COST SAVING AND THE FREEZING OF CORPORATE PENSION PLANS*

Joshua D. Rauh

Stanford University Graduate School of Business and NBER

rauh@stanford.edu

Irina Stefanescu

Federal Reserve Board, Washington D.C.

irina.stefanescu@frb.org

Stephen P. Zeldes

Columbia University Graduate School of Business and NBER

stephen.zeldes@columbia.edu

April 15, 2015

JEL Classification: G14, G23, G32, J31, J32, J33

Keywords: Defined benefit plans; Pension freezes, Retirement; Pension cost; Benefit accruals, Labor compensation, Firm value.

---

* The authors gratefully acknowledge the financial support from the Rotman International Centre for Pension Management (ICPM) at the Rotman School of Management, University of Toronto. We thank Cristian Badarinza Jeffrey Brown, Andrew Ellul, Alan Gustman, Stan Panis, Mark Warshawsky, Motohiro Yogo, and seminar participants at Indiana University, University of Florida, Netspar, the Financial Intermediation Research Conference (Minneapolis), National Bureau of Economic Research (NBER Summer Institute), the Mitsui Finance Symposium (University of Michigan) and the European Finance Association (Cambridge) for helpful suggestions. The views expressed in this paper are those of the authors and do not reflect the views of the Board of Governors of the Federal Reserve System or its staff members.

COST SAVING AND THE FREEZING OF CORPORATE PENSION PLANS

ABSTRACT

The decision to freeze corporate defined benefit (DB) plans is related to variation in prospective cost saving, and freezing DB plans reduces total corporate compensation costs. Firms that freeze have at least 50% higher 10-year expected DB accruals than matched non-freeze firms. Comparing counterfactual DB accruals to increases in contributions to 401(k)s and other replacement plans, firms save 2.7-3.6% of payroll annually and 3.1% of total assets over ten years. Workers would have to value the flexibility or portability of DC plans by at least this much to experience welfare gains. For older workers, the sponsor's savings are larger, consistent with renegotiation of implicit contracts. However, we also identify substantial savings from freezes of cash balance plans, whose accruals as a share of pay do not vary with age or service.

Since the early 1980s, there has been a dramatic shift from defined benefit (DB) to defined contribution (DC) pension arrangements in the U.S. corporate sector. DC plans differ from DB plans along three key dimensions. First, workers in DC plans bear the investment and longevity risk in the pension plan, whereas in traditional DB plans the employer bears this risk. Second, workers in a DC plan have substantially more individual choice and control over accumulation, asset allocation, and decumulation than under a DB plan. For example, benefits under a DB plan are typically paid as a life annuity, whereas benefits in a DC plan amount to a lump sum that can be withdrawn as desired. Finally, accrual patterns in DC plans differ significantly from those in DB plans. Employer contributions to a DC plan (either outright or matching) are typically a constant percentage of salary, independent of age and years of service. In contrast, in a DB plan, the present value of new accruals as a percentage of salary increases significantly with both age and years of service. In a typical plan, the present value cost of annual new accruals can range from 2% of salary for a newly hired younger worker to upwards of 40% of salary for an older worker with substantial seniority.

The shift from DB to DC has occurred through several channels. First, new firms have increasingly favored DC arrangements. Second, some private sector sponsors of DB pension plans have entered bankruptcy and terminated their plans, transferring unfunded liabilities to the Pension Benefit Guarantee Corporation (PBGC). Finally, many firms have limited or stopped new DB accruals by implementing a partial or complete freeze of these accruals. Firms undertaking a "soft freeze" have allowed DB benefits to continue to accrue for existing workers while offering new workers a DC plan only. Firms undertaking a "hard freeze" have stopped DB accruals entirely for all workers and introduced a DC plan instead. While workers do not lose defined benefits that they have earned up to the date of a hard freeze, their defined benefit pension ceases to grow with future work or pay increases. In place of the DB accruals, the employer offers a DC plan, making contributions that are specified as a share of payroll or that match employee contributions up to a limit. Between 1998 and 2013, 21% of *Fortune* 500 employers hard-froze their DB plans, and 15% closed their DB plans to new employees in a soft freeze.[1]

Why has this dramatic shift away from DB towards DC occurred, and in particular why have firms frozen their pension plans? A number of researchers have tried to identify the

[1] See Towers Watson (2014).

fundamental factors causing these changes in the pension landscape (see references below), yet no consensus has emerged. In this paper, we focus on one particular potential explanation - cost savings, i.e. the potential of firms to reduce total compensation costs by freezing their pension plan.

If labor markets are competitive and frictionless, and if the value to workers of all pension arrangements is equal to the cost that firms incur to provide them, then the freezing of pension benefits will not result in any cost saving for firms or reduction in total compensation for workers. Workers would simply receive contributions to DC plans that offset the loss of DB accruals, or alternatively they would demand and receive offsetting increases in wages or other benefits as compensating differentials (Rosen (1974)). If instead, due to labor market frictions or implicit contracts, some workers are receiving (or would in the future receive) compensation in excess of their marginal product or outside wage opportunity, the firm could potentially implement a freeze that would increase profits but leave workers worse off than they would have been had the DB plan been left unaltered. Alternatively, if workers value DB benefits less than it costs the firm to provide them, there would be a surplus over which employers and employees could bargain and both parties could be made better off with a freeze.

Starting from a comprehensive sample of DB plans in the U.S., this paper studies the prospective accrual patterns of firms that freeze pension plans versus those that do not, in order to shed light on three main questions.

First, we define *potential* cost savings as the difference between the projected DB accruals that would occur without and with a freeze, ignoring any changes in wages or DC contributions. We examine whether firms that freeze their DB plans ("freeze firms") have larger potential cost savings in the form of counterfactual DB accruals than comparable firms that do not. We find that firms that froze would have (had they not frozen) faced on average at least 50% higher accruals as a share of firm assets than comparable firms that did not freeze. We also find that the probability that a firm freezes a pension plan is positively related to the value of new accruals as a share of firm assets. We then decompose the accrual differences for freeze and non-freeze firms into benefit-related parameters, demographic factors, and the size of the labor force relative to firm assets. Much of the difference in prospective accruals between the freeze and matched non-freeze firms is driven by the size of the labor force relative to firm assets and differences in benefit factors.

Second, we examine how much annual cost saving is *realized* by firms that freeze, taking into account both the DB accruals that they avoid and the increases in DC contributions that they make. We estimate that net of the increase in total DC contributions, firms that freeze their DB plan save between 2.7 and 3.6% of payroll per year. From the perspective of the firm freezing the plan, the savings over ten years amount to 3.1% of total book assets. Since we find no evidence of compensating salary increases, we conclude that workers would have to value the structure, choice, flexibility, or portability of DC plans (relative to DB plans) by at least this much more to experience welfare gains from freezes.

Third, do different demographic groups experience different changes in total compensation as a result of the cost savings associated with a pension freeze? The richness of the data allows us to decompose the cost saving measurements by age and years of employee service. Assuming that the employer's DC plan contributions as a share of salary are constant across age groups, realized cost savings per worker as a percentage of salary is largest for workers aged 50-65 and smallest for workers aged 20-34. Thus, the net cost effects are largest for older employees.

In order to better understand the motivation for plan freezes, we further examine freezes of cash balance (CB) plans, which are pension plans into which firms had already incorporated hybrid features before the freeze. The benefit in a CB plan is determined by the grossing up at a fixed rate of interest contributions made at a fixed percent of salary, and then applying an annuity factor upon retirement. Referring back to the three dimensions described above differentiating DB and DC plans, CB plans therefore resemble DB plans along the first two dimensions (investment risk and control) but resemble DC plans in their accrual patterns. We find that cost savings from CB plan freezes net of new contributions to DC plans are also substantial, but about 20-30% smaller than savings from freezes of traditional DB plans.

Our findings have important implications for the economics of labor markets. Under a benchmark model, cost savings from a pension freeze would not be possible. Our findings that employers can achieve substantial cost savings by changing pension arrangements therefore suggest at least one of two possibilities. The first is that at some point (most likely before the freeze) at least some workers are not receiving compensation equal to their marginal product or outside option. The gap between compensation and marginal product could be due to the presence of labor market frictions such as search costs, firing costs, or downward wage rigidities, which would be likely to affect the entire tenure distribution. Or it could reflect an implicit pension contract where workers are undercompensated when they are younger and overcompensated when they are older in order to incentivize long tenures (Ippolito (1985)). One example of a setting that is consistent with our findings is as follows. Employees accumulate firm-specific human capital, so that the outside wage option for the worker is less than the marginal product of labor at the firm, and the gap between the two increases with seniority. The firm then has increasing monopoly power over the worker as the worker becomes more senior. The promise of higher pension accruals in the future offer workers some commitment that the firm will not exploit this monopoly power, but the commitment proves to be imperfect as the firm can freeze the plan.

The second possibility is that employees may not value DB pension benefits as much as they value an equal cost DC plan. Evidence suggests that individuals shy away from life annuities that economists argue should provide valuable insurance against uncertain lifetimes (see Benartzi, Previtero, and Thaler (2011) for a review). In this case, DB freezes would provide workers with a form of benefit that they prefer, at least at the time they receive the benefit. Workers may also value the flexibility to change jobs, which is penalized under the accrual patterns in DB plans where a very large portion of the benefits are earned by workers toward the end of long tenures.

Our finding that the benefit cuts from DB freezes are larger for older workers than for younger workers suggests that the freezes are not solely driven by the motivation to provide employees with the format of benefits that they prefer. It is hard to imagine that older workers value DC features more than younger workers. If anything, the younger workers would value portability and flexibility more, so that welfare-enhancing cost savings would be larger for the younger workers. Unless the relative benefit cuts from the freeze are matched exactly with offsetting differential salary adjustments (or simultaneous unanticipated declines in equilibrium real wages), the patterns we observe suggest that at least some cost saving is coming from reneging on implicit contracts to underpay DB plan participants when they are young and over pay them when they are older. In other words, the gap between compensation and the marginal product of labor was greater for older workers than younger workers before the freeze.

However, the fact that savings from CB plan freezes are only 20-30% smaller than savings from freezes of traditional DB plans indicates that savings from freezes cannot only be due to reneging on implicit contracts that pledge to increase compensation with tenure. This is because a CB freeze reduces compensation uniformly as a percentage of salary across age and tenure. Therefore, either some employees value the form of a DC benefit more than a DB one, or a freeze allows employers to reduce gaps between compensation and the marginal product of labor for the entire workforce.

This paper proceeds as follows. Section 1 describes the transformation over the last 35 years in the U.S. pension landscape and the role that pension freezes have played. Section 2 gives a simple model and describes the theoretical issues related to pension freezes and cost savings. Section 3 describes the data and the methodology used in our empirical tests. In Section 4 we present the results. Section 5 concludes.

1. Pension Freezes and the Transformation of the Pension Landscape

1.1. The Labor Market and DB versus DC Pension Structures

In a competitive and frictionless labor market equilibrium, a worker's total annual compensation must equal his or her annual marginal product of labor, and total compensation plus DB pension benefits would equal period-by-period marginal product. Some economic theories, however, have posited a number of reasons why compensation may deviate from a worker's marginal product. For example, efficiency wages may be paid to encourage effort (Shapiro and Stiglitz (1984)). Alternatively, downward wage rigidity may prevent firms from lowering wages in the presence of negative unanticipated shocks to worker productivity (see Bewley (1999) for a review). A third possibility is that implicit contracts in which workers are paid less than their marginal product at the beginning of their career, and more than their marginal product late in the career, may discourage worker shirking (Lazear (1979)).

A traditional DB pension promises a specific monthly income throughout retirement, with the amount based on salary and years of service. Workers are sometimes offered the option of receiving the benefit as a single lump-sum. The plan sponsor puts assets in a fund and invests those assets, but the fund's returns do not affect the retirement benefits promised to workers. Previous literature on the role of DB plans in the corporation have focused on work incentives (Ippolito (1985), Lazear (1983), Mitchell and Fields (1984)), tax benefits (Black (1980), Tepper (1981), Petersen (1992), Shivdasani and Stefanescu (2010)), earnings manipulation (Bergstresser, Desai, and Rauh (2006)) and financial slack (Ballester, Fried and Livnat (2002)).

Corporate pension plans have a significant impact on the investment policy of the company (Rauh (2006)) and firms with DB plans are less likely to be targeted in an acquisition (Cocco and Volpin (2013). In some pension systems, significant agency conflicts can exist between the insider trustees and plan members (Cocco and Volpin (2007)).

The literature has developed two key views of the relationship between the DB pension contract and the labor contract. The first, corresponding broadly to the view of a competitive equilibrium in spot markets for labor, is based on the assumptions that a firm can freeze or terminate its plan at any time without cost, and that there are no other economic benefits to deferring compensation (Sharpe (1976), Bulow (1982)). In such a setting, if workers are rational, they will only forgo wages in any given period equal to the accrual value of new benefits they have earned. The second view is that the DB pension is an implicit contract between the worker and the firm (Treynor (1977), Ippolito (1985)). In this framework, workers are undercompensated relative to their marginal product early in their career, overcompensated later in their career, and in the interim become to some extent bondholders in the firm. This contract creates an incentive for workers to develop human capital, and to stay at the firm in circumstances where they might otherwise quit. Borrowing the terminology from Ippolito (1985), we refer to these first two views as the legal contracts view and implicit contracts view, respectively.

A DC plan is a much simpler structure. It is a retirement savings program under which the employer provides certain contributions to the participant's account during employment, but there is no guaranteed retirement benefit. The participant has control over the investment allocations, and can withdraw all or part of it at will during retirement.

As pointed out in the introduction, DC plans differ from DB plans along three key dimensions: 1) The distribution of risk between employer and employees, 2) the degree of individual choice and control, and 3) the accrual patterns.

DB plan sponsors promise fixed retirement income to their employees, with employers bearing all the investment risk to meet the pension liability. The risk borne by the employee under a DB plan is limited to risk of job change, risk that future benefit accruals will be reduced or eliminated (as in a freeze), salary risk (since the pension is a function of late-career salary), and risk that benefits will be reduced if their employer becomes financially insolvent. The employer bears investment risk and longevity risk. DC plans typically give most or all responsibility to the employee for making their own contributions, bearing investment risk, and making financial decisions. See, for example, Bodie, Marcus, and Merton (1988), Samwick and Skinner (2004), and Poterba et al (2007). The sponsor responsibility in a DC plan arrangement essentially ends after its share of the contribution is made. In section 2.1 below, we describe in detail the differences in pension accrual patterns.

A CB plan is a hybrid form of pension that combines features of defined benefit and defined contribution plans.[2] In this arrangement, the employer contributions are pooled and invested by the sponsor, who promises a minimum guaranteed rate of return (Clark and Schieber (2004), Coronado and Copeland (2004)). As in the traditional DB plans, benefits do not depend on the plan's investment performance. A CB plan is therefore like a DB plan along the dimensions of risk and choice/control. As we will see in section 2.1 below, however, it is more like a DC plan along the dimension of accruals.

1.2. The transformation

DB plans were the predominant vehicle for retirement three and a half decades ago. Encouraged by the tax deductibility of pension contributions in times when corporate tax rates reached historical highs after World War II, these plans were viewed as a tool to build and retain human capital. In 1979, of all workers covered by a pension plan in their current job, 62% were covered only by a DB plan, 16% were covered by only a DC plan, and the remaining 22% were covered by both types of plans. Over the last 30 years, the pension landscape in the U.S. has changed dramatically, as shown in Figure 1. By 2011, merely 7% of covered workers were covered solely by a DB plan, 69% were covered only by a DC plan, and 24% were covered by both. Many other countries in the world have also undergone a significant shift from DB to DC pensions, with countries such as Germany, New Zealand, China, and India having to some extent moved in the same direction (Holzmann (2013)).

The relative decline of DB pensions has been documented beginning with early work by Clark and McDermed (1990) and Gustman and Steinmeier (1992). At first, this shift occurred primarily through newly created firms adopting DC rather than DB plans. Studies by Kruse (1995) and Ippolito and Thompson (2000) examine the periods 1980-1986 and 1987-2005 and find that the growth in DC plans over those periods was more the result of new firms adopting

[2] Legally, CB plans are governed by the rules of DB plans.

DC and DC firms growing faster than of DB plans terminating or of DC conversions. However, these studies came before the hybrid conversions and pension freezes of very large employers that became more common starting in the early 2000s. In 2005, for example, IBM, Hewlett Packard, Sears Holding, Verizon and many other firms announced pension freezes.

What are possible explanations for why this shift toward DC has occurred? In the purest form of the legal view (Bulow (1982)), there is no reason for one type of benefit to be preferred over another. With some slight variations, however, the legal view is consistent with an explanation where the shift to DC is best explained by the extent to which firms and workers want to bear risk.

Consider first the worker's perspective. A DB plan requires participants to take a mostly riskless benefit, essentially to buy deferred annuities with the pension contributions made on their behalf. A DC plan allows participants to choose their asset allocation and receive a distribution of outcomes. While in theory a worker could borrow against his or her future pension to invest in financial assets and achieve the distribution of outcomes that way, in practice this is likely to be infeasible. If workers prefer to control the investment of their contributions, they will prefer a DC plan. If these preferences have gotten stronger over time, then one would expect a shift from DB to DC.

Now consider the firm's perspective. Firms that sponsor DB plans typically invest amounts less than the present value of accrued benefits and take financial risk in hopes of being able to meet the benefit with lower contributions. While in theory the firm could immunize the pension promise, the vast majority firms do not, and instead are exposed to the risk of shortfalls which can have liquidity implications (Rauh (2006)).

Furthermore, the firm also bears interest rate risk, which affects the present value of the pension liability and therefore funding requirements. Life expectancy rates today are longer than they were 20-30 years ago when the plans were adopted. DB plans indeed imposed large costs on many employers during the first half of this decade, as poor asset market returns combined with low interest rates led to large cash funding requirements. In many instances, the pension plan becomes a competing interest for cash within the organization. Changing legislation has also altered expectations about costs. The Pension Protection Act (PPA) of 2006 tightened funding requirements for most industries and new accounting standards (FASB 158) have moved some liabilities onto the balance sheet that were previously off the balance sheet. A DC plan eliminates risk from the firm perspective.

