# Allocating Assets and Discounting Cash Flows:

# Pension Plan Finance

Mitchell A. Petersen[1]
Kellogg Graduate School of Management
Northwestern University

March, 1995

## Abstract

This paper examines two pension decisions which firms must make when they offer a defined benefit pension plan: how to pick the appropriate rate for discounting pension liabilities and how to allocate the assets in the pension plan. The correct allocation of assets must be driven by frictions which occur in real world financial markets. In the absence of market frictions, the asset allocation decision is irrelevant. The paper first reviews the theory which describes the optimal asset allocation in the presence of distortionary taxes and imperfect capital markets. This allows us to examine the role played by the pension plan in the financial structure of the firm. It also provides us the background for examining the actual asset allocation of defined benefit pension assets. The paper then turns to the choice of discount rates. If the goal is to value the pension liabilities, the correct discount rate should depend upon the type of risk inherent in the pension promise. The paper begins by developing the theory behind choosing the discount rate in a world without market frictions and then extends the analysis to the presence of market imperfections. I then compare the theory to the actual discount rates chosen by firms. I find that the discount rates are significantly lower than equivalent market rates and are very insensitive to changes in market rates. The framework of the paper provides a background for discussing the implications of the shift from defined benefit to defined contribution pension plans on capital markets -- given the perceived difference in how these two types of plans invest their assets.

---

[1] Mitchell A. Petersen, Assistant Professor of Finance, Kellogg Graduate School of Management, Northwestern University, 2001 Sheridan Road, Evanston, IL 60614. E-mail address: mpetersen@nwu.edu.

# INTRODUCTION.

The growth in the size of pension assets over the last two decades has created an enormous store of wealth. Their dramatic size means that the issues surrounding pensions are relevant not only to the public policy debate about the U.S. saving rate, but are also an important component of the finances of U.S. corporations. For publicly traded firms which report pension assets, the pension assets comprise just over 7 percent of the median firm's assets in 1988. Pensions have always been perceived as part of the employees compensation contract. However, the pension plan can also be considered an integral part of the finances of the firm. As the size of the pension plan has grown relative to the size of the firm's other assets, financial managers have become more sophisticated in managing the pension plan.

Pension plans can be divided into two basic forms. The defined contribution pension plan is akin to a savings account. The firm deposits money into each worker's pension plan. At retirement or separation from the firm, the workers are entitled to the balance of the pension plan. Although the pension plan may be administered by the firm, the finances of the pension plan are independent of the finances of the firm. If the return on assets is quite high, the extra return goes to the employees. If the return on the assets is negative, the losses are suffered by the employees. The employees of the pension plan bear the investment risk of the pension plan assets and receive their return.

In a defined benefit plan, the pension benefit depends less on the performance of the pension assets and in many cases may not depend at all upon the investment performance of the assets. In a defined benefit pension plan the firm makes a pension promise to the worker. This obligation of the firm is financially similar to the promise made by a debt security. The pension promise has first claim on the asset of the pension plan as well as an additional claim on the assets of the firm itself. Thus volatility in the value of the pension plan assets is borne, if at all, indirectly by the pension plan participants. Most of the risk and thus the return is born by the security holders of the firm.

The asset allocation of pension plan assets has implications for the regulation of pension plans in

the U.S. The regulatory goals for pension plans are diverse and not always consistent. The Pension Benefit Guaranty Corporation (PBGC) is interested in securing the solvency of the pension plan. Higher funding levels and safer assets both contribute to this goal. The Internal Revenue Service is interested in limiting the tax drain caused by pension plans. The more a firm can contribute to a pension plan the more its taxes are reduced. Saving inside the pension plan dominates saving outside a pension plan for a firm with a positive marginal tax rate. The government would like to subsidize pension plans through the tax code to encourage their adoption, but does not want the subsidy to be any larger than necessary. The Internal Revenue Service would thus like to limit overfunding. One way to do this is by regulating the discount rate used by firms. After developing a theory of choosing a discount rate, I will examine how the rate a plan chooses depends upon the characteristics of the plan and the sponsor.

The allocation of risk in a pension plan is an essential component to the total compensation contract offered to employees. The pension decisions made by the firm also provide an interesting opportunity for examining more generally the financial decisions made by firms. Corporate finance theory argues that imperfections in the capital markets create situations where capital structure decisions of the firm can distort a firm's investment decisions. The difficulty with testing these theories is measuring the potential investment decisions available to a firm. We may be able to observe the investments a firm makes, although even this can be difficult, but observing the ones that they do not make is extremely difficult. When we restrict our consideration to the set of possible pension decisions which a firm can make, the set is more manageable. Examining the effect of market imperfections on the firm's financial decisions is more tractable when we limit the analysis to the financial structure of the pension plan.

The goal of this paper is to examine two pension decisions which corporations must make when they offer a defined benefit pension plan: how to pick the appropriate discount rate for discounting pension liabilities and how to allocate the assets of the pension plan. Once the pension promise has been made -- how much are employees entitled to at retirement -- the promise must be valued. Using standard valuation techniques, actuaries take the expected future cash flows and discount them to the present. The first decision

this paper examines is the discount rate chosen to discount the future cash flow. Once the liability has been valued and the firm has contributed assets to the pension, the assets must be invested. Since the asset allocation decision is less important for a corporation when the pension plan is a defined contribution plan, this will provide a useful base case for examining the allocation of defined benefit pension plans. Secondly, the shift from defined benefit pension plans to defined contribution pension plans means that any differences in the way the assets of the two plan types are invested may have dramatic effects on both total personal savings as well as the demand for securities in the U.S. capital markets. (Kruse, 1991 and Petersen, 1994).

