ERASMUS UNIVERSITY ROTTERDAM
Erasmus School of Economics
Master Thesis Financial Economics

Freezes of defined benefit pension plans by U.S. corporations

Name student: Floris Mertens
Student ID number: 431473

Supervisor: prof. dr. O.W. Steenbeek
Second assessor: dr. A. Andonov

Date final version: 02-08-2017

ABSTRACT

Over the last decade, many U.S. corporations have frozen their DB pension plans and offer their (new) employees participation in DC pension plans. One heavily cited reason behind the shift is the significant increase in pension costs and risks to the employer. This study uses a comprehensive data set of plan sponsors that implemented a hard pension freeze in the period 2002-2015 to examine the characteristics of the freezing firms and to investigate the impact on firm performance in the years after the hard freeze. While poorer performance, lower discretionary spending, lower credit ratings, and higher leverage ratios seem to trigger hard freezes, low cash holdings appear to have no impact on the likelihood of implementing a hard freeze. With respect to firm performance after the implementation of the hard freeze, empirical evidence suggests that that profitability and cash holdings of financially constrained plan sponsors that implemented a hard freeze tend to increase more in the long-term relative to their industry peers. Also, after the hard freeze the leverage ratios of financially constrained plan sponsors appear to experience significant decreases relative to their industry peers. These results support arguments that plan sponsors who implement a hard pension freeze relieve themselves of the implicit promises made in DB pension plans.

ACKNOWLEDGEMENT

This research has been completed thanks to the feedback provided by my thesis supervisor prof. dr. O.W. Steenbeek. His thorough knowledge in the field of pensions and continuous availability helped me in writing this thesis successfully. Next to him, I would like to thank dr. A. Andonov for providing me with some very useful analytical knowledge that helped me to establish the results in this paper.

CONTENTS

1. Introduction

Pension funds are established to invest employees' retirement savings and provide pensions for employees when they retire. Pension funds represent the largest institutional investors in many nations. Willis Towers Watson (2016) study 19 major pension markets, which total $35,316 billion in pension assets and account for 80,0% of the GDP of these economies. One of the largest pension markets is the U.S. with 61.5% of total pension funds assets in the study. Due to their size, substantial changes in the pension fund industry have important implications for financial stability through the corporate and the household sector.

Traditionally, most U.S. corporations were offering their employees the opportunity to save for their retirement through a defined benefit (DB) pension plan. DB pension plans had enormous appeal to both employers and employees. On the employers' side, pension contributions are tax deductible and can be used as a source of tax shield for corporations. U.S. corporations were using the tax advantage of sponsoring DB pension plans to increase firm value. Shivdasani and Stefanescu (2010) find that the average value of tax shields from pension contributions is about one-third as large as the value of interest tax shields for firms with DB pension plans. In addition, the design of a DB contract has a competitive edge in attracting and retaining skilled workers. The employees, on the other hand, were facing low risks. Typically, the sponsor of a DB pension plan promises fixed retirement benefits for their employees while bearing all the risks. Furthermore, DB pension plans provided a tax friendly way for employees to save for their retirement. Despite the benefits for both employer and employees, many U.S. corporations have been shifting from DB pension plans to Defined Contribution (DC) pension plans in the recent decades. In the 1990s, assets in the private sector DB and DC pension plans were each around $2 trillion. By the end of 2010, DB pension plan assets in the private sector amounted to $2.5 trillion, compared to $3.8 trillion of DC pension plan assets (Rauh, Stefanescu, and Zeldes, 2013). Moreover, in 1980, pension plan participants covered by private sector DB pension plans were approximately 38 million, compared to roughly 20 million participants for DC pension plans. By the end of 2014, however, DB pension plans covered almost 38 million pension plan participants whereas DC pension plans covered more than 94 million pension plan participants (Department of Labor, 2016).

The shift from DB to DC pension plans in the private sector is the result of different factors. Aaronson and Coronado (2005) examined the relative importance of supply and demand factors that caused the shift from DB to DC pension plans. They conclude that

structural shifts in the labour market, such as changes in industry mix of employment and increasing labour mobility explain a large part of the overall shift in pension coverage. On the supply side, they find support for the theory that the increased pension costs and risks for employers have reduced the value of DB pension plans.

Due to the above-mentioned factors, many U.S. corporations consider terminating their existing DB pension plans. Terminating existing DB pension plans, however, is very costly for plan sponsors. Underfunded pension plans can only be terminated if the plan sponsor fills the pension plan with additional money to cover all the liabilities of the pension plan. And in case the pension plan is overfunded it is subject to a tax of 50% on the excess assets followed by corporate income tax (Rauh, Stefanescu, and Zeldes, 2013). Therefore, many U.S. corporate plan sponsors decided to freeze their DB pension plans and offer their (new) employees participation in DC pension plans (Atanasova & Hrazdil, 2010). Moreover, this shift is associated with the transfer of risks and responsibilities from employers to employees. More specifically, under DC pension plan coverage, employers must manage their own contribution levels, investments, and retirement distribution.

Although, the adverse effects of the decline in DB pensions plan coverage on employees retirement income have received widespread attention from academics, the existing literature provides little evidence on the impact of freezes on plan sponsors' performance. Several papers have attempted to examine whether DB plans freezes enhance shareholder value. However, these findings are inconclusive and prone to the challenges of identifying the exact moment in time when the information concerning the pension freeze was taken into account by investors. Meanwhile, other recent literature suggests that freezes of pension plans might actually be important for firm performance. For example, Rauh, Stefanescu, and Zelders (2013) analysed whether freezing of DB pension plans results in any cost savings related to the compensation costs for employees. They conclude that firms with frozen DB pension plans save on compensation costs in the short- and in the long-term. And Rauh (2006) studies the dependence of corporate investments on internal financial resources in a large sample. He argues that required contributions have a direct impact on a company's internal financial resources, and subsequently, if this firm is financially constrained, contribution requirements may also affect its ability to invest in new capital, conduct research and development (R&D), and make acquisitions. In line with these recent theories, this study tries to uncover the motivation behind the freezing decision and subsequently examine the impact of the freezes on firm performance. Accordingly, the research question in this paper is the following:

What are the characteristics of plan sponsors who implement a hard freeze and what is the impact on firm performance after the hard freeze?

So far, Munnell and Soto (2007) and Atanasova and Hrazdil (2010) are the only ones who carry out an analysis that combines both sponsor and plan level characteristics. The primary purpose of this study is to extend the existing literature and provide a more comprehensive understanding of DB pension plan freezes of U.S corporations.

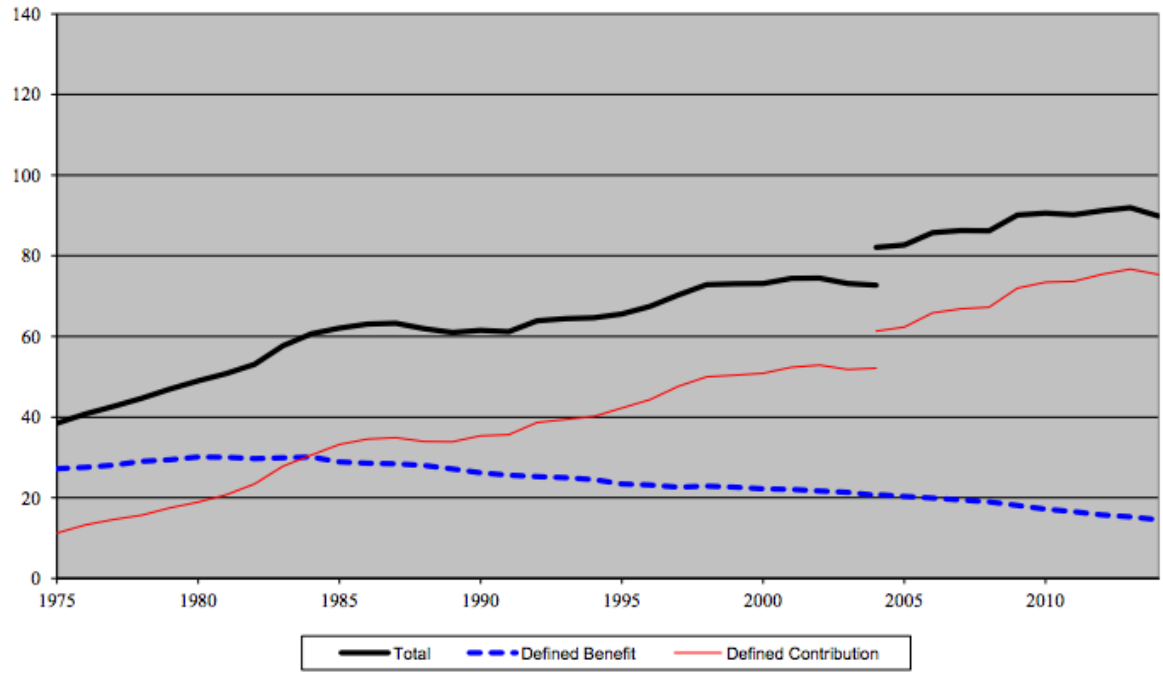
Information on plan level data is retrieved from Form 5500 filed by plan administrators with the Department of Labor (DOL), the Internal Revenue Service (IRS), and the Pension Benefit Guaranty Corporation for the period 2002 to 2015. Plan sponsor data is extracted from Compustat. The empirical results show that plan sponsors with relatively poorer performance and lower discretionary spending are more likely to implement a hard freeze. Furthermore, no evidence has been found to support the conjecture that low cash holdings trigger hard freezes. The opposite appears to be true: plan sponsors with relatively higher levels of cash holdings are more likely to implement a hard freeze. Lastly, plan sponsors with relatively higher leverage ratios and higher credit ratings (i.e. lower credibility) are more likely to implement a hard freeze. Taken together, it appears to be the case that hard freezes in the U.S. are motivated by poor performance and relatively high cash constraints. With regard to the impact of the hard freeze on firm performance in the years following the hard freeze, the findings in this paper suggest that plan sponsors relieve themselves of the implicit promises made in DB pension plans. In particular, this holds for financially constrained plan sponsors. More specifically, empirical evidence suggests that the profitability and the cash holdings of these financially constrained plan sponsors that implemented a hard freeze tend to increase more in the long-term relative to their industry peers. Also, after the hard freeze the leverage ratios of financially constrained plan sponsors appear to experience significant decreases relative to their industry peers.

The paper proceeds as follows. Section 2 provides background information on DB and DC pension plans, the recent trend towards DC pension plans, pension freezes in general, and the implications of freezing a DB pension plan. Section 3 introduces the different hypotheses. Section 4 describes the data and the methodology of the paper. Section 5 elaborates on the empirical results. Finally, section 6 summarizes and concludes the paper.

2. Institutional setting

U.S. employers may offer their employees pension provision through different mechanisms. Employees who work in state and local governments are covered by public pensions plans, whereas employees who work for companies are covered by private pension plans. This study elaborates on the second group. The U.S. private pension system consists of two different pension designs: occupational-voluntary and personal-voluntary. As the name suggests, the latter design is more individual based whereas the former design offers a more complementary pension plan for employees (OECD, 2008). The most common types of occupational-voluntary private pension contracts are DB pension plans, DC pension plans, and hybrid pension plans. As shown in figure 1, the number of active participants[1] in any pension plan in the U.S. increased from around 44,5 million in 1975 to approximately 132 million in 2014. However, the composition of pension coverage changed dramatically. The dashed blue line shows that, while more than 25% of active participants in 1975 had a DB pension plan, only about 16% had a DB pension plan in 2014. In contrast, the number of active participants in DC pension plans increased substantially from almost 15% in 1975 to slightly more than 75% active participants in 2014.

Figure 1: Number of active participants in pension plans by type of pension plan, 1975-2014 (in millions).

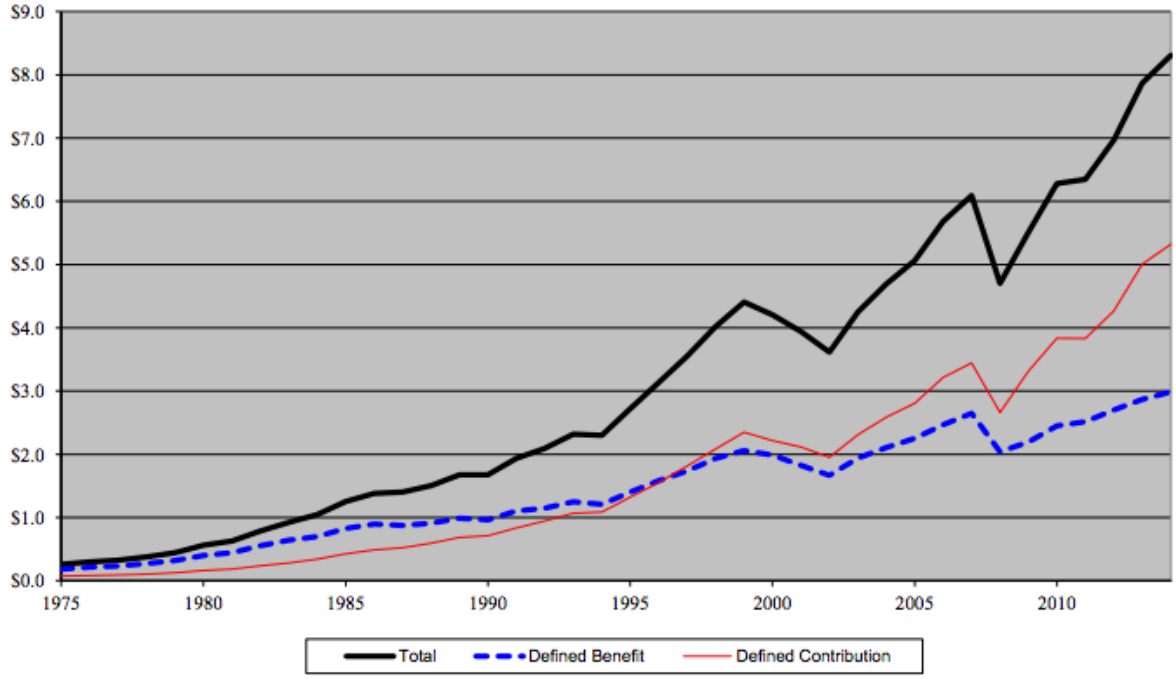


Source: Form 5500 filings with the U.S. Department of Labor.

[1] Active participants include any workers currently in employment covered by a pension plan and who are earning or retaining credited service under a pension plan.

Accordingly, figure 2 shows the pension plan assets by type of plan. Both types of pension plans experienced an increase in the value of assets in the period from 1975 to 2014. The share of DC pension plan assets, however, went up from 28% in 1975 to 64% in 2014.

Figure 2: Pension plan assets by type of pension plan, 1975-2014 (amounts in trillions).



Source: Form 5500 filings with the U.S. Department of Labor.

Any employer, industry association, labor union or some other professional organization can sponsor both DB and DC pension plans. Both types also offer tax advantages to encourage sponsorship and participation, economies of scale on the investment costs, and the opportunity to overcome possible self-control problems of individuals regarding saving. Despite off many common elements there are important differences between traditional DB and DC pension plans. In order to understand why DC pension plans have increased in prevalence while DB pension plans have declined, it is useful to outline the fundamental differences between DB and DC pension plans. It is also relevant to keep in mind that traditionally employer sponsored pensions were designed around DB pension plans. Thus, framing the comparison by asking which features of traditional DB pensions plans retain and which they eschew makes sense here. Section 2.1 and 2.2 will describe the differences between DB and DC pension plans. Subsequently, section 2.3 will elaborate on the shift away from DB pension plans, and finally section 2.4 will explain the implications of the shift.