Another possible reason for the shift is the desire to align employee compensation with the lower labor cost of global competitors. In equilibrium, the sum of cash wages and fringe benefits declines with competition, and employers may find it easier to cut pension benefits than wages. In other words, employee compensation may have temporarily become misaligned with marginal product, and the pension freeze could potentially restore this balance.

If DB pensions are best explained by the implicit contracts view (Ippolito (1985)), then the pension freeze could be essentially an abrogation of the implicit contract to undercompensate young workers and overcompensate older workers. In this case, we would expect to see older workers hurt by pension freezes, but not younger workers. If the value of firm-specific human capital has diminished and the firm no longer wants to incentivize younger workers, it can save costs by freezing the pension plan.

Some of the potential macroeconomic forces behind the DB to DC shift include declines in the value of existing jobs relative to new jobs (Friedberg and Owyang (2004)), changes in labor characteristics and preferences (Aaronson and Coronado (2005)), and reduced search costs (Friedberg et al (2006)).

1.3. Literature on Pension Freezes

One possible way for a firm to switch from a DB to a DC plan is to terminate the DB plan. However, the termination of a DB plan is often costly and in many cases not possible. Unfunded pension liabilities can be taken over by PBGC only when the sponsor has filed for bankruptcy. Under normal business conditions, plans can only be terminated if they are fully funded. In this case, a 50% excise tax is applied to any excess assets reverted to the employer, followed by another layer of corporate income taxes. However, if participants in a terminating plan are provided with a replacement plan, the excise tax is reduced to 20%.[3] If they decide to proceed, sponsors must pay off beneficiaries by purchasing annuities. Most of these "standard terminations" have been implemented for small single employer plans.[4] The number of "distress

[3] For this to take effect, the employer must demonstrate that he amended the plan prior to termination to provide immediate pro-rate benefit increases and that he transferred 25% of the terminating plan's excess assets directly to the replacement plan before any amount was reverted.

[4] According to Belt (2005), during the 1986-1994 period, 99,000 of the 101,000 single-employer plan terminations fell into the category of a standard termination, with only 2,000 being distress terminations.

terminations" is also small, but the large ones have been highly publicized (for example United Airlines).

The most common strategy for putting an end to new accruals is a pension freeze. While there are several types of freezes, all involve the reduction or the cessation of new accruals. A hard freeze eliminates all future accruals, so that the benefits will not grow from the level they reached at the time of the freeze. A soft freeze eliminates new accruals for a subset of employees, typically by closing the plan to new employees. Most often, sponsoring companies compensate workers by allowing them to participate in either an existing or a new 401(k) plan. Many large companies sponsor more than one plan, and firms frequently decide to freeze plans on a selective basis.

As an alternative or predecessor to freezing, some companies have undertaken conversions of their existing DB plans to CB plans. Having replaced DB accruals with the CB accruals, the sponsor still has the option to freeze the CB accruals at a later date. If the sponsor freezes the CB plan, the CB accruals are then replaced with contributions to a DC plan.

Reports issued by the Pension Benefit Corporation (2008), Government Accountability Office (2008) and Towers Watson (2012) show that the majority of the freezes affect small plans. They show that about 21 percent of all currently active DB participants have been affected by a freeze and that almost half of all sponsors have at least one frozen plan. [5]

Given the relatively recent wave of freezes (and the lag with which this information becomes available at the plan level), the determinants of the decision to freeze DB plan have not been completely understood. To our knowledge, Munnell and Soto (2007) is the only paper that carries out an analysis that combines both the sponsor and the plan level characteristics, exploring cross-sectional differences in 2005. They find the plan characteristics (underfunding level, size, large credit balances, bargaining power) play a role in the firm decision to freeze, and the financial health of the company has a small economic impact on the decision to freeze. In contrast, Beaudoin and al. (2010) find that the less profitable sponsors are more likely to freeze their DB plan. In addition, they show that the balance sheet impact of SFAS 158 is associated with the decision to freeze.

[5] The PBGC has calculated that as of 2003, 9.4% of DB plans were frozen (PBGC (2005)), and other studies have calculated that the occurrence of plans being frozen to new participants is even more prevalent than the PBGC suggests (Vanderhei (2006)).

Other papers have considered the impact of DB plan freezes on firms' financial and capital budgeting decisions. Phan and Hegde (2012) find that freezing does indeed relieve pressure on corporate liquid resources. Choy, Lin and Officer (2014) examine the impact of plan freezes on the sponsor's risk-taking activities, observing an increase in asset beta, earnings volatility, equity risk, and credit risk. They conclude that DB plans act as inside debt that aligns managers' interest with that of bondholders.

The set of potential explanatory factors for pension freezes is large. A non-exhaustive list would include: a firm's incentive to reduce employee compensation costs, the firm's desire to reduce volatility of cash flows, the demand of employees for more portable benefits, the relative effects of the two types of plans on reported accounting income, whether the firm is a federal contractor receiving reimbursed contributions (Morgensen (2011)), industrial competitiveness, and the impact of greater financial flexibility on operating leverage (Petersen (1994)).

Several papers have attempted to use equity market event studies to examine a closely related question, specifically whether DB plan freezes enhance shareholder value. Positive stock market announcement returns would indicate that the market believes that the cost reductions due to freezes will not be offset by other cost increases, in other words that freezes enhance shareholder value. However, due perhaps to the challenges of identifying the exact moment in time when the information about pension freezes was impounded by markets, this literature has been somewhat inconclusive. Phan and Hegde (2012) find evidence of positive short-run abnormal returns but no evidence of long-term abnormal returns. Rubin (2007) finds that pension freezes enhance firm market values with a lag, which would be consistent with long-run cost savings if markets focus on the short-run flows and do not capitalize long-run cost savings until they are evident in cash flows. Milevsky and Song (2010) find a positive impact of DB freezing on company value of around 3.8% but of marginal statistical significance. McFarland, Pang, and Warshawsky (2009) find instead small firm value declines in some specifications. They argue that 401(k) enhancements and declines in employee productivity may offset any potential cost savings, or alternatively that freezes are simply a reflection of financial challenges at the firm. In the sense that our paper considers the cost effects on the firm from a cash flow and accrual standpoint, it is complementary to this event-study strand of literature.

2. Pension Accruals and Freezes

2.1 Pension accruals

How much does it cost a firm on an annual basis to offer a pension to its workers? Answering this for a defined contribution plan is relatively straightforward, as the costs are simply equal to the contributions that the firm makes each year to the plan. Answering this for a defined benefit plan is more complicated, however, as the pension plan incurs future liabilities that are not necessarily equal to the current contributions that the firm makes to the plan.

Defined Contribution Plans

The annual cost to a firm to offer a defined contribution plan is equal to the contributions that the firm makes, either in the form of an outright contribution or as a matching contribution. Typically these are set as a percentage of each worker's current salary up to a ceiling. If we were to compute the annual costs as a percent of salary of offering the DC plan, and plot this as a function of age or years of service, it would be a flat horizontal line.[6]

Defined Benefit Plans

Most traditional defined benefit plan promise to pay an income stream in retirement whose magnitude depends on years of service, a salary measure, and a benefit factor, and the formula is usually multiplicative. We capture this with the following benefit formula:

$$B_R = k \cdot N_Q \cdot Y_Q$$

where B_R is the nominal benefit paid in year R and beyond, k is the benefit factor, typically in the range of 1.5 – 2.0 percent, N_Q is the number of years that the employee was covered by the plan before quitting, retiring, or being fired from the firm in year Q, and Y_Q is the salary in the final year that the worker was employed and covered by the plan.[7] The employee receives the benefit in the form of an annuity that pays out the same annual B_R every year, beginning at a specified

[6] This assumes that the rates of participation and contributions subject to matching in the DC plan do not vary with age or years of service.

[7] Final pay is most commonly used in the benefit formula. In practice, there are instances where employers take into account the career average pay or integrate the formula with Social Security benefits.

retirement age (e.g. age 65) and continuing as long as the recipient lives.[8] For example, for $k=1.5$, a worker with 40 years of service would receive an annual nominal pension benefit equal to 60 percent of his or her final salary.

At any point in time t, a firm has the option of terminating the plan or freezing benefits. Under the typical termination or freeze, the pension plan is obligated to pay the worker the future annual benefit determined by the formula above, with N_Q and Y_Q "frozen" at their current levels, N_t and Y_t , so that $B_R = k \cdot N_t \cdot Y_t$.

The present value of this future stream is referred to as the "Accumulated Benefit Obligation" (ABO). We focus on this measure of accrued benefits for our analysis.

$$ABO_t = k \cdot N_t \cdot Y_t \cdot Z_{t,R}$$

The annuity factor $Z_{t,R}$ is defined as the cost as of time t of buying a deferred annuity stream of \$1 that begins at year R (if the beneficiary is still alive) and continues as long as the recipient lives. The appropriate discount rate for a true present value from the perspective of the shareholders of the firm would reflect the fact that accrued benefits are bond-like promises on which firms can default only in the event of bankruptcy and termination by the PBGC. A corporate bond yield of the firm's own credit quality with maturity equal to the duration of the pension promise would have these characteristics. The statutory discount rates that firms must use to comply with regulatory rules differs from this in some respects, but is generally based on smoothed yields from either the US Treasury or corporate bond markets.

We define the annual cost to the firm of continuing the pension plan as the difference (in today's dollars) between next year's ABO if the plan continues running and next year's ABO if the plan were instead terminated or frozen today.[9] We refer to this as the value of the annual accruals. These annual costs are uncertain, as there is uncertainty about future salaries and separations.

[8] The worker can usually alter the features of the annuity received and receive a modified annual benefit, and some workers also have the option of receiving instead a single lump-sum payment.

[9] As emphasized by Lazear and Moore (1988) and Stock and Wise (1990), under the implicit contracts view, the option to continue to earn benefits under a DB plan is valuable in addition to the accrued defined benefits. The option is particularly valuable if vesting periods are long. As such the labor market decisions of pension plan participants should also be a function of this option value. If firms can freeze DB plans at their option, however, then the option value component of future DB plan participation for participants is at least in part diminished. In this paper we use the flow of DB accruals as the measure of the compensation cost of DB pensions to the firm, under the implicit assumption that firms have the option to freeze DB accruals.

This cost measure can be defined over a horizon of any length of time. The ABO liability for one worker at time $s>t$ if the plan is not frozen prior to s is:

$$ABO_{s|[no\ freeze\ prior\ to\ s]} = kN_sY_sZ_{s,R}$$

where Y_s is the salary at time $s>t$ (if the participant is still employed) or the last salary the participant received (if separated).[10]

If, instead, the freeze is implemented at time t, the number of years of service and the salary will remain "frozen" at their current levels N_t and Y_t. Therefore, the accumulated benefit obligation will be

$$ABO_{s|[freeze\ at\ t]} = kN_tY_tZ_{s,R}$$

We define $\lambda_{t,s}$ as the difference as of time s between these two measures.

$$\lambda_{t,s} = ABO_{s|[no\ freeze\ prior\ to\ s]} - ABO_{s|[freeze\ at\ t]})$$

Substituting and rearranging, we get:

$$\lambda_{t,s} = kZ_{s,R}[N_sY_s - N_tY_t] = kZ_{s,R}[(N_s - N_t)Y_t + (Y_s - Y_t)N_s]$$

This implies

$$\lambda_{t,s} = kZ_{s,R}Y_t\left[(N_s - N_t) + \left(\frac{Y_s - Y_t}{Y_t}\right)N_s\right] = kZ_{s,R}Y_t\left[(N_s - N_t) + g_{t,s}\,N_s\right]$$

where $g_{t,s}$ is the total salary growth between t and the minimum of s and the last year of employment. Recalling that $\lambda_{t,s}$ is a random variable as of time t, we define $\delta_{t,s}$ as the expected present value (as of time t) of $\lambda_{t,s}$.

$$\delta_{t,s} = E_t\,\{\lambda_{t,s}\,(1+i)^{-(s-t)}\} = E_t\,\{k\,Z_{s,R}(1+i)^{-(s-t)}\,Y_t\left[(N_s - N_t) + g_{t,s}\,N_s\right]\}$$

where the appropriate discount rate i should reflect the riskiness of the future accruals, which depend on the evolution of the worker's future salary and years worked. To the extent that the evolution of future salary and years worked is positively correlated with asset pricing factors, the appropriate discount rate is likely higher than the one appropriate for discounting a deferred

[10] The formula (including the indicator variable I_s) assumes that a worker who dies prior to retirement age receives no retirement benefit. If a spousal or other survivor benefit would be paid, then the formula would have to be adjusted accordingly.

annuity stream.[11] Nevertheless, for simplicity we ignore this distinction. We assume that $Z_{t,R} = E\{Z_{s,R}(1+i)^{-(s-t)}\}$, and that the evolution of salary and work is independent of the evolution of these annuity factors. The latter assumption allows us to use the same discount rate for the entire expression as would be appropriate for discounting $Z_{s,R}$ alone. With these assumptions we can simplify the above expression to

$$\delta_{t,s} = kZ_{t,R}\, Y_t E_t\, \{\, (N_s - N_t)\, + g_{t,s}\, N_s\, \}.$$

Theory suggests that the probability of a firm freezing today should be positively related to δ, the expected extra costs of waiting to freeze rather than freezing today.[12] In our empirical work below, we construct estimates of $\delta_{t,s}$ and test this prediction of the theory.[13]

For illustrative purposes, we assume for the moment that years of service is non-stochastic and always increases by 1 per year in the absence of a freeze. In this case, the one year expected accrual difference of one participant is:

$$\delta_{t,t+1} = kZ_t Y_t[1 + (N_t + 1) \cdot E_t\; (g_{t,t+1})]$$

Where $E_t(g_{t,t+1})$ is the expected growth in salary between t and $t+1$. $\delta_{t,t+1}$ is therefore the expected service cost, or expected one-year increase in accrued benefits if the plan is not frozen.

Dividing $\delta_{t,t+1}$ by current salary Y_t yields the annual cost of a DB plan as a percent of salary. Figure 2 plots this annual cost against age and service. This shows an increasing and convex function, i.e. costs as a function of salary increase both with years of service (assuming g>0) and with age (assuming i>0). Figure 3 shows that this contrasts sharply with the costs of a DC plan, which are constant as a percentage of salary. This difference in costs accrual patterns will be important in our empirical tests, because demographic differences across firms will generate differences in the potential cost savings from freezing a DB pension plan.

If s=t+5 and the worker is assumed to stay with the firm for five full years with certainty, then the expected five year accrual difference for one participant is:

$$\delta_{t,t+5} = kZ_t Y_t[5 + (N_t + 5)\; E(g_{t,t+5})]$$

---

[11] For derivations of the appropriate term structure of discount rates with salary risk and discussion of their correlations with the market, see Lucas and Zeldes (2006), Benzoni, Collin-Dufresne and Goldstein (2007), and Geanakoplos and Zeldes (2010, 2011).

[12] We note that this calculation for s>t+1 ignores the option value of freezing or not in the periods between s and t.

[13] Section 3.3 describes in more detail our estimation of $\delta_{t,s}$, including estimates of k_t, g_t, new hires, and separations.

Cash Balance Plans

In contrast to traditional DB plans, benefits in CB plans accrue linearly with years of service, not convexly, as the benefit is determined by the grossing up at a fixed rate of contributions made at a fixed percent of salary. This is important, as if a firm freezes CB plans and replaces it with a DC plan with the same contribution rate, the only element it is changing is the investment policy and control of the plan. That is, it changes from a CB plan that provides a benefit based on a given percentage of salary grossed up at a fixed investment rate with automatic annuitization at the end (though possibly with a lump sum opt-out), to a DC plan that provides the contributions into an account for the individual to invest and annuitize as she sees fit.

Under a CB plan, each worker has an "account" that is credited each year with a pay credit (a fixed percentage of salary) and an interest credit (equal to the starting balance multiplied by an interest rate – typically either a fixed rate or a rate tied to T-bill rate). The key difference between a traditional DB plan and a CB plan is the accrual pattern, not the form of the benefit, as both typically offer retiring employees to take the benefit as an annuity or as a lump sum.

If the crediting interest rate for the CB plan equals the appropriate market valuation discount rate, then accruals as a percentage of salary for the CB plan equal the flat line shown previously for the DC plan.[14] To the extent that the crediting rate is higher than the market rate, the CB plan could generate a present value cost to the employer that is *downward* sloping with respect to age or service, as in earlier years the employer is promising to pay the employee an above-market return for a longer period of time. When a DB plan is converted to a CB plan, the starting cash balance is typically set equal to the present value of the cash flows the worker would have received under the DB arrangement if there were no future accruals, i.e. the ABO as defined above.

2.1. Effects of Pension Freezes on Total Compensation

As we saw in figure 2, under typical DB pension benefit rules, annual DB accruals as a percent of salary are larger for older workers than for younger workers. This arrangement may

[14] The appropriate market valuation discount rate would be similar to that of a DB plan, reflecting the bond-like nature of the pension promise and the fact that firms can default on the ABO in bankruptcy due to the PBGC.

arise because a firm's older workers are more productive than younger workers, or it may be that the firm is using the implicit contract of the pension plan to reduce turnover or agency problems.

A freeze of DB pension accruals can be thought of as having three sets of effects. First, the freeze in isolation with no offsets would be a cut in the PV of the employee's compensation; this cut is larger for older and longer-tenured employees whose future annual accruals are larger. Hence, when considered in isolation, freezes lower DB pension accruals to zero and reduce the extent of seniority compensation.

Second, the firm may need to compensate employees affected by the freeze. The firm may do this by raising salaries or contributions to other benefit plans, including DC pension arrangements. In a perfectly competitive labor market in which employees and employers valued the pension benefits identically, the change in non-pension compensation should exactly offset the reduction in pension benefit accruals. All potential cost savings for the firm would be offset, and relative total compensation among young and old workers would be the same as they had been before the freeze. In contrast, these offsets will be smaller (or possibly non-existent) if workers were compensated more than their marginal products before the freeze and firms saw it as too costly to lower nominal wages. In other words, it may be less costly to firms to lower total compensation via pension cuts than via nominal wage cuts. Alternatively, if workers had valued the pension benefits at an amount less than the cost to the employer of providing those benefits, freezing the pension plan would generate a surplus over which employers and employees could bargain.

