Risk Taking and Incentives of Institutional Investors:

Evidence from US Defined Benefit Plans

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Abstract:

This paper investigates the volatility of defined benefit of pension plans over the period 1999-2006. We document economically significant relationships between the asset-liability structure and the risk-taking of pension plans. We find that increasing the underfunding of a bottom size-decile plan by one-standard deviation on average implies a 34% increase in the volatility of the plan. In contrast, the relationship between funding status and risk is reversed for top size-decile plans. The higher risk-taking of underfunded plans is confined to higher upside-risk exposure, consistent with plans hedging pension liabilities via structured finance instruments with non-linear payoffs.

Defined benefit (DB)[1] pension plans today seem less secure than a decade ago. The total amount of US retirement assets in private DB plans was $2.328 trillion as of March 2007 (According to the Investment Company Institute). There is a growing concern about the funding status of DB pension plans as many of them are experiencing declining solvency. While regulators and policy makers are calling for reform of the institutional framework of DB pension plans, understanding the determinants of DB risk-taking is of critical importance. This paper investigates the relationship between the risk-taking of US DB pension plans and their asset-liability structure and characteristics. We report evidence that the total risk exposure of privately-held pension plans is explained by the interaction of the funding status of the pension plan and the plan size, while the risk-taking of publicly-held corporate plans is driven by their commitment to accrue future obligations. Moreover, we find evidence of asymmetric risk exposure of the average pension plan that is consistent with hedging of pension liabilities. These relationships between funding and risk can be interpreted as evidence of different managerial incentive structures across different plans.

Theoretical arguments for optimal pension-plan risk-taking have produced conflicting predictions about both high and low risk (for example, Sharpe (1976), Treynor (1977), Black (1980), Bader (1981), Harrison and Sharpe (1983), see below). The main focus of the literature has been on the asset allocation decision on debt (low risk) versus equity (high risk). Existing models have abstracted from other asset classes, like alternative investments, that may provide diversification and hedging benefits. As capital markets have become more globalized and

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[1] In a Defined Benefit (DB) pension scheme, the employer pledges retirement benefits to employees according to a formula that is generally a function of each employee's age, tenure and salary.

institutional investors have become more sophisticated, the importance of such asset classes has been increasing, because they increase the opportunity set for hedging of pension plan liabilities.

In this paper, we focus on the realized volatility of pension plan returns as a direct measure of total risk exposure from modern sophisticated asset allocation. First, we examine the cross-sectional relationship between the risk taking of pension plans and their asset-liability structure. Table 1 illustrates our findings in a simple way.

[Table 1 here]

The annual volatility of small over-funded pension plans is 34% lower than the volatility of underfunded plans, while the relationship is reverse for large plans, where over-funded plans have 20% higher risk than under-funded ones. Our first set of results formalizes this result in a rigorous regression framework. Second, we consider conditional risk-taking of the fund, taking into account time-varying asset-liability structures and the changing investment opportunity set. Our second set of results documents the conditional risk-taking of pension plans in a panel dataset with pension plan asset class holdings.

Prior empirical studies have followed the theoretical literature focusing on the debt-equity ratio, in part due to lack of detailed data on pension plan asset allocations. For example, in a recent contribution Rauh (2008) examines the debt-versus-equity asset allocation as a function of other characteristics of the plans and sponsors to assess whether corporate cash-flow risk-management dominates risk-shifting due to moral hazard. Our study has a broader focus on how the asset-liability structure and managerial incentives affect the total risk exposure of pension plans for given institutional constraints.

The existing evidence of a relationship between pension funding status and debt-equity asset allocation and risk taking provides mixed results.[2] We believe that one reason for these inconclusive findings is that book leverage is a noisy proxy for risk. In this paper, we construct and use direct measures of total risk based on realized pension plan returns, rather than book leverage. We contribute new empirical evidence on the relationship between the risk taking of pension plans to their asset-liability structure and institutional constraints. Our results shed light on the effective risk aversion of institutional investors and their incentives given institutional constraints.

The next section provides background on the structure of pension plans in the US. Section two describes the data and section three describes our research methodology. Section four contains the empirical results. Section five concludes.