# THEORY: HOW SHOULD DISCOUNT RATE BE CHOSEN AND THE PENSION ASSETS ALLOCATED?

## CHOOSING THE DISCOUNT RATE.

A defined benefit pension plan commits the firm to pay a specified benefit to its employees at a given future date. This promise is financially equivalent to a bond. The firm has promised to make a series of future fixed payments. The firm will never pay more than the fixed amount, but may pay less.[2] The firm can only not pay the pension promise by defaulting on the promise, for example by declaring bankruptcy.[3] Thus the payments do not depend upon the value of the firm or the pension, unless those values fall below the promised liabilities. To value the pension liability using standard valuation techniques, we would take the expected cash flows and discount them to the present at the appropriate discount rate.

---

[2] Technically the firm could offer to pay more than the promised benefit. Although this never occurs with bond issues, it has arisen in the case of payment to defined benefit pension beneficiaries. Some plans have given ad hoc cost of living adjustments to their retired workers (Allen, Clark, and Sumner, 1986).

[3] In the case of bankruptcy or near bankruptcy, the Pension Benefit Guaranty Corporation will take over the liabilities in exchange for 30 percent of the firm's equity. Thus most employees will not lose their pension. However, our perspective here is the value of the pension liability to the firm. Thus our interest is in whether the firm ends up paying the pension, not whether the employee receives the pension. The difference between the two is the payments made by the PBGC.

$$\text{Pension liability} = \sum_{t=1}^{N} \frac{E[\text{ Cash flows }]}{(1 + r)^t}$$

This is the present value of the liability. The expected cash flow accounts for the effect of early separation as well as death. When actuaries value the liability, the future cash flows are those the corporation is expected to make if the pension plan is fully funded and maintained. They do not account for the possibility that the corporation may default on its promise.

To convert future cash flows into their present value, we use a discount rate. The appropriate discount rate is always equal to the expected rate of return on an asset. The discount rate measures the compensation required by an investor to hold the security. The security holders must be compensated both for the time value of money and the risk they bear. It consists of two components.

$$\text{Discount rate} = \text{risk free rate} + \text{risk premium}$$

The risk free rate is the compensation for the time value of money. A dollar today is worth more than a dollar next year. The risk free rate accounts for both changes in the real risk free rate as well as changes in the expected rate of inflation. The yields on government bonds are customarily used as risk free yields.[4] We will return to this issue below.

The security holders must also be compensated for risk. However in public security markets, investors are not compensated for risk which they need not bear. Modern portfolio theory argues that investors are not concerned with the specific risk of the individual assets in their portfolio, but with the risk of the entire portfolio (Markowitz, 1952). Thus if the assets in a portfolio are not perfectly correlated with each other, the risk of a portfolio containing a small portion of many different assets will be less risky than a portfolio containing only one of the assets. By holding multiple assets, investors can diversify away a

[4] Brealey and Myers, 1991, Chapter 7.

portion of the risk of their portfolio. The risk which cannot be diversified away is called systematic risk and is the only type of risk which is priced in a competitive financial market.[5] Thus the risk premium is positive only if the risk in the cashflows is systematic risk. Assets with systematic risk have more priced risk and therefore higher expected returns.

We are now ready to choose a discount rate for valuing the pension liabilities. As a first step, assume that the firm never defaults on its pension promise. This may occur because the pension plan will never be underfunded -- the pension is always solvent -- or because the firm can always make up for a funding deficiency -- the firm is always solvent. In this case, the pension promise is identical to a default free bond. The appropriate discount rate is the government bond yield of a similar maturity.

There are two reasons why we want to match the maturity of the pension liability to the maturity of the government bond yields when we choose a discount rate. First we want consistent inflation expectations. The market's expectation of inflation over the next year versus the next ten years, as implicitly revealed by the term structure of interest rates, may not be the same.[6] When long government bonds yield significantly more than short maturity bonds, this implies that the market is expecting greater inflation over the long term than over the short term.[7]

When choosing a discount rate, it is also necessary to match the maturities because of differences in risk. U.S. government bonds have zero default risk or at least the historic data suggest this. However,

---

[5] Systematic risk is also called market risk, undiversifiable risk, or priced risk.

[6] The term structure of interest rates is the relationship between the yield on bonds of different maturities and their maturities. It is most often drawn for government bond yields, but can in principle be drawn for bonds of any quality. An upward sloping term structure means that bonds with longer maturities are yielding more than bonds with shorter maturities.

[7] Actually, this implies that the market is expecting short term nominal interest rates to rise above the current level of short term nominal interest rates. This could imply that the market expected inflation to accelerate or that it expects real short term interest rates to rise. There is one additional caveat to this argument. The term structure of government bond yields is upward sloping on average. This implies that the yield on long term government bonds contains a risk premium. We discussed this below. To determine whether the government bond market expects short term rates to rise or fall, we must first remove this risk premium.

long maturity government bonds still bear some priced risk. The average historical return on long government bonds (ten to thirty year bonds) is approximately 1 percent higher than the historic return on treasury bills.[8] Thus an investor who continued to roll over her investment in ten-year government bonds opposed to an investment in treasury bonds would have earned an additional 1 percent per year. In a well functioning financial market this must be compensation for risk.[9] This is not default risk, but is instead compensation for what might be called inflation or real interest rate risk. Although the nominal return on long government bonds is fixed, the real returns can vary considerably.

The risk premium which is used for discounting the cashflows of the pension promise depends upon the nature of the promise. If the probability of defaulting on the pension benefit is zero then the appropriate discount rate is the return on government bonds of an identical maturity. By matching the maturity of the pension liability to the maturity of the government bond, we have accounted for the market's expectation of future nominal interest rates (real interest rates plus expected inflation) as well as the risk premium for inflation risk.

So far we have assumed that the probability of defaulting on the pension promise is zero. If the default probability is positive, then the pension promise is now riskier. Once the probability of default is positive, there is a difference between the promised return and the expected return. The promised return is the return a bond holder receives if the bond does not default. This is greater than the expected return when the bond has a positive probability of default. The future cashflows estimated by actuaries are the expected cashflows assuming a zero probability of default or the promised cashflows if the probability of default is positive. To value these liabilities, the cashflows can be discounted by the promised rate of return

---

[8] These averages are for the 1926 to 1988 period and are reported in *Stocks, Bonds, Bills, and Inflation 1989 Yearbook,* Ibbotson Associates, Inc. 1989.