Third, workers themselves may respond to the changed compensation package by pursuing outside options. If the total compensation of some workers relative to their outside options has decreased, then turnover for those workers would be expected to increase.

Given these effects, there are several sets of conditions that would induce a firm to freeze DB plans. For example, a firm whose longer-service workers were being compensated more than their marginal product under the DB plan in the context of wage rigidities might attempt to freeze the plans to improve their competitive position. Firms that are in a weak financial position might also be induced to freeze plans in order to avoid the liquidity or cash flow problems associated with having to fund DB plans instead of investing in other productive opportunities.[15]

[15] DB plans could in theory be funded with riskless assets, but in practice they are not. Riskless funding implies a stream of contributions that is higher in expected value but has the same present-value cost, due to the fact that funding with risky assets requires higher contributions in the most expensive states of the world (Novy-Marx and

Freezing is likely to be more costly for firms facing stronger employee representation in the form of unions.

3. Empirical Tests: Data and Methodology

Our primary source of information on DB pensions is Form 5500 filed annually by plan administrators with the Department of Labor (DOL) and the Internal Revenue Service (IRS). The information is compiled electronically by the DOL and made available on their website.

3.1. Sample Selection

We begin by extracting information on all DB plans filing the form 5500 between 1999 and 2010.[16] Next, we restrict the sample to the subset of plans that can be reliably linked to sponsors covered by Compustat. The reported sponsor name and its employer identification number (EIN) serve as the primary identifiers. While these variables allow us to generate a first link to Compustat sponsors, in many instances the Form 5500 reports the name and the EIN of one of the parent sponsor's subsidiaries. Under the current IRS rules, subsidiaries that are at least 80% owned by the parent may elect to file consolidated income tax returns. But they can also choose to file taxes separately while still remaining consolidated with the parent company for financial purposes. In this case, the EIN and the sponsor name reported in Form 5500 will differ from its parent's. To overcome these problems we manually collect the names of all subsidiaries reported by all sponsors in the 10-k filings (Exhibit 21). We identify potential sponsors in Compustat based on the availability of aggregate pension information such as pension assets and liabilities. This process allows us to obtain a very close match between sponsors and plans. We describe our sample selection in Table I. In the end, we are able to reliably match 40,637 plan-years to Compustat.

The sample is further restricted by the availability of age-service tables at the plan level. Under the current disclosure rules only plans with more than 1,000 active participants are required to disclose this information. We therefore restrict the sample to plans that report 1,000 active participants for at least one year during our sample period. This limits the sample to 14,315 plan-year observations. The age-service tables are reported in the paper attachments to

Rauh (2009)). If firms are financially constrained then risky funding becomes even more costly for the firm, as it may have to forgo capital investment opportunities to fund pensions (Rauh (2006)).

[16] We work with the September 2011 update of the dataset. DOL compiles and posts the most recent filings on a monthly basis. These updates include amendments of filings from previous years as well as late filings.

Form 5500, they are not in a standardized form or collected electronically.[17] An example of this table is reported in the Appendix. Adding a small subgroup of matrices from earlier years that were obtainable from DOL, we are able to identify age-service tables for 8,551 plan-years.[18]

There are 2,049 plan-years forms that are filed by CB plans. Where available, we also collect the cash balance table which reports individual account balances by age-service groups.

3.2 Creating an accurate measure of pension freezes

To pursue our analysis, we need an accurate list of which pension plans were frozen and when the freezing took place. Since 2003, there has been a question (check box) on the form that asks whether the pension plan is frozen. Using the sample of larger plans linked to firms listed on Compustat (described above), we identify all plan-years where administrators report that a hard-freeze is in effect. Once the plan is reported as frozen, all subsequent filings should have this annotation.

In principle, we can identify the year the plan was frozen by examining when the box on the Form 5500 was first checked. Of course, this would only be appropriate starting in 2004, the second year that the question was included on the form. To deal with plans that checked the box in the first year, and as a check on the general accuracy of the information reported in the check box, we searched for information about plan freezes in the news, annual reports, and in the history of the plan as reported in the attachments to Form 5500. We found, and fixed, a number of inaccuracies, including a number of plans that report the freeze in Form 5500 with a long delay.

Table II shows the development of this sample of pension freezes. Our procedure identifies 213 plans that have been frozen during our sample period.[19]

---

[17] The Department of Labor made publicly available Form 5500 attachments during the summer of 2011, for all years between 2003- 2011. We hired a data service (Digital Divide Data) to manually enter the data from these age-service matrices into excel spreadsheets, and we subsequently standardized them for a uniform definition of age and service groups.

[18] The results are not sensitive to the inclusion or exclusion of the roughly 100 observations obtainable for 1999-2002. We requested this subset of paper attachments based on a pilot of sample plan freezes that we identified from public news announcements.

[19] Due to other data requirements, we only use 175 of these for our sample (see below). 52 of the 175 plans have a cash balance feature prior to the announcement.

3.3. Measurement of Accruals

In section 2 above, we defined $\delta_{t,s}$ as the expected value of the benefit accruals that would occur over the period between t and $t+s$ in the absence of a pension freeze. This is a measure of how much a firm could potentially save in pension benefits by freezing its plan today rather than at some point in the future. Recall that $\delta_{t,s} = kZ_{t,R}\, Y_t E_t \,\{\, (N_s - N_t) \; + g_{t,s}\, N_s \,\}$.

We need estimates of $\delta_{t,s}$ for both freeze and non-freeze firms, over different horizons. The data contain plan-level reports of expected one-year increases in accrued benefits in each of many years. However, they do not show the accruals that are expected at a given point in time to occur over multiple years.

Estimating these $\delta_{t,s}$ requires information on projected future salaries and years of service, as well as benefit parameters and discount rates. To obtain these estimates, we use a combination of i) plan-level summary information and also ii) worker-level data from the plan's age-service-salary matrices.

3.3.1 Salaries:

We estimate future salaries and salary growth using the salary information in the age-service salary matrices in the years preceding the freeze, separately for traditional and cash balance plans. Our presumption is that salary growth is persistent at the plan level, and does not change significantly from year to year. Thus, salaries are expected to grow at the same rate as in the past (in the absence of a freeze event). We further apply the estimated plan level salary growth to individual participants' salaries in each age service cell of the matrix to estimate their level in future years.

Estimating missing salary information

Most of the tables include both the number of participants and the average salary per participant, within each age-service group. However, for confidentiality reasons the salary information is only disclosed for age-service groups with more than 20 participants. We therefore estimate the average salary in these age-service groups (where the number of participants is available) by using information on disclosed salaries for the other age-service groups for that plan year and in the plan time series. The imputation relies on the following estimation, using the time series information on all available plans, at the age-service group level:

$$Log(Salary_{wpt}) = \alpha_1 + \alpha_2 Age_{wt} + \alpha_3 Age_{wt}^2 + \alpha_4 Service_{wt} + \alpha_5 Service_{wt}^2 + \varepsilon_p + \vartheta_t + \delta_{wpt}$$

where $Salary_{wpt}$ is the salary for participant w in plan p at time t, Age_{wt} and $Service_{wt}$ are the age and the service groups for participant w at time t, ε_p is the plan fixed effect, ϑ_t is the time fixed effect and δ_{wpt} is the residual term. We run the regressions separately for cash balance (CB) plans and for traditional DB plans, allowing the possibility that the salaries of participants in CB plans follow a different path. We use the regression estimates and age-service data to compute predicted salaries for missing age-service groups.

3.3.2 Future years of service

If no workers transitioned in or out of employment with the firm, then the number of years of service of each worker would simply increase by one per year. In practice, of course, entry and exit does occur and we therefore need to incorporate this into our analysis. We use snapshots of the age-service matrices to estimate the entry and exits (separations) as a percentage of total participants by age groups each year, at the plan and industry level. Entry is easily identified in the first column of the matrix each year while exit is estimated from matrix snapshots at 5 years intervals, on a rolling window.[20] An example of the age-service matrix is provided in the appendix.

3.3.3 Benefit parameters and discount rate

Measuring the change in accrued benefits over any given horizon requires estimates, at the plan level, of the benefit factor (k), the rate of salary growth, and the discount rate.

[20] New participants are generally disclosed in the first column of the age-service matrix (participants with less than one year of service). Exits (or separations) are estimated from snapshots of the age-service matrices at time t and t+5. The matrix at *t+5* allows us to observe a complete shift of the remaining participants on the diagonal. For example, all participants in the cell corresponding to 30-34 age group and 1-4 years of service group are transitioning into a diagonal cell corresponding to 35-39 age group and 5-9 years of service, unless they leave the firm. This structure helps us estimate the separating probability at t+5 at the age-service group level (on a rolling window). This strategy allows us to circumvent additional assumptions on the age service distribution of age and service of participants within each cell of the matrix. Once we calculate the proportion of participants that stay with the firm in 5 years we estimate the separation probability for all years between time t and t+5 by using a geometric average. In the absence of an insufficient time series of matrices at the plan level, we use industry averages, calculated separately for freeze and non-freeze plans, for all years before the freeze.

(a*) The benefit factor (k).* We don't have direct information on the benefit factor *k.* Instead, we impute an estimate of *k* from two different accrual measures: a plan-level service cost measure from the Form 5500 and a plan-level measure that we compute up to an unknown scalar *k* by aggregating information based on age, salary, and years of service. We then compute the value of *k* that equalizes these two service costs.

The first measure is reported in line 1d(2)(b) on Schedule B of Form 5500 as the "Expected Increase in Current Liability", defined as "the amount by which the 'RPA '94' current liability is expected to increase due to benefits accruing during the plan year on account of credited service and/or salary changes for the current year." This variable, also known as "service cost", corresponds to our projected accrual variable ($\delta_{t,s}$) over a one year horizon, i.e. $\delta_{t,t+1}$. We refer to this first estimate as $\widehat{SC}_t^1$.[21]

For the second measure, we start by estimating this service cost for each bracketed age-service cell group w (where here w represents a cell group of workers rather than an individual worker):

$$SC_{w,t} = k \cdot Z_{t,R} \left[N_{w,t+1}Y_{w,t+1} - N_{w,t}Y_{w,t}\right]$$

where $SC_{w,t}$ is the service cost for participant group w in the plan in year t, *k* is the plan level benefit factor, $N_{w,t}$ is the number of years of service of employee group *w* as of time *t*, $Y_{w,t}$ is the time *t* salary of employee group w, and $Z_{t,R}$ is the discounted annuity factor defined above, but instead using the plan-level statutory discount rate (i_p) as reported in Form 5500 (which, recall, may differ from the discount rate that the firm should use when deciding whether to freeze).[22]
We compute a weighted sum across age (a) and service (s) groups (using the number of participants in each group as weights) to obtain

$$\widehat{SC}_t^2 = \sum_a \sum_s SC_{w,t} = k \sum_a \sum_s Z_{t,R} \left[N_{w,t+1}Y_{w,t+1} - N_{w,t}Y_{w,t}\right]$$

[21] Our annual projected accrual calculation allows us to estimate future benefits by age and tenure groups, at any point in time. Most importantly, it allows us to estimate the counterfactual that is what the future benefits would have been for all frozen plans in the absence of the freeze.
[22] We use the statutory discount rate here because we are attempting to match the service cost as reported on Form 5500 (which is based on this statutory discount rate).

as a function of k. We then compute the estimated benefit factor k, which we allow to vary across both plans and time, as the level of k such that $\widehat{SC}_t^1 = \widehat{SC}_t^2$, i.e.

$$\widehat{k_t} = \frac{\widehat{SC}_t^1}{\sum_a \sum_s Z_{t,R}\left[N_{w,t+1}Y_{w,t+1} - N_{w,t}Y_{w,t}\right]}$$

Note that because we model simplified plans, the benefit factors we estimate reflect a range of plan features that affect accrual rates, not just the benefit factor themselves. These might include different COLAs, retirement ages, and vesting provisions.

b. *Salary growth (g_R).* Our estimate of average plan level salary growth in each period is calculated from past salary information, reported in each cell of the age-service matrices along with the number of participants.

c. *Discount rates (i)*. Regulations require firms to use market-based discount rates in calculating their current liability for the IRS 5500 filing. For 2002-2003 the current liability discount rate could not be more than 20% above or 10% below the weighted average of interest rates (set forth by the Treasury department) on the rates of interest on 30-year Treasury securities during the past 4 years. For 2004-2006, the current liability discount rate could not be 10% above or below the weighted average of interest rates on long term investment-grade corporate bonds during the previous 4 years. For 2007-2010, pursuant to the Pension Protection Act, the current liability discount rate used could not be more than 5% above or 10% below the below the weighted average of interest rates on 30-year Treasury securities during the previous 4 years.

Pension obligations are tied to salary at separation, but fixed in nominal terms once separation has occurred. Thus, the value of benefits is very sensitive to the price of the risk of future inflation. The use of market-based discount rates assumes that the bond market properly prices the risk of future inflation. This is particularly true if there are gaps between when workers separate from employment and when they begin drawing a pension. If inflation turns out to be much higher than expected, then the nominal benefit in the DB plan ends up being cheap for the sponsor. The benefit for those who separate from employment before drawing the pension is eroded by the inflation, and this is particularly the case for employees who won't draw benefits for a long time. In contrast, if inflation turns out to be unexpectedly low, then the nominal benefit promised in the DB ends up being very expensive for the sponsor, both because of less erosion of the benefits for separated employees and a higher duration of the promised cash flows.[23] Our assumption is that market discount rates correctly price the risks of future inflation.

Table III reports plan-reported discount rates and the calibration results. The average salary growth varies from 3.35% in 2000 to 4.76% in 2002, but we observe a significant cross sectional variation in all years from about -1.20% to 11.2%. Similarly, the calibrated benefit factor varies from 0% to 4% across plans and years, with a mean of 1.17% and a median of 1.06%. We winsorize both variables at the 0.01 level to reduce the impact of any extreme outliers. Figure 4 reports the distribution of the estimated benefit factor, excluding plan freezes. We note that many plans have very low benefit factors, and some are in fact equal to zero. One possible explanation is the existence of soft-freezes (or freezes occurring before our sample period but having grandfathered participants), in our sample of control firms. Soft freezes are difficult to identify and vary significantly across plans and sponsors. Their inclusion in our control group of plans that are not frozen biases our analysis against finding significant results.

3.3.5 Cash Balance Accruals

We estimate the benefit accruals separately for CB plans as their benefit formula is structured differently. Since the cash balance increases from year to year by a certain percentage of salary and accumulated balance, we require information on each age-service group's account balance, in addition to participant and salary information. We estimate the cash balance increase by running a fixed plan and year effects regression of the log of the change in the cash balance on log of the salary, age group and service group:

$$Log(\Delta CB)_{w,t+1} = \beta_1 + \beta_2\, Age_w + \beta_3 Service_w + \beta_4 Log(Salary)_{wt} + \varepsilon_t + \vartheta_p + \delta_{wt}$$

where ε_t is the time fixed effect and ϑ_p is the plan fixed effect. We then carry these balances forward by taking into account the estimated salary growth, allowing for future potential and exit into the plans as described earlier for regular plans.

[23] We thank Stan Panis for highlighting this point.

3.3.6 DC Accruals

Finally, our cost savings analysis requires an estimate of the difference between future 401(k) contributions made by the sponsor after the freeze and what those 401(k) contributions would have been in the absence of a freeze. Since we obviously cannot observe contributions under this counterfactual, we estimate them using two assumptions. First, we assume that in the absence of a freeze, future 401(k) contributions would equal current contributions multiplied by salary growth. Second, because there is no salary information in the form 5500 for DC plans, we assume that the rate of salary growth for existing participants in the 401(k) plan is the same as the rate of salary growth for participants in the DB plans. Thus, we aggregate (using Form 5500 Schedule H) all actual contributions made by the sponsor to all of its 401(k) plans in the year before the freeze, and then multiply this by the pre-freeze salary growth of participants in the DB plan. Any difference between the actual reported employer contribution and the projected employer contribution is then attributed to the accounts of the DB participants now included in these DC plans.[24] Finally, we translate the incremental 401(k) contributions that we calculate into a present value by using the formula of a growing annuity (over 1-10 years) and assuming constant salary growth, in order to be consistent with the measurement of the DB accruals.[25]

3.4. Summary Statistics on Freeze and Non-Freeze Plans

Panel A of Table IV shows that the freeze and non-freeze plans in our sample differ on a variety of observable dimensions. The observations in this panel consist of all traditional DB plan-years except those plan-years of freeze plans after their freeze. Thus, it excludes the CB freezes. The pre-freeze plan-year observations on the firms that eventually freeze are pooled in the left panel, the plan-year observations on firms that do not freeze at any time in the sample are pooled in the middle panel, and the difference is presented in the right panel.

Firms that freeze pension plans are smaller in that they have an average of $22.5 billion in book assets (from Compustat) compared to $36.9 billion for non-freeze firms. They are also more levered, have lower interest coverage, and have smaller operating margins. The plans of firms that freeze are also smaller in that they have both fewer total participants (a difference of

[24] To the extent that employers temporarily suspended their matching contributions after the financial crisis (especially in 2009), our calculation overestimates the additional 401(k) contributions attributed to the transfer of DB employees into these plans.
[25] We use the same discount rate that we used for DB accruals above (again ignoring any adjustment for salary risk).

4,288 at the mean and 1,126 at the median) and fewer total liabilities (by $316 million at the mean and $92 million at the median) before the freeze. Similarly, freeze plans have lower total payroll by $101 million, although their payroll is higher as a share of total assets by 3.0 percentage points. This suggests that labor costs are more important for firms that freeze than for firms that do not.

Freeze plans also appear to be in worse financial condition than those that do not freeze, as they have funding ratios that are on average 9% lower than non-freeze firms before the freeze. They have a higher ratio of active participants to total participants, by 5.5% at the mean and 7% at the median, suggesting that relatively more of the liability is coming from promises to active employees. However, freeze plans use slightly lower pension discount rates, which is interesting in light of the fact that freeze plans have a higher share of active workers than non-freeze plans. The liabilities of freeze plans are therefore longer duration and would in theory support a higher average discount rate than the non-freeze plans due to the upward sloping term structure.[26]

According to the plans' own reporting, service costs (accruals) for freeze plans are somewhat lower as a share of payroll, by around 0.9% at the mean. However, these service costs are higher as a percentage of the total liability, reflecting the fact that the total liability is smaller. This difference also implies that the ratio of payroll to total liability, and hence the expected growth rate of the total liability, is greater for the freeze plans. Based on our estimates described in the previous section, freeze firms have benefit factors that are 9 basis points greater than firms that do not freeze. Recall that the benefit factors we estimate act as a summary statistic for a range of plan features that affect accrual rates.