Background

Occupational pensions are a form of deferred compensation, usually advantageous to the employee and the employer for tax reasons. Pension plans are typically two types: defined benefit (DB) or defined contribution (DC) schemes. DB plans entitle participants to an annuity of pension benefits at retirement that is based on a formula using factors such as salary history and duration of employment. Investment risk and portfolio management are under the control of the sponsoring company. Employers generally fund retirement benefits by making contributions to pension trusts. In a DC plan, there is no funding of pension liabilities by the sponsor and instead the employer contributes to an individual savings account for each member of the plan.

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[2] Bodie et al. (1987) find a negative correlation between funding and risk taking, whereas Petersen (1996) and Rauh (2008) find a positive relationship.

Although a DB pension fund is a separate legal entity, it is ultimately the company that is responsible for funding the pension plan on behalf of the shareholders. The shareholders bear the risk associated with the performance of the DB plan. The current literature treats pension fund's assets and liabilities as an integral part of the firm's balance sheet.

In a Modigliani-Miller world DB pension fund investment is irrelevant. Given their risk preferences, shareholders can use their own portfolios to trade and achieve their optimal asset allocation. Market imperfections, however, make pension fund investment policy relevant for pension fund sponsors. Black (1980) and Tepper (1991) consider the role of taxes on policy mix and show that it is optimal to contribute as much to the pension plan as regulations allow and invest the funds fully in fixed income securities. The contributions and returns of the pension plan assets are tax exempt. By placing fixed income assets in the pension plan and holding equity on the balance sheet, the company will create value for the shareholders in the form of interest tax shields[3]. The policy will also reduce the volatility of future contributions.

How much risk is appropriate for a particular pension plan? While early studies of pension plans have focused on the tax benefits of funding pension plan liabilities with debt (low risk assets), on average U.S. pension sponsors invest roughly 60% of pension fund assets in equity securities. Theoretical arguments exist to explain why pension managers might optimally increase their risk taking in the plan. Sharpe (1976) and Treynor (1977) argue that the structure of DB US pension plans create moral hazard incentives for sponsors to underfund pension plans and invest the assets in risky securities. The pension liabilities of the employer are similar to

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[3] Tax minimization strategy makes existing bondholders claims riskier. Pension claims have much lower priority over firm's non-pension assets than senior debt. By funding the pension plan fully, pension liabilities become senior to the on balance sheet debt. Such a strategy shifts the risk from the pension beneficiaries to the bondholders.

long-term corporate debt in that limited liability protects shareholders from having to transfer or liquidate corporate assets to compensate the employees in the event of bankruptcy[4].

The limited liability of shareholders also creates incentives for increasing the risk of the pension plan. Risky assets may lower future contributions but shareholders are not liable beyond the assets of the company. These incentives are exacerbated when a government agency provides pension liability insurance in case of default. If a DB pension plan is insured with the Pension Benefit Guaranty Corporation (PBGC) and the sponsoring firm enters bankruptcy, the U.S. government provides plan recipients with their annual pensions up to a statutory maximum amount. In practice, pension insurance premium are the same for all corporations, regardless of their risk and are lower than the fair economic value. Harrison and Sharpe (1983) argue that the existence of the Pension Benefit Guarantee Corporation (PBGC) provides US companies with a put option on its extremely under-funded pension obligation. Together with the limited tax deductibility of over-funded plans this implies that the asset allocation and funding decisions are joint and extreme with a U-shape relationship between funding and equity investment.

Theoretical reasons also exist to explain why the risk in the pension fund might optimally decrease when funding status deteriorates. Bader (1991) argues that firms attempt to minimize the volatility of their pension contributions. These contributions are often predictable for moderately underfunded or overfunded plans, but less predictable when funding levels become more extreme. Bader's argument suggests an inverted U-shape relationship between funding and equity investment where extremely over-funded and under-funded plans invest in fixed income securities and only moderately funded plans should increase their allocation to equity investment.

[4] Shareholders have a put option with a strike price equal to the value of the pension liabilities and a short position in a bond with value equal to the pension liabilities.

