal to the excess of accumulated benefit obligation over pension assets. The pension plan's funding status measured by the difference between projected benefit obligation and pension asset is only disclosed in the footnotes. The prior literature provides vast evidence that investors misinterpret the off-balance-sheet pension information disclosure (Coronado and Sharpe, 2003; Coronado et al., 2008; Franzoni and Marin, 2006; Picconi, 2006). Regarding this issue, FASB issued SFAS No.158 as a reform of pension accounting. This statement requires an employer to recognize the funding status of a DB pension plan as an asset or liability in its statement of financial position and to recognize changes in that funded status in the year in which the changes occur through the comprehensive income of a business entity. Most importantly, the funded status measured by the difference between projected benefit obligation and pension asset is reported on the balance sheet as of the date of its year-end statement of financial position. After adopting SFAS No.158, the previously unrecognized pension liabilities will be reflected in the balance sheet. Therefore, more pension information probably increases the volatility of financial statements. My second chapter contributes the literature which examines the effect of SFAS No.158 on the value and credit relevance of pension information (Shaw, 2008; Yu, 2013). Based on the recent sample period, I find pension information's quality is associated with the magnitude of the pension deficit. The pension information is still not transparent enough for the most severely underfunded pension plans, and investors require extra risk compensation.

In chapter 5, I document that managers actively increase the excess cash

holding level with the precautionary motive for future pension funding pressure. My findings contribute to the growing literature that investigates the implications of short-term cash management on cash holdings motivation (Opler et al., 1999; Almeida, Campello and Weisbach, 2004; Bates, Kahle and Stulz, 2009; Sasaki, 2015). I employ the anticipated cash pressure caused by mandatory pension contribution to demonstrate that precautionary motives significantly determine the current cash holdings policy. In addition, this chapter also contributes the literature that examines the implications of pension policy on firms' financial policy. In the spirit of previous research (Rauh, 2006a; Campbell, Dhaliwal and Schwartz Jr, 2010), I employ the current pension plan's funding status as a proxy for the future pension contribution. According to my findings, although the severe current pension deficit will reduce the internally generated cash flow, the final excess cash holding will increase. My evidence shows that cash reserving benefits more for firms facing higher anticipated future pension contributions. Therefore, it demonstrates that managers will incorporate pension information into short-term cash management strategies.

6.2 Summary

This thesis consists of three main chapters. In chapter 3, I provide evidence that the growth component embeds in equity price is negatively related to pension deficit. According to the pension funding requirement, a current severe pension deficit indicates severer pension funding pressure in the future. Therefore, my evidence demonstrates that investors can anticipate the future implications caused by sponsoring a DB pension plan. Since the prior literature finds the investors can not fully understand the pension information disclosed in financial statements, it will be more accurate to explain my findings. Investors accept pension accounting as the best available information source and adjust the expected growth rate by corresponding. In addition, my results show that the extent to which DB pension deficits affect the predicted growth depends on a company's profitability, financial constraints and non-working cash holding positions, and the actuarial assumptions that the company applies.

In chapter 4, I revisit a topic that has been well discussed in prior literature: the implication of transparency of pension information disclosure on various stakeholders. Existing literature commonly employs the asset pricing theory to examine whether pension assets, liabilities and pension deficits can explain the subsequent stock returns and whether stock returns reflect the efficiency of pension information transformation. If the capital market is efficient and pension information is sufficiently transparent, the pension plan funding status should not explain the subsequent stock returns. In this chapter, I try to answer the questions from a different angle. I analyse how the capital market prices the risk induced by the defined benefit (DB) pension plans. I find the expected stock returns for sponsors with underfunded DB pension plans cannot be fully explained by conventional risk factor models, namely the Fama-French 6 factor model and the q-5 factor model. In particular, the results suggest that the unexplained expected stock returns are economically and significantly different from zero for the most severely underfunded plans. That is, investors require compensation for holding stocks of firms with the most severely underfunded pension plans. At the same time, the empirical evidence shows that firms with severely underfunded plans are exposed to severe information asymmetry. I attribute the excess stock returns to the asymmetric information between sponsoring firms and investors. I argue that the market has priced information risk associated with severely underfunded DB pension plans, while the factor models do not capture the information risk.