Panel B of Table IV compares freeze and non-freeze plans looking only at the sample of firms that have a cash balance feature. The observations in this panel consist of all cash balance plan-years except those of freeze plans after their freeze. Here we observe broadly similar patterns as in Panel A which considered traditional DB plans. CB plans that ultimately freeze have worse funding and a higher ratio of active participants. In contrast to the relationship between freeze and non-freeze traditional DB plans, there is some evidence that the CB plans that ultimately freeze are at the mean somewhat larger than those that do not, though not at the median. Finally, as was the case with traditional DB plans, the CB plans that ultimately freeze

[26] One possibility is that sponsors make plans look more underfunded before the freeze in order to be able to negotiate with participants. Bounds for discount rates are set by federal regulation, but as explained in footnote 12, firms do have some flexibility within these bounds.

have lower service costs as a share of payroll but higher service costs expressed as a fraction of the total liability.

3.5. Matched Control Samples

In order to examine whether the decision to freeze is related to accruals, we use propensity score matched control samples. The goal of this technique is to eliminate the confounding factors of unobserved industry-level trends, year-level correlations such as changes in regulation following the Pension Protection Act of 2006, and other potential covariates. We construct five control samples for this analysis: (1) *'Non-freezes'*, the entire universe of plans that did not freeze during our sample period for which age-service tables were available; (2) '*Ind Controls'*, the subsample of the non-freezes within the same 2-digit SIC code and year; (3) *'PS Match1',* the subsample of the non-freezes group matched on propensity scores calculated based on 2-digit SIC, ABO and year; (4) *'PS Match2'*, the subsample of the non-freezes group matched on propensity scores calculated based on 2-digit SIC, funding ratio, and year; (5) *'PS Match3'*, the subsample of the non-freezes group matched on propensity scores calculated based on 2-digit SIC, ABO, funding ratio, and year. On the presumption that industry wide trends were similar across all plans, the matched-pair research design will allow us to separate the effects of the freeze.

Our matching relies on a matching of propensity scores, originally developed by Rosenbaum and Rubin (1983, 1985) and Heckman et al. (2007). The propensity score is the conditional probability of treatment assignment given ex-ante variables. These variables include the industry classification, the accumulated benefit obligation (ABO) and the funding ratio, for the year preceding the freeze. We measure the industry at the 2-digit SIC level and the funding ratio as the difference between the pension assets and the ABO divided by the ABO. We follow a similar matching procedure to identify matched plans for CB plans freezes from a large sample of CB plans that did not freeze during our sample period.

Our final treatment sample includes 116 traditional pension freezes and 49 cash balance freezes. Our control groups have 4,896 non-freeze plans, 1,634 industry control plans, and 116 PS Matched plans. Similarly, we identify 1,641 non-freeze CB plans, 338 cash balance industry control plans and 49 PS Matched CB plans.

4. Results

4.1. Accrual Comparison

In this section we address the question of whether plans that freeze would have experienced higher or lower accruals than comparable plans that do not freeze. To do so we compare the counterfactual projected accruals of freeze plans with the projected accruals of non-freeze plans over horizons from one to ten years. We focus on scaling by total firm assets, as this reflects the fact that the firm cares about the cost savings of the freeze compared to the total value of the firm rather than just relative to payroll.

Table V presents the projected DB accruals for freeze firms and for various possible control samples. Each row shows the $\delta_{t,s}$, the difference between projected accruals with and without a freeze, over time horizons (s-t) ranging from one to ten years

Whether these total accruals are expected to be increasing more or less than linearly with the time horizon (i.e. whether average per-year accruals are expected to be increasing or decreasing with the time horizon) depends on several factors. First, due to the interaction between salary and years of service, annual accrual patterns in DB plans for a given employee are typically convex with respect to his age, so that an *n*-year accrual for a given employee is more than *n* times a one-year accrual. However, an employee who is going to retire or leave the firm in the near future has no accruals beyond this date, and thus long-horizon accruals for older workers may not be as large as those of younger workers, a possibility we investigate below. Workers with around or just over *n* (e.g. 10) years of work remaining before retirement would have the highest expected accruals over those *n* years (e.g. 10 years), when compared with other groups. The age and service distribution of workers within a plan along with entry and exit and the benefit accrual slopes of those individual workers, will in aggregate determine the convexity of the plan's total benefit accrual with respect to time.

The first row of Table V contains the projected accruals $\delta_{t,s}$ for plans that ended up freezing. It shows that the accruals are slightly concave with respect to the horizon for the first five years, and then becomes even more concave as workers with fewer than ten years remaining retire.[27] As we will show momentarily, this pattern is due to the fact that over longer horizons,

[27] The separating probability from the plan is integrated for all future years and for all age service groups. Our estimation is not able to differentiate participants who retire from those who leave the firm. However, the exit probability for older and longer tenured probability is most likely due to retirement. Benefits earned by workers that exit the plan before the year of the estimation are also incorporated, up to the year of separation. Entry in future years and the benefits earned by these employees thereafter are included as well.

older workers are retiring and therefore would only have accrued benefits for a limited number of years.

We find that the projected accruals for freeze firms are 37% higher than accruals for non-freeze firms on a one-year horizon (that is 0.41% of assets compared to 0.26% of assets), and even larger at longer horizons. The difference between counterfactual freeze and projected non-freeze firm accruals amounts to 0.15% (=0.0041-0.0026) of assets at a one-year horizon and 1.00% (=0.0335-0.0239) of assets at a ten-year horizon (These differences are statistically significant at the 1% level. Restricting the control sample to the plans that are in the same SIC2 industry and year as the freeze plans yields very similar results. Thus, firms that actually freeze have greater potential cost savings from accruals than the firms that do not freeze.

However, as shown in the comparison of means in Table IV, plans that freeze are different from plans that do not freeze in meaningful ways. Most critically, they are smaller in terms of total liabilities, and they also have lower funding ratios. The *PS Match* lines in Table V show the counterfactual freeze plan accruals relative to the projected accruals of propensity-score matched firms that do not freeze. Recall that the first propensity score matched sample (PS1) is matched on industry, year, and total size of the accrued liability, the second propensity score matched sample (PS2) is matched on industry, year, and funding ratio, and the third propensity score matched sample (PS3) is matched on industry, year, total size of accrued liability, and funding ratio. The accruals of the propensity score matched sample are in almost all cases slightly lower than the accruals of the larger and more general control samples. Overall, comparing the estimated counterfactual accruals of the freeze plans to the estimated accruals of the PS Matched control plans yields very similar results to the differences we find when we use the larger and more general control samples.

Panel B of Table V makes similar calculations for the freeze and control samples of CB plans and finds similar patterns. For example, the difference between counterfactual freeze and projected non-freeze cash balance accruals amounts to 0.08% (=0.0026-0.0018) of assets at a one-year horizon and 0.7% (=0.0247-0.0177) of assets at a ten-year horizon.

In untabulated results, we also examined these relationships for accruals as a share of payroll. Under this scaling the differences are typically only statistically significant in propensity score matched samples, reflecting the differences in the relative magnitudes of payroll and assets for the freeze and non-freeze samples. As shown in Table IV, payroll is a considerably larger share of total assets for freeze firms than non-freeze firms. The difference in accruals as a share of total assets is therefore in part due to the fact that firms that freeze have relatively larger payrolls, and in part due to the different age-service distributions and plan parameters (higher benefit factors and salary growth) of the freeze firms.

Figure 5 illustrates these patterns graphically, where the most relevant comparison is the solid line (freeze sample) to the dotted line (matched controls). The upper left graph shows projected counterfactual benefit accruals for freeze plans relative to projected benefit accruals for non-freeze plans, scaled by total assets. The lower left graph does the same for CB plans. These correspond directly to the top and bottom panels of Table V respectively. The graph on the right show that when scaling by total payroll, both the unmatched and the matched sample of non-freeze firms have larger accruals as a share of payroll than the freeze firms, but these differences are insignificant.

Figure 6 examines one potential explanation for why freeze and non-freeze plans may differ in their accruals, specifically the age and service distribution of the workforce. The left column of graphs shows the age and service distribution of freeze and non-freeze plans. When calculating the statistics for the freeze firms we include only those observations in years before the freeze. From the graph in the upper left, it can be seen that plans that ultimately freeze have more workers ages 55-64 and fewer workers ages 40-54 than comparable firms that do not freeze. Specifically, around 2% less of the workforce is 40-44 years old, around 1.5% less of the workforce is 45-49 years old, around 2% more of the workforce is 55-59, and around 1% more of the workforce is 60-64. Service patterns are similar but more extreme. Freeze plans have a higher share of very long-tenured employees with 30 years or more service, and a correspondingly lower share of workers with 5-29 years of service. The graphs on the right show the similar comparisons limiting the control group to the propensity score matched sample. In Figure 6, the joint age-service distribution is shown for freeze plans (Panel A), non-freeze plans (Panel B), and the difference between the two (Panel C). Freeze firms have a small extra mountain of older and longer-tenured workers.

Table VI undertakes a more precise decomposition of the accrual differences for freeze and non-freeze firms into benefit-related parameters, demographic factors, and the size of the labor force relative to firm assets. In each panel, the starting point is the counterfactual prospective DB accruals for freeze firms. The characteristics of each firm are then replaced with those of the propensity score matched controls sequentially and cumulatively, and the prospective DB accruals are re-calculated.

The results are independent of the particular propensity score control sample used. In all cases, scaling by total sponsor assets and the relative ratio of participants to assets ratio has a substantial effect on accruals. For example, in the *PS Match1* the combined effect decreases accruals from 0.0041 to 0.0031, almost half of the differential accruals between the freeze plans and their matched sample. This suggests that labor is more important in the firm production function for sponsors that freeze their plans versus those who do not.

The plan age-service distribution of participants (demographics) and salaries (human capital) have a further effect of decreasing the difference in accruals by about 21% (that is (0.0031-0.0027)/(0.0041-0.0022)). The remaining difference of about 26% is attributed to the combined effect of plan level assumptions on the benefit formulas (the benefit accrual, salary growth and the discount factor). Of all, probably the most significant effect comes from the larger benefit factor offered by freeze plans sponsors to their employees.

Table VII shows probit analysis of accruals on the probability of freezing. The dependent variable is 1 if the plan is frozen in the following year and zero otherwise. Plan-year observations after the plan has been frozen are excluded, and all standard errors are clustered at the firm level. The first column shows that firms with higher accruals as a share of total firm assets ($\delta_{t,s}/TA$) are more likely to freeze, controlling for the size of the plan. The marginal effect is 2.06, which implies that for each 1 percentage point increase in DB accruals scaled by total assets, there is a 2.06 percentage point higher probability of the plan freezing. One standard deviation of $\delta_{t,s}$ /TA is 0.4%, so a plan with on standard deviation more accruals is 0.82 (=0.4*2.06) percentage points more likely to be frozen.

The remaining columns of Table VII include controls for various other plan characteristics. The greater the share of active participants in the plan, the more likely the plan is to freeze. Plans with higher funding levels are less likely to freeze, and plans with unionized workforces are less likely to freeze. Measures of the financial health of the firm such as margins and interest coverage do not have strong effects in the presence of the accruals variable. In the most restrictive specifications, a 1 percentage point increase in DB accruals scaled by total assets is correlated with a 1.147 percentage point higher probability of a plan freeze.

4.2. Realized Cost Savings

In this section we analyze whether firms that freeze their DB plans achieve cost savings ex-post. In freezing a DB plan, a firm stops DB accruals completely. However, after the freeze, employers generally contribute to DC plans for the employees. If the employer ultimately increases DC contributions by as much as (or more than) the DB accruals would have been, then the firm does not save any costs.

Table VIII shows counterfactual DB accruals and estimated actual increases in 401(k) contributions as a share of payroll, for both firms that freeze traditional DB plans and those that freeze CB plans. This analysis is conducted at the sponsor firm level. We define realized cost savings as the difference between counterfactual DB accruals and actual DC contribution. This definition assumes that that there are no other offsets to the employees such as improvements in non-pension fringe benefits or compensating salary changes (we address the latter below).

The top row of Table VIII shows the projected counterfactual accruals for the freeze firms in the sample over time horizons ranging from one to ten years, i.e. the average accruals that would have occurred if the plans had not been frozen. This is similar to the analysis in Table V, but is conducted at the sponsor level. As was the case in Table V, these accruals are slightly concave.

The second row of Table VIII shows the estimated actual increases in contributions to 401(k) plans as a share of payroll. These are also slightly concave, which is related to the fact that discount rates are generally higher than salary growth.[28] Recall that these long-run estimates of DC contributions are based on the assumption that the DB participants of the frozen plan are offered a 401(k) alternative and any additional contribution into these plans (in excess of their normal growth) is attributed to these participants. Compared to a one-year counterfactual DB accrual of 6.2% of payroll, we find that firms increase contributions to DC plans by 2.6% of payroll in the first year after the freeze. Over 10 years, compared to counterfactual DB accruals of 54% of payroll, we estimate that firms will contribute approximately 23% of payroll.[29]

---

[28] As explained in Section 2.3, the 401(k) increases are converted to a present value in order to be consistent with the measurement of the DB accruals.

[29] Our estimates are in effect very close to those reported by Towers Watson in 2009 in their report on “Employer Commitment to Retirement Plans in the United States” (Towers Watson (2009)). Although their data sources and analysis is very different from ours, they find that “sponsors that transitioned from DB to DC-only coverage increased their DC benefits values by an average of 27 percentage points (of payroll), but the enhancement covered only about half of the DB value lost by closing or freezing pension plans”.

The *Difference* line in Table VIII shows the difference between counterfactual accruals and estimated actual 401(k) contribution increases.[30] The *Break even condition* line in the table then shows the annualized, compound additional yearly pre-tax compensation as a percentage of payroll that would be required as a supplement to the post-freeze pension benefit in order to equalize compensation before and after the freeze. There is a shortfall from the perspective of the employee (and thus cost savings from the perspective of the firm) of 3.6% of payroll over a one-year horizon, and 30.1% of payroll over a 10-year horizon. Alternatively, the employee would need a 2.7% compounded annual increase in pre-tax compensation to be indifferent over 10 years.[31]

These results can be interpreted in several contexts. Workers as a group would have to value the structure, choice, flexibility, or portability of DC plans by at least 2.7-3.6% of payroll to experience welfare gains from freezes. From the perspective of the firm, on the other hand, it appears substantial cost savings are realized from freezes. The bottom of Table VIII shows the same analysis scaled by total firm assets to illustrate the financial impact on the firm. The difference between forgone accruals and new firm contributions to DC plans is 0.40% of firm assets in the first year, and 3.1% of total firm assets over 10 years.

Panel B shows that for CB plans, both the counterfactual accruals and the estimated 401(k) increases are significantly smaller. Nevertheless, the net shortfalls from the perspective of the employee (and thus cost savings from the perspective of the firm) are only around 20-30% below the cost effects of the DB plan freezes. Specifically, meeting the break even condition would require extra pre-tax pay of 2.51% of payroll over a 1-year horizon and 24.6% of payroll over a 10-year horizon, or 2.23% pay increases compounded annually over 10 years.

In Figure 7, we investigate the extent to which the cost savings is greater for certain age groups. The graph in the upper left shows the accruals for the freeze plans by age group, scaled by payroll, and the graph in the lower left shows the same accruals scaled by plan assets. At a 5-year horizon the youngest group would have had accruals of 2% of payroll, the middle group of 12% of payroll, and the oldest group 16% of payroll, for a total of 30% which closely matches

[30] While the administrative costs might be different under the two arrangements, current evidence is inconclusive. Administrative expenses are frequently paid by plan participants in DC arrangements. New disclosures on such fees and expenses would be available to participants under Department of Labor regulations by the end of 2012.
[31] The additional compensation would only have to be pre-tax as the counterfactual DB benefit payments would be taxed, and hence the DB accruals are analogous to pre-tax income.

the 5-year accruals shown in Table V.[32] Over a 10-year horizon, the workers who were 20-34 at the time of the freeze have accruals of 4% of payroll, the workers who were 35-49 at the time of the freeze have accruals of 23% payroll, and the workers who were over 50 have accruals of 27% payroll, totaling the 54% of payroll shown in Table V.

Relative to the projected increase in 401(k) contributions for these plans, the figures on the right then show that for the youngest employees (ages 20-34), the increased 401(k) contributions mostly offset the lost DB accruals.[33] On a horizon of one to five-seven years, the most savings is achieved at the expense of the workers in the oldest age group (ages 50-65), followed by those in the middle group (ages 35-49). On a horizon of longer than seven years, the middle group (ages 35-39) bears the greatest cost as a share of payroll. For example, over 10 years, for employees aged 35-49, there is a difference of approximately 17.1% of payroll, and for employees aged 50-65 there is a difference of 15% of payroll. The total cost savings for firms (30.7% of payroll as reported in Table V) is therefore achieved due to the fact that the increase in DC contributions is small relative to the forgone DB accruals for workers in the 35-65 age range, and especially in the 35-49 age range. As a share of firm assets the patterns are similar.

For CB plans, there are no age-specific patterns, since both forgone DB accruals and the cost of DC plans that replace them are flat as a percentage of salary for workers of all wages.

Overall, workers would have to value the structure, choice, flexibility, or portability of DC plans by at least 2.7-3.6% of payroll per year in order not to receive welfare losses from freezes of traditional DB plans, and only slightly less for CB plans. The financial loss to employees varies by age for DB freezes, with the oldest workers most affected, whereas for CB freezes the financial loss to employees is flat across age groups. These patterns support the view that freezes are a partial default on an implicit contract that previously skewed total compensation towards long-tenured workers, but also that reneging on implicit contracts is not the sole reason for freezes.

4.3. Salary Growth

[32] Very small differences from Table V are due to fact that ratios are averaged here by cohort and not across all plans.