In a similar spirit, Rauh (2008) argues that risk management incentives to avoid costly financial distress dominate risk shifting (shareholder maximizing the value of their put option). His findings show that the better funded pension plans in his sample, which should have less incentive to engage in excessive risk taking invest in risky equity than the more poorly funded plans. This is also the case within plans over time. After the funding status of a given pension plan improves, the plan assets tend to be invested more in equities; after the funding status deteriorates the plan assets tends to be invested more in safe assets such as government debt and cash. Similarly, plans that were terminated had less volatility that those that remained open. Rauh's results are robust to controlling for lagged investment return. This suggests that the relationship between asset allocation and funding status cannot be explained completely by pension plans' attempt to time the market, i.e. lagged performance.[5]

Other studies have also pointed out reasons why pension managers might invest in risky assets rather than in long term debt. Bergstresser, et al. (2006) show that the earnings impact (reporting regulations) of risky pension investments creates an incentive to increase the volatility of the plan. Firms may also desire to offer access to alternative securities that may not be available to individual investors (Campbell and Viceira, 2005). Campbell and Viceira argue that DB plans tend to be large relative to almost any individual investor. They have fairly predictable inflows and outflows. These characteristics make them well suited to hold asset classes where large investments are required and liquidity is limited. Finally, equity investing may hedge against increases in real wages if future earnings growth and stock returns are positively correlated (Lucas and Zeldes (2006), Sundaresan and Zapatero (1997)).

[5] For the effect of behavioral biases such as investment inertia and focusing on short-term lagged returns is assessing asset allocation see Thaler (1980) and others.

Existing Empirical evidence

Friedman (1983) was the first to test the effect of plan sponsor financial characteristics on pension policy. He finds that unfunded liabilities and the proportion of pension assets invested in fixed income securities are positively related to ordinary balance sheet liabilities. He also finds that a reverse relationship holds, with balance sheet liabilities positively related to unfunded pension liabilities – “a risk offsetting effect”.

Tests with variables such as tax-paying status, however, do not provide strong conclusions. This may be a result of a bias induced by actuarial assumptions used in calculating reported liabilities. Bodie, Light, Morck and Taggart (1987) show that reported liabilities were systematically biased because of the way firms choose the discount rates they use. They find that the reporting of pension fund liabilities is systematically linked to profitability through the choice of a discount rate. More profitable firms choose lower discount rates and thus report greater pension liabilities. They also find that firm profitability is positively related to funding, that there is evidence of the pension put effects, but there is no significant relationship between funding and risk or tax-paying characteristics. The proportion of assets held in fixed income securities is also related to the same firm characteristics listed above.

Many studies have examined the effect of pension risk on the market valuation of the sponsoring firm. These papers provide evidence that pension plan risk is reflected in firm value. Carroll and Niehaus (1998) confirm the positive relationship between funding of DB pension schemes and debt ratings. Jin, Merton and Bodie (2006) examine whether systematic equity risk of US firms as measured by beta from the capital asset pricing model reflects the risk of their pension plans. They find evidence that equity risk does reflect the risk of the firm's pension plan despite arcane accounting rules for pensions.

Rauh (2006) examines the dependence of corporate investment on the availability of internal finance. He shows that capital expenditures decline with mandatory contributions to DB pension plans. This effect is particularly strong for firms that face financing constraints.

Most of the previous work focuses on the performance of delegated portfolios rather than plan level data. From a point of view of the pension beneficiary what matters is the performance of the pension plan since she or he does not (usually) select a manager but contributes to and receives benefits directly from the plan. For example, Brinson, Hood and Beebower (1986, 1991) show that more than 90% of the variability of the average fund’s return over time can be explained by the asset allocation. The authors used time series regressions of fund’s total return against its asset mix return. They concluded that strategic asset allocation explains much of the variability of pension fund’s performance over time.