[9] To see that it must be a risk premium, assume the converse. If the two portfolios (treasury bills and ten-year government bonds) had the same systematic risk and the latter had a higher expected return, no investor would purchase the former. Thus for treasury bills to be held in equilibrium, ten-year government bonds must be riskier.

on assets with a similar default risk. Thus if the probability of default was very small, the promised yield on very high quality bonds, such as AAA, would be appropriate.[10] If the probability of default was higher, than the promised yield on lower quality bonds (bonds with a higher probability of default) such as BBB would be appropriate. As a guide to the appropriate risk of default and thus a discount rate, we could examine the bond rating of the firm's debt. Highly levered and very risky firms will have lower bond ratings and thus must promise higher rates of return. This is to compensate investors for the greater and more costly risk of default. The pension liabilities of these firms would accordingly be riskier. Of course, the pension liabilities of a corporation are in general less risky than the bonds of the same corporation. The pension liabilities have the added security of the pension assets standing behind the pension promise. The better funded the plan and the lower the riskiness of the plan's assets, the more valuable this added security is.

The preceding discussion has assumed that the goal in choosing a discount rate was to value the pension liability. When choosing a discount rate, firms may have other goals. The discount rate may be chosen instead to manage the firm's pension plan contributions. By altering the discount rate, the firm can alter the reported funding status of the pension plan and thus their allowed or required contribution. Since firms facing high marginal tax brackets would like to make additional contributions, they have an incentive to raise their reported pension liability which can be done by lowering their reported discount rate (Feldstein and Mørck, 1983). Alternatively, firms facing financial difficulties or temporary cash flow shortages have an incentive to lower their required contribution (Bodie, Light, Mørck, and Taggart, 1987). Such firms would therefore have an incentive to raise their reported discount rate to lower their reported liabilities and thus their required contributions. The practical importance of these considerations is, however, an empirical question.

---

[10] The average cumulative default rates over 20 years for AAA bonds is less than 3 percent (*Corporate Bond Defaults,* Moody's Investor's Service, 1993).

## CHOOSING THE ASSET ALLOCATION FOR THE PENSION PLAN ASSETS.

Although our goal is to examine the asset allocation of defined benefit pension plans, we begin with a brief discussion of the asset allocation decision for a defined contribution pension plan. Since defined contribution plans are independent of the finances of the corporation, they provide a good bench mark against which to judge the asset allocation of defined benefit pension plans. In many defined contribution plans, the employees have discretion over how to invest the assets. Without inside information, an investor's decision is based on how much risk they are willing to accept. By purchasing assets with more systematic risk, an investor will raise their expected return. However, a higher average or expected return is not free. By purchasing assets with a higher expected return (i.e., stocks), an investor is bearing more risk. The correct asset allocation will thus depend upon the underlying preferences of the employees as well as the allocation of their non-pension assets. The asset allocation in a defined contribution pension plan should represent the underlying risk tolerance of the employees.

Defined benefit plans are different. The employee's claim is the pension promise. It is not a direct claim on the assets of the pension plan. The equity holders of the firm bear much of the risk of the pension assets. If the value of the pension assets exceeds the promised benefits, the equity holders receive the excess.[11] If the value of the pension plan assets is insufficient to pay the benefits, then the equity holders are responsible for the shortfall, up to 30 percent of their equity, (Bodie, Light, Mørck, and Taggart, 1987). Thus in a solvent firm, the equity holders bear 100 percent of the investment risk of the pension plan assets. The argument that equity holders should manage the pension assets in their interest is based on this observation.

As with most corporate finance theory, the discussion of optimal investment and capital structure

[11] Since 1986 it is more difficult to access the excess assets in the pension plan. Excise taxes imposed on asset reversions significantly reduced the number of terminations of overfunded pension plans (Petersen, 1992). However, the share holders of the firm can still recapture the excess pension assets in the form of lower future contributions.

begins with the Modigliani-Miller irrelevance theorems (Modigliani and Miller, 1958, and Modigliani and Miller, 1961). In the absence of market frictions, changes in the allocation of risk have no effect on the value of the firm or the wealth of shareholders. In the pension context, this implies that the asset allocation of the pension plan assets does not change the wealth of shareholders or the value of the employee's claim.

Assume for the moment that the firm will honor the pension promise independent of the performance of the assets. This will occur if the plan assets will always exceed the value of the pension promise or if the firm will make up any shortfall. In this case, shifting the assets of the pension plan to riskier assets, will raise the volatility of the pension plan's asset value. Since the excess assets are assets of the firm and thus the equity holders, this raises the riskiness of the equity holders claim. It also, however, raises the expected return on the assets of the pension plan and therefore the expected return on the equity. The value of equity does not change.

Increasing the risk of the pension assets may also raise the riskiness of the pension promise. If the plan is exactly funded, then investing the assets in government bonds will hedge the pension liability. When the pension promise comes due in the future, the pension plan will have enough cash to pay the pension promise with certainty. If the pension assets are instead shifted to higher risk assets (i.e., equities), the plan is still fully funded but no longer fully hedged. If the return on equity is above average, the excess return will be an asset of the equity holders. If the equity return is below average then the plan is underfunded. If the firm cannot make good on its pension promise, then the pension promise is worth less in expectation. In the case where the plan is underfunded or may become underfunded, and the firm is unable to make up the shortfall in the pension, then shifting the assets to a riskier class can raise the value of the equity holders claim. The equity holder's gain comes at the expense of the employees -- or in the presence of the PBGC guarantee -- at the expense of the U.S. taxpayer (Alan, 1987). Equity holders' payoff function is asymmetric. They receive the entire upside, but only a portion of the downside. This may encourage the equity holders of less solvent firms to invest in riskier assets.