[33] As expected, savings are negative in the near future for the youngest cohorts, as their accumulated benefits tend to be small. Note that the smaller magnitudes in the graph reflect the cumulative net savings per groups at the plan level and therefore the fact that the younger cohorts have a smaller number of participants.

In Table IX we examine whether there is a compensating differential through salary increases after freezes. In fact we find the opposite. There are 72 plan-year freeze observations for which salary data exist in at least one year before the freeze and one year after the freeze. Before the freeze, employees in these plans see average salary growth of 4.35%, but the year after the freeze salary only grows by an average 2.56%. Control firms see comparable salary growth in years before the freeze and substantially higher salary growth in the year after the freeze. For example, the PS1 group matched to the freezes on industry, year, and size of liability sees average salary growth of 4.44% in the years before the freeze and 5.72% in the year after the freeze. The PS3 group matched to the freezes on industry, year, size of liability, and funding ratio, sees slightly lower salary growth in the years before the matched firm conducts the freeze (4.07%), but 5.31% salary growth after the freeze.

The evolution of salaries in the control plans also allows us to address some alternative hypotheses about cost saving, specifically that the cost saving we observe might simply reflect other labor cost saving measures that would have been taken in the absence of a freeze. In other words, if firms that freeze are distressed or need to cut labor costs, they might have faced a choice between either freezing the plan or directly cutting wages, and then the cost savings measured in Section 3.1 above would not be cost saving from the freeze but rather a measure of general compensation cuts that are achieved by distressed firms. However, in Table IX where we examine the salary changes of propensity-score matched firms, we find that in fact firms in the same industry and year with similar pension funding ratios actually had higher salary growth rates than the firms that did freeze their plans. To the extent that a deteriorated funding ratio is an indication of the sponsor's weak financial condition, these results suggest that employers of similar financial condition that decided not to freeze their pension plans did not elect to cut wage compensation instead.

5. Conclusions

In this paper, we show that the decision to freeze corporate defined benefit plans is positively related to prospective cost savings resulting from the freeze. Our analysis reveals that freeze firms have at least 50% higher 10-year expected DB accruals than similar non-freeze firms. Firms that freeze pension plans considerably reduce their costs of providing retirement benefits to workers even net of increases to 401(k) contributions over long horizons. On the other hand, employees of these firms have seen decreases in the net present value of their retirement benefits, again inclusive of increased employer contributions to 401(k) plans.

Our findings have implications for the economics of labor markets. In a perfectly competitive frictionless market, costs savings would not be possible. Our result of substantial cost savings suggests that either some workers were receiving compensation above their marginal product of labor (or above their outside option) due to labor market frictions, or that employees value less the DB plan than an equal cost DC plan. The later possibility goes against our finding that benefits cuts are larger for older workers. At the same time, reneging on implicit contracts that pledge to increase compensation with tenure cannot be the only explication, as savings from CB plan freezes are only slightly smaller than savings from freezes of traditional DB plans. We therefore conclude that our results are a combination of these two theories. They are consistent with the hypothesis that the pension promise is an imperfect commitment for the firm not to exploit monopoly power over workers with firm-specific human capital.

REFERENCES

Aaronson, S. and J. Coronado, 2005. Are firms or workers behind the shift away from DB pension plans?, Finance and Economics Discussion Series 2005-17. Board of Governors of the Federal Reserve System (U.S.).

Ballester, M., D. Fried, and J. Livnat, 2002. Pension plan contributions and financial slack. Working Paper, New York University.

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

Belt, B., 2005. Testimony before the Committee on education and the workforce, United States House Of Representatives.

Benartzi, S., Previtero A., and R. Thaler, 2011. Annuitization puzzles. Journal of Economics Perspectives 25(4), 143-164.

Benzoni, L., Collin-Dufresne P., and R. Goldstein, 2007. Portfolio choice over the life-cycle when the stock and labor markets are cointegrated. Journal of Finance 62(5), 2123-2167.

Bewley, T. F, 1999. Why wages don't fall during a recession. Harvard University Press, Cambridge, MA.

Bergstresser, D., M. A. Desai, and J. Rauh, 2006. Earnings manipulation, pension assumptions and managerial investment decisions. Quarterly Journal of Economics 121(1), 157-195.

Black, F., 1980. The tax consequences of long-run pension policy, Financial Analyst Journal 36 (4), 21-28.

Bodie, Z., Alan J.M., and R.C. Merton, 1988. Defined benefit versus defined contribution pension plans: what are the real trade-offs? NBER Chapters, in: Pensions in the U.S. Economy, 139-162, National Bureau of Economic Research, Inc.

Bulow, J., 1982. What are corporate pension liabilities? Quarterly Journal of Economics, 435–52.

Choy, H., Lin J., and M.S. Officer, 2014. Does freezing a defined benefit pension plan affect firm risk? Journal of Accounting and Economics 57(1), 1-21.

Clark, R.and A. McDermed, 1990. The choice of pension plans in a changing environment. Washington: American Enterprise Institute.

Clark , R. and Schieber , S. , 2004. Adopting cash balance pension plans: Implications and issues. Journal of Pension Economics and Finance 3, 271-295.

Cocco, J. and Volpin, 2007. The corporate governance of defined benefit pension plans: Evidence from the United Kingdom, Financial Analysts Journal 63, 70-83.

Cocco, J. and Volpin, 2013. Corporate pension plans as takeover deterrents. Journal of Financial and Quantitative Analysis 48(4), 1119-1144.

EBRI, 2014. FAQs About Benefits-Retirement Issues: http://www.ebri.org/publications/benfaq/index.cfm?fa=retfaqt14fig2.

Friedberg, L. and M. Owyang, 2004. Explaining the evolution of pension structure and job tenure. NBER Working Paper #10714.

Friedberg, L., M. Owyang, and T.Sinclair, 2006. Searching for better prospects: Endogenizing falling job tenure and private pension coverage. Topics In Economic Analysis And Policy 6(1).

Geanakoplos, J., and S.P. Zeldes, 2010. Market valuation of accrued social security benefits, in measuring and managing federal financial risk. Ed. Deborah Lucas, 213-233. Chicago: University of Chicago Press.

Geanakoplos, J., and S.P. Zeldes, 2011. The market value of social security, Working Paper.

Gustman, A., and T. Steinmeier, 1992. The stampede towards defined contribution plans. Industrial Relations 31, 361-369.

Heckman, J. and E.J. Vytlacil, 2007. Econometric evaluation of social programs: causal models, structural models and econometric policy evaluation. Handbook of Econometrics 6B, ed. J. Heckman and E. Leamer. Amsterdam: Elsevier, 4779-4874.

Holzmann, R., 2013. Global Pension Systems and Their Reform. International Social Security Review 66(2), 1-29.

Ippolito, R. A., 1985. The economic function of underfunded pension plans. Journal of Law and Economics 28, 611-651.

Ippolito, R.A. and J.W. Thompson, 2000. The survival rate of defined benefit plans, 1987-1995. Industrial Relations 39, 228-245.

Kruse, D., 1995. Pension substitution in the 1980s: Why the shift toward defined contribution plans. Industrial Relations 34, 218-241.

Lazear, E. 1979. Why is there mandatory retirement?. The Journal of Political Economy 6, 1261-1284.

Lazear, E., 1983. "Pensions as severance pay", in financial aspects of the United States Pension System. Z. Bodie and J. Shoven, eds., Chicago: University of Chicago Press, 57-89.

Lazear, E.P. and R.L. Moore, 1988. Pensions and turnover. In Pensions in the US. Economy, ed. Zvi Bodie, John B. Shoven, and David A. Wise, 163-88, Chicago: University of Chicago Press.

Lucas, D. and S. P. Zeldes, 2006. Valuing and hedging defined benefit pension obligations - the role of stocks revisited. Working Paper.

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

Milevsky, M. and K. Song, 2010. Do markets like frozen defined benefit pension plans? An event study. Journal of Risk and Insurance 77(4), 893-909.

Mitchell, O.S. and G.S. Fields, 1984. The economics of retirement behavior. Journal of Labor Economics 42(1), 84-105.

Munnell, A.H. and M. Soto, 2007. Why are companies freezing their pensions?, Center For Retirement Research At Boston College, Working Paper 2007-22.

Morgensen, G., 2011. Dear committee: Main street says look at pensions. New York Times, 12 November 2011.

Novy-Marx, R., and J. Rauh, 2011. Public Pension Promises: how big are they and what are they worth?. Journal of Finance 66(4), 1207-1245.

Petersen, M. A., 1992. Pension reversions and worker-stockholder wealth transfers. The Quarterly Journal of Economics 107(3), 1033-56.

Petersen, M. A., 1994. Cash flow variability and firm's pension choice: a role for operating leverage, Journal of Financial Economics 36, 361-383.

Phan, H. and S.Hegde, 2012. Pension contributions and firm performance: evidence from frozen defined benefit plans. Financial Management 42(2), 373-411.

Poterba J, J. Rauh, S. Venti, and D. Wise, 2007. Defined contribution plans, defined benefit plans, and the accumulation of retirement wealth. Journal of Public Economics 91(10), 2062-2086.

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

Rosen, 1974, Hedonic prices and implicit markets: product differentiation in pure competition. Journal of Political Economy 82(1), 34-55.

Rosenbaum, P. R., and D. B. Rubin, 1985. Constructing a control group using multivariate matched sampling methods that incorporate the propensity score. The American Statistician 39, 33-38.

Shapiro, C. and Stiglitz, J.E., 1984, Equilibrium unemployment as a worker discipline device, American Economic Review 74, 433-44.

Shivdasani, A. and I. Stefanescu, 2010. How do pensions plans affect capital structure decisions?, The Review of Financial Studies 23, 1287-1323.

Rubin, J., 2007. The impact of pension freezes on firm value. Wharton Research Scholars Journal 39.

Samwick, A.A. and J. Skinner, 2004. Will 401(k) pension plans affect retirement income?, The American Economic Review 94(1), 329-343.

Sharpe, W.F., 1975. Corporate pension fund policy. Journal of Financial Economics 3, 183-193.

Stock, J.H., and D.A. Wise, 1990. Pensions, the option value of work, and retirement. Econometrics 58(5), 1151-1180.

Tepper, I., 1981, Taxation and corporate pension policy. Journal of Finance 36 (1), 1-13.

Towers Watson, 2009. Employer Commitment to Retirement Plans in the United States.

Treynor, J., 1977. The principles of corporate pension finance. Journal of Finance 32(2), 627-638.

Towers Watson, 2012. Pensions in transition: retirement plan changes and employer motivations.

Towers Watson, 2014. Retirement in transition for the Fortune 500: 1998 to 2013, Insider.

Vanderhei, J., 2006. EBRI Issue Brief #291, Employee Benefits Research Institute.

Table I: Sample Selection of Defined Benefit Plans

This table describes our sample selection process. First, we identify all defined benefit plans filing Form 5500 with the Internal Revenue Service and the Department of Labor (column 1). Second, we extract the subset of plans sponsored by companies covered by Compustat (column 2). Our methodology requires the disclosure of the age-service matrix, which is only mandated for plans with more than 1000 active participants. We therefore restrict the sample based on whether the plan reported more than 1000 active participants for at least one year during our sample period (column 3). The age-service matrix is disclosed in the attachments to Form 5500. We screen our sample for the availability of such attachments (column 4). We manually search these filings for the age-service matrices which contain participants and salary information. We report the number of plans for which participant information is available in column 5. For confidentiality purposes, the salary information is only disclosed for cells with more than 20 participants. We report the number of plans for which salary information exists in column 6. As a first screen test, we identify hard freezes based on the plan disclosure from Form 5500 (column 7). Separately, we identify all defined benefit plans that disclose a cash balance feature (column 8). When these plans disclose a cash balance table in the attachments, we report it in column 9.

Fiscal Year	Universe	Linked to Compustat	w/ at least 1000 active	w/ attachments	w/ participants table	w/ salary table	w/ Hard Freeze Code	w/CBP code	w/ cash balance table
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1999	27,733	3335	1,061	45	45	35	0	5	0
2000	39,270	4311	1,386	22	17	15	0	5	0
2001	40,984	4284	1,413	42	28	22	0	6	0
2002	40,904	4065	1,380	51	51	43	3	10	0
2003	41,171	3912	1,373	1,228	1,205	925	53	271	214
2004	41,285	3729	1,333	1,296	1,274	988	73	291	260
2005	41,981	3745	1,342	1,322	1,307	991	100	313	270
2006	42,413	3604	1,321	1,238	1,197	862	126	284	251
2007	42,609	3429	1,286	1,175	1,137	780	159	292	255
2008	47,376	3092	1,197	935	906	614	167	233	211
2009	36,639	2605	1,055	1,044	1,035	705	189	307	265
2010	17,208	526	168	153	147	88	27	32	27
2011	13								
Total	459,586	40,637	14,315	8,551	8,349	6,068	897	2,049	1,753

TABLE II: Sample Freezes

This table describes the sample selection of defined benefit plans (DBPs) subject to a hard freeze during our sample period. A hard freeze implies the plan closure to new participants and the discontinuation of all benefit accruals. While hard freezes are reported in Form 5500, often the disclosure is delayed. We proceed by manually searching the news and the attachments to Form 5500 in order to correctly identify the year of the freeze. In column 1 we report the plans that froze during our sample period and the year of the freeze. In column 2 we report the plans for which we could identify at least one attachment to form 5500 prior to the freeze. In columns 3-4 we report the availability of the age-service matrix for regular freezes, while in columns 5-7 we report the availability of the age-service matrix for cash balance (CB) plans. CB plans are defined benefit plans for accounting and funding purposes. However, the benefit accrual is calculated based on a different rule.

Fiscal Year	Freeze Year Hand collected	Freezes with PDF attachments before freeze	DBPs with participants table	DBPs w/salary table	CBPs with participants table	CBPs with salary table	CBPs with account balance table
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
2000	2						
2001	7						
2002	14	2	2	1			
2003	25	15	12	12	3	2	
2004	25	22	15	10	7	5	5
2005	21	18	13	13	5	4	2
2006	33	33	23	21	10	9	9
2007	27	26	21	18	5	2	2
2008	21	21	14	12	7	7	6
2009	31	31	19	17	12	11	10
2010	5	5	2	1	3	3	3
2011	2	2	2	2			
Total	213	175	123	107	52	43	37

Table III: Calibration

This table reports summary statistics of the three parameters used in the estimation of benefit accruals of active participants. The discount rate (i) is collected from Form 5500 (Schedule B). The plan level salary growth (g) is estimated based on the salary information available in the age-service matrices at cell level, across all years. For plan freezes, the estimation relies on pre-freeze years. The benefit factor (k) is also estimated as described in the text.

Plan year	No. plans	i (MIN)	i (MED)	i (MEAN)	i (MAX)	No. plans	g (MIN)	g (MED)	g (MEAN)	g (MAX)	No. plans	k (MIN)	k (MED)	k (MEAN)	k (MAX)
1999	45	5.62%	6.55%	6.37%	6.56%	38	-1.21%	4.40%	4.31%	11.20%	38	0.00%	1.08%	1.05%	4.00%
2000	17	5.41%	6.30%	6.09%	6.32%	12	-1.21%	4.12%	3.35%	7.12%	10	0.00%	1.09%	1.73%	4.00%
2001	28	5.29%	6.21%	6.16%	6.23%	21	-1.21%	3.82%	3.60%	9.54%	21	0.00%	1.55%	1.65%	4.00%
2002	51	5.14%	6.80%	6.46%	6.85%	29	0.16%	4.40%	4.76%	11.20%	27	0.00%	1.17%	1.03%	1.66%
2003	1,204	4.81%	6.65%	6.15%	8.18%	1122	-1.21%	4.40%	4.54%	11.20%	896	0.00%	1.03%	1.16%	4.00%
2004	1,272	4.72%	6.55%	6.39%	8.18%	1178	-1.21%	4.47%	4.53%	11.20%	932	0.00%	1.05%	1.17%	4.00%
2005	1,306	4.59%	6.10%	6.06%	8.18%	1202	-1.21%	4.40%	4.44%	11.20%	940	0.00%	1.05%	1.16%	4.00%
2006	1,196	4.60%	5.77%	5.72%	8.18%	1080	-1.21%	4.34%	4.35%	11.20%	842	0.00%	1.03%	1.15%	4.00%
2007	1,136	5.21%	5.78%	5.76%	8.02%	1011	-1.21%	4.29%	4.30%	10.52%	767	0.00%	1.08%	1.17%	4.00%
2008	905	5.29%	6.12%	6.13%	8.25%	794	-1.21%	4.25%	4.24%	9.89%	606	0.00%	1.08%	1.19%	4.00%
2009	1,034	6.05%	8.12%	7.84%	8.50%	898	-1.21%	4.26%	4.23%	11.20%	640	0.00%	1.07%	1.20%	4.00%
2010	147	5.70%	6.64%	6.64%	7.61%	132	-1.21%	3.96%	4.05%	7.98%	103	0.00%	1.13%	1.15%	3.95%
Total	8,341	4.59%	6.10%	6.28%	8.50%	7,517	-1.21%	4.39%	4.38%	11.20%	5,822	0.00%	1.06%	1.17%	4.00%

Table IV: Sample Statistics

The table presents the characteristics of plans that have been frozen (for all years preceding the freeze) relative to all plans that have not been frozen. In *Panel A* we report these characteristics for freeze and non-freeze defined benefit plans (excluding CB plans) while in *Panel B* we focus on defined benefit plans with a cash balance feature. *Funding (%)* is defined as plan assets minus plan liabilities divided by plan liabilities. Both plan assets and plan liabilities are collected from Form 5500. The pension liability disclosed in Form 5500 is commonly referred to as the Accumulated Benefit Obligation (ABO) and represents the present value of all accrued benefits. *Active Participants (%)* is the ratio between the number of active participants and the number of total participants, as reported in Form 5500. *Salary per active participant* is calculated based on the age-service salary information. Service cost is the reported expected increase of pension benefits during the year as reported in Form 5500. Payroll is the sum of all participants' salaries as reported in the age-service tables. Discount rate is the rate used to discount future expected pension benefits, as reported in Form 5500. The benefit factor and the salary growth are both estimated based on the collected age-service tables.