Similarly, Ibbotson and Kaplan (2000) examine the cross sectional variability of pension funds returns. They claim that policy mix explains as little as 35% of the variation in returns. The rest can be attributed to factors such as the ability of the manager in market timing and security selection. Blake, Lehmann, and Timmermann (1999) analyse more than 300 UK pension funds' asset holdings in order to examine the performance of managed portfolios across multiple asset classes. They find strong evidence of slow mean reversion in the funds' portfolio weights towards a time-varying strategic asset allocation. Lakonishok, Shleifer and Vishny (1992) show that their sample of 769 US DB plans underperforms the S&P 500 index by 260 basis points per year during 1983-1989. Elton, Gruber and Blake (2006) examine mutual funds offered by 43 DC pension plans in the period 1993-1999 and document 31 basis points annual underperformance. Several studies have shown significant persistence in pension fund performance (see

Christipherson, Ferson and Glassman, 1998 and Busse, Goyal, and Wahal, 2006). These studies are all based on managed accounts (rather than plan level) data.

Our study focuses on the impact of the asset-liability structure on the total risk exposure and can be interpreted as tests of several of the above hypotheses (notably Bader (1991), Harrison and Sharpe (1983) and Sundaresan and Zapatero (1997)) about the U-shaped or linear relationship between risk-exposure and funding status.

Research Design

In our first set of results, we document the cross-sectional relationship between the realized annual volatility of pension plan returns and the funding status of the plan. We include other theoretically important variables that should affect risk taking, like the size of the plan, its type, the status of the plan's commitment to accrue future liabilities, and the share of active participants. Our cross-sectional regression has the specification

$$Volatility_i = \beta_1 \, FundingStatus_i + \beta_2 \, Size_i + \beta_3 \, FundingStatus_i * Size_i + \quad (1)$$
$$+ \beta_4 \, Frozen_i + \beta_5 Type_i + Controls_i + e_i$$

The dependent variable $Volatility_i$ is the sample volatility of annual plan returns from form 5500, defined as investment income divided by beginning-of-year pension assets. Plan assets are reported in Schedule H. Investment income is calculated as total income from Schedule H, minus contributions minus other non-investment income. The main explanatory variable of interest is $FundingStatus_i$, which is calculated as the ratio of plan assets to liabilities based on the beginning-of-year assets and liabilities reported in the 5500 forms. Thus, under-funded plans have $FundingStatus_i < 1$. The other explanatory variables are constructed as follows. The plan $Size_i$ is measured as the log of plan assets at the beginning of the year. The

$Frozen_i$ indicator variable is the status of the plan's commitment to accrue future liabilities. The $Type_i$ indicator is for publicly-held versus privately-held plans. The controls include plan expenses, indicator for collective bargaining, indicator for PGBC insurance, and the plan's expected annual return and industry dummies.

Testing the hypothesis that pension plan managers minimize the contributions of the plan sponsor subject to asset-liability and incentive constraints, we expect to find significant coefficient $\beta_1 < 0$, and if size is correlated with wage growth risk, then $\beta_2 > 0$ or in the specification with the interaction term, $\beta_3 > 0$. Next, we expect to find a significant difference between publicly-held and privately-held plans, due to different managerial incentives, with a significant coefficient β_4. The decision to freeze the plan is expected to affect the risk exposure, with frozen plans invested in low-risk assets, so we expect to find $\beta_5 < 0$.

In our second set of results, we report panel regressions of the annualized conditional volatility of monthly returns on the plans asset-allocation on the plan asset-liability structure and characteristics. The panel regression has the specification

$$Volatility_{i,t} = \beta_1\, FundingStatus_{i,t} + \beta_2\, Size_{i,t} + \beta_3\, FundingStatus_{i,t} * Size_{i,t} + \qquad (2)$$

$$+ \beta_4\, Frozen_{i,t} + \beta_5\, ActiveParticipants_{i,t} + Controls + e_{i,t}$$

The dependent variable $Volatility_{i,t}$ is the annualized sample volatility of monthly returns for year t, where the returns are on a portfolio invested in benchmark indexes with portfolio weights as the asset allocation of the plan. As before, the main explanatory variable of interest is $FundingStatus_{i,t}$, which is calculated as the ratio of plan assets to liabilities based on the beginning-of-year assets and liabilities for year t. The plan $Size_{i,t}$ for year t is measured as the log of plan assets at the beginning of the year. The $Frozen_{i,t}$ indicator variable is the status of the plan's commitment to accrue future liabilities for the current year t. The $Type_i$ indicator for publicly-held versus privately-held plans is included in the specifications without fixed effects. The $ActiveParticipants_i$ variable is calculated as the ratio of the active plan participants to total participants. The controls include plan expenses, indicator for collective bargaining, indicator for PGBC insurance, and the plan's expected annual return and industry dummies.