The ability to shift risk to fixed claim holders, such as employees, is limited by the ability of fixed

claim holders to detect and prevent such a shift. Employees are not in a position to monitor the investments of their defined benefit pension plans (Petersen, 1994). This is one of the justifications for the Pension Benefit Guaranty Corporation. If the firm cannot pay the pension benefits, the PBGC will pay them up to a fixed limit per employee. The PBGC is therefore at risk if the pension plan in a financially distressed firm becomes underfunded due to a risky investment strategy. If the PBGC is better able to understand and monitor the pension investments made by firms, this allocation of risk is justifiable.

The presence of taxes creates an opposing set of incentives for choosing an asset allocation strategy. Since corporations can borrow at the after tax- rate of interest and can earn the before-tax rate of interest in their pension plans, they have an incentive to invest their pension assets entirely in bonds. The firm earns arbitrage profits as long as it is taxable, since the profits are based on the ability of the firm to deduct its interest payments while not paying taxes on the interest earned inside the pension plan (Black, 1980 and Tepper, 1981). These two arguments both imply that overfunded firms are more likely to be invested in bonds (safe and tax disfavored assets) and underfunded plans are more likely to be invested in stocks (risky and tax favored assets). This tilting should be accentuated by the financial condition of the firm. For example, the incentive to invest the assets of an overfunded plan in bonds will be stronger for a profitable and highly taxed firm.

Some pension fund managers argue that the pension assets should be invested entirely in fixed income securities to hedge the risk. To assess this argument, we need to proceed in two steps. First we must consider the nature of risk inherent in the pension obligation of a defined benefit promise -- what is the firm's risk exposure? Then we can discuss the justification for hedging the risks.

For a retired employee, the future promised benefits are fixed. In this case the promise looks identical to the promises made by a debt contract. For individuals who have not yet retired, the pension benefit has two components. The first is the benefit the employee has earned and is entitled to even if the employee were to leave the firm or the firm was to close the plan. This is identical to the pension benefit of the retired worker. The future cash flows to this benefit do not change. The other portion of the benefit

depends upon the future employment and wages of the worker. The future cashflows are uncertain. Thus hedging the future pension liability with a fixed income security is only correct for the portion of the pension liability which has already vested. If future wage growth is correlated with aggregate equity returns, then the nonvested but expected portions of the pension promise could be hedged with an investment in equity securities (Black, 1989).

The fact that a risk can be hedged, does not mean that it is optimal to do so. In fact, in an idealized world without market frictions, hedging does not add value. By hedging a risk, the firm lowers the risk it faces but it must pay to do so. Its shareholders are indifferent since the lower risk is exactly offset by the lower expected return. Thus for a financial hedge to add value, we must assume the presence of some market distortion. Petersen (1994) examines several possible justifications for hedging and then examines the pension plan choice as a way to reduce the operating leverage of the firm. By replacing fixed costs (costs which do not vary with revenues) with variables costs (costs which rise when revenues rise and fall when revenues fall), the firm can shift risk from its security holders (debt and equity holders) to its employees. Those firms which find such a shift more valuable are more likely to adopt a defined contribution pension plan as opposed to a defined benefit pension plan.

The firm can also change the risk of its pension plan by changing the allocation of the plan's assets. Risky assets, such as equities, have large positive returns sometimes and large negative returns at other times. If the return on the pension assets translates into changes in the required funding contribution, then risky assets will translate into more risky required contributions to the pension plan. Variable contributions may not be costly to the firm. Cash flow variability is costly only if it does not coincide with the corporations net demand for capital. If the firm's cash flows from current operations are high when it has many positive net present value (NPV) projects and is low when it has few positive NPV projects, then the variability is not costly. In fact, a financial hedge would take cash away from the firm when the value of cash flow is high and return it to the firm when the value of cash flow is low. To evaluate the value of a financial hedge, we must examine not only the reduction in cash flow variability, but also its correlation

with project availability. In the case of a pension plan, a high allocation in stocks will mean the plan's required contributions will be higher in down markets than in up markets. The question is whether the firm's available cash flow is higher in up markets or down markets.

## THE INTERACTION OF DISCOUNT RATES AND ASSET ALLOCATIONS.

Since the expected return on stocks is higher than bonds, pension plans which are invested in equities will in expectation become overfunded if the plan uses a bond-like discount rate. The expected growth rate of the assets (stocks) exceeds the expected growth rate of the (bond like) liabilities. Does this imply that the discount rate should be adjusted to account for the asset allocation of the pension? This would limit the expected overfunding of the pension plan.

The discount rate appropriate for discounting future pension liabilities, is related to the riskiness of the underlying assets, but it is not the same. Remember, a defined benefit pension liability is like a debt of the firm. If the debt (pension liability) is riskfree, then the expected rate of return on the debt -- and thus the appropriate discount rate for the debt payments -- is the risk free rate. This does not change as the assets become riskier, as long as the liability remains risk free. Raising the risk of the assets makes the equity riskier, but not necessarily the debt. As the risk of the assets is increased, a point will be reached when the debt (pension liability) is no longer risk free. In this case, increasing the risk of the assets, will raise the riskiness and the expected rate of return on the debt. However, even in this case the expected return on the debt will be less than the expected return on the assets. The expected return on the debt will rise with the expected return on the assets, but not one for one. Equivalently, the appropriate rate for discounting the cashflows to the pension liability will be less than the rate appropriate for discounting the cashflows to the pension assets. The reason for this difference is the pension liabilities only carry a fraction of the asset's risk. The value of the pension liabilities covaries with the asset's value only in the range where the asset's value is less than or equal to the value of the pension liability. For higher values of the assets, changes in the asset's value do not increase the value of the pension asset -- because it does not

increase its payoff. Most of the risk is being born by the equity holders, not the pension plan beneficiaries.

Thus the appropriate discount rate for the pension assets should be below the expected return on the pension assets. As the firm shifts the pension assets from low risk assets (cash) to higher risk assets (stocks) the discount rate will rise only if the pension liability does not remain risk free. This will be more likely the lower the funding level of the pension and the riskier the firm.