2.1 Defined Benefit Pension Plans

In a traditional DB pension plan, the plan sponsor promises fixed (monthly) retirement income to their employees starting from the date of retirement until their death (or in some cases until the death of their spouse). The promised retirement income is based on a formula that considers factors, such as employee's salary, years of service at the sponsoring firm, and age. The most common type of formula is based on final salary. In such a DB pension plan, the employee earns a unit of pension, expressed as a percentage of their final salary, for each year of service. This implies that employees in DB pension plans accrue few benefits early in their careers and the value of their benefits accelerates after many years of service. This is often referred to as "back-loading". The replacement rate or the expected retirement income relative to the pre-retirement gross earnings in such a final salary DB pension plan is on average 60%-70% (Broadbent et al., 2006).

Table 1 presents the distribution of risk between employer and employee. Employers bear the investment risk; the risk that the actual returns on the assets set aside are not sufficient to meet the pension liability or the promised retirement. Employers also face longevity risk because they guarantee lifetime fixed retirement income. Hence, in case the beneficiary lives longer than expected, companies are exposed to the risk of higher than expected payout ratios. Employees, on the other hand, typically bear the inflation risk, because DB pension plans generally do not adjust the pensions to inflation. Another important risk borne by the employee under a DB pension plans is the risk that future benefit accruals will be reduced or eliminated (Rauh, Stefanescu, and Zeldes, 2013). As mentioned earlier, most of the retirement income is accrued just before retirement, therefore pension freezes, plan sponsor insolvency, job change or changes in the computation of retirement payments will result in pension "shortfalls[2]".

[2] The term pension shortfall refers to a situation where the employee receives much lower than expected retirement income.

Table 1: Risk distribution in a DB pension plan.

Type of risk	**Who assumes it?**
Investment	Employer
Inflation	Employee / Employer
Longevity	Employer
Market timing (temporal)	Employer
Accrual (portability)	Employee
Vesting	Employee
Employer insolvency	Employee / Taxpayers
Salary replacement risk	Employer

Source: Broadbent et al. (2006).

2.2 Defined Contribution Pension Plans

In a DC pension plan, a certain amount is set a side each year, the pension contribution, to accrue future retirement benefits for the employee. The amount set a side each year is usually based on a fixed percentage of the employee salary and is often matched[3] by the employer (Broadbent et al., 2006). Also, because of these fixed contributions, there is a very different pattern of benefit accrual over the course of an employee's career compared to DB pensions; DC pension plan benefits accrue more constant over time (Aaronson & Coronado, 2005). However, the retirement income that will be provided at retirement age is unknown and depends on the amount of contributions made and the generated returns on these contributions. So, unlike DB pension plans, the contributions rather than the benefits are fixed. Furthermore, the DC pension plan assets fully belong to the employee. The differences in the design of DC pension plans have important implications for the distribution of risk between employer and employees, as can be seen in table 2.

Because the employee owns the plan assets, he is fully responsible for the investment and longevity risks. The employee has to make difficult investment decisions by himself, and severe market downturns could substantially reduce his assets. In that case, the employee would not be able to claim prespecified, indefinitely retirement benefits in contrast to DB pension plans, and thus has to accept a lower retirement income. On the other hand, the fact that the plan assets are fully controlled by the employee imply that he may be able to transfer the assets to a new employer's plan or transfer the assets to an individual retirement plan. In

[3] The term matching contribution refers to a matching dollar amount contributed by the employer to the retirement saving plan of an employee.

addition, the portability of the assets removes the risk of employer insolvency. Thus, in a DC pension plan, the responsibilities of the employer basically end after they have matched the contribution. However, they may face potential lawsuits in case the retirement income from the DC pension fund is not sufficient (Broadbent et al., 2006).

Table 2: Risk distribution in a DC pension plan.

Type of risk	**Who assumes it?**
Investment	Employee
Inflation	Employee
Longevity	Employee
Market timing (temporal)	Employee
Accrual (portability)	DC plans are portable
Vesting	Employee
Employer insolvency	DC plans always fully funded
Salary replacement risk	Employee
Fiduciary / legal risk	Employer

Source: Broadbent et al. (2006).

2.3 Reasons for the shift

Private sector pension plans (DB and DC) are mostly voluntarily, and employee demand and employers willingness to offer these plans are influenced by multiple factors. For this reason, there exist no single theory to explain the recent shift from DB to DC pension plans. In contrast, the shift is influenced by a wide variety of factors, such as the increasing labor mobility, and the increasing risks and costs for employers.

2.3.1 Labor mobility

One heavily cited reason behind the shift is the increase in labor mobility. The value of a DB pension is highly dependent on the probability of remaining on the job, because of the "back loading" characteristic of a DB pension plan. Increasing labor mobility lowers benefit accruals for employees who switch between jobs and thereby increases the demand for a more flexible pension plan. Coronado and Copeland (2004) also found evidence for this negative correlation between labor mobility and the use of DB pension plans. They state that in competitive industries with younger, and more mobile workers, significantly more sponsoring

firms converted their traditional DB pension plans into hybrid pension plans[4]. According to Aaronson and Coronado (2005), the entry of women to the labor force is an important factor for the increase in labor mobility. They argue that the increase in the share of female workers resulted in more workers who are caring for children or elderly parents. Subsequently, these caregivers are less attached to the labor market because they have to balance their demand for home production with their labor supply. Should, such a caregiver leave the labor force for a period, a DC pension plan would be more attractive because benefits in these types of plans accrue more evenly throughout their career and are entirely portable. Moreover, the increase in the share of women in the labor force has also led to an increase in dual-earner households. Dual-earner household may also lead to greater job mobility (and thus an increased demand for more flexible pension plans), since changes in the employment situation of one spouse may require a change in the employment of the other. Besides changes in the demographic composition of the labor force, the nature of the industry has also changed dramatically over the past decades. Large unionized, capital-intensive industries, where DB pension plans were the standard, were decreasing, and technological changes resulted in fast growing "high-tech" companies and non-unionized, small companies in the service sector whom both increased worker mobility.

2.3.2 Increasing risks and costs for employees

Besides changes on the demand side there are also factors affecting the employers' willingness to offer DB pension plans. The Employee Retirement Income Security Act of 1974 (ERISA) for example imposed standards for funding ratios and required plan sponsors to pay premiums to the Pension Benefit Guaranty Corporation (PBGC). Both standards were introduced to protect employees, but had an adverse effect on the costs of offering DB pension plans. Also, over the course of the years these funding standards became tighter and congress repeatedly raised PBGC premiums (Munnell & Soto, 2007). Furthermore, in response to the growing deficit of the PBGC and the default of several large DB pension plans; the Bush Administration came with the Pension Protection Act of 2006. The most important change under these new regulations involves the rules governing the funding of DB pension plans. Minimum funding ratios were increased from 90% to 100%, and any funding shortfall must be amortized over a seven-year period instead of over a thirty-years period. Also, in previous years, plan sponsors were allowed to use a four-years average interest rates

[4] Hybrid pension plans combine features of DB and DC pension plans, and are often referred to as cash balance plans. Coronado and Copeland (2004) assume that these hybrid pension plans, in critical ways, are like DC plans, and thus can be used in analysing the broader trend toward DC pension plans.

to calculate current pension liabilities and asset values could be averaged over five years. With the introduction of the Pension Protection Act of 2006, plan sponsors were no longer allowed to smooth funding values. Under the new legislation a more mark-to-market method[5] was required were the present value of plan liabilities are calculated by specified mortality rates and long-term corporate bond interest rates, and asset values are based upon current market values (Munnell and Soto, 2007). This new approach has led to more accurate values of plan assets and liabilities but at the same time this new regulation increased the funding ratio volatility for plan sponsors substantially. More specifically, plan sponsors were facing the "perfect storm" of declining stock markets and extremely low interest rates in the 21st century. The declining interest rates were boosting pension funds liabilities and most pension funds had risky positions in equities that worked well in the 1990s but caused huge losses during the financial crisis. In the years after the financial crisis, however, equity markets recovered and U.S stocks climbed to record highs. Interest rates, on the other hand remained historically low and as a result of the mark-to-market approach the current market value of pension plan assets is now often less than the present value of the liabilities. In that case many pension funds are now considered underfunded. Plan sponsors are then required by law to make additional contributions to bring funding back up to acceptable levels. Thus, due to the increased volatility in funding ratios, the timing of contributions is now less predictable and subsequently puts more risks on the financial resources of plan sponsors.

In addition, in an attempt to bring U.S. accounting standards more in line with international standards, employers also faced reporting changes. More specifically, the Financial Accounting Standards Board (FASB) introduced new accounting rules concerning the recognition and the disclosure of the overfunded or underfunded status of a DB pension plan in the financial statements of the plan sponsor. In short, as a result of these new accounting standards some liabilities were moved onto the balance sheets that were previously off the balance sheet (Rauh, Stefanescu, and Zeldes, 2013). Previous literature has shown that the sponsoring of pension plans can have important implications for the capital structure of the corporate plan sponsor. For example, Shivdasani and Stefanescu (2010) find that when sponsoring corporations show pension assets and liabilities on their balance sheets, they seem to follow less conservative financial policies. Another interesting result comes from Jin, Merton, and Bodie (2006), according to them; the risk of a firm's equity reflects the risk of its pension plan. In other words the cost of capital of a plan sponsor reflects the

[5] Measuring the value of an account based using the current market value (or fair value) rather than historical costs (or book values).

presence of the pension plan. Thus, the impact of legislative changes not only increased the costs of administering the plans but also lead investors to assess the firm as more risky which could lead to a higher cost of capital.

Finally, the actual costs of funding a DB pension plan began to rise for the employer. Life expectancy has increased considerably in recent decades and in a DB pension plan benefits are paid out as a life annuity. So, if workers live longer, these lifetime annuities become increasingly expensive because the post-retirement period has lengthened. On the other hand, increased longevity also increased the level of accrued benefits. In theory, plan sponsors could adjust the pension contract in response to the increased life expectancy, and the increased risks and costs caused by changes in legislation and economics conditions. Employers could for example offset the effect of the rise in life expectancy by increasing the retirement age. In practice, however, it is difficult or even impossible for employers to adjust the DB pension contracts due to regulatory constraints, litigation risk, and the impact on employee morale (Broadbent et al., 2006).

2.4 Implications of the shift

Facing all the above-mentioned challenges, DB pension plans become an important source of risk for employers and therefore became less attractive. Termination of a DB pension plan, however, is often very costly and difficult. Firstly, plan sponsors who want to terminate their pension plans are required to immediately vest all benefits promised to their employees. Immediately vesting the promised benefits requires plan sponsors to either purchase an annuity or provide a lump-sum payment. If pension plans are underfunded, this implies that the plan sponsor has to come up with additional money to cover the liabilities of the pension plan. Moreover, even for fully funded pension plans, the historically low interest rates make either purchasing an annuity or providing a lump-sum payment extremely expensive (Munnell & Soto, 2007). On top of that, the excess assets available to the plan sponsors are subject to an excise tax of 50% followed by the usual corporate income tax (Rauh, Stefanescu, and Zeldes, 2013). Secondly, only plan sponsors who filed for bankruptcy can transfer their liabilities to the Pension Benefit Guaranty Corporation (PBGC). Plan sponsors obviously do not prefer the latter.

Thus, in order to get rid of the expensive and risky DB pension plans, most U.S. plan sponsors decided to “freeze” rather than terminating their pension plans. Simply put, a pension freeze means that plan sponsors stop allowing new benefit accruals; the pension benefits already earned will not disappear. The number of active participants in the pension

plan will then decline slowly and without new participants, the pension plan will eventually terminate. Firms with frozen pension plans are still subject to the same regulation as any other firm that offers a DB pension plan, and in contrast to the termination of pension plan, firms are free to freeze their pension plan at any time to avoid any future pension accruals. There is only one exception and this concerns pension plans for employees covered by collective bargaining agreements. In this case, the employer must negotiate any proposed change with the union first (Munnell & Soto, 2007).

In practice, there are several types of freezes. Common to all is that new employees are no longer allowed to participate in the DB pension plan. Instead, employers offer these new employees participation in other arrangements such as DC pension plans. What will happen with employees who already participate in the DB pension plan categorizes the types of freezes. A "hard freeze[6]" stops the additional pension benefit accrual of all current participants. Already earned pension benefits will not grow anymore and will retain the same value as at the time of the pension freeze. Hence, additional years of service or salary increases will not affect the retirement income of the employee. Under a "soft freeze", current participants are only allowed to accrue additional pension benefits for salary increases. Similar to a hard freeze, additional years of service have no impact on pension benefits under a soft freeze. Finally, plan sponsors can freeze their pension plan under a "closed freeze". Current participants are then allowed to continue new benefit accruals as in the previous situation, but new employees are no longer allowed to participate in the pension plan (Munnell & Soto, 2007).

According to Willis Towers Watson (2016) who studies Fortune 500 companies in the period 1998-2015, 17% of plan sponsors had frozen[7] their DB pension plans in 2008. In the years after the financial crisis pension freezes have risen significantly. By 2014, plan sponsors with a frozen DB pension plan outnumbered those with an open plan for the first time since 1998. And in 2015, 39% of all Fortune 500 plan sponsors who offered a DB pension plan in 1998 had frozen their pension plan and 24% had closed their pension plan for new employees (i.e. closed freeze). The Pension Benefit Guaranty Corporation (PBGC, 2005) also analysed pension freezes of PGBC-insured single-employer[8] plans. Based on Form 5500 filings in 2003-2005, they find that 14.1% of pension plans were hard frozen in 2005. They also find a

[6] This study will only focus on hard freezes.
[7] According to Willis Towers Watson (2016), frozen DB pension plans refer to either "hard" or "soft" frozen pension plans.
[8] A single-employer plan is only available to participants from one specific employer. In contrast, a multi-employer plan has participants from multiple employers.

negative correlation between plan sizes and hard freezes, indicating that smaller pension plans are more likely to implement a hard freeze. Furthermore, the study concludes that the funding ratios of hard-frozen pension plans are worse than the funding ratios of those pension plans that have not been frozen. In the period 2003-2005, unfrozen plans were on average approximately twice as likely as hard-frozen plans to be fully funded.

Employers may benefit from freezing their pension plan in several ways. First, because constraining the growth of pension benefits reduces the firm's risks and pension costs. In a hard freeze, additional years of service by employees do not increase the firm's pension liability, and in a soft or closed freeze the firm's pension liability increases much more slowly than otherwise. Secondly, the firm is no longer reliable for the expected future benefits that were included in the pension liability previously. This leads to a direct reduction of the pension liability and may subsequently improve the funding status of the plan. Finally, plan sponsors benefit from more flexibility concerning future benefit payments. The gradual decline of active participants and the eventual termination of the pension plan have given sponsors time to improve the funding ratio of their pension plans. The plan's assets could grow at a faster rate than the frozen plan liability or interest rates could rise again resulting in lower pension liabilities. Both events clearly have the potential to resolve the underfunding problem over time without requiring additional contributions from the firm (Comprix & Muller, 2011).