As before, our null hypothesis is that $\beta_1 < 0$, and if size is correlated with wage growth risk, then $\beta_2 > 0$ or in the specification with the interaction term, $\beta_3 > 0$. Next, we expect to find frozen plans invested in low-risk assets, so we expect to find $\beta_4 < 0$. Finally, the number of active participants determines the expected liability growth, with more active participants implying greater hedging demand, so we expect to find $\beta_5 > 0$.

Next, we describe the data used to test these hypotheses.

Data

We use two sources of data for this study. All pension sponsors with more than 100 participants must file the IRS 5500 form on an annual basis. Our sample consists of all corporate sponsored defined benefit plans that have more than 100 participants with information on beginning of year pension assets (nonzero value) over the sample period 1999-2006. Pension assets (beginning of plan filing year) and pension liabilities are taken from Schedule B of the 5500 form. Pension funding status is measured as pension assets scaled by pension liabilities. For more details on how to measure pension assets and liabilities see Kwan (2003) .

Our sample of plan-level data consists of 83,702 observations on 17,352 DB pension plans (unique sponsor EIN and plan number) and 13,553 sponsoring companies (unique EIN) for the period 1999 to 2006. Table 2 shows descriptive statistics for our sample.

[Table 2 here]

The table shows that on average, the annualized volatility of pension plan returns was 8.65% and the average fund in our was slightly under-funded at 97.4% ratio of assets to liabilities. The average fund size is 122.23 million, but the large standard deviation is driven by very large funds. About 6% of our funds were frozen in a given year of the sample period and 9.4% of the funds were publicly-held. In other words, note that most of the pension plans in our IRS 5500 sample are plans with privately-held sponsors. Most funds (93%) were PGBC insured, while on average about 55% of plan participants were active.

We link the pension data obtained from the 5500 forms to asset allocation data for the largest 1,000 US pension funds from the annual Pensions and Investments survey. This results in 707 corporate plans that have at least one year of matching data. We then calculate monthly returns for portfolios of benchmarks with portfolio weights as the pension plan asset allocation. The benchmarks used are as follows:

- S&P 500 for domestic equity investment returns;
- MSCI EAFE for international equity investment returns;
- Barclay's US Aggregate Bond Index for domestic fixed income investment returns;
- Barclay's Global Bond Index for global fixed income investment returns;
- 13-month T-bill yield for money market investment returns;
- NCREIF Property Index for real estate investment returns;
- Venture Economics Private Equity index for private equity returns;
- Barclay's MBS Index for returns from mortgage investments;

We then calculate the annualized monthly volatility of the asset-allocation benchmark portfolios for each year in our panel and use in as the independent variable in our specification (2).

Results

Cross-sectional Analysis

Our first set of results highlights the intuition of Table I in a rigorous way using the cross-sectional regression specification (1). These results can be interpreted as tests of several of the above model predictions about the relationship between the realized annual volatility of pension plan returns and the funding status of the pension plans. In particular:

- Sundaresan and Zapatero (1997) predict that risk declines linearly as funding increases
- Harrison and Sharpe (1983) predict U-shaped relationship between risk-exposure and funding status.
- Bader (1991) predicts inverse U-shaped relationship

Table 3 contains our main findings. The table reports robust standard errors.