Panel A: Frozen plans versus non-frozen plans

	N	Freezes (MEAN)	Freezes (MED)	N	Non-Freezes (MEAN)	Non-Freezes (MED)	Diff (MEAN)		Diff (MED)	
Sponsor level										
Total assets (sponsor) ($mil)	399	22,545	2,814	4,897	36,932	6,664	-14,387	***	-3,850	***
Market leverage	366	0.34	0.28	4329	0.30	0.25	0.04	**	0.03	**
Interest coverage	356	7.64	4.35	4313	10.23	5.16	-2.59	**	-0.81	***
EBITDA/ Sales	391	0.15	0.12	4614	0.17	0.14	-0.02	***	-0.02	***
Plan level										
ABO ($mil)	409	397	98	4,981	713	189	-316.00	***	-91.50	***
ABO/ Total Assets (sponsor)	399	10.6%	4.8%	4,622	8.1%	3.8%	0.02	***	1.04%	***
ABO / Payroll	409	179.7%	100.5%	4,977	232.8%	152.0%	-53.0%	***	-51.5%	***
Payroll ($mil)	411	232	97	5,023	333	116	-101.00	***	-19.50	***
Payroll/ Total assets (sponsor)	397	7.8%	5.0%	4,634	4.8%	2.4%	3.0%	***	2.6%	***
Salary per Active Participant	411	51,904	49,641	5,022	58,578	57,123	-6,673	***	-7,482	***
Active Participants (%)	407	55.7%	56.6%	4,973	50.2%	49.3%	5.5%	***	7.3%	***
Total Participants	409	9,522	3,671	4,988	13,810	4,797	-4,288	***	-1,126	***
Funding (%)	409	-6.2%	-9.1%	4,977	2.9%	-2.2%	-9.1%	***	-6.9%	***
Service Cost/ Payroll	409	5.67%	4.7%	4,978	6.57%	5.6%	-0.90%	**	-0.81%	**
Service Cost/ABO	409	5.49%	4.6%	4,974	4.47%	3.6%	1.02%	***	0.98%	***
Discount rate (%)	411	6.15%	6.1%	5,022	6.26%	6.1%	-0.11%	***	0.00%	
Benefit Factor (%)	411	1.33%	1.1%	5,022	1.23%	1.1%	0.09%	***	-0.03%	
Salary Growth (%)	411	4.45%	4.4%	5,022	4.36%	4.3%	0.09%		0.05%	

Panel B: Frozen plans versus non-frozen plans (defined benefit plans with a cash balance feature)

	N	CBPs Freezes (MEAN)	CBPs Freezes (MED)	N	CBPs Non-Freezes (MEAN)	CBPs Non-Freezes (MED)	Diff (MEAN)		Diff (MED)	
Sponsor level										
Total assets (sponsor) ($mil)	171	45,508	13,365	1,643	61,558	11,456	-16,050		1,909	
Market leverage	144	0.37	0.31	1,505	0.33	0.28	0.04	*	0.03	*
Interest coverage	138	6.03	3.67	1,478	8.56	4.76	-2.53	**	-1.09	***
EBITDA/ Sales	159	0.19	0.15	1,573	0.20	0.18	-0.01		-0.03	**
Plan level										
ABO ($mil)	170	2,180	156	1,688	1,170	327	1,010	***	-171	***
ABO/ Total Assets (sponsor)	171	11.6%	4.4%	1,643	8.0%	4.4%	3.6%	***	0.0%	
ABO / Payroll	170	204.5%	79.0%	1,688	241.8%	141.9%	-37.3%		-62.9%	***
Payroll ($mil)	171	931	228	1,689	597	245	334	***	-17	
Payroll/ Total assets (sponsor)	170	4.5%	2.7%	1,688	7.7%	4.1%	-3.2%	***	-1.4%	***
Salary per Active Participant	171	58,853	53,024	1,689	64,066	62,881	-5,213	***	-9,857	***
Active Participants (%)	171	61.1%	62.3%	1,689	54.8%	54.9%	6.4%	***	7.4%	***
Total Participants	171	35,844	9,234	1,689	23,382	8,787	12,461	***	448	
Funding (%)	170	-1.20%	-4.78%	1,688	2.26%	0.14%	-3.46%	**	-4.92%	**
Service Cost/ Payroll	170	4.9%	4.6%	1,688	6.0%	5.0%	-1.1%	***	-0.4%	***
Service Cost/ABO	170	6.9%	5.3%	1,688	4.8%	3.6%	2.1%	***	1.6%	***
Discount rate (%)	171	6.1%	6.1%	1,689	6.3%	6.1%	-0.2%	***	0.0%	
Salary Growth (%)	171	4.4%	4.2%	1,689	4.2%	4.2%	0.2%		0.1%	

Table V: Projected Defined Benefit Plans Accruals for Plans in Absence of Freeze (plan level)

This table reports the estimated benefit accruals for plans that have been frozen relative to the several control groups of plans that have not been frozen. In *Panel A* we report the estimated accruals for freeze relative to non-freeze plans while in *Panel B* we report freeze and non- freeze plans with a cash balance feature. The estimation is fully described in the text. For freezes, the table shows the estimated accrual based on the age-service table for the year preceding the freeze. $\delta_{t,s}$ is the estimated benefit accrual for regular plans. $\delta_{t,s}$ *(CB)* is the estimated benefit accrual for cash balance plans. *Non-freezes* refer to the group of plans that have not been frozen during the sample period. *Ind Controls* constrains the non-freezes group based on the 2-digit SIC code and year. *PS Match1* selects a matched non-freezes group based on propensity scores calculated based on 2-digit SIC, ABO and year. *PS Match2* selects a matched non-freezes group based on propensity scores calculated based on 2-digit SIC, year, and the funding ratio. *PS Match3* selects a matched non-freezes group based on propensity scores calculated based on 2-digit SIC, ABO, year, and the funding ratio.***, **, * indicates the statistical significance of 0.01, 0.05 and 0.1 of the difference between the estimated benefit accruals of freezes relative to the control group.

Panel A: dABO/Total assets, frozen plans versus non-frozen plan.

	N	Sig.(diff)	Year +1	Year +2	Year +3	Year +4	Year +5	Year +6	Year +7	Year +8	Year +9	Year +10
Freezes	116	***	0.0041	0.0081	0.0119	0.0153	0.0185	0.0228	0.0258	0.0286	0.0312	0.0335
Non-freezes	4,896	***	0.0026	0.0052	0.0077	0.0101	0.0124	0.0154	0.0177	0.0199	0.0220	0.0239
Ind Controls	1,634	***	0.0026	0.0051	0.0077	0.0101	0.0125	0.0155	0.0179	0.0202	0.0224	0.0245
PS Match1	116	***	0.0022	0.0044	0.0066	0.0087	0.0108	0.0134	0.0155	0.0175	0.0195	0.0213
PS Match2	116	***	0.0023	0.0046	0.0069	0.0091	0.0112	0.0139	0.0161	0.0183	0.0203	0.0221
PS Match3	116	***	0.0022	0.0044	0.0065	0.0086	0.0106	0.0131	0.0151	0.0170	0.0189	0.0206

Panel B: $\delta_{t,s}$ *(CB)/Total assets, frozen plans versus non-frozen plans (defined benefit plans with a cash balance feature)*

	N	Sig.(diff)	Year +1	Year +2	Year +3	Year +4	Year +5	Year +6	Year +7	Year +8	Year +9	Year +10
Freezes	49		0.0026	0.0051	0.0076	0.0102	0.0126	0.0151	0.0175	0.0199	0.0223	0.0247
Non-freezes	1,641	*	0.0018	0.0037	0.0055	0.0073	0.0091	0.0109	0.0126	0.0143	0.0160	0.0177
Ind Controls	338	**	0.0015	0.0029	0.0044	0.0058	0.0072	0.0086	0.0099	0.0113	0.0126	0.0140
PS Match1	49	*	0.0018	0.0037	0.0056	0.0075	0.0093	0.0111	0.0129	0.0146	0.0164	0.0181
PS Match2	49	*	0.0019	0.0038	0.0058	0.0077	0.0095	0.0114	0.0132	0.0150	0.0168	0.0186
PS Match3	49	*	0.0019	0.0039	0.0059	0.0078	0.0097	0.0115	0.0134	0.0152	0.0169	0.0187

Table VI: Decomposition of Accrual Differences Between Freeze and Non-Freeze Firms

This table decomposes the differences between freeze firms and propensity-score matched control plans into benefit-related parameters, demographic factors, and the size of the labor force relative to firm assets. In each panel, the starting point is the counterfactual prospective DB accruals for freeze plans. The characteristics of each plan are then replaced with those of the propensity score matched controls sequentially and cumulatively, and the prospective DB accruals are re-calculated.

	$\delta_{t,s}$ /*TA* (Year +1)	$\delta_{t,s}$ /*TA* (Year +5)	$\delta_{t,s}$ /*TA* (Year +10)
Freezes	0.0041	0.0185	0.0335
Sequential Changes in Characteristics to PS Match1			
Plan level scaling			
Sponsor Assets	0.0057	0.0275	0.0537
Total Participants	0.0031	0.0151	0.0312
Plan age service distribution			
Cell participants	0.0026	0.0133	0.0282
Cell salaries	0.0027	0.0131	0.0261
Plan level assumptions			
g (salary growth)	0.0026	0.0125	0.0247
i (discount rate)	0.0025	0.0123	0.0241
k (accrual factor)	0.0022	0.0108	0.0213
Sequential Changes in Characteristics to PS Match2			
Plan level scaling			
Sponsor Assets	0.0036	0.0174	0.0331
Total Participants	0.0033	0.0157	0.0302
Plan age service distribution			
Cell participants	0.0027	0.0136	0.027
Cell salaries	0.0028	0.0137	0.0276
Plan level assumptions			
g (salary growth)	0.0028	0.0137	0.0286
i (discount rate)	0.0028	0.0143	0.0305
k (accrual factor)	0.0023	0.0112	0.0221
Sequential Changes in Characteristics to PS Match3			
Plan level scaling			
Sponsor Assets	0.0047	0.0215	0.041
Total Participants	0.003	0.0143	0.0281
Plan age service distribution			
Cell participants	0.0026	0.013	0.0259
Cell salaries	0.0028	0.0137	0.0272
Plan level assumptions			
g (salary growth)	0.0028	0.0135	0.027
i (discount rate)	0.0028	0.0135	0.0271
k (accrual factor)	0.0022	0.0106	0.0206

Table VII: Probability of Plan Freeze as a Function of Defined Benefit Accruals

This table shows the marginal effects from the probit estimation of the probability of a plan freeze. The dependent variable is 1 if the plan is frozen next year and zero otherwise. Plan-year observations after the plan has been frozen are excluded. $\delta_{t,s}$ */TA* is the estimated benefit accrual for regular plans, normalized by the total assets (*TA*) of the sponsor. *ABO* is the Accumulated Benefit Obligation and *Active Participants (%)* is the ratio between the number of active participants and the number of total participants, as reported in Form 5500. *Funding (%)* is defined as plan assets (PA) minus plan liabilities (or ABO) divided by plan liabilities. Both plan assets and plan liabilities are collected from Form 5500. *Unionized* is a categorical variable equal to 1 if the plan is represented by a union, and zero otherwise. *EBITDA/Sales* refers to earnings before interest, taxes and depreciation and amortization expenses, normalized by total sales. *Interest coverage* is the ratio between EBIT and the interest payments on debt. Standard errors clustered at the sponsored level are reported in parenthesis. * denotes significance at the 10% level, ** at the 5% level, at the 1% level.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
VARIABLES	ME	ME	ME	ME	ME	ME	ME	ME	ME
$\delta_{t,s}$ /TA	2.060***	1.676***	1.431***	1.428***	1.797***	1.428***	1.563***	1.565***	1.147***
	(0.393)	(0.406)	(0.365)	(0.358)	(0.352)	(0.358)	(0.341)	(0.397)	(0.316)
ABO (log)	-0.006***				-0.006***		-0.005***	-0.005***	-0.004***
	(0.001)				(0.001)		(0.001)	(0.001)	(0.001)
ACTIVE PARTICIPANTS (%)		0.022**		0.019*		0.019*			
		(0.011)		(0.010)		(0.010)			
PLAN FUNDING			-0.042***	-0.042***	-0.036***	-0.042***	-0.037***		-0.033***
			(0.011)	(0.011)	(0.010)	(0.011)	(0.010)		(0.010)
UNIONIZED							-0.014***	-0.015***	-0.014***
							(0.003)	(0.003)	(0.003)
EBITDA/ SALES								-0.009*	-0.003
								(0.005)	(0.004)
INTEREST COVERAGE									-0.000***
									(0.000)
Cluster SE (firm level)	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	5,123	5,165	5,123	5,123	5,123	5,123	5,123	5,051	4,710
pseudo-r2	0.0343	0.0166	0.0312	0.0354	0.0515	0.0354	0.0655	0.0444	0.0754

Table VIII: Estimated Cost Savings as a Share of Payroll at the Sponsor Level

The table presents the estimated cost savings emerging from pension plan freezes, at sponsor level. Panel A focuses on regular freezes whereas Panel B focuses on cash balance (CB) plan freezes. *Payroll* is the sum of all participants' salaries for the year preceding the estimation. *Assets* denotes the total book assets of the sponsoring firm. $\delta_{t,s}$ is the estimated benefit accrual for regular plans, aggregated at the sponsor level. $\delta_{t,s}$ *(CB)* is the estimated benefit accrual for CB plans, aggregated at the sponsor level. *d401k* is the increase in the 401(k) contribution following the freeze. *Difference* is the difference between the $\delta_{t,s}$ and d401(k) lines. The *Break even condition* is the compounded annualized pre-tax compensation increase that would make the pension benefit in the absence of the freeze equal to the pension benefit in the presence of the freeze.

Panel A: Defined Benefit (DB) Plan Freezes

	N	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
δt,s / payroll [counterfactual]	114	0.0625	0.1232	0.1815	0.2379	0.2902	0.3589	0.4091	0.4573	0.5023	0.5434
d401k/ payroll [estimated actual]	114	0.0262	0.0519	0.0768	0.1013	0.1251	0.1484	0.1711	0.1934	0.2152	0.2365
Difference		0.036	0.071	0.105	0.137	0.165	0.211	0.238	0.264	0.287	0.307
Break even condition		3.63%	3.50%	3.37%	3.25%	3.10%	3.24%	3.10%	2.97%	2.84%	2.71%
δt,s / TA [counterfactual]	114	0.0044	0.0085	0.0125	0.0161	0.0195	0.024	0.0271	0.0301	0.0329	0.0353
d401k/ TA [estimated actual]	114	0.0005	0.0009	0.0014	0.0018	0.0022	0.0027	0.003	0.0034	0.0038	0.0042
Difference		0.004	0.008	0.011	0.014	0.017	0.021	0.024	0.027	0.029	0.031
Break even condition		0.39%	0.38%	0.37%	0.36%	0.34%	0.35%	0.34%	0.33%	0.32%	0.31%

Panel B: Cash Balance (CB) Plan Freezes

	N	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
$\delta_{t,s}$ (CB)/ payroll [counterfactual]	45	0.0275	0.0549	0.082	0.1088	0.1348	0.1618	0.189	0.2162	0.2433	0.2686
d401k/ payroll [estimated actual]	45	0.0024	0.0047	0.007	0.0093	0.0115	0.0137	0.0159	0.018	0.0201	0.0222
Difference		0.025	0.050	0.075	0.100	0.123	0.148	0.173	0.198	0.223	0.246
Break even condition		2.51%	2.48%	2.44%	2.40%	2.35%	2.33%	2.31%	2.29%	2.26%	2.23%

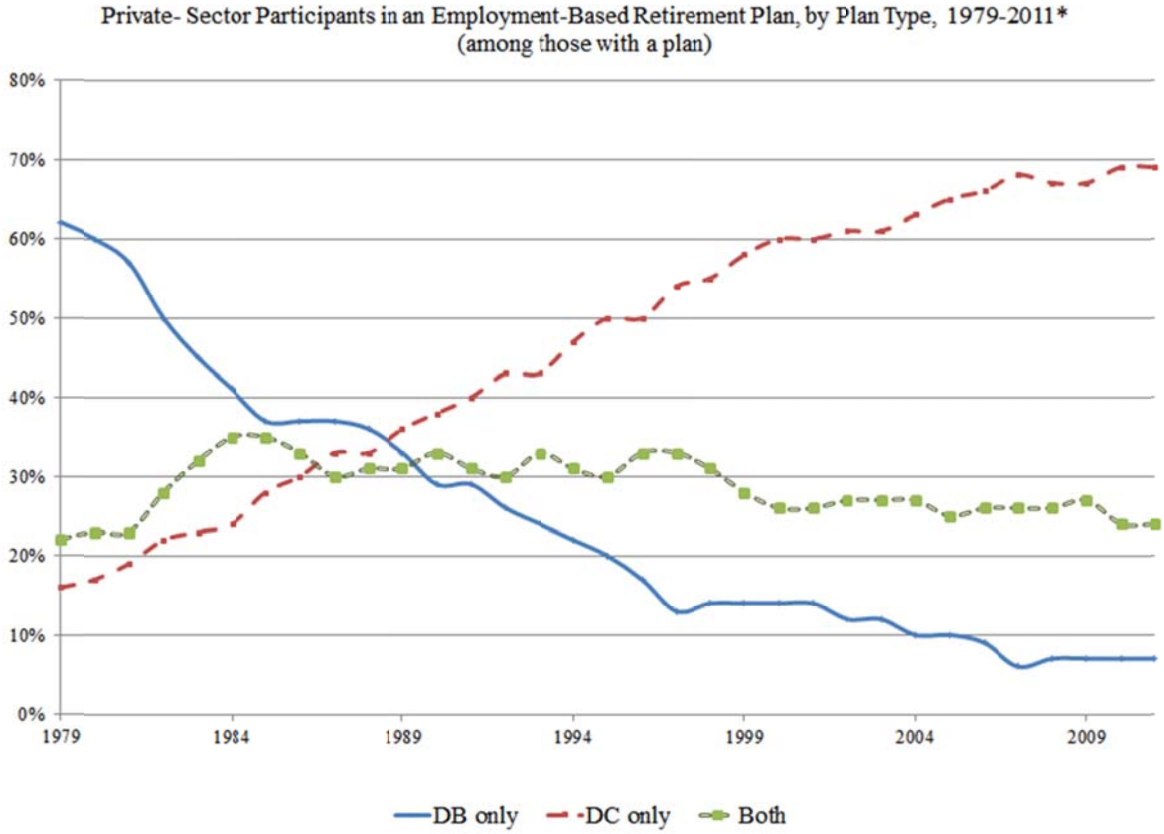
$\delta_{t,s}$ (CB)/TA [counterfactual]	45	0.0026	0.0053	0.0079	0.0104	0.0130	0.0155	0.0180	0.0205	0.0229	0.0254
d401k/ TA [estimated actual]	45	0.0006	0.0011	0.0017	0.0022	0.0027	0.0032	0.0037	0.0042	0.0047	0.0051
Difference		0.0020	0.0042	0.0062	0.0082	0.0103	0.0123	0.0143	0.0163	0.0182	0.0203
Break even condition		0.20%	0.21%	0.21%	0.20%	0.21%	0.20%	0.20%	0.20%	0.20%	0.20%

Table IX: *Ex Post* Salary growth

The table presents the actual salary growth before and after the freeze for freeze plans and their controls. *'Previous years'* refer to all years before the freeze and '*Year +1*' refers to the first year after the freeze was implemented. *Ind Controls* constrains the non-freezes group based on the 2-digit SIC code and year. *PS Match1* selects a matched non-freezes group based on propensity scores calculated based on 2-digit SIC, ABO and year. *PS Match3* selects a matched non-freezes group based on propensity scores calculated based on 2-digit SIC, ABO, year, and the funding ratio.