From the employee perspective, the freeze of pension benefit accruals reduces retirement benefits. Even though, most employers have introduced a DC pension plan to offset these reductions, the net impact of the pension freeze and the participation into the new DC pension plan could be substantial for some employees. Friedberg and Webb (2005) argue that employees with DC pension contracts retire almost two years later than employees with DB pension contracts because of these reduced retirement benefits. Table 3 shows the replacement rates under a DB pension plan with an accrual rate of 1.5% for every year of service, and under a 401(k)[9] plan with a contribution rate of 6% and a 3% match by the employer. Suppose an employee who joins the firm's DB pension plan at an age of 35. By the age of 50 the employer freezes the DB pension plan and the employee is offered participation into the 401(k) plan. At the age of 62, the employee would now receive 13% of final pay from the DB pension plan and 15% from the new 401(k) plan. Thus, the total replacement rate after the freeze is 28%, whereas the total replacement rate without the freeze would have been

[9] A 401(k) plan is the most popular form of a DC pension plan in the Unites States.

43%. Alternatively, suppose that for the same employee, who retires at 62, the DB pension plan had been frozen at the age of 40. In this case, the employee receives 3% of final pay from the DB pension plan and 33% from the 401(k) plan. The total replacement rate of 36% would have been higher than the 28% replacement rate in the previous case; however, the employee would still receive fewer benefits than without the freeze. These examples show that mid-career employees suffer the most from a pension freeze. Relatively young employees, and employees who are near their retirement age do not face significant changes in their replacement rates (Munnell & Soto, 2007). This can be attributed to the fact that DB pension wealth accumulates slowly early in the beginning of the employees' careers and accelerates after many years of service. Friedberg and Webb (2005) show that the consequences on pension benefit accruals caused by the shift to DC pension plans significantly affect the retirement age. They argue that employees with DB pension plans retire almost two years earlier, on average, than employees with DC pension plans.

Table 3: Replacement rates for DB and 401(k) plans by age of entry and exit.

Panel 1. Replacement Rate for a traditional DB pension plan						Panel 2. Replacement Rate for a 401(k) pension plan					
Exits plan at age	Enter plan at age					Exits plan at age	Enter plan at age				
	35	40	45	50	55		35	40	45	50	55
35	0%	0%	0%	0%	0%	35	1%	0%	0%	0%	0%
40	3%	0%	0%	0%	0%	40	5%	1%	0%	0%	0%
45	7%	4%	0%	0%	0%	45	11%	5%	1%	0%	0%
50	13%	9%	5%	0%	0%	50	18%	12%	6%	1%	0%
55	20%	16%	11%	6%	0%	55	27%	19%	12%	6%	1%
62	43%	35%	27	20%	12%	62	44%	33%	23%	15%	8%

Source: Munnell at al. (2006).

3. Hypothesis development

Given that one of the main reasons behind the fundamental shift away from DB pension plans are the increased risks and costs for employers. It is no surprise that the two driving forces behind employers' decision to freeze DB pension plan are often long-term cost savings and reductions in contribution volatility (Aon Hewitt, 2011; Mercer Human Resources Consulting, 2007). As can be seen in section 2.4, most employers, however, simultaneously offer their employees participation in other arrangements such as DC pension plans. These plans also require contributions from the employer. Thus, whether the employer actually reduces its costs depends partly on the magnitude of these new contributions. Rauh, Stefanescu, and Zeldes (2013) examine how much cost saving is realized by firms that freeze their DB pension plan by taking into account the increases in DC contributions. They conclude that firms save around 2.7-3.6% of payroll per year, and overall the freeze reduces the firm's costs by approximately 0.4% of total book assets in the first year, and 3.1% of total firm assets over 10 years. Consequently, one would expect that firms who are performing poorly have an incentive to implement a pension freeze. Consistent with this expectation, prior research shows that freezes do in fact improve underlying firm value. Specifically, Atanasova and Hrazdil (2010) find that plan sponsors who freeze their DB pension plans experience an increase in equity return in the next period. Rubin (2007) also finds evidence that freezes enhance firm value, although he argues that this relationship is lagged. Finally, Beaudoin et al. (2010) state that firm profitability, in terms of return on assets is significantly lower for firms that implement a pension freeze. This indicates that firms with lower profitability relative to assets are more likely to freeze their DB plans. These results also imply that poor financial performance generally may motivate a plan sponsor to freeze its DB pension plan. Accordingly, this study examines the following hypothesis:

- *H1: Plan sponsors with relatively poorer performance are more likely to implement a hard freeze.*

The extent to what plan sponsors are required to make financial contributions to their pension plans depends on the funding status of the pension plan. Plan sponsors with overfunded plans do not necessarily have to make pension contributions to their pension plans. They may choose to do so but beyond a certain full funding level additional pension contributions lose their favourable tax treatment. In case the pension plan is underfunded, the plan sponsor is required by law to make financial contributions to its pension plan according

to legally determined formulas. These required pension contributions might have a direct impact on a plan sponsor's internal financial resources. Moreover, previous literature has shown strong investment-cash flow sensitivities (e.g. Fazzari, Hubbard, and Petersen, 1988). Accordingly, these pension contributions may also affect the plan sponsor's ability to invest in new capital, conduct research and development (R&D), make dividend payments, make acquisitions etc. Rauh (2006) investigates the response of corporate expenditures to changes in internal financial resources. He uses the variation in required pension contributions as an instrument for the firm's internal financial resources and finds a strong and significant negative relationship between capital expenditures and required pension contributions. More specifically, $1 of mandatory pension contributions reduces capital expenditures by $0.60-$0.70. Moreover, this negative relationship is most obvious among plan sponsors that are more cash constrained or more dependent on external finance. When plan sponsors freeze their DB pension plans they can increase their liquidity level, and subsequently use the funds for corporate investments rather than for funding the gap between pension assets and liabilities. Consequently, the following two hypothesises are formulated:

- *H2 (a): Plan sponsors that are cash constrained are more likely to implement a hard freeze.*
- *H2 (b): Plan sponsors with relatively low investments are more likely to implement a hard freeze.*

Financial markets assign value to growth opportunities and this is reflected in the share price of a firm (Smit and Trigeorgis, 2004). The market to book ratio is often used as proxy to value these growth opportunities, where high market to book ratios reflect high growth opportunities and vice versa. Plan sponsors with financing constraints may face difficulties in translating growth opportunities into real firm value. In other words, they are unable to invest in the desired growth opportunities. Therefore, one would expect that financially constrained plan sponsors, with high values of growth opportunities (i.e. high market to book ratios) have incentives to freeze their pension plans in order to increase their cash flow. Accordingly, this leads to the next hypothesis:

- *H3: Financially constrained plan sponsors with high market to book ratios are more likely to implement a hard freeze.*

Furthermore, Rauh (2006) argues that plan sponsors in general do not increase borrowing in response to the cash constraints. Consistent with this finding, Shivdasani and Stefanescu (2010) also find lower leverage ratios for plan sponsors. The explanation behind these findings is the following. Empirical evidence suggests that a plan sponsor's cost of equity not only reflects the risk of its operating assets but also the risk of its pension plan (see e.g. Jin, Merton, and Bodie, 2006). Moreover, Carroll and Niehaus (1998) empirically examine the influence of excess pension assets and unfunded pension liabilities on credit ratings. They provide statistically evidence that excess pension assets and unfunded pension liabilities are asymmetrically associated with credit ratings. This indicates that an increase in unfunded pension liabilities has a larger impact on credit ratings than an identical increase in excess pension assets. Any plan sponsor of an underfunded pension plan must use some of its (corporate) assets to pay unfunded liabilities; this decreases the assets available to other creditors and thus increases the likelihood of a default on these claims. Simultaneously, the plan sponsor's credit rating will deteriorate, and consequently the costs of debt financing increase.

In addition, according to Myers trade-off theory of capital structure (2003) the optimal financing mix that maximizes firm value (or minimizes the cost of financing) is represented as a trade-off between debt and equity. A firm's choice of how much debt financing it uses typically depends on the benefits (interest tax shields) and costs (financial distress) of debt financing. Interest payments on debt are tax deductible and using debt financing therefore creates a tax shield that enhances firm value. Since pension contributions up to a certain maximum are also tax deductible, they provide an important source of tax saving and this potentially lowers the advantages of debt financing. Shivdasani and Stefanescu (2010) find that the average value of tax shields from pension contributions is about one-third as large as the value of interest tax shields for firms with DB pension plans.

All together, plan sponsor's advantages of debt financing decrease due to the tax deductibility of pension contributions, whereas the costs of financial distress increase substantially due to the adverse effects of unfunded pension liabilities. Accordingly, one would expect that plan sponsors with high leverage ratios tend to freeze their pension plans in order to relieve financial pressure. More specifically, the pension freeze will reduce the pension liabilities and might subsequently improve the creditworthiness of the plan sponsor. Recent literature confirms this expectation. Atanasova and Hrazdil (2010) argue that a pension plan freeze has a positive impact on a plan sponsor's credit rating. In addition, Munnell and Soto (2007) find that plan sponsors with large credit balances are more likely to

freeze, and a plan sponsor's financial health (in terms of credit rating) is negatively correlated with the likelihood of implementing a freeze. These findings result in the fourth hypothesis:

- *H4: Plan sponsors with high leverage ratios are more likely to implement a hard freeze.*

Firms basically have two options to finance their corporate investments. They could either use internal financing (cash flow) or external financing (debt or equity) for their corporate investments. Internal funds are often cheaper than external funds because there are less information asymmetries and agency costs (Myers, 2003). For plan sponsors, however, both sources of financing are potentially constrained. Firstly, the cash flow position of plan sponsors is potentially constrained by the mandatory pension contributions[10]. The plan sponsor will likely choose to raise external funds instead. But the ability to use debt is also affected by these mandatory pension contributions and they substantially increase the costs of financial distress[11]. In addition, empirical evidence argues that a plan sponsor's cost of equity also reflects the risk of its pension plan (Jin, Merton, and Bodie, 2006), and this in turn may adversely affect equity financing. All these financing frictions for plan sponsors could subsequently distort their corporate investments decisions. They might have to reject projects that have a positive net present value because there is no cash available to use for the investments. Consistent with this rationale, Rauh (2006) finds evidence for a reduction in capital expenditures due to a reduction in the plan sponsor's cash flow position. The decline in liquidity of the plan sponsors is the result of mandatory pension contributions. Furthermore, Campbell, Dhaliwal, and Schwarz (2012), find that these reductions in cash flow increase the cost of capital. Both findings, however, are significantly stronger for firms that are more financially constrained. In accordance with this evidence, this research assumes that the impact of a hard pension freeze on firm performance is larger for financially constrained plan sponsors. Based on this reasoning the following hypotheses is formulated:

- *H5 (a): Financially constrained plan sponsors experience higher increases in their liquidity than less financially constrained plan sponsors after the hard freeze.*
- *H5 (b): Financially constrained plan sponsors experience higher increases in their investments than less financially constrained plan sponsors after the hard freeze.*

[10] See Rauh (2006) or hypothesis 3 for further explanation.
[11] See hypothesis 3 for further explanation.

The shift from DB pension plans to DC pension plan helps the plan sponsor to save on its pension costs (Stefanescu and Zeldes, 2013). In addition, the improved liquidity allows financially constrained plan sponsors to undertake profitable projects, which could not be undertaken previously. Both consequences could enhance firm profitability. This results in the following hypothesis:

- *H6: Financially constrained plan sponsors experience higher increases in their profitability than less financially constrained plan sponsors after the hard freeze.*

Also, after implementing a hard pension freeze, the plan sponsor is no longer reliable for the expected future retirement benefits, and as a result the value of the plan's liabilities could decrease. Consequently, the probability of a default might decrease because the plan sponsor no longer bears the risks associated with expected future promised retirement benefits. Simultaneously, the plan sponsor's borrowing costs decrease. However, financially constrained plan sponsors still face higher financial distress costs compared to less financially constrained plan sponsors. Therefore, it is expected that the leverage ratio of a financially constrained plan sponsor changes less in response to a hard pension freeze than the leverage ratio of a less financially constrained plan sponsor. This proposition results in the final hypothesis:

- *H7: Financially constrained plan sponsors experience smaller increases in leverage ratios than less financially constrained plan sponsors after the hard freeze.*

4. Research design

4.1 Data and summary statistics

This study examines Form 5500 filings between 2002 and 2015 filed with the Department of Labor, Internal Revenue Service, and the Pension Benefit Guaranty Corporation. The Form 5500 must be filed by al pension plans to satisfy annual reporting requirements. The information is composed electronically by the Department of Labor and made available on their website (DOL, 2016). On top of basic plan information, such as the number of participants[12], name and identification number etc., the Form 5500 also provides information on whether the pension plan implemented a hard pension freeze or not. More specifically, DB pension plans are required to state 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)'', and this indicates a so-called ''hard freeze''. The sample period starts in 2002 because the question about the hard freeze was added to the form in this year and the final year of the sample is 2015 because this is the latest year for which the data is available.

After extracting all the information on pension plan Form 5500 filings between 2002 and 2015, this study first removes all the duplicates. Next, the sample is restricted to the subset of pension plans that offer a DB pension scheme because this study is only interested in the effects of freezes on DB pension plan sponsors. To identify DB pension plans from Form 5500 filings, plan characteristic codes are used. Nevertheless, not all plan sponsors file plan characteristic codes, therefore, all missing values are dropped and all pension plans with liabilities equal to zero are also removed from the sample. The reason behind the removal of zero liability pension plans is that DC pension plans generally do not make any promises regarding future retirement benefits and therefore it is assumed that these pension plans have zero liabilities. Hereafter, this study is able to identify DB pension plans that stated that their DB pension scheme was frozen under a ''hard freeze'' definition. As discussed earlier in section 2.4, not all plan freezes are hard freezes. Nevertheless, this study only takes into account hard freezes because at the moment there are no data available that can be used to reliably identify other types of freezes. In addition to basic pension plan variables retrieved from Form 5500 filings, more detailed financial information about the pension plans is extracted from Schedule H that is attached to the Form 5500. Subsequently, the plan variables gathered from Form 5500 and the attached Schedule H filings are merged. The employer

[12] The term participant includes active employees as well as former employees who still have account balances or benefits in the pension plan.

identification number (EIN) is used as primary identifier.

In order to further examine the characteristics of plan sponsors that decided to implement a hard pension freeze, this study also uses plan sponsor variables. For every year in the sample from 2002 until 2015, plan sponsor variables are obtained from Compustat. Plan level data and plan sponsor data are then again matched by the EIN. Pension plans that cannot be matched with plan sponsor data from Compustat are left out of the sample. After carefully matching pension plan data with plan sponsor data, the sample contains 2,718 firms that sponsor at least one DB pension plan from 2002 to 2015, of which 1,465 firms implemented a hard freeze. Table 4 provides the annual distribution of the hard freezes in the period from 2002 to 2015. Most of the hard freezes were implemented after 2008, probably because of the financial crisis of 2007-2008. In practise, however, some firms may sponsor more than one pension plan at the same time and these firms will occur multiple times in the sample. Consequently, plan level data is adjusted. For every single plan sponsor in any given year, pension plan variables are combined to aggregate values. This study acknowledges that this matching process is not perfectly since a plan sponsor's subsidiary may have its own EIN and therefore files a separate Form 5500. This will probably result in the underestimation of the parent firm's pension assets and liabilities and/or income and expenses.