[Table 3 here]

The main result in the table is that funding status and size are the main drivers of privately held plans' risk-taking, while the status of commitments to accrue future liabilities and size drive publicly-held plans' riskiness. The coefficient on funding status is significant at the one-percent level in all specifications for the full sample and for the privately-held sample. The table shows positive isolated effect of better funding status associated with an increase in risk-taking for privately-held funds. However, including the interaction of funding status with size in columns 2 and 4 shows that the effect is different for pension plans of different size. The coefficient of the interaction term is positive significant at the 1% level in both the full sample and in the privately-held plans sub-sample. The magnitude is economically large, for example for the average-sized privately-held pension plan (column 4), increasing funding by one standard deviation relative to the mean on average is associated with 5% increase in volatility, which is more than a one-standard deviation of the annual volatility.

The coefficient of the plan expense ratio is negative and significant, consistent with the hypothesis of hedging demand when liabilities are correlated with risky asset returns. Unreported results show that in a specification with interaction between expected return and funding, the coefficient of the interaction term is positive and significant.

The overall conclusion is that the above hypotheses are rejected because the models are not sufficiently rich to capture the multi-dimensional relationship between risk-exposure and funding status. In particular, fund size emerges as an important proxy for differential hedging demand that is driven by changing managerial incentives for given asset-liability structure, sponsor characteristics and institutional constraints.

Panel Regressions

Our second set of results characterizes the conditional risk-taking of pension plans using the panel regression specification (2). The realized conditional volatility of pension plan asset allocation benchmark returns is determined by the asset allocations of the plans. Table 4 presents summary statistics for the asset allocations in our sample.

[Table 4 here]

The table shows that on average plans invest about 50% of their assets in US equity and about 30% in US Fixed Income Securities. The total equity exposure is about 60% on average, while investment in alternative asset classes like private equity and real estate is only 6.3%. The cash holdings average is 2.4%. Overall, the table indicates that the riskiness of the pension plans is driven by the equity exposure and in particular the exposure to the US stock market.

Table 5 breaks down the asset allocation sample across plan type (Corporate, Public and Union, panel A) and size (panel B, top 10%, 10-90% and bottom 10%).

[Table 5 here]

The table shows that there are market differences in the asset allocations of non-corporate versus corporate plans and small versus large plans. Panel A reveals that corporate plans have more exposure to equity and are more internationally diversified than non-corporate plans. While public and union plans on average invest about 46% in US equity, corporate plans average exposure is 52%. The difference is especially striking when we compare the average corporate and public plans allocations to international equity of 10.4-11%, which is four times as large as the average union plan allocation of 2.4%. The fixed income asset class exposure of corporate plans is about 29%, while public plans invest about 35% in fixed income securities and union plans exposure is about 40%. Overall, the results suggest that corporate plans have greater allocation to historically volatile asset classes than public can union plans. These findings reaffirm the simple intuition of Table I.

Panel B shows that there as significant differences in the asset allocations of small versus large funds. While small funds on average invest about 53% in US equity, the average large plan asset allocation to US equity only about 45%. On the other hand the large plan exposure to international equity is almost twice as high as the 7.5% average exposure of small plans. The fixed income allocations are broadly similar across plans of different size. The asset allocation breakdown suggests that the difference between corporate and non-corporate plan exposures is driven by the equity exposure. Across the non-corporate plans, the smaller plans allocate more funds to US equity than larger plans that have more international equity exposure.

Our main results on the total conditional risk exposure of pension plan allocations are presented in Table 6. We consider specification with industry controls as well as specifications with fixed effects.

[Table 6 here]

The table shows that funding status is the main driver of conditional risk taking of pension plans. The coefficient of funding status is positive and significant in the simple specifications without interaction (column 1 and column 3), suggesting that relatively better funded plan take on more risk, through increased equity allocation. The full specifications (columns 2 and 4) that include the interaction of size and funding status show that the interaction coefficient is positive and significant while the size and funding coefficients are negative and one of them is significant for each specification. These results show that the relationship between funding status and conditional risk-taking and portfolio re-balancing is qualitatively different for small versus large funds.

The more general fixed effects full specification with interactions (column 4) shows that the Freeze status and the share of active participants are significant explanatory variables. The coefficient on the freeze dummy is negative, consistent with risk reduction when a frozen plan's portfolio is shifted from equities into fixed income securities that immunize liabilities. This interpretation is consistent with the predictions of Bader (1991). The coefficient on the active participant share is positive, consistent with stronger hedging demand associated with stronger liability growth, under the assumption that wage growth is positively correlated with risky equity returns as in Sundaresan and Zapatero (1997).