# EMPIRICAL RESULTS.

## DATA DESCRIPTION.

The data for this empirical analysis are extracted from two sources. The data on the allocation of pension assets and the discount rate which firms choose to discount their pension liabilities are taken from the firm's Form 5500 -- 'Annual Return/Report of Employee Benefit Plan'. The Form 5500 is the form which all private pension plans with more than 100 employees or more must file with the Federal government. My data are taken from the Form 5500s for years 1988 to 1990. Since the 1988 forms contain filing dates in both 1988 and 1989, the data set spans the 1988 to 1991 time period. The forms contain a rough break down of the asset categories in which the plan's assets are invested.[12] In addition to the financial information, the forms also contain information on the pension plan type, the covered employees, and the plan sponsor. Not all plans report a detailed break down of the type of assets they own. Instead they only report that the assets are held through a trust or are invested through a pooled account with an insurance company, for example. Since we do not know in what assets these moneys are eventually invested, they are excluded from this analysis.[13] I condensed the remaining asset categories into six broad categories --

[12] These asset categories include interest bearing cash (including money market funds), certificates of deposit, U.S. government securities, corporate debt instruments, corporate stock (both preferred and common), partnership/joint venture interests, real estate, loans secured by mortgages, loans to participants, other loans, and employer-related investments.

[13] I excluded pension plans that invested more than five percent of their assets through either an insurance company or an investment trust.

although we will focus on only the major categories. In order of increasing risk, the pension plan can invest in short term fixed income securities (cash), government bonds, corporate bonds, and equity.[14] In addition, the pension plans can invest in the securities of the employer or plan sponsor as well as other assets.

If a defined benefit pension plan is treated as an integral part of the firm's finances, then management of the pension will be influenced by the firm's non pension finances. To test these hypotheses, I linked the pension data (Form 5500) to the firm's income statement and balance sheet. This data is taken from Compustat. The two data sets are linked using the firm's employer identification number (EIN). Compustat reports only one employer identification number per firm. Thus Form 5500 files under any EIN other than the primary one are not included.[15] The financial data is taken from the ten years prior to the Form 5500 filings. This assures us that the financial variables are exogenous and thus we do not need to be concerned with how the choice of the pension's asset allocation or discount rate feeds back to the financial variables.

## THE ASSET ALLOCATION DECISION.

### Comparing defined benefit and defined contribution plans.

We begin by examining the asset allocation of defined benefit and defined contribution plans. Since the asset allocation of a defined contribution plan should depend only upon the choices made by the plan participants (or the pension fund manager as the participant's agent) and should not be affected by the incentives of the firm, we can use it as a benchmark.

---

[14] Due to their similar risk characteristics, I have included real estate investments with equities and mortgages (both commercial and residential) with corporate bonds. However, neither category represents a large fraction of the pension plan's assets. Less than four percent of pension plans have assets invested in real estate and less than one half of one percent of pension assets are invested in real estate in 1988. Mortgages are owned by about 3 percent of plans and they comprise about 0.4 percent of pension plan assets in 1988.

[15] Linking the Form 5500 and Compustat data has proven to be a difficult task. Other researchers have augmented the list of Compustat EINs by reading the sponsor's name manually and then matching the data by hand (Petersen, 1992).

The average asset allocations reported by defined benefit and defined contribution plans are broadly similar. Both types of pension plans invest approximately a fifth of their funds in cash type instruments (see Table I, Panel A). Another quarter is invested in equities for defined contribution plans. Defined benefit plans invest a larger fraction of their assets in stocks (31 percent). The largest difference in the asset allocation of defined benefit and defined contribution occurs in their weighting in bonds. Defined benefit pension plans invest a significantly larger fraction of their assets in bonds (44.6 versus 33.7 percent). Given that a significant fraction of their liabilities are long term fixed nominal claims, this is understandable. By matching their assets and liabilities the defined benefit pension plans have hedged both the interest rate risk (from mismatched maturities) and equity market risk (from funding fixed nominal claims with equity). Defined contribution plans overweight their asset allocation in assets of the employers. The vast majority of these assets are securities issued by the employer -- for example common stock or preferred stock issued by the plan sponsor.

Table I:
ASSET ALLOCATION FOR PENSION PLANS
by Pension Plan Type

Panel A: Defined Benefit and Defined Contribution

| Asset Category | Defined Benefit | Defined Contribution |
|---|---|---|
| Cash | 17.7 | 20.3 |
| Government Bonds | 28.9 | 18.9 |
| Corporate Bonds | 15.7 | 14.8 |
| Equities | 30.7 | 23.9 |
| Employers Assets | 0.4 | 12.9 |
| Other Assets | 6.6 | 9.2 |
| Number of Observations | 19,729 | 37,188 |

Panel B: Defined Benefit, Defined Contribution, and ESOPs

| Asset Category | Defined Benefit | Defined Contribution | ESOPs |
|---|---|---|---|
| Cash | 17.7 | 23.9 | 5.3 |

| | | | |
|---|---|---|---|
| Government Bonds | 28.9 | 22.3 | 4.9 |
| Corporate Bonds | 15.7 | 17.3 | 4.5 |
| Equities | 30.7 | 25.0 | 19.8 |
| Employers Assets | 0.4 | 0.9 | 62.2 |
| Other Assets | 6.6 | 10.6 | 3.3 |
| Number of Observations | 19,729 | 2,9903 | 7,285 |

Notes:

These tables contain the percentage of pension assets invested in each of the six categories. Those pension plans which do not report their asset allocations because they invest through an investment trust or insurance company where the funds are held in general accounts are excluded. The data are based on the asset allocations reported on the firm's Form 5500 between the years 1988 and 1991. In Panel A, Employee Stock Ownership Plans are included in the defined contribution category (Source: Form 5500s).