Table 5 presents descriptive statistics for the data sample. All data is winsorized at the 1th and 99th percentiles in order to mitigate the effect of outliers. Non-freeze firms tend to be more profitable than freeze firms, as evidenced by higher return on equity, return on assets, and higher cash flow from operating activities. Furthermore, freeze firms appear to have lower liquidity, as indicated by lower means for discretionary spending. However, these summary statistics seem a bit ambiguous since cash holdings are higher for freeze firms. In addition, freeze firms on average appear to be less credible than non-freeze firms, as indicated by higher credit ratings. With regard to leverage ratios it is observable that freeze firms seem to have more debt relative to their assets than non-freeze firms. More specifically, freeze firms' values of long-term debt are on average 0.244 of their assets, whereas non-freeze firms' long-term debt to assets ratio is on average 0.227. Concerning pension plan level characteristics, it is observable that freeze firms on average have higher funding ratios compared to non-freeze firms. Moreover, freeze firms tend to have younger pension plans indicated by the ratio of retirees to active participants. On the other hand, non-freeze firms on average have larger pension plans, pay slightly higher contributions to their pension plans, and 37.9% of their employees are covered by their pension plans, whereas freeze firms' pension plans only cover 16.1% of their employees.

Table 5: Descriptive statistics of freeze firms and non-freeze firms.

This table summarizes characteristics of plan sponsors and pension plans calculated from 2002 to 2015. Plan sponsor level characteristics are retrieved from Compustat and pension plan level characteristics are retrieved from Form 5500 filings. For each variable the mean, standard deviation (SD), median, minimum (min), and maximum (max) are reported. All data are winsorized at the 1% and 99% levels. Return on equity (assets) is calculated as net income of the plan sponsor divided by plan sponsor's total equity (assets). Cash flow from operating activities, capital- and R&D-expenditures, acquisitions, dividends, cash holdings, corporate debt, and plan sponsor's contributions are all scaled by total plan sponsor's assets. Credit risk is a categorical variable, with a value of 1 for investment grade credit ratings, and a value of 2 for non-investment grade credit ratings. Market to book ratio is the ratio of market value of equity to book value of equity. The funding ratio is calculated as the ratio of pension plan assets divided by pension plan liabilities. Retired participants are calculated as the number of retired or separated participants divided by total participants. Participants to employees are the ratio of active participants to total plan sponsor's employees. Plan size is measured as the log of the aggregated pension plan assets for each plan sponsor.

	Freeze firms						**Non-freeze firms**					
Variable	Mean	SD	Median	Min.	Max.	*N*	Mean	SD	Median	Min.	Max.	*N*
Panel A: Plan sponsor level												
ROE	0.086	0.622	0.096	-5.571	3.640	1,311	0.107	0.572	0.104	-5.571	3.848	1,134
ROA	0.020	0.096	0.031	-0.741	0.280	1,311	0.025	0.096	0.036	-0.712	0.300	1,134
CFO/Assets	0.070	0.075	0.068	-0.434	0.346	1,308	0.078	0.069	0.077	-0.286	0.346	1,125
CAPEX/Assets	0.039	0.041	0.028	0	0.028	1,307	0.044	0.040	0.034	0	0.266	1,125
R&D/Assets	0.024	0.033	0.013	0	0.333	658	0.024	0.040	0.013	0	0.374	601
Acquisition/Assets	0.020	0.055	0	-0.008	0.438	1,266	0.022	0.059	0	-0.008	0.416	1,082
Dividends/Assets	0.011	0.021	0.003	0	0.211	1,457	0.013	0.018	0.007	0	0.178	1,243
Cash/Assets	0.074	0.082	0.041	0	0.526	1,445	0.059	0.079	0.033	0	0.525	1,232
Cash+short-term investments/Assets	0.095	0.099	0.061	0	0.729	1,314	0.075	0.092	0.045	0	0.724	1,133
Credit risk	1.487	0.5	1	1	2	805	1.316	0.465	1	1	2	763
Market-to-book ratio	2.141	4.920	1.612	-34.822	55.98	1,330	2.295	3.761	1.752	-18.129	55.980	1,103
Short-term debt/Assets	0.039	0.061	0.015	0	0.395	1,461	0.040	0.066	0.016	0	0.499	1,244
Long-term debt/Assets	0.244	0.231	0.178	0	1.078	1,461	0.227	0.178	0.211	0	1.078	1,244
Total debt/Assets	0.286	0.236	0.223	0	1.101	1,460	0.270	0.189	0.250	0	1.236	1,239
Panel B: Pension plan level												
Funding ratio	1.630	0.424	1.572	1.060	5.493	819	1.551	0.380	1.498	1.049	3.950	1,211
Plan sponsor's contributions/Assets	0.003	0.006	0.001	0	0.034	1,266	0.005	0.007	0.001	0	0.034	1,153
Retirees	2.251	25.050	0.733	0	851.500	1,424	2.905	29.076	0.537	0.011	602.602	1,242
Participants to employees	0.161	0.213	0.069	0	1.486	1,436	0.379	0.334	0.285	0	1.458	1,226
Plan size	19.361	1.859	19.318	14.481	24.967	1,463	19.786	1.839	19.831	14.481	25.181	1,253

To better understand the impact of hard freezes on plan sponsor's performance in the subsequent years after the pension freezes, this study further matches each plan sponsor that implemented a hard pension freeze with an industry peer that did not implement a hard freeze. The first group is referred to as the treatment group, whereas the sample of matched industry peers is referred to as the control group. First, the year of the hard freeze is determined in order to be able to examine the post freeze performance. The year of the hard freeze is identified by the first occurrence of the hard freeze in the data sample. Next, additional plan sponsor variables are obtained from Compustat for one year prior to the hard freeze and for the three-year period after the hard freeze. The investigation period starts one year prior to the hardfreeze, because Rauh, Stefanescu, and Zeldes (2013) find that many of the plan sponsors report the pension freeze in Form 5500 with a long delay. Furthermore, since only Form 5500 filings between 2002 and 2015 are used in this study, plan sponsor variables prior to 2002 and after 2016 are not used. Also, all plan sponsors that are part of the treatment group are removed from the control sample. Consequently, the control group contains only plan sponsors that are matched by industry but did not implement a hard pension freeze. More specifically, the control group is selected on the basis of the following criteria: whether they are active in the same industry as classified by the Standard Industrial Classification (SIC) code, and whether they are similar in terms of assets compared to the plan sponsor who implemented a hard pension freeze. For each plan sponsor in the treatment group, the matching algorithm follows Rauh, Stefanescu, and Zeldes (2013), and first searches for an industry match by using the 2-digit SIC code. After matching by industry, the matching algorithm searches for firms that are similar in size. This involves searching for the industry peer with the value of assets within 70 to 130 percent of the plan sponsor's assets. If no matches are found, the plan sponsor is removed from the sample. Eventually, the algorithm finds 395 matches for 402 plan sponsors in the treatment group. Table 6 presents the annual distribution of these matches specified by year in the period from 2002 to 2015. Table 7 provides a comparison of the characteristics of the plan sponsors that implemented a hard pension freeze with those of their industry peers. As the table shows, when R&D expenses of freeze firms are compared to their industry peers, freeze firms have significantly lower R&D expenditures. Furthermore, when comparing the means of freeze firms' cash and cash plus short-term investments (6.7%, and 9.3%) to the control sample's means (10%, and 14.2%), it is observable that both differences are statistically significant. Finally, testing for differences in long-term debt ratios yields statistically significant results. This implies that freeze firms on average have higher long-term debt ratios than their industry peers.

Table 7: Sample characteristics of treatment group versus control group.

This table summarizes characteristics of plan sponsors that implemented a hard freeze (treatment group) and a control group (matched by industry and size) calculated for the period 2002-2015. Firm level characteristics are retrieved from Compustat. For each variable the mean and median is reported. The table also presents the differences between the means of the treatment and control group, and whether this difference is statistically different. All tests assume unequal variances between samples. ***, **, ** Denote significance at the 0.01, 0.05, and 0.10 levels. All data are winsorized at the 1% and 99% levels. Return on equity (assets) is calculated as net income of the plan sponsor divided by plan sponsor's total equity (assets). Cash flow from operating activities, capital- and R&D-expenditures, acquisitions, dividends, cash holdings, and corporate debt are all scaled by total balance sheet assets. Credit risk is a categorical variable, with a value of 1 for investment grade credit ratings, and a value of 2 for non-investment grade credit ratings. Market to book ratio is the ratio of market value of equity to book value of equity.

	Treatment group			**Control group**			**Difference**
Variable	Mean (1)	Median	*N*	Mean (4)	Median	*N*	t-test (4)-(1)
ROE	0.132	0.102	355	0.059	0.101	357	-0.073
ROA	0.014	0.026	355	0.021	0.035	357	0.008
CFO/Assets	0.073	0.072	353	0.071	0.074	353	-0.002
CAPEX/Assets	0.039	0.027	353	0.037	0.025	353	-0.002
R&D/Assets	0.026	0.015	180	0.059	0.026	179	0.033***
Acquisition/Assets	0.022	0.000	337	0.029	0.000	339	0.008
Dividends/Assets	0.011	0.004	399	0.011	0.001	394	0.001
Cash/Assets	0.067	0.041	399	0.100	0.051	386	0.030***
Cash+short-term investments/Assets	0.093	0.060	356	0.142	0.081	357	0.048***
Credit risk	1.432	1	236	1.490	1	196	0.058
Market-to-book ratio	2.294	1.712	357	2.449	2.014	350	0.155
Short-term debt/Assets	0.041	0.016	402	0.047	0.012	393	0.006
Long-term debt/Assets	0.254	0.193	402	0.223	0.156	395	-0.031*
Total debt/Assets	0.0295	0.251	402	0.275	0.232	393	-0.020

4.2 Definition of variables

The main dependent variable in this study is the binary variable *hardfreeze*. This variable indicates whether the plan sponsor implemented a hard freeze with value 1 for frozen DB pension plans, and 0 otherwise. In order to identify the characteristics of freeze firms and to examine the post-freeze impact on liquidity, investments, leverage, and profitability, this study follows the empirical design of Klein and Zur (2009), in particular concerning the independent variables.

The first group of independent variables includes three measures of prior-period accounting profitability and financial health:

1. The first one concerns the *return on assets (ROA)* and is defined as the ratio of plan sponsor's net income to its total assets. The plan sponsor's ROA determines how much profit is generated with the assets invested. Higher levels of ROA are associated with higher profitability and efficiency.
2. Secondly, the *return on equity (ROE)* is used. ROE measures how much profit the plan sponsor generated with the money invested by the shareholders and is calculated by net income divided by total stockholders' equity.
3. Lastly, the *cash flow from operating activities (CFO)* is used. The CFO describes how much cash the plan sponsor generated from operating activities net of cash used up doing so. In general, firm's operating activities provide the majority of the firm's cash flow and are therefore a good proxy of its profitability. The CFO are scaled by the total assets of the particular plan sponsor.

The second group of independent variables consists of three measures that reflect the liquidity level of the firms in the sample:

4. *Cash* is defined as instruments normally accepted by banks for deposit and interest-denominated investments with maturities up to 3 months. Cash is scaled to total balance sheet assets of the firm.
5. In addition, *cash plus short-term investments* is used, where the latter is defined as interest-denominated investments with maturities between 3 months and 1 year. Again the variable is measured as a ratio to total assets of the firm.
6. Next, this study uses a credit risk variable to reflect the creditworthiness of plan sponsors. This variable reflects the ability of the plan sponsor to borrow additional funds and thus the ability to increase its liquidity. *Credit risk* is a categorical variable

that represent the Standard & Poor's long-term credit rating[13] for each of the plan sponsors. Credit rating levels are divided into two groups: non-investment grade and investment grade credit ratings. Non-investment grade credit ratings correspond to lower creditworthiness, whereas investment grade credit ratings correspond to higher creditworthiness. In case the plan sponsor has an investment grade credit rating, the variable credit risk will equal 1, and if the plan sponsor has a non-investment grade credit rating the variable will equal 2.

The third group of independent variables includes discretionary spending items. The rationale of discretionary spending items is the following. In general, discretionary spending is spending that must be done for long-term growth of a company in order to sustain profitability (Klein and Zur, 2009). However, Rauh (2006) argues that firms often cut discretionary spending in response to cash constraints. Accordingly, this study uses discretionary spending items such as capital expenditures (CAPEX), research and development (R&D) expenditures, acquisition expenditures, and dividends paid to common shareholders to reflect the firm's discretionary expenditures; lower discretionary spending corresponds with lower investments.

7. *CAPEX* represent a plan sponsor's expenses used to expand or upgrade its assets such as property, plan, and equipment. This variable is measured as a ratio to total balance sheet assets.
8. *R&D* expenses represent all costs incurred during the year that relate to the development of new products or services. This variable is measured as a ratio to total balance sheet assets.
9. *Acquisition* expenditures represent cash outflows of funds used for costs relating to the acquisition of a firm. This variable is measured as a ratio to total balance sheet assets.
10. Lastly, the total amount of *dividends*, other than stock dividends, declared on all equity capital of the plan sponsor is used. This variable is measured as a ratio to total balance sheet assets.

[13] The variable credit risk is coded into the following numerical values: AAA=1,AA+=1, AA=1, AA-=1, A+=1, A=1, A-=1, BBB+=1, BBB=1, BBB-=1, BB+=2, BB=2, BB-=2, B+=2, B=2, B-=2, CCC+=2, CCC=2, CC=2, C=2, D=2, SD=2.

The fourth group of independent variables includes variables that reflect the leverage of the firms in the sample:

11. *Short-term debt* represents the total amount of debt due in one year. This variable is measured as a ratio to total balance sheet assets.
12. *Long-term debt* represents debt obligations due more than one year from the plan sponsor's balance sheet date. This variable is measured as a ratio to total balance sheet assets.
13. *Total debt* is the sum of short-term and long-term debt. This variable is measured as a ratio to total balance sheet assets.

As mentioned before financial markets assign value to growth opportunities and this is reflected in the share price of a firm (Smit and Trigeorgis, 2004). In order to identify these growth opportunities this study uses the market-to-book ratio.

14. The *market-to-book ratio* is calculated as the market value of common shares outstanding divided by the book value of shareholders' equity. The former is measured by common shares outstanding multiplied by the month-end price that corresponds to the period end date. High (low) market-to-book ratios corresponds to more (less) growth opportunities

Following Munnell and Soto (2007), this study assumes that the probability of a pension plan being frozen depends on three factors: the potential damage of the pension plan to the financial results of the plan sponsor, the cost of closing the plan, and the competitive environment in which the plan sponsor is active. For each of the before-mentioned factors this study incorporates certain control variables:

15. *Funding ratio* is measured as the ratio of total pension plan assets to total pension plan liabilities. Plan sponsors with underfunded pension plans will face high costs when terminating the plan since they have to come up with large amounts of money to close the funding gap. Moreover, underfunded pension plans are also required to make mandatory contributions. Hard pension freezes, on the other hand give them the opportunity to relieve the impact on their earnings and therefore motivate them to implement a pension freeze.
16. *Plan sponsor's contributions* are measured as the ratio of total plan sponsor contributions (cash and non-cash) to total plan sponsor's balance sheet assets. High

ratios of plan sponsor contributions adversely affect the sponsor's results and therefore motivate them to implement a hard freeze as well.