Overall, the results suggest that when taken individually, the simple empirical predictions of the specialized theoretical models in the current literature cannot explain the rich empirical pattern of pension plan risk taking. Rather, the current models are complementary and need to be incorporated into a more general framework that highlights multiple trade-offs when optimizing pension plan investments.

Conclusion

This paper investigates the relationship between the risk-taking of pension s and their asset-liability structure characteristics. We examine what is the cross-sectional relationship between the risk taking of pension plans and their asset-liability structure. Taking into account the time-varying asset-liability structure and investment opportunity set, we also characterize the conditional risk-taking of pension plans in a panel dataset with pension plan asset class holdings. We focus on the analysis of the total risk exposure of pension plans as a function of the funding status of the plan and other plan characteristics. We analyze both conditional risk exposure and average risk-taking in the cross-section. We test empirically several hypotheses about linear and non-linear relationships between total risk exposure and asset-liability structure, including the hypothesis that sponsors whose expected liabilities have relatively higher expected growth have greater hedging demands and take on more systematic risk. We find evidence of qualitatively different relationship for small versus large plans and for publicly-held versus privately-held plans. These findings are contrary to the predictions of the popular models and suggest that the theoretical analysis of pension plan risk-taking demands a modelling framework that incorporates institutional constraints and explicit consideration of managerial incentives for different asset-liability structures.

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Table 1

Annual Volatility of pension plans estimated with annualplan return observations over the sample period 1998-2002. The total return of pension plans is calculated from 5500 forms. The data are sorted on size and then on funding, so that each row reports the average volatility for all plans in the funding percentile for the corresponding size column.

		Size		
Funding		Small Bottom 10%	Inter-decile 10%-90%	Large Top 10%
Underfunded Bottom 10%		8.02%	8.65%	8.85%
	Not publicly held	8.03%	8.58%	9.04%
Inter-decile 10%-90%		7.48%	8.62%	9.74%
	Not publicly held	7.50%	8.53%	9.33%
Overfunded Top 10%		5.68%	8.93%	10.62%
	Not publicly held	5.32%	8.85%	10.03%

Table 2

Summary statistics of form 5500 pension plan variables. The table reports averages of annual observations over the sample period 1998-2002.

Variable	Mean	Standard Deviation
Volatility	0.0865	0.0408
Size (Millions)	112.23	777.46
Funding Status	0.9738	0.2247
Frozen Status	0.0615	0.1777
PGBC Insured Dummy	0.9301	0.2364
Publicly Held Dummy	0.0941	0.2920
Plan Expenses	0.0693	0.0430
Active Participants Share	0.5478	0.2295
Age (Years)	26.6950	15.4545

Table 3

Cross-sectional regressions of average annual pension plan volatility on funding status, size and other plan characteristics.

Variable	All		Privately-held		Publicly-held	
Funding Status	0.00791	-0.06935	0.00786	-0.09108	0.00633	0.07284
	(0.00207)***	(0.01851)***	(0.00221)***	(0.02043)***	(0.00601)	(0.06719)
Size	0.00370	-0.00076	0.00368	-0.00201	0.00380	0.00748
	(0.00024)***	(0.00105)	(0.00026)***	(0.00116)*	(0.00070)***	(0.00351)**
Funding * Size		0.00465		0.00603		-0.00362
		(0.00109)***		(0.00122)***		(0.00355)
Frozen	-0.00187	-0.00228	0.00013	-0.00036	-0.02219	-0.02141
	(0.00226)	(0.00226)	(0.00239)	(0.00238)	(0.00675)***	(0.00679)*
PGBC	0.00254	0.00222	0.00302	0.00256	-0.00310	-0.00284
	(0.0017)	(0.00170)	(0.00180)*	(0.00179)	(0.00485)	(0.00482)
Plan Expenses	0.05455	0.05336	0.05424	0.05347	0.05818	0.05955
	(0.01241)***	(0.01240)***	(0.01320)***	(0.01318)***	(0.03306)*	(0.03312)*
Return	-0.09604	-0.09465	-0.09700	-0.09528	-0.08306	-0.08416
	(0.01506)***	(0.01498)***	(0.01589)*	(0.01579)***	(0.04623)*	(0.04617)*
Publicly held	0.00567	0.00491				
	(0.00115)***	(0.00116)***				
R-squared	0.04	0.04	0.03	0.03	0.06	0.06
Observations	11787	11787	10615	10615	1172	1172