In chapter 5, I examine whether a pension plan's performance affects managers' cash management strategies. Since pension plans are non-operating activities, naturally, excess cash or non-working cash is a more relevant concept in this analysis. Consistent with this intuition, a firm's pension plan is mainly associated with excess cash holdings instead of total cash holdings. Furthermore, firms with the most severely underfunded DB pension plans tend to hold more excess cash in response to the subsequent mandatory pension contributions. Most importantly, the impact of the most severely underfunded pension plans on excess cash holdings depends on the firm's financial constraints. A financially constrained firm increases its excess cash holdings in response to an increasing mandatory pension contribution. In contrast, I

do not find any causal relationship between pension plan funding status and excess cash holdings for unconstrained firms. It suggests that precautionary cash holdings for subsequent pension contributions mainly result from the costly external fund-raising. The implication of financial constraints provides further evidence that holing higher excess cash is at the precautionary motive for the subsequent mandatory pension contributions. Finally, I find that cash value is determined by how investors expect the usage of cash holdings by pension sponsoring firms.

6.3 Limitations and Future research

The FASB states that disclosure of pension information may be a substitute for recognition only for sophisticated users but not for other users (SFAS No.87). This statement suggests the reactions to disclosed pension information vary across various financial statement users. For example, Yu (2013) examines whether institutional ownership affects the value relevance of disclosed versus recognised pension liabilities. Correspondingly, the sponsor firms' ownership structure plays a vital role in explaining the market reaction to disclosed pension information. Since the adoption of SFAS No.158, pension information is more transparent and easy to understand. However, the previously unrecognised pension liability will increase the volatility of pension accounting. Therefore, we assume the sophisticated financial statement users have a better understanding than other normal users. Further analysing the ownership structure of sponsoring firms is beyond the scope of this thesis. Whether the portion of institutional shareholders and the retail shareholders affect the conclusion in this thesis depends on future research.

Another noted issue is the potential endogeneity. When examining the implications of DB pension plans on equity price, market reaction or managers short-term management strategy, the pension plan's funding status measured by pension accounting items is the primary measurement variable. Firstly, managers have certain leeway to manipulate pension accounting. So, a further robustness test is necessary while examining the causality relationship between pension plan's funding status and the variable of interest. Secondly, as introduced by Franzoni and Marin (2006), the

market tends to slowly impound earnings news into prices, with negative information taking even longer to spread in the market. Therefore, the observed value relevance of pension information might result from prior pension information. In that case, the static OLS regression is not an appropriate research method. More test with a dynamic regression is necessary for future research.

7. The Appendix

7.1 Estimating the expected asset growth rate

The prior literature has provided many explanatory variables to predict firm's future investment. In this thesis, we employ the fitted value of growth of assets to expect future investment. Fama and French, 2006 describe the fitted value of forward asset growth rate, $AG\tau_{i,t} = (AT_{i,t+\tau}/AT_{i,t})^{1/\tau} - 1, \tau = 1, 2, 3.$, could give good picture for firm's expected investment comparing to the growth of equity value. We follow their regression specification to generate out-of-sample 1-, 2- and 3-year ahead asset growth rates.

$$\begin{aligned}\frac{\Delta A_{t+\tau}}{A_t} =& a_0 + \beta_1 ln\ \frac{B_t}{M_t} + \beta_2 ln\ MC_t + \beta_3 Neg_t + \beta_4 \frac{Y_t}{B_t} + \beta_5 \frac{-AC_t}{B_t} + \beta_6 \frac{AC_t}{B_t} + \beta_7 NoD_t + \beta_8 \frac{D_t}{B_t} + \beta_9 \frac{\Delta A_{t+\tau-1}}{A_{t-1}} \\ &+ \beta_{10} 1Yr_t + \beta_{11} 3Yr_t + \beta_{11} OH_t + \beta_{12} PT_t + \beta_{13} \frac{I_t}{B_t}, \tau = 1, 2, 3, and\ 5.\end{aligned} \tag{7.1}$$

where B_t is the book value of equity (CEQ), M_t is the stock price pershare at the end of fiscal year t, MC_t is the market capitalization at the end of fiscal year $(Prcc_f * CSHO)$, Neg_t is a dummy variable that is one for firms that have negative earnings for fiscal year t (zero otherwise) the log value of book-to-market ratio, log of market capitalization, a dummy variable for negative earnings, profitability measured by return on equity, both positive accruals-to-lagged book value and negative accruals-to-lagged book value ratios, investment $(\Delta AT_t/AT_{t-1})$, a dummy variable for companies that do not pay dividends, dividend-to-book equity ratio, the stock return for the year up to the end of fiscal year t $(1Yr_t)$, the two-year return for the years up to the end of fiscal year t-1 (2_3Yr_t), the I/B/E/S consensus forecast of earnings for the coming year, sampled at the end of fiscal year t scaled by book

value, the composite measure of firm strength used in Piotroski et al., 2000 and the probability of debt default ratio proposed in Ohlson, 1980.