I have argued that defined contribution plans provide a useful benchmark, since their asset allocation decision is not constrained by the firm's incentives. The exceptions to this statement are employee stock ownership plans (ESOPs). The discretion of the employees to choose the asset distribution in ESOPs is limited. ESOPs are designed to invest a large fraction of their assets in the securities of the employer. For ESOP plans, the assets are concentrated in equities and securities of the employer.[16] Thus we might expect them to appear to invest more heavily in equities, since they have a majority of their assets in the stock of the sponsor. The fraction of ESOP assets held in equities is reported to be 20 percent, which is actually lower than the holdings of non-ESOP defined contribution plans (see Table I, Panel B) -- and much lower than expected. This is probably a classification issue (see discussion below). Some ESOPs classify their holdings of the sponsor's securities as equity; other ESOPs classify their holdings as securities of the employer. The latter classification may be more common if the ESOP purchases a preferred equity issue which is only issued to the ESOP.

Since the asset allocation of ESOPs is more constrained than other defined contribution or defined

[16] The Form 5500 identifies pension plans as ESOPs. However, there were some defined contribution plans not identified as ESOPs which held a majority of their assets in the securities of the employer. I classified these plans as ESOPs.

benefit plans, it is necessary to look at their asset allocation separately. As expected, the ESOPs have very different asset distributions (see Table I, Panel B). Assets invested in the securities of the employer comprise more than 60 percent of the plan's assets. Thus if we combine the ESOP's investment in equities and their investment in the securities of the sponsor, their total investment in equities could be over 80 percent. Once the ESOPs are removed, the asset distribution of defined contribution and defined benefit plans look only slightly more similar. The difference between their holdings of long term government bonds and equities both decline slightly. Defined contribution plans have a slight bias in their fixed income investments toward the shorter end of the term structure. Their holdings of cash are higher (23.9 versus 17.7 percent) and their holdings of bonds are lower (39.6 versus 44.6 percent).

## Pension plan funding and the maturity of liabilities.

Prior to turning to the financial condition of the firm, we will examine the pension asset allocation strictly as a function of the pension characteristics. The investment incentives for the firm may depend upon both the funding status of the pension plan as well as the maturity of the pension plan liabilities. To describe the asset allocation decision we will look at two variables: the fraction of the pension plan assets which are invested in equities and the fraction which are invested in bonds (both corporate and government bonds). Thus the regressions can be interpreted as explaining the allocation between stocks and cash in the first regression and between bonds and cash in the second regression. The regressions include both defined benefit and defined contribution plans so that we can compare the marginal effect that pension plan type has on the asset allocation decision. The marginal effect of pension plan type has a statistically significant effect on the asset allocation decision (see Table II). However, the magnitude of the difference is not large. The marginal effect of changing from a defined contribution to a defined benefit plan increases the weighting in equity by less than two percentage points. The univariate difference was 5.7 percent (see Table I). Thus most of the difference between the stock allocation of defined benefit and defined contribution plans can be traced to a difference in the characteristics of the specific plans. As we saw in Table I, the

defined benefit plans invest more in bonds. The magnitude of this difference is similar (5-6 percent) after we control for the characteristics of the pension plan (see Table II).[17]

Table II:
ASSET ALLOCATION REGRESSIONS
Plan Level Data

| Coefficient | Percent in Stock | Percent in Bonds |
|---|---|---|
| Defined Benefit Plan | 0.018[1] | 0.066[1] |
| | (0.003) | (0.004) |
| Funding Status | 0.104[1] | -0.059[1] |
| | (0.010) | (0.012) |
| Zero Contribution | 0.021[1] | -0.064[1] |
| (0,1) | (0.004) | (0.005) |
| Benefit/Assets | -0.241[1] | 0.116[1] |
| | (0.012) | (0.014) |
| Benefit/Assets > 0.5 | -0.057[1] | 0.027[5] |
| (0,1) | (0.010) | (0.012) |
| Nonvested Participants | -0.006 | 0.031[1] |
| (% of total participants) | (0.005) | (0.006) |
| Self Directed Contributions | -0.019[1] | -0.005 |
| (0,1) | (0.005) | (0.006) |
| Plan subject to a Collectively | -0.037[1] | 0.032[1] |
| Bargained Agreement (0,1) | (0.004) | (0.005) |
| Year the plan started | -0.005[1] | 0.001[1] |
| | (0.000) | (0.000) |
| Constant | 0.665[1] | 0.425[1] |
| | (0.017) | (0.020) |
| Year dummies | 3 | 3 |
| Industry dummies | 8 | 8 |
| $R^2$ | 0.163 | 0.111 |

[17] Since many of these variables vary for only one type of pension plan, an argument can be made for running the regression separately for defined benefit or defined contribution plans. Empirically this turns out not to be important. When the regressions are run separately for defined benefit and defined contribution plans, the coefficient estimates are very similar to the ones reported in Table II.

| | | |
|---|---|---|
| Number of Observations | 47,455 | 47,455 |

Notes:

The dependent variable is the fraction of pension assets invested in stocks or bonds. Bonds include both government and corporate bonds. The mean stock allocation is 0.28 and the mean bond allocation is 0.42. Funding status is defined as the assets of the plan divided by its liabilities. It is set equal to one for defined contribution plans. The variable nonvested participants was set equal to zero for defined contribution plans. ESOPs were not included in these regressions. To limit the influence observations with extreme values of the funding ratio, I capped this variable at its 1st (0.36) and 99th percentile (1.56) (Source: Form 5500s).

[1] Coefficient is statistically different from zero at the 1 percent level.