17. *Retirees* are calculated as the sum of all retired participants divided by total participants. Retired participants are participants who are currently receiving retirement benefits and/or are entitled to future retirement benefits. Total participants are the sum of both active and retired participants. This variable reflects the age of the pension plan and a high ratio of retirees to total participants implies large cash outflows of plan sponsor contributions to provide retirement benefits for past employees. This variable can be seen as an indicator of the attractiveness of the pension plan. More specifically, high ratios of retirees are a sign of unattractiveness of the pension plan among current employees, which reduces the resistance against changes in the pension contract for current employees.
18. *Participants to employees* are calculated by dividing the total number of active participants by the total number of employees in a given year. It measures how much of the plan sponsor's employees are covered by the pension plan. This variable can be seen as an indicator of the attractiveness of the pension plan. More specifically, pension plans that cover large parts of total employees are difficult to freeze since plan sponsors are likely to face relatively more resistance from unions, employees etc.
19. Finally, this study controls for the size of the pension plan. *Plan size* is measured by taking the natural logarithm of the total pension plan assets for each of the plan sponsor. In accordance with Atanasova and Hrazdil (2010), this study expects that the larger the pension plan, the more costly it will be for the plan sponsor to implement a pension freeze.

4.3 Research methodology

This research can be divided into two main steps. First, this study examines the characteristics of plan sponsors that implemented a hard freeze and the second step involves analysing the effects of the hard freeze on plan sponsor's liquidity, investments, leverage, and profitability. In order to provide a comprehensive look at the behaviour of the variables of interest before and after the implementation of the hard freeze, an event-study approach to the data is used. The corporate event being studied here is clearly defined and identified by the hard freeze definition in Form 5500 filings by plan sponsors.

4.3.1 Probit regressions

Given the binary nature of the variable of interest – 1 if a plan is hard frozen, 0 otherwise – a probit regression model is used to address the first research question. In this case, the probit model[14] is used to measure the marginal effect of each independent variable on the probability of implementing a hard pension freeze. More specifically, a positive (negative) coefficient for one of the independent variables implies an increasing (decreasing) probability of implementing a hard freeze, while keeping other independent variables constant. In an attempt to examine the relationship between the independent variables and the likelihood of a hard pension freeze, this study runs 8 different probit regressions. To avoid omitted variable bias, these 8 probit regressions all incorporate the following control variables: funding ratio, plan sponsor's contributions, retirees, participants to employees, and plan size. Recent literature proves significant impact on hard freeze decisions for all five variables (Munnell and Soto, 2007). Moreover, omitted variable bias might also be driven by both time-specific factors not covered by the other independent variables. Figure 3 is a great example of how macro economic events that are not covered by incorporated variables affect the financial variables used in this study. Clearly, there are two periods of extreme low profitability in terms of return on equity for the firms in the sample. The first period considers the year 2002; this period is known because of the Dot-Com bubble. The second period, around 2008, is linked to the global financial crisis. Both periods show significant drops in return on equity, thus these events should be taken into account while conducting various tests

[14] Important to note here is that the Probit model indirectly estimates the probabilities. More specifically, the model predicts z-scores, which subsequently can be translated into probabilities. For example, a coefficient of 0.12 of variable X means: if X goes up by one, then the z-score goes up by 0.12.

on firm's financial variables. Therefore, this study also incorporates time-fixed effects.

The first model in the analysis examines the relation between plan sponsor's profitability and the likelihood of implementing a hard freeze. To measure the profitability of the plan sponsor, the ROE, ROA, and CFO are used. As predicted by hypothesis 1, one would expect that plan sponsors with relatively poorer profitability are more likely to implement a hard freeze. Therefore, the predicted sign for all three independent variables is negative, indicating that an increase in one of these independent variables (i.e. increase in profitability) reduces the likelihood of implementing a hard freeze. The appropriate probit regression to test for hypothesis 1 is the following:

$$(1)\ Hardfreeze = \beta_0 + \beta_1 ROE_{i,t} + \beta_2 ROA_{i,t} + \beta_3 CFO_{i,t} + controls_{i,t} + \epsilon_{i,t}$$

The second model help to separate the effects of plan sponsor's cash constraints, and their discretionary spending on the likelihood of implementing a hard freeze. Hypothesis 2 predicts that relatively more cash constrained plan sponsors, and plan sponsors with relatively lower investments are more likely to freeze their pension plan because the required contributions significantly reduce their internal resources. Hard freezes could improve the average level of liquidity for plan sponsors. Accordingly, the predicted sign for discretionary spending items, such as CAPEX, R&D, acquisition, and dividends is negative. High levels of discretionary spending correspond with high levels of liquidity and vice versa. Hence, if a plan sponsor is able to continue to make large contributions to discretionary spending items despite mandatory pension contributions, the likelihood of a hard freeze decreases. As for cash holdings the predicted sign is expected to be negative as well. For the same reason as for discretionary spending items, namely high levels of cash to assets reduces the necessity to freeze the pension plan in order to increase liquidity, and thus reduces the probability of a hard freeze. Finally, the credit rating is incorporated into the model. The predicted sign for credit risk is positive. Plan sponsors with higher credit ratings are more vulnerable to bankruptcy and therefore their borrowing costs increase. This simultaneously reduces their ability to gather additional funds by borrowing. The following probit regression is executed:

$$\begin{aligned}(2) Hardfreeze = {} & \beta_0 + \beta_1 CAPEX_{i,t} + \beta_2 R\&D_{i,t} + \beta_3 Acquisition_{i,t} + \beta_3 Dividends_{i,t} \\ & + \beta_4 Cash\&Investments_{i,t} + \beta_5 Credit\ Rating_{i,t} + controls_{i,t} + \epsilon_{i,t}\end{aligned}$$

The third model measures the relationship between the plan sponsor's growth opportunities and the likelihood of implementing hard freeze. Following hypothesis 3, financially constrained plan sponsors in particular tend to freeze their pension plan in order to be capable to translate growth opportunities into firm value. To see whether the relationship between the likelihood of implementing a hard freeze and growth opportunities differs across liquidity levels, this study incorporates an interaction variable between market-to-book ratio and credit rating. The credit rating reflects the ability to borrow additional funds and is therefore used as a proxy for cash constraints. The predicted sign of the interaction variable is positive since both variables separately are expected to have a positive sign. The higher the market-to-book ratio of the plan sponsor, the more growth opportunities and the higher the motivation to freeze the pension plans. Simultaneously, a higher credit rating increases the probability of implementing a hard freeze. Accordingly, the probit regression is:

(3) $$Hardfreeze = \beta_0 + \beta_1 MTB_{i,t} + \beta_2 Credit\ Rating_{i,t} + \beta_3 MTB_{i,t} \cdot Credit\ Rating_{i,t} + controls_{i,t} + \epsilon_{i,t}$$

The fourth model examines the impact of leverage on the likelihood of implementing a hard freeze. According to hypothesis 4, plan sponsors with high leverage ratios tend to freeze their pension plan in order to relieve financial pressure. Consequently, the predicted sign of leverage items such as, short-term debt, and long-term debt to assets are all positive. The probit regression is presented below:

(4) $$Hardfreeze = \beta_0 + \beta_1 Short - term\ debt_{i,t} + \beta_2 Long - term\ debt_{i,t} + controls_{i,t} + \epsilon_{i,t}$$

The annual disclosure of detailed pension plan information in Form 5500 allows plan sponsors to delay publication of the hard freeze for a significant period. Rauh, Stefanescu, and Zeldes (2013) searched for information about the actual date of pension plan freezes in the news, annual reports, and Form 5500 filings and they find that many of these plan sponsors indeed report the pension freeze in Form 5500 with a long delay. Thus, plan sponsors that implement a hard freeze are more likely to report the hard freeze in the next period Form 5500. Since Form 5500 filings are annually filed this study incorporates one year lagged variables. The following four models are very similar to the previous four models, the only

difference is the change from contemporaneous to lagged independent variables:

$$(5)\ Hardfreeze = \beta_0 + \beta_1 ROE_{i,t-1} + \beta_2 ROA_{i,t-1} + \beta_3 CFO_{i,t-1} + controls_{i,t-1} + \epsilon_{i,t-1}$$

$$(6)\ Hardfreeze = \beta_0 + \beta_1 CAPEX_{i,t} + \beta_2 R\&D_{i,t} + \beta_3 Acquisition_{i,t} + \beta_3 Dividends_{i,t} + \beta_4 Cash\&Investments_{i,t} + \beta_5 Credit\ Rating_{i,t} + Controls_{i,t} + \epsilon_{i,t}$$

$$(7)\ Hardfreeze = \beta_0 + \beta_1 MTB_{i,t-1} + \beta_2 Credit\ Rating_{i,t-1} + \beta_3 MTB_{i,t-1} \cdot Credit\ Rating_{i,t-1} + controls_{i,t-1} + \epsilon_{i,t-1}$$

$$(8)\ Hardfreeze = \beta_0 + \beta_1 Short - term\ debt_{i,t-1} + \beta_2 Long - term\ debt_{i,t-1} + controls_{i,t} + \epsilon_{i,t}$$

4.3.2 Matched pair t-test

With regard to the second step of the analysis, this study proceeds by examining the changes in liquidity, investments, leverage, and profitability of plan sponsors from one-year prior to the hard freeze until three years after the implementation of the hard freeze. The primary purpose is to observe the impact of hard freezes on plan sponsor's performance. In order to examine these effects, each of the plan sponsors that implemented a hard freeze is matched with another firm by industry and size. The former group is referred to as the treatment group, whereas the latter group is considered to be the control group. Following prior literature[15], this study assumes that the impact of a hard pension freeze on firm performance is larger for financially constrained plan sponsors. According to Rauh (2006), a firm's credit rating is a good proxy for the firm's external financing constraints. Therefore, the treatment group is divided into plan sponsors with investment grade credit ratings and plan sponsors with non-investment grade credit ratings. To assess whether changes in firm performance of the control group differ from changes in firm performance of the treatment group, this study performs a matched paired t-test. More specifically, the matched paired t-test is used to test whether the mean differences in liquidity, investments, leverage, and profitability, measured 1 year prior to the hard freeze and 3 years after the hard freeze is statistically different between the control and treatment group. The null hypothesis for such a test states that the mean difference in the measures (1 year prior to and 3 years after the hard freeze) between the two groups is equal to zero. In contrast, the alternative hypothesis states that the mean differences between the two groups are larger or smaller than zero. The raw change in plan sponsor's performance for freeze firm *i* from the one-year prior to the hard freeze to year *t is*

[15] See for example Rauh (2006) and Campbell, Dhaliwal, and Schwarz (2012).

$$\Delta Performance_{i,(-1,t)} = Performance_{i,t} - Performance_{i,-1}.$$

The adjusted change in plan sponsor's performance, which controls for the contemporaneous change in firm *i*'s matched control firm, is

$$Adjusted\ \Delta Performance_{i,(-1,t)} = \left(Matched\ Performance_{i,t} - Matched\ Performance_{i,-1}\right) - \left(Performance_{i,t} - Performance_{i,-1}\right).$$

In accordance with prior literature, and hypothesis 5(A&B), 6, and 7 of this research, this study expects to reject the null hypothesis for all four measures, in particular for non-investment grade credit rating plan sponsors. In other words, this study expects significant differences in liquidity, investments, leverage, and profitability 1 year prior to and 3 years after the implementation of the hard freeze between non-investment grade credit rating plan sponsors and their industry peers. More specifically, financially constrained plan sponsors are expected to experience higher increases in liquidity, investments, and profitability than less financially constrained plan sponsors after the hard freeze. The leverage ratios of financially constrained plan sponsors, on the other hand, are expected to experience smaller increases than less financially constrained plan sponsors after the hard freeze.

4.4 Multicollinearity

Before performing the probit regression analyses to determine the characteristics of plan sponsors that implemented a hard freeze it is important to rule out perfect multicollinearity. Perfect multicollinearity occurs if one of the independent variables is a perfect linear function of the other independent variables (Stock and Watson, 2011). In that case one or more regression coefficients could be estimated imprecisely. Unlike perfect multicollinearity, imperfect multicollinearity (that is, very high but not perfectly correlated independent variables) does not lead to biased coefficient estimates. Nevertheless, when high multicollinearity is present, standard errors of independent variables are biased upwards, confidence intervals tend to be very wide, and t-statistics are biased downwards. Accordingly, it will be harder to observe significant results (Stock and Watson, 2011).

4.4.1 Pearson Correlation Matrix

In order to identify any strong linear relationship between one of the independent variables, this study first performs a Pearson Correlation Matrix. The Pearson Correlation Matrix calculates the strength of the linear correlation between the independent variables. The correlation coefficients can obtain values between -1 and +1. There is no real consensus about

the magnitude of the correlation coefficient that classifies too much multicollinearity. However, theory argues that perfect multicollinearity, which is a correlation coefficient of -1 or +1, is definitely a problem (Stock and Watson, 2011). Table 8 reports the Pearson Correlation Matrix of the data sample. High levels of cash usually correspond with high levels of cash plus short-term investments as indicated by a correlation coefficient of 0.850. According to Klein and Zur (2009), firms tend to place their excess cash in short-term securities. For this reason, this study includes cash and cash plus short-term investments as a proxy for cash holdings. Though, the strong linear relationship between the two variables is worrying. To rule out multicollinearity problems it is therefore sufficient to include only one of the variables as a proxy for cash holdings. Furthermore, there appears to be a very strong linear relationship between long-term debt to assets and total debt to assets. This is indicated by a correlation coefficient of 0.924. High long-term debt is associated with high levels of total debt. Thus, including only one of these variables prevents for the risk of having multicollinearity problems as well.

Table 8: Pearson Correlation Matrix.

This table contains correlation coefficients between firm variables calculated from 2002 to 2015. Plan sponsor level characteristics are retrieved from Compustat and pension plan level characteristics are retrieved from Form 5500 filings All data are winsorized at the 1% and 99% levels. Return on equity (assets) is calculated as net income of the firm divided by plan sponsor's total equity (assets). Cash flow from operating activities, capital- and R&D-expenditures, acquisitions, dividends, cash holdings, corporate debt, and plan sponsor's contributions are all scaled by plan sponsor's assets. Credit risk is a categorical variable, with a value of 1 for investment grade credit ratings, and a value of 2 for non-investment grade credit ratings. Market to book ratio is the ratio of market value of equity to book value of equity. The funding ratio is calculated as the ratio of pension plan assets divided by pension plan liabilities. Retired participants are calculated as the number of retired or separated participants divided by total participants. Participants to employees are the ratio of active participants to total plan sponsor's employees. Plan size is measured as the log of the aggregated pension plan assets for each plan sponsor. ***, **, ** Denote significance at the 0.01, 0.05, and 0.10 levels.