	N	Previous Years (MEAN)	Previous Years (MEDIAN)	Year +1 (MEAN)	Year +1 (MEDIAN)
Freezes	72	4.35%	4.40%	2.56%	3.14%
Industry controls	1,150	4.41%	4.41%	4.86%	3.78%
Freezes	72	4.35%	4.40%	2.56%	3.14%
PS Match1	72	4.44%	4.53%	5.72%	4.91%
Freezes	72	4.35%	4.40%	2.56%	3.14%
PS Match3	72	4.07%	4.26%	5.31%	3.90%

Figure 1: Participation in Retirement Plans



Source: Employee Benefit Research Institute, based on U.S. Department of Labor Form 5500 Summaries for 1979–1998; PBGC, Current Population Survey Data for 1999–2011.

Figure 2: Employer Cost in a DB Plan as a Percent of Salary

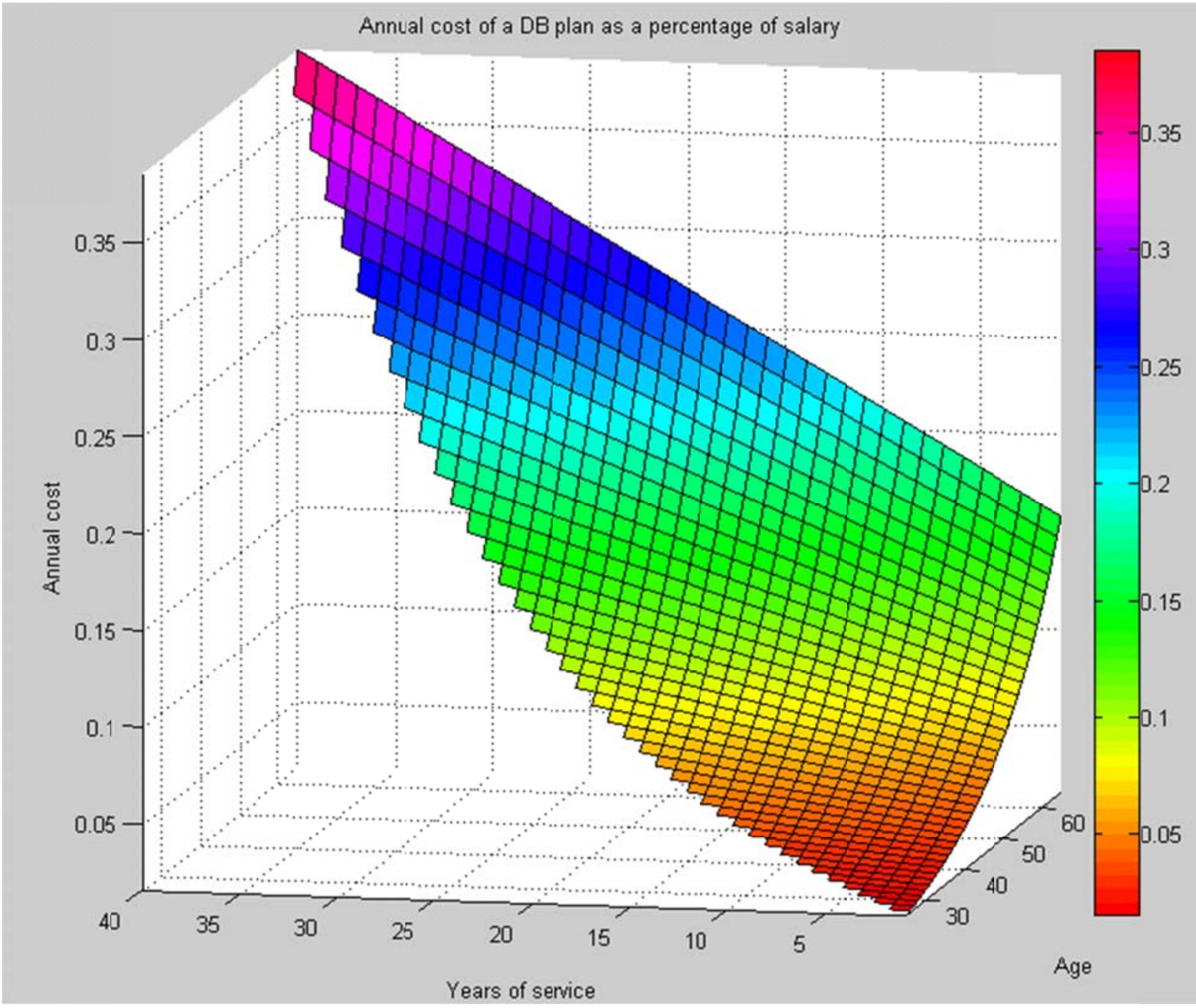


Figure 3: Employer Cost in a DC and in a DB plan

The figure shows the expected cost (as a percentage of salary) for the sponsor over time, for one worker hired at age 25 and remaining with the firm until age 65, in a DB versus a DC arrangement. The starting salary is $40,000, the salary growth is 4% per year, the discount rate is 6%, and the benefit factor is 1.5%. The employer contribution is 4% per year.

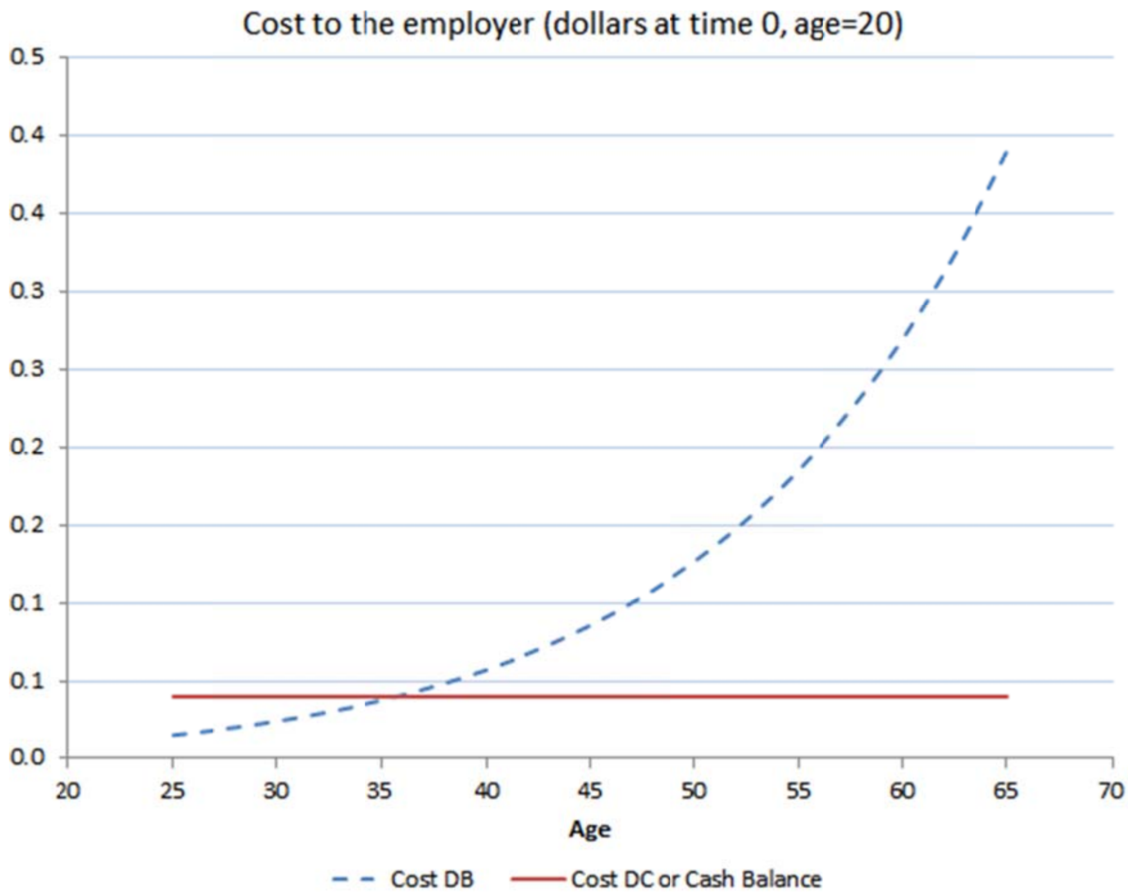


Figure 4: Estimated benefit factor

This figure shows the estimated benefit factor at the plan level, for all plans excluding plan freezes. The benefit factor is estimated based on past plan service cost (from Form 5500) and the age-service tables distributions of participants and salaries.

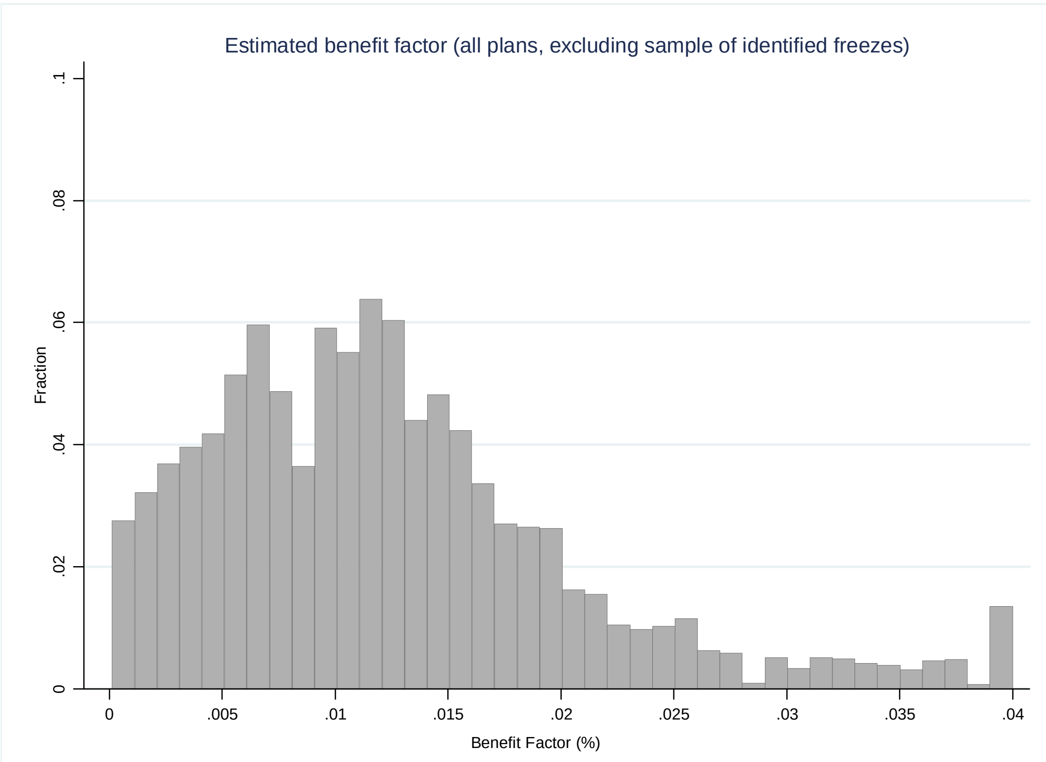
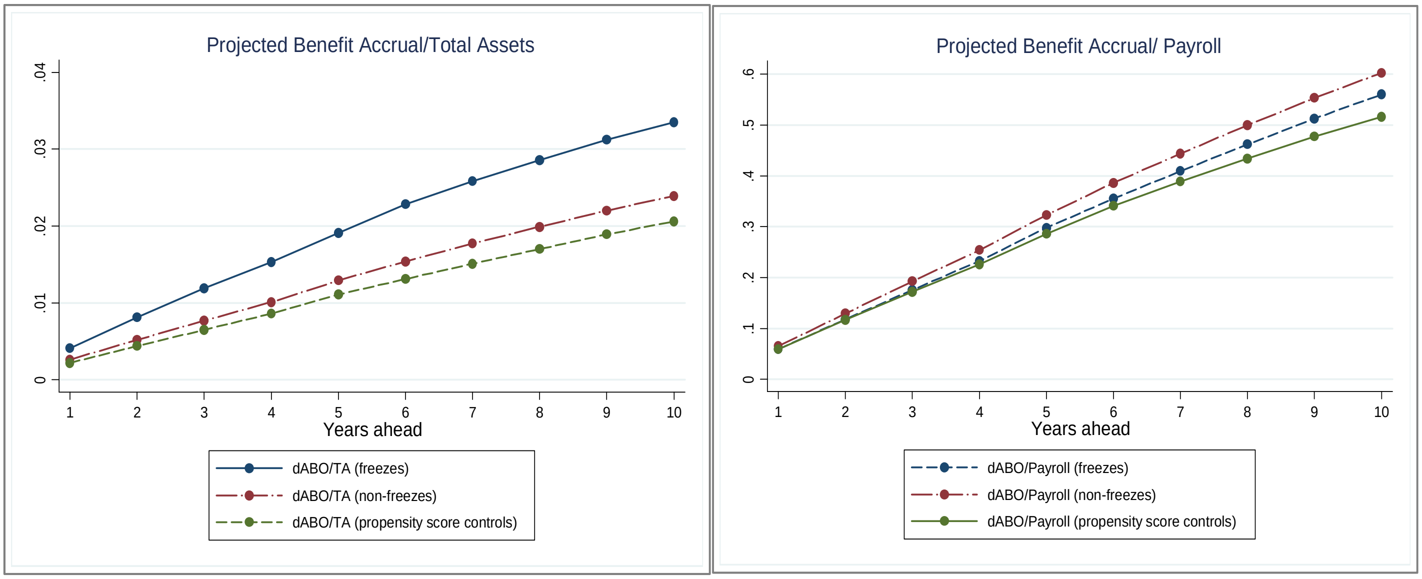


Figure 5: Projected Benefit Accruals for Freezes and Controls

The table shows projected benefit accruals as a percentage of the payroll and of total sponsor assets (*TA*) for traditional Defined Benefit plans (Panel A) and Cash Balance plans (Panel B). Each graph includes estimates for three different groups: freezes, non-freezes, propensity control plans.