We compute the average slopes of these explanatory variable from annual cross-section regression using past ten years' data. Then, we assume the estimated slopes of explanatory variables from past information carry forward to the future. So, we can compute the out-of-sample forecasts for firms' one-, two- and three-year ahead growth of assets according to the value of explanatory variables in current period.

7.2 The proxies for asymmetric information

The proxies for investors' opinion divergence used in this chapter is calculated based on the SAS program provided by WRDS Research Notes. The bid-ask spread (ba) is calculated as the difference between the bid and ask price scaled by their mean value, and it is filtered by the method of Chung and Zhang (2014), if the bid or ask price is zero, or calculated bid-ask spread is greater than 0.5, then deleted. The bid and ask price are collected from the CRSP database. For calculating the standardized unexplained volume (suv), we calculate the stock turnover ratio in the first step. For NYSE and AMEX common stocks, we calculate the market-wide turnover simply as the ratio of the sum of daily trading volume against the daily total outstanding: $sum(vol * cfacshr)/sum(shrout * cfacshr * 1000)$. For the NASDAQ common stock, the adjustment method follows Anderson and Dyl, 2005 : $turn = (date <= 01Jan1997) * 0.5 * turn + (date > 01Jan1997) * 0.62 * turn$. Then, the predicted value of the turnover ratio is computed by a 60-days rolling window regression with stock return as the exposure variable. After obtaining the predicted value of the turnover ratio, the standardized unexplained volume (suv) measure is $suv = (turn - predicted\_turn)/(root\ mean\ square\ errors)$. The calculation process keeps only those observations for which missing turnover values do not exceed 20% of the estimation window.

Moreover, we calculate two measures of analysts' forecast dispersion. In this thesis, we keep only the latest stock forecasts by an analyst in a given month. We keep only those records with the closest fiscal period end for a given (ticker, year, month, analyst forecast) combination. The monthly analysts forecast estimate will be carried forward to either the next estimate issue date or the date 105 days ahead or the next actual earnings announcement days, whichever comes sooner. The decision to carry the forecast forward for up to 105 days is based on the IBES methodology.[1] According to which if an estimate has not been updated for 105 days, it is filtered, footnoted and excluded from the consensus calculation.[2] This methodology helps

[1] See IBES Detailed Estimates Manual, page 19

[2] I/B/E/S uses 120 days for the cutoff of estimates for Q4, but we stick to 105 days as it is a more conservative approach

alleviate, albeit not eliminate, the issue of forecast staleness. The first measure (d1) is the standard deviation of all available analysts' forecasts in the prior month, scaled by the absolute value of the mean analysts' forecast. The second measure (d2) is the standard deviation of all available analysts' forecasts in the prior month, scaled by the firm's average monthly stock price. The number of available analysts' forecasts (na) is collected from the I/B/E/S database.

7.3 The excess cash holding

In this thesis, we define the residuals of the firm's cash holding determination equation as excess cash, which is introduced in Dittmar and Mahrt-Smith (2007)'s appendix. The firm's cash holding determination equation is:

$$\begin{aligned}\ln \frac{Cash_{i,t}}{NA_{i,t}} =& \beta_0 + \beta_1 \ln NA_{i,t} + \beta_2 \frac{FCF_{i,t}}{NA_{i,t}} + \beta_3 \frac{NWC_{i,t}}{NA_{i,t}} + \beta_4 Industry\ Sigma_{i,t} \\ &+ \beta_5 \frac{MV_{i,t}}{NA_{i,t}} + \gamma_6 \frac{RD_{i,t}}{NA_{i,t}} + \epsilon_{i,t},\end{aligned} \tag{7.2}$$

where (Compustat codes in parentheses): $Cash_{i,t}$= Cash and Equivalents (CHE) at time t, $NA_{i,t}$=Net Assets (AT – CHE) at time t, $FCF_{i,t}$=Operating Income (OIBDP) minus Interest (XINT) minus Taxes (TXT) over year t,$NWC_{i,t}$=Current Assets (ACT) minus Current Liabilities (LCT) minus Cash (CHE) at time t, $IndustrySigma_{i,t}$=industry average of prior 10 year standard deviation of $\frac{FCF}{NA}$, $MV_{i,t}$= Market Value at time t=Price (PRCC_C) times Shares (CSHO) plus total liabilities (LT) at time t, and $RD_{i,t}$=R&D expenditures (XRD), set to zero if missing, over year t.