Variable	ROE	ROA	CFO	CAPEX	R&D	Acquisition	Dividends	Cash	Cash+Inv.	Credit risk	MTB	Short-t. debt	Long-t debt	Total debt	Funding	Sponsor's contr.	Retirees	Part./empl.	Plan size
	Panel A: Plan sponsor level																		
ROE	1																		
ROA	0.195***	1																	
CFO/Assets	0.066***	0.393***	1																
CAPEX/Assets	-0.032	0.076***	0.322***	1															
R&D/Assets	0.070**	-0.079***	0.033	0.028	1														
Acquisition/Assets	0.025	0.066***	0.053***	-0.068***	-0.047	1													
Dividends/Assets	0.091***	0.228***	0.279***	0.081***	-0.036	-0.028	1												
Cash/Assets	0.051**	0.127***	0.182***	-0.082***	0.241***	-0.037*	0.120***	1											
Cash+short-term investments/Assets	0.075***	0.120***	0.125***	-0.115***	0.286***	-0.061***	0.071***	0.850***	1										
Credit risk	-0.046*	-0.297***	-0.252***	-0.058**	-0.161***	-0.004	-0.206***	0.048*	-0.020	1									
Market-to-book ratio	0.226***	0.168***	0.181***	0.070***	0.001	0.058***	0.172***	0.040*	0.028	-0.070**	1								
Short-term debt/Assets	0.051*	-0.179***	-0.146***	-0.079***	0.078***	-0.040*	-0.091***	-0.130***	-0.099***	-0.136***	-0.075***	1							
Long-term debt/Assets	-0.039*	-0.173***	-0.043**	0.061***	-0.106***	0.090***	0.010	-.0154***	-0.221***	0.459***	0.045**	-0.099***	1						
Total debt/Assets	-0.018	-0.230***	-0.099***	0.027	-0.086***	0.070***	-0.026	-0.189***	-0.241***	0.414***	0.014	0.254***	0.924***	1					
	Panel B: Pension plan level																		
Funding ratio	-0.047**	-0.005	-0.044*	-0.041*	0.150***	-0.030	-0.090***	0.086***	0.077***	0.167***	-0.034	0.045**	-0.076***	-0.041*	1				
Plan sponsor's contributions/Assets	0.038*	0.066***	0.057***	0.043**	0.238***	-0.049**	0.061***	0.158***	0.111***	0.052*	0.031	-0.040**	-0.054***	-0.067***	-0.064***	1			
Retirees	0.091***	-0.015	-0.028	-0.020	-0.008	0.002	0.005	-0.015	-0.010	-0.025	-0.023	0.053***	0.001	0.016	-0.075***	-0.021	1		
Participants to employees	0.017	-0.028	-0.074***	0.028	0.081***	-0.110***	0.041**	-0.123***	-0.072***	-0.150***	-0.051**	0.059***	-0.092***	-0.071***	-0.028	0.062***	-0.063***	1	
Plan size	0.068***	0.130***	0.117***	-0.015	-0.117***	0.034	0.098***	-0.019	-0.032	-0.345***	0.083***	-0.056***	0.066***	0.044**	-0.282***	-0.062***	0.085***	-0.078***	1

4.4.2 Variance Inflation Factor

In addition to the Pearson Correlation Matrix this study further examines multicollinearity issues by looking at the Variance Inflation Factor (VIF). Recall that when multicollinearity is present, standard errors of independent variables are biased upwards, and hence the variances of the independent variables are also inflated. The VIF is based on the shared proportion of variance between two independent variables and the measure is directly related to the variance of the regression coefficient of the independent variable (O'Brien, 2007). As the name suggests, the VIF quantifies by how much the variances of the regression coefficients are inflated: a VIF of 5 indicates that (all other things being equal) the variance of the regression coefficient of a particular independent variable is 5 times bigger than it would have been if this particular independent variable had been linearly independent of another independent variable (O'Brien, 2007). Various rules of thumb to identify multicollinearity through VIF are used in the literature. O'Brien (2007) mentions a VIF of 10 or 4 as the two most applied rules of thumb to indicate multicollinearity. In this study, a VIF of 10 is used and this implies that when the VIF reaches the value of 10, there appears to be a multicollinearity problem. Table 9 summarizes all VIF for the probit regression models as described in section 4.3. Based on these values no multicollinearity risks are present in the probit regression analyses.

Table 9: Variance Inflation Factors (VIF).

In models 5, 6, 7, and 8 one-year lagged independent variables are used instead of the contemporaneous independent variables used in the previous four models.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
ROE	1.05				1.07			
ROA	1.32				1.20			
CFO/Assets	1.26				1.16			
CAPEX/Assets		1.07				1.14		
R&D/Assets		1.21				1.33		
Acquisition/Assets		1.13				1.35		
Dividends/Assets		1.09				1.20		
Cash+short-term investments/Assets		1.25				1.47		
Credit risk		1.33	1.43			1.44	1.56	
Market-to-book ratio			1.82				1.56	
Market-to-book*Credit risk			1.96				1.76	
Short-term debt/Assets				1.04				1.05
Long-term debt/Assets				1.03				1.05
Funding ratio	1.14	1.14	1.15	1.14	1.12	1.13	1.06	1.13
Plan sponsor's contributions/Assets	1.05	1.16	1.05	1.04	1.07	1.26	1.09	1.05
Retirees	1.05	1.08	1.06	1.03	1.03	1.35	1.05	1.04
Participants to employees	1.06	1.17	1.09	1.05	1.07	1.21	1.14	1.07
Plan size	1.20	1.29	1.29	1.17	1.17	1.32	1.23	1.15

5. Empirical results and analysis

5.1 Probit regressions

The results from the probit regressions on the contemporaneous relationship between plan sponsor characteristics and the likelihood of implementing a hard freeze are reported in table 9. In addition, table 10 summarizes the results from the probit regressions on the one-year lagged relationship between plan sponsor characteristics and the likelihood of implementing a hard freeze.

Table 9: Results probit regressions.

This table contains the results from the probit regressions. The dependent variable is a binary variable with value 1 for hardfreeze and 0 otherwise. Plan sponsor level characteristics are retrieved from Compustat and pension plan level characteristics are retrieved from Form 5500 filings from 2002 to 2015. All data are winsorized at the 1% and 99% levels. Standard errors are clustered by firm. Return on equity (assets) is calculated as net income of the firm divided by plan sponsor's total equity (assets). Cash flow from operating activities, capital- and R&D-expenditures, acquisitions, dividends, cash holdings, corporate debt, and plan sponsor's contributions are all scaled by plan sponsor's assets. Credit risk is a categorical variable with investment grade credit ratings as the reference category. Market to book ratio is the ratio of market value of equity to book value of equity. The funding ratio is calculated as the ratio of pension plan assets divided by pension plan liabilities. Retired participants are calculated as the number of retired or separated participants divided by total participants. Participants to employees are the ratio of active participants to total plan sponsor's employees. Plan size is measured as the log of the aggregated pension plan assets for each plan sponsor. ***, **, ** Denote significance at the 0.01, 0.05, and 0.10 levels. P-values are in parentheses.

		Model 1	**Model 2**	**Model 3**	**Model 4**
	Expected sign	Coefficients	Coefficients	Coefficients	Coefficients
Profitabilty					
ROE	-	-0.012			
		(0.853)			
ROA	-	-0.471			
		(0.423)			
CFO/Assets	-	-1.492**			
		(0.039)			
Discretionary spending					
CAPEX/Assets	-		-5.650		
			(0.169)		
R&D/Assets	-		-4.397		
			(0.208)		
Acquisition/Assets	-		-5.138***		
			(0.001)		
Dividends/Assets	-		-6.395		
			(0.237)		
Cash balances, debt, and Market-to-Book ratio					
Cash+short-term investments/Assets	-		3.090**		
			(0.035)		
Non-investment grade credit rating	+		0.075	0.194	
			(0.760)	(0.268)	
Market-to-book ratio	+			-0.036***	
				(0.003)	
Market-to-book*Credit risk	+			0.025	
				(0.203)	
Short-term debt/Assets	+				1.336*
					(0.067)
Long-term debt/Assets	+				0.019
					(0.949)
Controls					
Funding ratio	-	0.217	0.016	0.038	0.193
		(0.105)	(0.959)	(0.857)	(0.136)
Plan sponsor's contributions/Assets	+	-6.743	-26.172	-30.458**	-10.977
		(0.383)	(0.159)	(0.013)	(0.162)
Retirees	+	0.000	0.000	0.001	0.000
		(0.689)	(0.850)	(0.444)	(0.613)
Participants to employees	-	-1.910***	-3.237***	-2.194***	-1.911***
		(0.000)	(0.000)	(0.000)	(0.000)
Plan size	-	-0.047	-0.064	-0.040	-0.063**
		(0.171)	(0.408)	(0.468)	(0.056)
Year fixed effects		Yes	Yes	Yes	Yes
Pseudo R^2		0.236	0.303	0.250	0.246
N		1,582	480	926	1,750

Table 10: Results probit regressions.

This table contains the results from the one-year lagged probit regressions. The dependent variable is a binary variable with value 1 for hardfreeze and 0 otherwise. Plan sponsor level characteristics are retrieved from Compustat and pension plan level characteristics are retrieved from Form 5500 filings from 2002 to 2015. All data are winsorized at the 1% and 99% levels. Standard errors are clustered by firm. Return on equity (assets) is calculated as net income of the firm divided by plan sponsor's total equity (assets). Cash flow from operating activities, capital- and R&D-expenditures, acquisitions, dividends, cash holdings, corporate debt, and plan sponsor's contributions are all scaled by plan sponsor's assets. Credit risk is a categorical variable with investment grade credit ratings as the reference category. Market to book ratio is the ratio of market value of equity to book value of equity. The funding ratio is calculated as the ratio of pension plan assets divided by pension plan liabilities. Retired participants are calculated as the number of retired or separated participants divided by total participants. Participants to employees are the ratio of active participants to total plan sponsor's employees. Plan size is measured as the log of the aggregated pension plan assets for each plan sponsor. ***, **, ** Denote significance at the 0.01, 0.05, and 0.10 levels. P-values are in parentheses.

		Model 5	**Model 6**	**Model 7**	**Model 8**
	Expected sign	Coefficients	Coefficients	Coefficients	Coefficients
Profitabilty					
ROE [L1]	-	0.053			
		(0.621)			
ROA [L1]	-	-1.899**			
		(0.046)			
CFO/Assets [L1]	-	-2.129**			
		(0.035)			
Discretionary spending					
CAPEX/Assets [L1]	-		-10.739*		
			(0.061)		
R&D/Assets [L1]	-		-8.271**		
			(0.039)		
Acquisition/Assets [L1]	-		-0.630		
			(0.727)		
Dividends/Assets [L1]	-		-26.682**		
			(0.024)		
Cash balances, debt, and Market-to-Book ratio					
Cash+short-term investments/Assets [L1]	-		2.656		
			(0.230)		
Non-investment grade credit rating [L1]	+		-0.032	0.149	
			(0.420)	(0.548)	
Market-to-book ratio [L1]	+			-0.026	
				(0.117)	
Market-to-book*Credit risk [L1]	+			0.024	
				(0.533)	
Short-term debt/Assets [L1]	+				2.093**
					(0.041)
Long-term debt/Assets [L1]	+				0.269
					(0.041)
Controls					
Funding ratio [L1]	-	0.263	0.280	0.039	0.239
		(0.138)	(0.464)	(0.891)	(0.158)
Plan sponsor's contributions/Assets [L1]	+	3.179	7.564	-16.792	-3.809
		(0.739)	(0.790)	(0.319)	(0.693)
Retirees [L1]	+	-0.009***	1.677***	0.730*	-0.004
		(0.007)	(0.009)	(0.071)	(0.318)
Participants to employees [L1]	-	-1.884***	-4.736***	-1.614***	-1.797***
		(0.000)	(0.000)	(0.000)	(0.000)
Plan size [L1]	-	-0.090**	-0.398***	-0.158*	-0.110**
		(0.066)	(0.007)	(0.061)	(0.014)
Year fixed effects		Yes	Yes	Yes	Yes
Pseudo R^2		0.221	0.494	0.247	0.219
N		703	217	401	795

The first characteristic examined is firm profitability. The *ROE, ROA, and CFO* coefficients are all negative in model 1. This indicates that the probability of implementing a hard freeze is negatively related to an increase in one of these variables. More specifically, the coefficient of -1.492 for *CFO* is statistically significant at the 1 percent level, implying that the coefficient is statistically different from zero. A one-percentage point increase in *CFO* at time T, reduces the z-score by 1.492 (and thus the probability of implementing a hard freeze), while all other variables are held constant. Furthermore, as *ROA* or *CFO* go up by one unit at time T, then the z-score goes down by 0.471 and 0.012 respectively, while holding other variables constant. These two coefficients, however, are not statistically significant. When considering the one-year lagged profitability measures in model 5, *ROA* and *CFO* both have negative coefficients again. Also, both coefficients are now significantly different from zero at the 5 percent level. One-year lagged *ROE*, however, has a positive coefficient. Hence, a one-percentage point increase in *ROE* at time T-1 increases the probability of implementing a hard freeze, while holding other variables constant. This is not in line with the first hypothesis since bad performing plan sponsors are often motivated to implement a hard pension freeze in order to save on pension costs and to reduce the contribution volatility. Nevertheless, the coefficient for one-year lagged *ROE* is not statistically significant related to the likelihood of implementing a hard freeze. Thus, to the extent that *CFO* and *ROA* are associated with plan sponsors' profitability, these results indicate that the probability of implementing a hard pension freeze is negatively related to profitability, in particular for the one-year lagged variables. This result is consistent with the first hypothesis that plan sponsors with relatively poorer performance are more likely to implement a hard freeze. Consequently, there is not enough evidence to reject hypothesis 1.

Models 2 and 6 report on a test in which discretionary spending items, credit ratings, and cash holdings are used to examine the association between liquidity, investments, and the likelihood of implementing a hard freeze. Discretionary spending items are used as a proxy for investments. Both contemporaneous (model 2) and the one-year lagged variables (model 6) show negative coefficients for discretionary spending items, such as *CAPEX*, *R&D*, *Acquisition*, and *Dividends*. Thus, a one-percentage point increase in discretionary spending items reduces the probability of implementing a hard freeze, while keeping all other things equal. This is consistent with the second hypothesis that predicts that plan sponsors with relatively low investments are more likely to implement a hard freeze. Though, the coefficient for *Acquisition* in model 1 is the only discretionary spending item that is statistically significant. Concerning the one-year lagged variables, however, table 6 reports negative and

statistically significant coefficients for *CAPEX*, *R&D*, and *Dividends*. This implies that if the one-year lagged discretionary spending items go up by one unit, then the probability of implementing a hard freeze goes down. Based on these results no evidence has been found to reject hypothesis 2 (A).

Considering the association between liquidity and the likelihood of implementing a hard freeze this study uses *cash plus short-term investment* and the plan sponsor's *credit rating* as a proxy for liquidity. The coefficient for *Cash plus short-term investments* is positive and statistically significant at the 5 percent level in model 2. A one-percentage point increase in *cash plus short-term investments* at time T, thus increases the z-score (and the probability of freezing) by 3.090, all else being equal. When considering the one-year lagged *cash plus short-term investments* in model 6, the coefficient is still positive but no longer statistically significant. Both results are inconsistent with the second hypothesis (B) that predicts a negative sign for *cash plus short-term investments*, meaning that plan sponsors that are more cash constrained are more likely to implement a hard freeze. A possible explanation for the unexpected results is the following. In anticipation of future costly (mandatory) pension contributions, cash constrained plan sponsors might use incremental cash flow to build up liquidity (i.e. *cash plus short-term investments)* instead of using the internal funds for additional discretionary spending. This explanation is also consistent with the negative and statistically significant relation between discretionary spending and implementing a hard freeze as described above. In addition, Rauh (2006) finds a strong and significant negative relationship between capital expenditures and required pension contributions. Furthermore, the coefficient for *credit rating* in model 2 is positive but insignificant. This indicates that a plan sponsor with a non-investment grade credit rating (i.e. BB or lower) is more likely to implement a hard freeze than a plan sponsor who has an investment-grade credit rating. Although the coefficient is not significantly different from zero, the sign of the coefficient is consistent with the second hypothesis (B) that plan sponsors that are more cash constrained are more likely to implement a hard freeze. An increase in the credit rating of the plan sponsor in the previous year (model 6), on the other hand, is negative and statistically insignificant related to the likelihood of implementing a hard freeze. This is not in line with the conjecture that plan sponsors with a lower credit rating are more likely to implement a hard freeze in order to improve their creditability and subsequently their liquidity level (Atanasova and Hrazdil, 2010). In summary, to the extent that *cash plus short-term investments* and *credit rating* are associated with a plan sponsor's cash constraints, there appears to be no relevant negative effects on the likelihood of implementing a hard pension freeze. Theory and prior

research, on the other hand, both agree on the fact that hard freezes are motivated by the desire to reduce the impact of pension contributions on plan sponsor's internal financial resources (see e.g. Rauh, 2006). For this reason, this study cannot reject hypothesis 2 (B) despite the low evidence from the probit regressions in models 2 and 6.