Panel A: Benefit accruals for regular Defined Benefit plans



Panel B: Benefit accruals for defined benefit plans with a Cash Balance feature

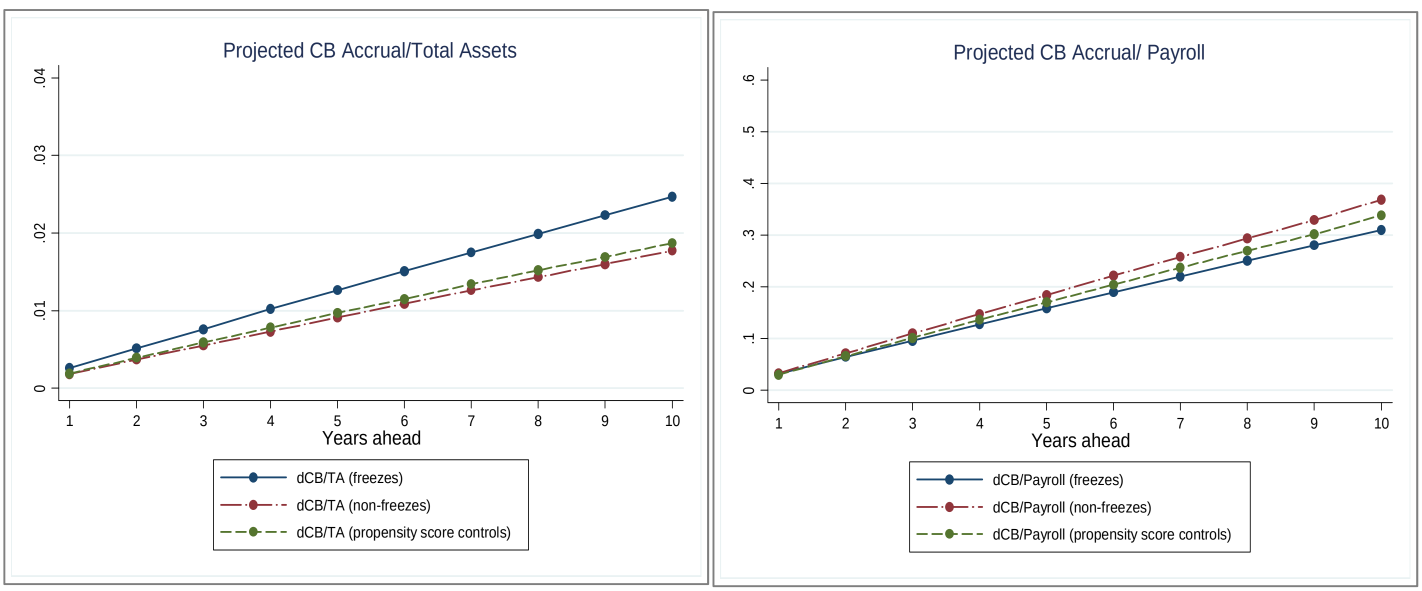
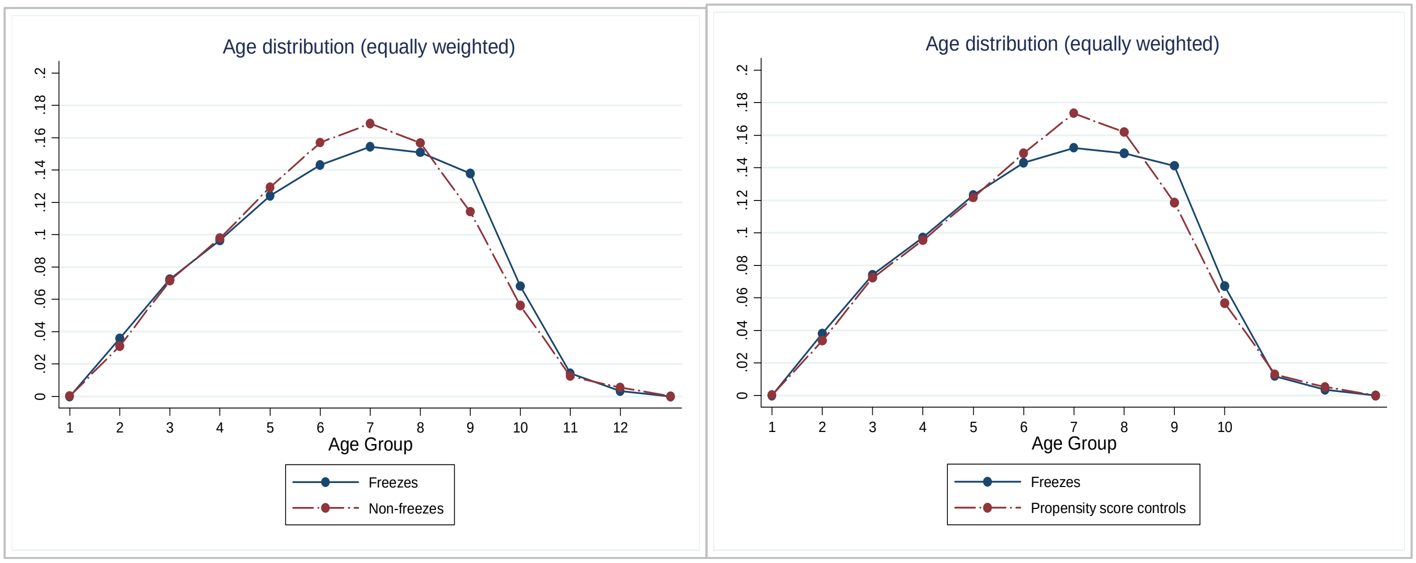


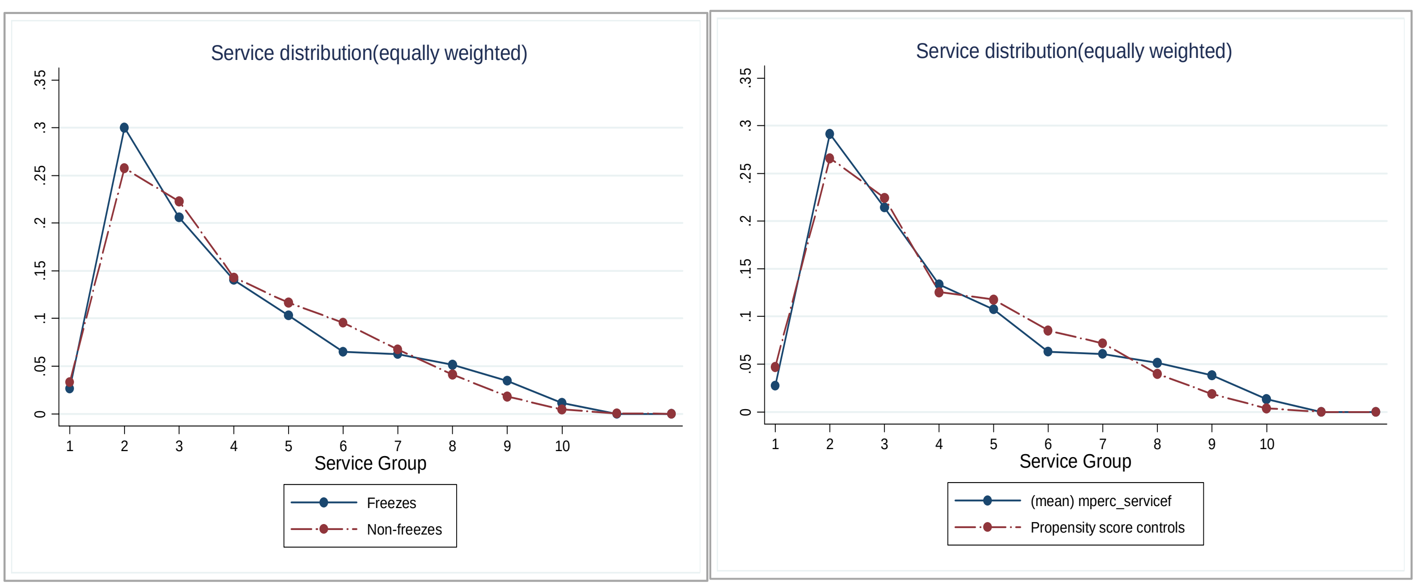
Figure 6: Age-Service Distributions

The figure shows the age distribution (Panel A) and the service distribution (Panel B) for traditional pension plan freezes (left panel) and cash balance plan freezes (right panel). We include all plan years preceding the freeze.

Panel A: Age distribution



Panel B: Service distribution



Notes:

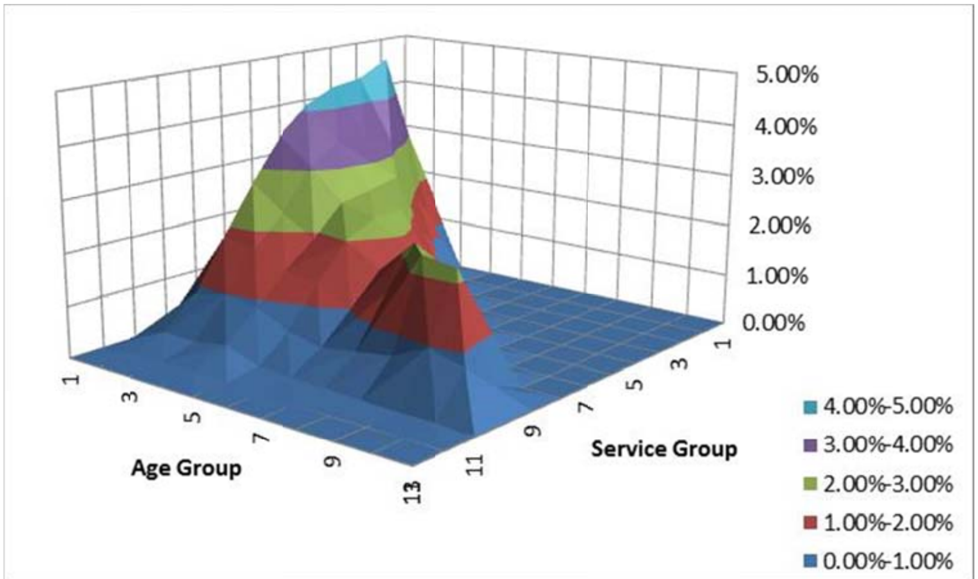
Age Group	1	2	3	4	5	6	7	8	9	10	11	12	13
Age	<20	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75<

Service Group	1	2	3	4	5	6	7	8	9	10	11	12
Service	<1	1-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40	45	50

Figure 6: Age Service Distributions (alternative)

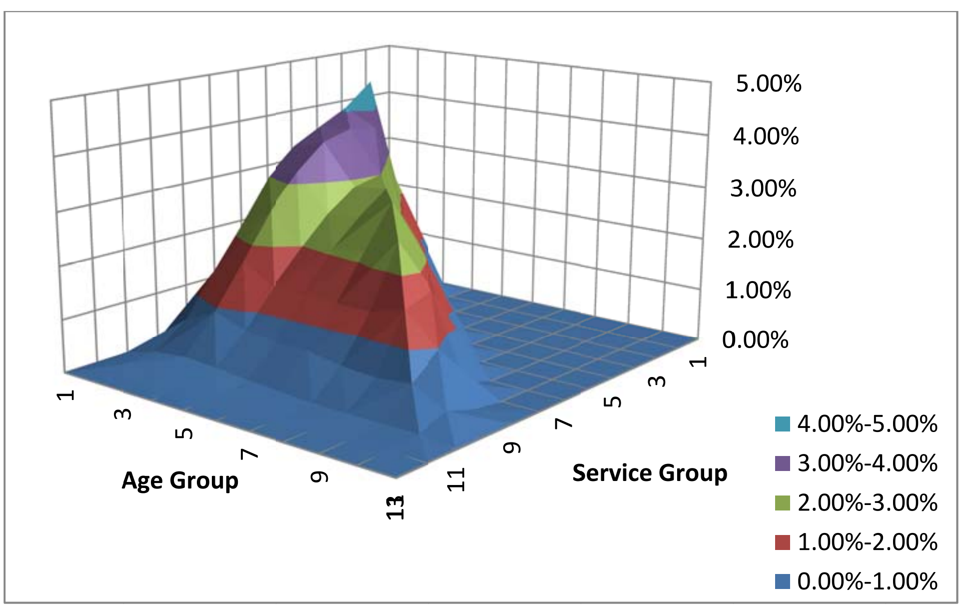
The figure shows the age-service distribution for freeze (Panel A) and non-freeze plans (Panel B). Panel C shows the plot of the difference between the age-service distribution of freeze and non-freeze plans. We include all plan years preceding the freeze.

Panel A: Age Service Distribution (Freezes)



Age Group	1	2	3	4	5	6	7	8	9	10	11	12	13
Age	<20	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75<
Service Group	1	2	3	4	5	6	7	8	9	10	11	12	
Service	<1	1-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40	45	50	

Panel B: Age Service Distribution (Non Freezes)



Panel C: Difference Age Service Distributions (Freezes- Non Freezes)

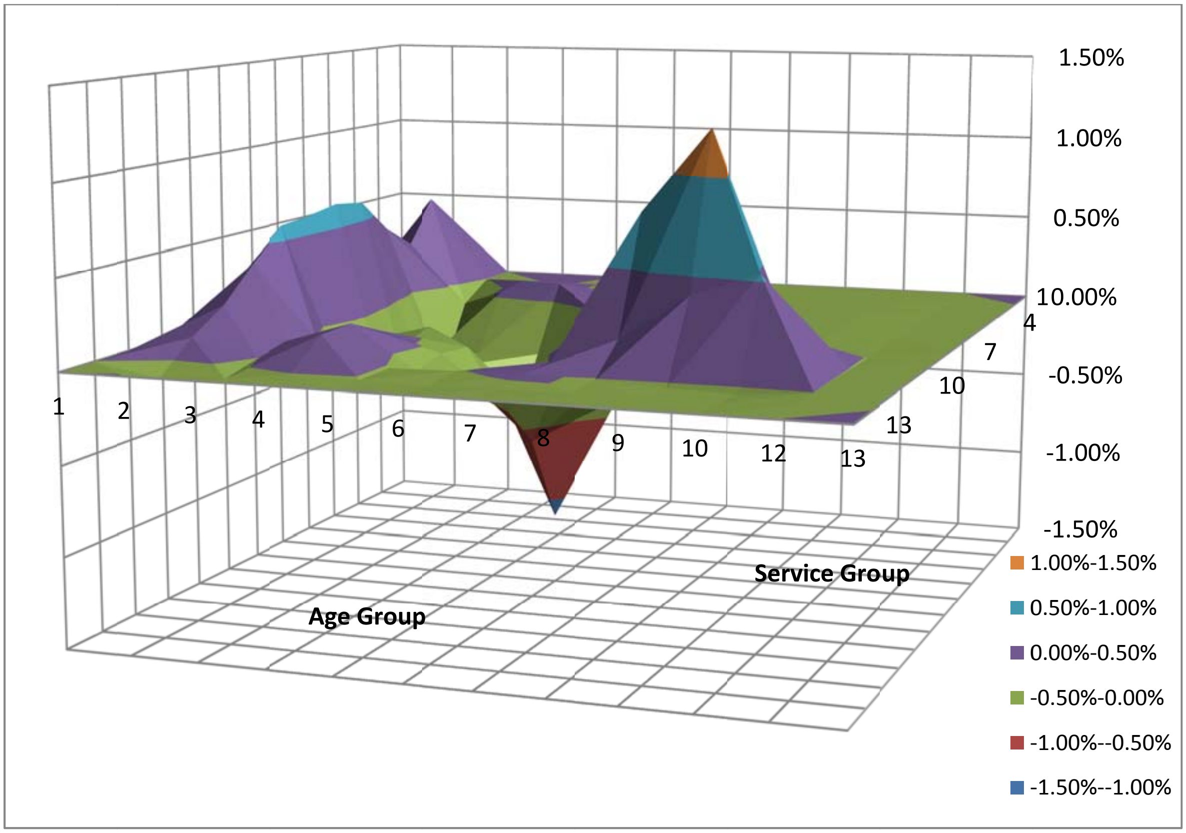
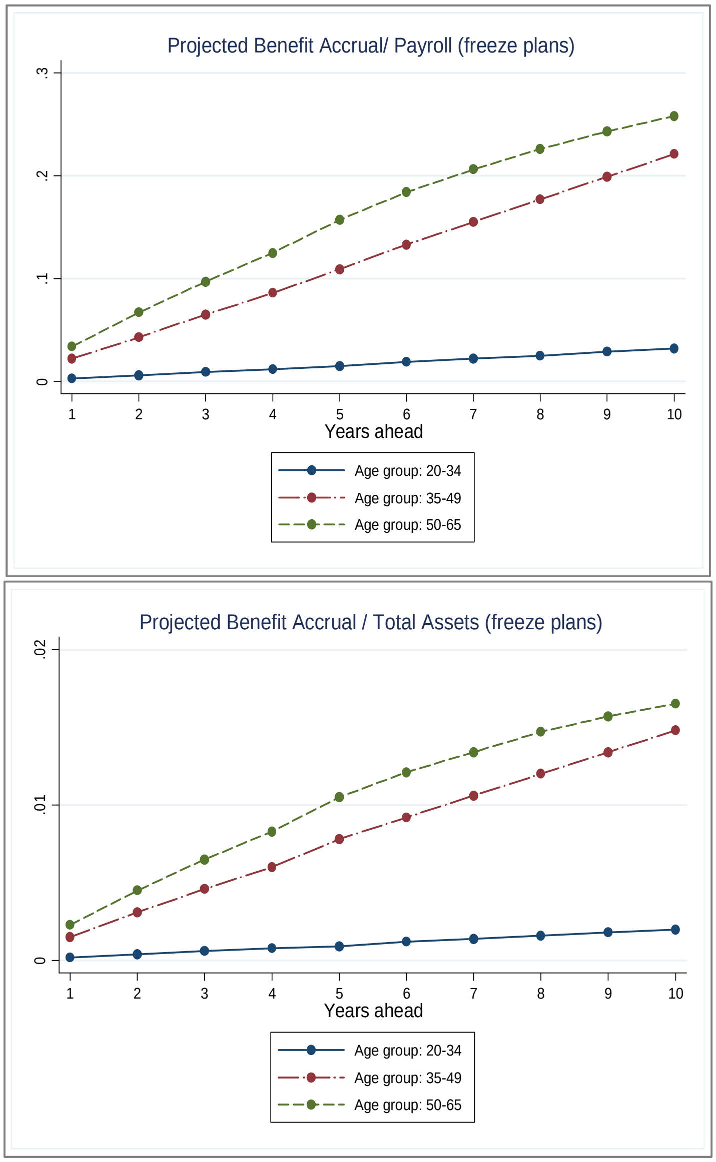


Figure 7: Estimated Cost savings as a share of payroll by age groups

The figure shows the estimated cost savings projected 10 years into the future for three age groups: (a) 20-34 years old; (b) 35-49 years old; (c) 50-65 years old. The cost savings are calculated as the difference between the counterfactual accrual benefits and the actual change in 401(k) contribution, relative to the payroll and total sponsor assets.



Appendix: Example of Age-Service Matrix

This is an example of an age-service (and compensation) matrix, collected from the paper attachments to Form 5500.

Attained Age	Years of Service									
	<1	1-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40+
<25	157	297	38							
	$37,272	$47,783	$46,381							
25-29	290	1,877	1,113	28						
	$45,609	$62,874	$64,188	$64,280						
30-34	268	2,037	2,704	678	69					
	$48,594	$70,739	$71,797	$73,889	$70,838					
35-39	221	1,367	2,094	1,437	1,369	70				
	$49,442	$74,445	$75,538	$82,468	$83,476	$77,843				
40-44	205	1,047	1,624	1,049	2,007	2,373	355			
	$53,620	$75,557	$77,173	$85,723	$90,267	$85,715	$78,478			
45-49	145	638	1,092	690	1,289	3,410	1,999	406		
	$49,954	$71,965	$75,501	$83,525	$91,437	$90,855	$87,143	$86,384		
50-54	103	428	651	432	806	1,060	1,224	1,696	114	
	$51,393	$72,208	$73,844	$80,177	$87,100	$89,129	$91,712	$93,062	$88,210	
55-59	45	248	351	239	286	271	281	564	312	21
	$51,026	$71,141	$77,044	$75,080	$82,843	$87,265	$91,771	$93,768	$91,462	$93,106
60-64	13	76	120	66	50	54	52	73	96	36
		$66,371	$73,213	$68,061	$77,637	$70,217	$66,673	$87,677	$86,666	$86,447
65-69	3	12	15	5	4	3	3	7	5	14
70+		1	1	6		1		2	1	2

Plan
Name: Xerox Corporation Retirement Income Guarantee Plan
EIN: 16-0468020
PN: 333