The two main theories on pension fund asset allocation, both argue that the funding status of the pension should affect its asset allocation decision. Firms with overfunded pension plans are less likely to default on their pension promises. Thus to maximize their tax savings, overfunded plans should invest in bonds (Black, 1980, and Tepper, 1981). Firms with underfunded plans are more likely to default on their promise. To maximize the value of the option to default, they should invest the pension funds in riskier assets (Sharpe, 1976). Empirically, better funded plans invest more of their assets in stocks, not less (see Table II).[18] Each 10 percent increase in funding level, increases the equity percentage by one percentage point. The allocation to bonds drops as the plans become overfunded. Each 10 percent increase in funding level, lowers the bond weighting by 60 basis points (0.6 percentage points). As a second measure of the firm's funding status, I also controlled for whether the firm made any contributions. These could be firms which are against their maximum funding limits of their defined benefit pension and are thus not allowed to make additional contributions. Plans which did not receive contributions, invest 2.1 percent more of their assets in stocks and almost 6.4 percent less in bonds. This positive correlation between funding level and the investment in riskier assets (stocks) supports the argument that plan sponsors are trying to hedge their contribution risk. Taking on more risk is in some sense less costly for overfunded plans than for underfunded plans. If the plan's investment performance is poor, there is a larger cushion of assets. Thus

[18] Interestingly using data from the 1980 Form 5500, Bodie, Light, Morck, and Taggart (1987) make the opposite finding (see Table 2.1). They find that overfunded plans invest more in fixed income securities and thus less in stock. When they include the firm's bond rating this result is no longer statistically significant.

it is less likely the firm will be forced to contribute more in years where the market is down. For just funded or even underfunded plans, the greater volatility of equity returns has a much greater effect on the volatility of contributions. These plan sponsors thus invest more in bonds and cash where the volatility of returns is lower.

In addition to the funding status, the maturity of the pension liabilities may affect the asset allocation decision. Young plans have benefit promises a long way in the future. In addition, most of these benefits depend upon future wages and service and so are not fixed in nominal terms. As the plan and the participants age, the benefits depend more upon past service and wages. In these plans the liabilities should depend only upon long term (or short term interest rates). I measure the maturity of the plan's benefits in two ways. First, I use the plan's current benefit payments as a fraction of the plan's assets. In addition, I include the fraction of the plan participants which are not fully vested. Plans with short maturity liabilities should have a large value for the first variable (benefits/assets) and a small value of the second variable (percentage of participants which are not fully vested). Increases in the benefits to assets raises the plans weighting in stocks and lowers the weighting in bonds (see Table II). For example, increasing the benefits to asset ratio from zero (no current benefits being paid) to 8 percent (the median) lowers the equity weighting by two percentage points and raises the bond weighting by one percentage point.[19] The plans which must pay current benefits shift money out of stocks and put some in bonds and some in cash. Once we include the benefit to asset ratio, the percentage of nonvested participants has no additional effect on the plan's asset allocation decision.

Before turning to the financial side of the firm, there is one more hypothesis to consider. One motivation behind the debate over asset allocation is the belief that, left to their own, individuals will invest

[19] Some of the plans have very large benefit to asset ratios. To make sure the coefficient on the benefit to asset ratio was not driven by these observations, I also included a dummy variable for plans whose benefits exceeded half their assets. The asset allocation for these plans is even more extreme. Compared to a firm paying no benefits, a firm whose benefits are equal to one half the plan's assets invest 18 percent less in stocks and 8.5 percent more in bonds. These are large changes.

too little of their pension assets in equities. As we discussed above, the choice among assets should be influenced by an investor's tolerance for risk, not strictly on the basis of expected return. However, some commentators have made the argument that individuals are too conservative in their pension plan's investments. We can directly examine whether individuals' choices differ from the choices made by professional money managers. Fourteen percent of the defined contribution plans permit participants to exercise independent control over the assets in their accounts. These plans do have more conservative investments. Compared to an otherwise identical plan, these plans invest 1.9 percent less in equities and half a percent less in bonds. Although the first coefficient is statistically significant, neither is economically large. For example, based on historic return on the stock market, moving 1.9 percent of a portfolio from stocks to treasury bills would lower the annual expected return on the portfolio by 0.16 percent.[20]

## The financial condition of the firm.

The argument that defined benefit plans are an integral part of the firm has the strong prediction that the pension assets are assets of the firm and the pension liabilities are liabilities of the firm. If managers believe this, then their management of the pension assets will be influenced by the financial condition of the firm. As we discussed above, the profitability, riskiness, and tax paying status of the firm can affect how the managers allocate the pension's assets.[21] By contrast, the assets of a defined contribution plan are independent of the firm. Thus their management should not be influenced by the finances of the firm.[22] To

[20] This is based on the fact that the excess return on the stock market over the return on treasury bills has averaged 8.5 percent over the last six decades (Ibbotson Associates, Inc., 1989).

[21] The inclusion of financial variables in the regression causes the sample size to shrink. This occurs predominantly because many of the firms filing Form 5500s are not public firms and thus they are not included in the Compustat data base. The sample also shrinks due to difficulty in matching the firms financial data with the Form 5500. I used the employer identification number to match firms. Compustat reports only one EIN for each firm. However, since some firms file Form 5500s under many different EINs, not all will be included in this sample.

[22] This may not be technically correct. In a defined contribution plan the participants allocate the assets based on their preferences for risk and the allocation of their other assets. An employee in a highly volatile industry, in terms of employment and wages, may choose less risky pension assets to offset the

test the dependence of the pension's asset allocation decision, I regressed the percentage of the pension assets invested in stocks and the percentage invested in bonds on characteristics of the plan and proxies for the profitability, riskiness, and tax paying status of the firm. The results are reported in Table III.

higher risk of his or her human capital. Although we might find the asset allocation decision in a defined contribution plan depends upon the firm or industry characteristics, this may be too complicated a decision process to observe in practice.