Next, this study examines the relationship between plan sponsor's growth opportunities and the probability of implementing a hard freeze. Plan sponsor's growth opportunities are reflected in the firm's share price. As predicted by the third hypothesis, financially constrained plan sponsors with high market to book ratios are more likely to implement a hard freeze because they face difficulties in translating growth opportunities into real firm value. The coefficient for both the current (model 3) and the one-year lagged (model 7) interaction term *Market-to-book*Credit risk* is positive but not statistically significant. This indicates that if the interaction term goes up by one unit at time T (above and beyond a one unit increase *market-to-book ratio* alone and a unit increase in *credit risk* alone), then the probability of implementing a hard freeze goes up as well. Although, the coefficient is not significant, the sign of the interaction term is consistent with the third hypothesis; hence the hypothesis is cannot be rejected.

Lastly, the impact of plan sponsor's leverage ratios on the likelihood of implementing a hard freeze is examined. Both the coefficient for *short-term debt* and *long-term debt* are positive (model 4), while that for *short-term debt* is also statistically significant at the 10 percent level. This means that a one unit increase in leverage at time T, increases the likelihood of implementing a hard freeze. Also, when considering the one-year lagged leverage ratios in model 8, both coefficients are positive. Moreover, *short-term debt* is statistically significant at the 5 percent level. These results are consistent with the notion that plan sponsors are freezing their DB pension plans to relief financial pressure. Accordingly, the fourth hypothesis cannot be rejected.

This study also includes several control variables in all eight models. In all models, the coefficient for *funding ratio* is positive and statistically insignificant. This implies that a one-percentage point increase in funding ratio at time T or time T-1, increases the probability of implementing a hard freeze. This result differs from that found by Munnell and Soto (2007), who find that the likelihood of implementing a pension freeze is negatively related to funding ratio. *Plan sponsor's contributions* coefficient is negative and statistically significant in all models expect for the one-year lagged coefficients in models 5 and 6. This indicates that if *plan sponsor's contributions* in the current year or in the previous year go up by one-percentage point, the probability of implementing a hard freeze goes down. Again, this differs

from what is expected; high levels of plan sponsor contributions adversely affect the sponsor's results and therefore motivate plan sponsors to implement a hard freeze. The coefficient *retirees* is zero for all contemporaneous regressions (models 1 to 4). Although, the p-values do not indicate any statistically significant results, the effect of the pension's plan age on the likelihood of implementing a hard freeze was expected to be positive (Munnell and Soto, 2007). The *retirees* coefficients in the one-year lagged regressions (models 5 to 8), on the other hand do have statistically significant impact on the probability of implementing a hard freeze. Nevertheless, the effects are ambiguous since the coefficients in models 6 and 7 are both positive and statistically significant, whereas the coefficients in models 5 and 8 are negative. Finally, the coefficients for *participants to employees* and *plan size* are all negative and the majority of them are statistically significant related to the probability of implementing a hard freeze. Hence, a one-percentage point increase in one of these variables, decreases the probability of implementing a hard freeze, all else being equal. This is consistent with Munnell and Soto (2007), and Atanasova and Hrazdil (2010) findings.

5.2 Matched pair t-test

In this section, changes in liquidity, investments, leverage, and profitability of plan sponsors from one-year prior to the hard freeze until three years after the implementation of the hard freeze are examined. The primary purpose is to observe the impact of hard freezes on plan sponsor's performance. Table 11 presents the results on the matched pair t-tests.

Table 11: Matched pair t-test.

This table presents average changes in firm performance from the prefreeze year to three years following the hard freeze for plan sponsors that implemented a hard freeze from 2002 through 2015. Plan sponsor level characteristics are retrieved from Compustat. Panel A reports the mean raw change in plan sponsor's performance, where the freeze year is defined as year *t*. Reported values are changes in the key variables from the base year *t*-1. Panel B reports the mean adjusted change in plan sponsor's performance, where the adjusted change is the contemporaneous change in firm performance of the two-digit SIC code firms (control group) minus the raw change. The control group consists of firms in the same industry with the value of assets in the range of 70% to 130% of the corresponding values of the DB freeze firm in year *t*. In Panel A, the numbers of plan sponsors for which data are available range from 381 (for *t* results) to 36 (for *t*+3 results). In Panel B, the numbers of matched pairs of firms range from 381 (for *t* results) to 28 (for *t*+3 results). Return on equity (assets) is calculated as net income of the firm divided by plan sponsor's total equity (assets). Cash flow from operating activities, capital- and R&D-expenditures, acquisitions, dividends, cash holdings, corporate debt, and plan sponsor's contributions are all scaled by plan sponsor's assets. Credit risk is a categorical variable, with a value of 1 for investment grade credit ratings, and a value of 2 for non-investment grade credit ratings. Market to book ratio is the ratio of market value of equity to book value of equity. All tests assume unequal variances between samples and all data are winsorized at the 1% and 99% levels. Statistical inference is based on *t*-test for means. ***, **, ** Denote significance at the 0.01, 0.05, and 0.10 levels.

	All plan sponsors				**Non-investment grade**				**Investment grade**			
	t	***t*+1**	***t*+2**	***t*+3**	***t***	***t*+1**	***t*+2**	***t*+3**	***t***	***t*+1**	***t*+2**	***t*+3**
Panel A: Raw change in plan sponsor's performance												
ROE	0.014	-0.022	0.117*	0.022	0.057	0.086	0.121	0.004	-0.047	-0.060	0.098**	-0.025
ROA	-0.004	0.010	0.015*	0.007	-0.015	0.012	0.014	0.008	0.002	0.007	0.004	-0.001
CFO/Assets	-0.001	-0.002	0.004	0.003	-0.008	-0.002	0.013	0.020*	0.001	-0.003	0.003	0.001
CAPEX/Assets	0.001	0.000	0.004*	0.002	0.002	0.001	0.005	0.005	0.001	0.002	0.008**	0.003
R&D/Assets	0.001*	-0.000	-0.000	-0.002*	0.001	0.000	0.001	-0.000	0.002	0.001	0.001	-0.002
Acquisition/Assets	-0.002	-0.005	-0.011**	-0.004	0.004	-0.009	-0.004	0.003	-0.006	-0.000	-0.026***	-0.013
Dividends/Assets	0.001	0.001	0.003*	0.004**	-0.002	-0.002	0.001	0.002	0.002**	0.002***	0.005**	0.004*
Cash/Assets	-0.002	0.003	0.007*	0.009*	0.003	0.008	0.014*	0.016*	-0.002	-0.003	0.004	0.003
Cash+short-term investments/Assets	-0.001	0.002	0.006	0.008	0.002	0.004	0.011	0.013	-0.001	-0.003	0.001	0.000
Short-term debt/Assets	-0.001	0.005	-0.005	-0.004	-0.003	0.008	-0.005	-0.005	-0.002	-0.001	-0.006	-0.011
Long-term debt/Assets	-0.001	-0.013	-0.002	-0.005	-0.011	-0.041**	-0.032	-0.043**	0.007	0.013*	0.017*	0.019*
Total debt/Assets	-0.000	-0.001	-0.003	-0.012	-0.014	-0.028	-0.033	-0.048**	0.004	0.013	0.011	0.010

Table 11: Matched pair t-test (continued).

	All plan sponsors				Non-investment grade				Investment grade			
	t	*t*+1	*t*+2	*t*+3	*t*	*t*+1	*t*+2	*t*+3	*t*	*t*+1	*t*+2	*t*+3
Panel B: Adjusted change in plan sponsor's performance												
ROE	-0.085	0.018	-0.108	-0.055	-0.166	-0.011	-0.354*	-0.146	0.076	0.115	0.139	0.248
ROA	0.011	0.002	-0.029**	-0.010	0.018	-0.007	-0.033	0.007	0.005	-0.009	-0.015	0.002
CFO/Assets	-0.006	-0.009	-0.011	-0.015*	0.001	-0.008	-0.013	-0.029**	-0.007	0.001	-0.014	-0.012
CAPEX/Assets	-0.001	0.001	-0.002	-0.002	-0.002	-0.002	-0.006	-0.011*	0.001	-0.003	-0.006	-0.002
R&D/Assets	-0.005	-0.003	-0.003	0.001	-0.000	0.003	-0.001	0.001	-0.006**	-0.004	-0.008**	-0.003
Acquisition/Assets	0.003	-0.002	0.005	0.002	-0.006	0.006	-0.012	-0.015	0.010	-0.011	0.020	0.002
Dividends/Assets	-0.001	-0.001	-0.002	-0.003	0.000	-0.000	-0.001	-0.000	0.001	0.001	-0.004	-0.002
Cash/Assets	0.005	-0.007	-0.011	-0.013*	0.006	-0.003	-0.010	-0.011	0.001	0.002	-0.011	-0.002
Cash+short-term investments/Assets	0.006	-0.004	-0.007	-0.012	0.011	-0.003	-0.013	-0.002	-0.004	0.002	-0.009	-0.003
Short-term debt/Assets	0.000	-0.011*	-0.002	-0.003	-0.003	-0.002	0.006	0.018	0.004	-0.007	-0.001	0.003
Long-term debt/Assets	0.007	0.020*	0.012	0.009	0.026	0.055**	0.054*	0.042	-0.003	-0.013	-0.011	-0.007
Total debt/Assets	0.007	0.004	0.009	0.013	0.021	0.046*	0.056**	0.065**	0.003	-0.020	-0.012	-0.005

Starting with the changes in accounting profitability, such as *ROE*, *ROA*, and *CFO* after the hard freeze. The differences in means for both *raw profitability* and *adjusted profitability* are statistically insignificant for all plan sponsors including non-investment grade and investment grade plan sponsors over the (-1, 1) interval, suggesting that short-term changes in accounting profitability are not related to the implementation of a hard freeze. However, the results for the mean *adjusted changes in profitability* over (-1, 2) and (-1, 3) intervals indicate that, for longer periods after the implementation of a hard freeze, changes in accounting profitability tend to be larger for plan sponsors that implemented a hard freeze compared to their industry peers. In particular, this is true for non-investment grade plan sponsors. Over the (-1, 2) interval, for example, the mean *adjusted change in ROE* is -0.354, and statistically significant at the 10 percent level. In contrast, the mean *adjusted change in ROE* for investment grade plan sponsors over the same (-1, 2) interval is 0.139 and statistically insignificant. Another example is the mean *adjusted change in CFO* over the (-1, 3) interval, which is -0.029, and statistically significant at the 5 percent level for non-investment grade plan sponsors. The mean *adjusted change in CFO* for investment grade plan sponsors over the same (-1, 3) interval, on the other hand is -0.012, and statistically insignificant. Both results are consistent with the sixth hypothesis that financially constrained plan sponsors experience higher increases in their profitability than less financially constrained plan sponsors after the hard freeze. Hence, based on these findings this study cannot reject the sixth hypothesis.

When examining changes in liquidity, such as *cash holdings* and *cash plus short-term investment* holdings, the means for *raw changes in cash plus short-term investments* are statistically insignificant for all plan sponsors including both non-investment grade and investment grade plan sponsors. This suggests that short-term changes in *cash plus short-term investments* are not related to the implementation of a hard freeze. In contrast, all plan sponsors including non-investment grade plan sponsors both have mean *raw changes in cash holdings* over the (-1, 2) and (-1, 3) intervals that are positive, and statistically significant at the 10 percent level. This indicates that cash on hand for plan sponsors increases in the long-term after implementing a hard freeze. These results, however, are not statistically different from the mean changes in *cash holdings* of the industry peers of the plan sponsors that implemented a hard freeze. More specifically, the mean *adjusted change in liquidity* for all plan sponsors including non-investment grade, and investment grade plan sponsors is not statistically significant in Panel B of table 11. This suggests that changes in liquidity for plan sponsors are not driven by the implementation of a hard freeze because their industry peers

experience similar increases in liquidity. However, there is one exception namely the mean *adjusted change in cash holdings* for all plan sponsors is -0.013, and statistically significant at the 10 percent level over the (-1, 3) interval. This indicates that cash on hand for all plan sponsors (relative to their industry peers) tend to increase more in the years after the hard freeze. This result, however, is inconsistent with hypothesis 5(A) that predicts relatively higher increases in liquidity for financially constrained plan sponsors after the hard freeze. Thus, while *raw changes in liquidity* for non-investment grade plan sponsors are positive after the implementation of a hard freeze, there is no evidence that they are related to the hard freeze (as evidenced by the insignificant mean *adjusted changes in liquidity).* Based on these findings hypothesis 5(A) is rejected.

Next, changes in plan sponsor's discretionary spending are examined. For non-investment grade plan sponsors there is little to no change in the mean *raw change in discretionary spending* items, such as *CAPEX, R&D, Acquisitions*, and *Dividends* over all intervals. In contrast, there is an increase in dividend expenditures for investment-grade plan sponsors over all intervals, as evidenced by the positive, and statistically significant changes in mean *raw changes in dividend* expenditures. Furthermore, mean *raw change in CAPEX*, and mean *raw change in acquisitions* expenditures over the (-1, 2) interval are also statistically significant for investment grade plan sponsors. For *CAPEX* expenditures, the mean *raw change* is positive, indicating that longer-term changes in *CAPEX* expenditures are positively related to the implementation of a hard freeze. For *Acquisition* expenditures, the mean *raw change* is negative, indicating that longer-term changes in *Acquisition* expenditures are negatively related to the implementation of a hard freeze. Considering all plan sponsors together, similar mean *raw changes in discretionary spending* items are observed as for investment grade plan sponsors. In addition, the mean *raw change in R&D* expenditures over the (-1, 0) interval appears to be positive, and statistically significant at the 10 percent level for all plan sponsors that implemented a hard freeze. Also, the mean *raw change in R&D* expenditures over the (-1, 3) interval appears to be negative, and statistically significant at the 10 percent level. Thus, *R&D* expenditures in the short-term tend to be positively related to the implementation of a hard freeze, whereas long-term *R&D* expenditures tend to be negatively related to the implementation of a hard freeze. Relative to their industry peers, however, mean *adjusted changes in discretionary spending* items in Panel B show little to no statistically differences with a few exceptions. For non-investment grade plan sponsors, mean *raw changes in CAPEX* expenditures over the (-1, 3) interval increase by 0.005. This change is significantly higher than the control sample mean difference in *CAPEX* expenditures, as

evidenced by the negative, and statistically significant mean *adjusted changes in CAPEX*. This is consistent with hypothesis 5(B) that financially constrained plan sponsors experience higher increases in their investments (i.e. discretionary spending) than less financially constrained plan sponsors after the hard freeze. At the same time, however, investment grade plan sponsors mean *adjusted changes in R&D* over the (-1, 0) and (-1, 2) interval are negative and statistically significant at the 5 percent level, suggesting that investment grade plan sponsors that implemented a hard freeze experience higher increases in their *R&D* expenditures relative to their industry peers. Hence, all these findings indicate that there exists some degree of relationship between discretionary spending and the implementation of a hard freeze, but this holds for both financially constrained as well as for less financially constrained plan sponsors. Due to the mixed evidence, however, this study cannot reject hypothesis 5(B).