We employ this model to fit the firm's cash holding in our sample period. Then, we define the difference between the actual cash holding and its fitted value as the excess cash holding, which is the residuals of the firm's cash holding determination equation. This proportion of cash holdings is not used in day-to-day operation and investment and hold most at the manager's discretion.

7.4 The estimation of firm's expected return

In Chapter 4, the firm's expected stock return is estimated based on the firm's characteristics. Green, Hand and Zhang (2017) test and identify the firm's characteristics which are used by prior literature to predict the firm's stock return, then select 94 firm characteristics which could provide significant and independent explanations about US one-month-ahead stock return. We select appropriate firm characteristics from 94 candidates to estimate firm's one-month-ahead expected return. For ensuring the significance and independence of explanatory variables, we calculate the variance inflation factor (VIF) and delete variables with VIF over 5, then the left firm characteristics are used to fit the firm's one-month-ahead stock return, all variables which are lower than 3-star significance are eliminated from the eventual sample. A subgroup composed of 26 variables is eventually selected to predict a firm's expected return in this chapter. The definition and referred paper of these variables are: *aeavol* (Lerman, Livnat and Mendenhall, 2008) is the average daily trading volume for 3 days around earnings announcement minus average daily volume for 1 month ending 2 weeks before earnings announcement divided by 1-month average daily volume. Earnings announcement day is collected from Compustat quarterly. *bm_ia* (Asness, Porter and Stevens, 2000) is the industry adjusted book-to-market ratio. *cash* (Palazzo, 2012) is the cash and cash equivalents divided by average total assets. cfp (Desai, Rajgopal and Venkatachalam, 2004) is the operating cash flows divided by fiscal-year-end market capitalization. *chatoia* (Soliman, 2008) is the 2-digit sic-fiscal-year mean-adjusted change in sales divided by average total assets. *chempia* (Asness, Porter and Stevens, 2000) is the industry-adjusted change in the number of employees. *chpmia* (Soliman, 2008) is the 2-digit sic-fiscal-year mean adjusted change in income before extraordinary items divided by sales. *chtx* (Thomas and Zhang, 2011) is the percentage change in total taxes from quarter t-4 to t. *idiovol* (Ali, Hwang and Trombley, 2003) is the standard deviation of residuals of weekly returns on weekly equal-weighted market returns for 3 years before month-end. *ill* (Amihud, 2002) is the average of daily (absolute return/dollar volume). *indmom* (Moskowitz and Grinblatt, 1999) is the equal-weighted average

industry 12-month returns. *mom*1*m* (Jegadeesh and Titman, 1993) is the 1-month cumulative return. *ms* (Mohanram, 2005) is the sum of 8 indicator variables for fundamental performance. *nanalyst* (Elgers, Lo and Pfeiffer Jr, 2001) is the number of analyst forecasts from the most recently available I/B/E/S summary files in the month prior to the month of portfolio formation. Nanalyst set to zero if not covered in the I/B/E/S summary file. *nincr* (Barth, Elliott and Finn, 1999) is the number of consecutive quarters (up to eight quarters) with an increase in earnings over the same quarter in the prior year. *pchcapx_ia* (Abarbanell and Bushee, 1998) is the 2-digit sic-fiscal-year mean adjusted change in capital expenditures. *pchsale_pchrect* (Abarbanell and Bushee, 1998) is the annual percent change in sales minus annual percent change in receivables. *roic* (Brown and Rowe, 2007) is the annual earnings before interest and taxes minus non-operating income divided by non-cash enterprise value. *rsup* (Kama, 2009) is the sales from quarter t minus sales from quarter t-4 divided by fiscal-quarter-end market capitalization. *sgr* (Lakonishok, Shleifer and Vishny, 1994) is the annual percent change in sales. *sp* (Barbee Jr, Mukherji and Raines, 1996) is the annual revenue divided by fiscal year-end market capitalization. *std_dolvol* (Chordia, Subrahmanyam and Anshuman, 2001) is the monthly standard deviation of daily dollar trading volume. *tang* (Almeida and Campello, 2007) is the cash holdings + 0.715*receivables + 0.547*inventory + 0.535*PPE/total assets. *turn* (Datar, Naik and Radcliffe, 1998) is the average monthly trading volume for the most recent 3 months scaled by the number of shares outstanding in the current month. *zerotrade* (Liu, 2006) is the turnover weighted number of zero trading days for the most recent 1 month.

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