Table 4

Summary statistics of Pension plan asset allocations in the period 1999-2002. The data for the largest 1,000 US pension funds is from the annual Pensions and Investments survey.

Variable	Mean	Standard Deviation
US Equity	49.89%	13.62%
US Bonds	30.31%	13.02%
Non-US Equity	9.83%	8.30%
Non-US Bonds	1.34%	3.61%
Cash	2.43%	5.42%
Private Equity	1.25%	2.98%
Real Estate	2.41%	3.43%
Mortgages	0.47%	2.36%
Other	2.15%	7.50%

Table 5

Summary statistics of Pension plan asset allocations in the period 1999-2002 across sponsor type and size. The data for the largest 1,000 US pension funds is from the annual Pensions and Investments survey. The small and large plans are in the bottom and top size deciles respectively. The medium plans are the inter-decile plans.

Variable	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Panel A						
	Corporate		Public		Union	
US Equity	52.59%	14.50%	46.35%	10.26%	45.99%	13.56%
US Bonds	27.82%	12.35%	32.60%	11.46%	39.65%	13.78%
Non-US Equity	10.38%	8.72%	10.95%	6.83%	2.39%	4.50%
Non-US Bonds	1.09%	3.42%	1.87%	3.94%	0.44%	1.44%
Cash	2.45%	6.33%	1.95%	3.11%	3.22%	4.51%
Private Equity	1.35%	3.11%	1.58%	3.10%	0.58%	2.89%
Real Estate	1.87%	2.88%	3.08%	3.64%	3.71%	4.76%
Mortgages	0.12%	1.04%	0.69%	2.57%	1.84%	4.62%
Other	2.37%	8.73%	1.03%	3.16%	2.24%	8.12%
Panel B						
	Small		Medium		Large	
US Equity	53.01%	18.14%	50.15%	13.12%	44.69%	10.55%
US Bonds	28.64%	16.20%	30.61%	12.67%	29.53%	11.98%
Non-US Equity	7.47%	8.39%	9.75%	8.30%	12.91%	7.27%
Non-US Bonds	1.04%	4.62%	1.28%	3.46%	2.20%	3.50%
Cash	4.14%	12.06%	2.25%	4.14%	2.17%	2.82%
Private Equity	0.34%	1.92%	1.11%	2.81%	3.29%	4.09%
Real Estate	1.28%	2.63%	2.38%	3.49%	3.78%	3.21%
Mortgages	0.44%	2.93%	0.45%	2.36%	0.62%	1.63%
Other	3.68%	13.18%	2.10%	6.89%	0.96%	2.34%

Table 6

Panel regression of annualized volatility of the monthly asset allocation benchmark returns for pension plans estimated with monthly benchmark return observations over the sample period 1999-2002. Standard errors are clustered by sponsor (EIN, form 5500).

Independent Variable	Industry Controls		Fixed Effects	
Funding	0.005413 (0.0026843)*	-0.027204 (0.0171315)	0.0061186 (0.0033088)*	-0.0475147 (0.0240881)**
Size	0.000043 (0.000327)	-0.0018014 (0.0008054)**	0.0006812 (0.0012465)	-0.001911 (0.0017951)
Funding*Size		0.0017763 (0.0008577)**		0.0028513 (0.0012496)**
Frozen		-0.0010857 (0.0018358)		-0.0048874 (0.0022099)**
Active Participants		0.0036523 (0.0027916)		0.011293 (0.0061812)*
Controls (unreported)				
Industry Dummies	yes	yes	no	no
Fixed Effects	no	no	yes	yes
Time Dummies	yes	yes	yes	yes