Finally, to examine whether hard freezes have an impact on leverage ratios this study uses changes in leverage ratios, such as *short-term debt*, *long-term debt*, and *total debt to assets*. Looking at the mean *raw changes in leverage* for all plan sponsors, the results of the t-test do not appear to be statistically significant over all intervals. This indicates that implementing a hard freeze does not affect the leverage ratios of the plan sponsor in the years after the hard freeze. In contrast, when considering the mean *raw changes in long-term debt to assets* for non-investment grade plan sponsors, negative, and statistically significant changes over the (-1, 1) and (-1, +3) intervals are observed. Moreover, over the (-1, 3) interval, the mean *raw changes in total debt to assets* are negative, and statistically significant at the 5 percent level as well. Both findings suggest that non-investment grade plan sponsors experience significant decreases in leverage ratios after the implementation of a hard freeze. With regard to changes in leverage ratios for investment grade plan sponsors, positive, and statistically significant changes are observed for mean *raw changes in long-term debt to assets* over (-1, 1), (-1, 2), and (-1, 3) intervals. These positive changes suggest that investment grade plan sponsors experience significant increases their long-term debt ratios after the implementation of a hard freeze. According to the sixth hypothesis, it is expected that financially constrained plan sponsors experience smaller increases in leverage ratios than less financially constrained plan sponsors after the hard freeze. Although, investment grade plan sponsors experience significant increases their long-term debt ratios after the hard freeze, non-investment grade plan sponsors seem to experience significant decreases in leverage ratios after the implementation of a hard freeze. Thus, these findings are inconsistent with the expectations. To see if these findings persist after analyzing the mean *raw changes in*

leverage for the industry peers, this study uses the mean *adjusted changes* again. It appears to be the case that non-investment grade plan sponsors experience significant changes in their long-term debt ratios over the (-1,1), and (-1, 3) intervals, as indicated by the negative, and statistically significant change in the mean *adjusted changes in long-term debt to assets*. Over the (-1, 3) interval, the mean *adjusted changes in total debt to assets* are positive, and statistically significant at the 10 percent level as well. Both findings suggest significant decreases in leverage ratios for non-investment grade plan sponsors that implemented a hard freeze (relative to their industry peers). The mean *adjusted changes in long-term debt to assets* for investment grade plan sponsors, however, are positive, and statistically significant at the 10 percent level over the (-1, 1), (-1, 2), and (-1, 3) intervals. This indicates that leverage ratios of investment grade plan sponsors (relative to their industry peers) tend to increase more in the years after the hard freeze. Thus, while investment grade plan sponsors (relative to their industry peers) experience significant increases in leverage ratios this is not the case for non-investment grade plan sponsors. In contrast, they appear to experience significant decreases in leverage ratios relative to their peers. Taken together, these findings are inconsistent with hypothesis 7, because one would expect increases in leverage ratios for both non-investment grade and investment grade plan sponsors after the hard freeze. Based on the evidence, hypothesis 7 is rejected.

6. Conclusion

Many U.S. corporations decided to freeze their DB pension plan and offer their (new) employees the opportunity to save for their retirement through a DC pension plan. One of the main reasons for the shift away from the traditional DB pension plans was to reduce the firm's pension costs and risks. This paper examines the recent shift from DB pension plans to DC pension plans by using Form 5500 filings of pension plans that stated that they have implemented a hard pension freeze in the period 2002-2015. In particular, this study examines the characteristics of plan sponsors that implemented a hard freeze and subsequently investigates the impact of the hard freeze on plan sponsor's liquidity, investments, leverage, and profitability. The primary purpose of this study is to extend the existing literature and provide a more comprehensive understanding of DB pension plan freezes by U.S. corporations.

To address the first research question, different probit regression models are used. It appears that plan sponsors with relatively poorer performance and lower discretionary spending are more likely to implement a hard freeze. Furthermore, prior literature suggests that mandatory pension contributions have a direct and significant impact on a plan sponsor's internal financial resources. Accordingly, this study expects that financial constraints trigger hard freezes. However, to the extent that cash holdings reflect a firm's financial constraints, evidence to confirm this theory is not found. In contrast, evidence suggests that plan sponsors with relatively higher levels of cash holdings are more likely to implement a hard freeze. With respect to the leverage ratios and the credit risk of plan sponsors, on the other hand, the evidence is more consistent with the expectations. Namely, plan sponsors with non-investment grade credit ratings are more likely to implement a hard freeze than plan sponsors that have an investment grade credit rating. Also plan sponsors with higher leverage ratios are more likely to implement a hard freeze. Lastly, non-investment grade plan sponsors with high market to book ratios are more likely to implement a hard freeze. These plan sponsors are triggered to implement a hard freeze because they face difficulties in translating growth opportunities into real firm value due to financial constraints. Taken together, it appears to be the case that hard freezes in the U.S. are triggered by poor performance and relatively high financial constraints.

With regard to the second research question this study examines two samples of firms: a treatment group and a control group, where the former consist of plan sponsors that implemented a hard freeze and the latter group is matched by industry and size. For longer periods after the implementation of a hard freeze, increases in accounting profitability tend to

be larger for plan sponsors that implemented a hard freeze compared to their industry peers. In particular, this is true for non-investment grade plan sponsors. Also, cash holdings of plan sponsors that implemented a hard freeze tend to increase more in the long-term relative to their industry peers. Furthermore, plan sponsors that implemented a hard freeze experience higher increases in their investments (i.e. discretionary spending) than their industry peers. Finally, disparities in leverage ratios between both samples are present. Investment grade plan sponsors experience significant increases in leverage ratios relative to their industry peers, while non-investment grade plan sponsors appear to experience significant decreases in leverage ratios relative to their industry peers.

Overall, the findings in this paper suggest that the benefits of hard freezing DB pension plans are concentrated in the fact that plan sponsors relieve themselves of the implicit promises made in DB pension plans. In particular, the promises made in DB pension plans by financially constrained plan sponsors appear to be relatively more important for firm performance, as evidenced by relatively more statistically significant improvements in firm performance for non-investment grade plan sponsors in the years after the hard freeze. It is important to emphasize, however, that under a hard freeze additional years of service or salary increases will not affect the retirement income of the employee, but the plan sponsor will continue to be liable for the already earned pension benefits. Hence, a plan sponsor's post freeze performance is still partially affected by the promises made in the old DB pension plan.

Although, the results presented in this study suggest that the hard freeze of DB pension plans is beneficial to the sponsoring firm, the hard freeze may have adverse effects on the employees. Even though most employers have introduced a DC pension plan to offset the reductions in retirement income, the net impact of the pension freeze and the participation into the new DC pension plan could be substantial for some employees. Moreover, the shift to DC pension contracts is associated with the transfer of risks and responsibilities from employers to employees. More specifically, under a DC arrangement employees must manage their own contribution levels, investments, and retirement distribution. Employees may be uninformed about their investment choices, lack the financial knowledge or fail to motivate themselves to manage their own retirement money. This might eventually lead to inadequate retirement income. It is therefore important that companies under the supervision of other stakeholders, such as the government and the supervisor pay attention to the information provision regarding the (new) DC arrangements. Besides supervision, another important task has been attributed to the government, namely paying attention to the financial education of employees and improving the willingness of the employees to save for their retirement.

Further research on this topic is needed and should not only focus on making employees aware of their retirement income but also on how people can be motivated to save for their retirement. Furthermore, this study only incorporates (backward looking) accounting measures to examine the effects of the hard freeze. The design of a DB pension contract had a competitive edge in attracting and retaining skilled workers and the shift to DC pension contracts could lead to serious problems related to firm productivity as well as challenges with respect to attracting and retaining skilled workers. Both have the potential to adversely affect long-term firm performance and these potentially damaging effects are not (yet) incorporated in this study. Investment theory states that stock prices reflect all available information (Fama, 1970). Therefore, further research should focus on incorporating market data to see how investors perceive the freezing decision and how they weigh the additional costs of implementing a hard freeze to the firm's employees. Nevertheless, form 5500 filings do not provide exact freeze announcement dates. Thus, in order to identify the exact moment in time when the information concerning the pension freeze was taken into account by investors, one should search the news about the hard freeze.

REFERENCES

Aaronson, S. and Coronado, J. (2005). Are Firms or Workers Behind the Shift Away from DB Pension Plans? Federal Reserve Board Finance and Economics Discussion Series Working Paper No. 2005-17

Aon Hewitt, (2011). Survey: 2011 Hot Topics in Retirement, a changing horizon.

Atanasova, C., and Hrazdil, K. (2010). Why do healthy firms freeze their defined-benefit pension plans? Global Finance Journal, 21(3), 293-303.

Beaudoin, C., Chandar, N., and Werner, E. M. (2010). Are potential effects of SFAS 158 associated with firms' decisions to freeze their defined benefit pension plans? Review of Accounting and Finance, 9(4), 424-451.

Broadbent, J., Palumbo, M., and Woodman, E. (2006, December). The shift from defined benefit to defined contribution pension plans–implications for asset allocation and risk management. Reserve Bank of Australia, Board of Governors of the Federal Reserve System and Bank of Canada.

Campbell J, Dhaliwal D, Schwartz W., (2012). Financing constraints and the cost of capital: evidence from the funding of corporate pension plans. The Review of Financial Studies. 25(3), 868–912

Carroll, T., and Niehaus, G., (1998). Pension plan funding and corporate debt ratings. Journal of Risk and Insurance 65(3), 427–443.

Cocco, J., (2014). Corporate Pension Plans. Annual Review of Financial Economics, 6, 163-184.

Comprix, J., and Muller, K. A. (2011). Pension plan accounting estimates and the freezing of defined benefit pension plans. Journal of Accounting and Economics, 51(1), 115-133.

Coronado, J. L. and Philip C. C. (2004). Cash Balance Pension Plan Conversions and the New Economy. Journal of Pension Economics and Finance. 3(3), 1-18.

Department of Labor, (2016, September). Private Pension Plan Bulletin Historical Tables and Graphs 1975-2014. *Retrieved from* https://www.dol.gov/sites/default/files/ebsa/researchers/statistics/retirement-bulletins/private-pension-plan-bulletin-historical-tables-and-graphs.pdf

Fama, E.F., (1970). Efficient Capital Markets: A Review of Theory and Emperical Work. The Journal of Finance 25(2), 383-417.

Fazzari, S.M., Hubbard G.R., and Petersen B.C. (1988), Financing Constraints and Corporate Investment. Brookings Paper on Economic Activity 1, 141-195

Friedberg, L., and Webb, A. (2005). Retirement and the evolution of pension structure. Journal of Human Resources, 40(2), 281-308.

Internal Revenue Service, (2016, October 5). Form 5500 corner. *Retrieved from* https://www.irs.gov/retirement-plans/form-5500-corner

Jin, L., Merton, R., and Bodie, Z., (2006). Do a firm's equity returns reflect the risk of its pension plan? Journal of Financial Economics, 1-26.

Klein, A., Zur, E., (2009). Entrepreneurial Shareholder Activism: Hedge Funds and Other Private Investors. The Journal of Finance, 64(1), 187-229.

McFarland, B., Pang, G., and Warshawsky, M., (2009). Does freezing a defined-benefit pension plan increase company value? Empirical evidence. Financial Analysts Journal, 65(4), 47-59.

Mercer Human Resources Consulting. (2006). A Closer Look at Recent High Profile Pension Plan Freezes. Update. Mercer Human Resources Consulting, New York, NY (February).

Munnell, A.H., Golub-Sass, F., Soto, M., and Vitagliano F., (2006). Why are healty employers freezing their pensions? Center of Retirement Research, 44.

Munnell, A. H., and Soto, M. (2007). Why are companies freezing their pensions? Available at SSRN 1294772.

Myers, S.C., (2003). Financing of corporations. In: Constantinides, G., M. Harris, and R. Stulz (eds.), Handbook of the Economics of Finance: Corporate Finance Volume 1A, Elsevier North Holland.

O'Brien, R.M., (2007). A Caution Regarding Rules of Thumb for Variance Inflation Factors. Springer.

OECD (2008). OECD Private Pensions Outlook 2008. *Retrieved from* http://www.oecd.org/finance/private-pensions/42575094.pdf

Pension Benefit Guaranty Corporation (December 21, 2005). An Analysis of Frozen Defined Benefit Plans. Washington, DC: Pension Benefit Guaranty Corporation.

Rauh, J. D. (2006). Investment and financing constraints: Evidence from the funding of corporate pension plans. The Journal of Finance, 61(1), 33-71.

Rauh, J., Stefanescu, I., and Zeldes. S., (2013). Cost shifting and the freezing of corporate pension plans. Unpublished working Paper.

Rubin, J., (2007, May). The Impact of Pension Freezes on Firm Value. Wharton Research Scholars Journal, no. 39.

Shivdasani, A., and Stefanescu, I., (2010). How Do Pensions Affect Corporate Capital Structure Decisions? Review of Financial Studies, 23(3), 1287-1323.

Smit, H.T.J., and Trigeorgis, L., (2004). Strategic Investment: real options and games. Princeton University Press, Princeton and Oxford.

Stock, J.H., Watson, M.H., (2011). Introduction to econometrics. Pearson Education Limited.

United States Department of Labor, (2016, December 22). Employee Benefits Security Administration. *Retrieved from* https://www.dol.gov/agencies/ebsa/about-ebsa/our-activities/public-disclosure/foia/form-5500-datasets

Willis Towers Watson, (2016, February 16). Global Pension Asset Study 2016. *Retrieved from* https://www.willistowerswatson.com/en/insights/2016/02/global-pensions-asset-study-2016

Willis Towers Watson, (2016, February). A Continuing Shift in Retirement Offerings in the Fortune 500. *Retrieved from* https://www.towerswatson.com/en-US/Insights/Newsletters/Americas/insider/2016/02/a-continuing-shift-in-retirement-offerings-in-the-fortune-500

APPENDIX

Figure 3: Return on equity for all firms in the data sample (2002-2015)

Source: Compustat data.

Table 4: Merged Form 5500 – Compustat Data for the period 2002-2015.
Annual distribution of hard freezes of plan sponsors where hard freezes are identified by the "hard freeze" identification code in Form 5500 filings with 1 indicating a hard freeze, and 0 otherwise.

Year	Hardfreeze		Total
	0	1	
2002	164	7	171
2003	136	54	190
2004	130	68	198
2005	110	82	192
2006	104	106	210
2007	100	111	211
2008	74	89	163
2009	88	113	201
2010	75	119	194
2011	65	122	187
2012	64	148	212
2013	63	156	219
2014	44	147	191
2015	36	143	179
Total	1253	1465	2718

Source: Form 5500 filings and Compustat data.

Table 6: Treatment and control group for the period 2002-2015

Year	Control group	Treatment group	Total
2002	7	7	14
2003	49	49	98
2004	32	32	64
2005	31	31	62
2006	45	47	92
2007	36	36	72
2008	20	21	41
2009	25	25	50
2010	32	32	64
2011	26	27	53
2012	24	25	49
2013	36	36	72
2014	17	18	35
2015	15	16	31
Total	395	402	797

Source: Form 5500 filings and Compustat data.