Table III:
ASSET ALLOCATION REGRESSIONS
Financial and Plan Level Data

| Coefficient | Defined Benefit | | Defined Contribution | |
|---|---|---|---|---|
| | Percent in Stock | Percent in Bonds | Percent in Stock | Percent in Bonds |
| Funding Status | 0.108[1] | -0.105[1] | | |
| | (0.029) | (0.036) | | |
| Zero Contribution | 0.052[1] | -0.119[1] | 0.068[1] | -0.023 |
| (0,1) | (0.015) | (0.018) | (0.025) | (0.027) |
| Benefit/Assets | -0.422[1] | 0.184[1] | -0.289[1] | 0.154[1] |
| | (0.052) | (0.066) | (0.052) | (0.057) |
| Benefit/Assets > 0.5 | 0.045 | 0.020 | 0.039 | 0.063 |
| (0,1) | (0.043) | (0.055) | (0.041) | (0.045) |
| Nonvested Participants | -0.106[1] | 0.112[1] | -0.014 | 0.081[1] |
| (% of total participants) | (0.032) | (0.041) | (0.025) | (0.027) |
| Self Directed Contributions | | | -0.051[1] | -0.014 |
| (0,1) | | | (0.017) | (0.018) |
| Plan subject to a Collectively | -0.039[1] | 0.059[1] | -0.041 | 0.114[1] |
| Bargained Agreement (0,1) | (0.014) | (0.018) | (0.021) | (0.023) |
| Income / Avg(Assets) | 0.030 | -0.037 | 0.073 | -0.067 |
| | (0.091) | (0.115) | (0.077) | (0.085) |
| Avg(Income) / Avg(Assets) | 1.182[1] | -0.646 | 0.023 | 0.414 |
| | (0.404) | (0.512) | (0.425) | (0.466) |
| Std Dev(Income) / Avg(Assets) | -0.717[1] | 0.215 | -0.278 | -0.147 |
| | (0.211) | (0.268) | (0.214) | (0.234) |
| ρ(Income, Stock Returns) | 0.005 | -0.009 | -0.031 | 0.005 |
| | (0.014) | (0.018) | (0.016) | (0.018) |
| Avg(Tax Payments) / Avg(Assets) | -0.515 | 0.356 | -0.164 | 0.239 |
| | (0.455) | (0.577) | (0.443) | (0.486) |
| Year the plan started | -0.003[1] | 0.001 | -0.003[1] | -0.000 |
| | (0.000) | (0.001) | (0.001) | (0.001) |
| Constant | 0.324 | | 0.583[1] | 0.310 |
| | (0.193) | | (0.165) | (0.181) |
| Year dummies | 3 | 3 | 3 | 3 |

| | | | | |
|---|---|---|---|---|
| Industry dummies | 8 | 8 | 8 | 8 |
| $R^2$ | 0.336 | 0.258 | 0.202 | 0.250 |
| Number of Observations | 1,957 | 1,957 | 2,098 | 2,098 |

Notes:

The dependent variable is the fraction of pension assets invested in stocks or bonds. Bonds include both government and corporate bonds. The mean stock allocation is 0.28 and the mean bond allocation is 0.42. Funding status is defined as the assets of the plan divided by its liabilities. It is set equal to one for defined contribution plans. The variable nonvested participants was set equal to zero for defined contribution plans. ESOPs were not included in these regressions. To limit the influence observations with extreme values of the funding ratio, I capped this variable at its 1st (0.36) and 99th percentile (1.56). The averages, standard deviations, and correlations are calculated using ten years of data predating the filing of the Form 5500. Thus a Form 5500 filed in 1988, would use financial data from 1978 to 1987. The stock return in the correlation is the stock return on the value weighted market index (Source: Form 5500s and Compustat).

[1] Coefficient is statistically different from zero at the 1 percent level.

The inclusion of financial variables adds nothing to the explanatory power for defined contribution plans. In the equity regression, the $R^2$ rises from 0.198 to 0.202 when the financial variables are included.[23] The results for the percentage of assets in bonds are identical. None of the coefficients on the financial variables are significant, nor are they large in magnitude.[24] This is evidence that the asset management of defined contribution plans is essentially independent of the firm. Defined contribution plans by design and structure are independent entities.

The answer for the defined benefit plan regressions is quite different. The financial variables do not help us predict the allocation of bonds versus cash in the pension plan. However, the explanatory power of the equity allocation regression rises when the financial variables are added (see Table III). The hypothesis that the coefficients on all the financial variables are zero can be rejected at less than the 1 percent significance level ($F_{5,1933} = 4.1$). The added explanatory power comes from the average profitability and variability of profits over the previous ten years. Since the asset allocation may depend upon both the

[23] Since the sample size shrinks when the financial variables are added, we can not directly compare the $R^2$ from Table II with the $R^2$ in Table III. To make them comparable, I reestimated the regressions in Table II using only the observations for which I had financial data, thus making the samples comparable.

[24] The hypothesis that the coefficients on the financial variables are jointly significant can not be rejected at the 6 percent significance level for the stock regression and at the 36 percent significance level for the bond regression.

long run profitability of the firm as well as temporary fluctuations, I included proxies for both. The long run profitability or riskiness of the firm was estimated with ten years of historical data. Thus if we wanted to estimate the asset allocation of a plan in 1988, I used data from 1978 to 1987 to estimate the average profitability and variability of the firm's income.[25]

The fraction of the plan invested in stocks does depend upon the long run profitability of the firm and the riskiness of its cashflows. However, the sign of that relationship is inconsistent with the theory discussed above. Profitable firms should be investing their portfolio in bonds to take advantage of the tax favored nature of pension plans (Black, 1980 and Tepper, 1981). Unprofitable and risky firms should be investing in stocks to maximize the value of the option to default (Sharpe, 1976). In this sample of pension plans, the exact opposite is true. Those firms with high average profitability have higher average weighting in stocks. For example, increasing the average income to asset ratio from the 25th percentile (1.8 percent) to the 75th percentile (6.2 percent) increases the weighting in stock by five percentage points. Temporary fluctuations in profitability have little effect on the asset allocation. Holding average profitability constant, if I increase last year's profits, the allocation in equities rises but insignificantly so. Just as high average income leads to higher weighting in stock, highly variable income leads to lower investment weights in stock. Increasing the standard deviation of income (over assets) from the 25th percentile (1.8 percent) to the 75th percentile (4.2 percent) lowers the allocation in stock by two percentage points.

The results thus far are not consistent with firms attempting to transfer wealth from the U.S. Treasury (by lowering the present value of their taxes) or the PBGC (by increasing the value of the PBGC put). Instead managers appear to be managing pension investments with the intent of minimizing the risk the plan imposes on the operations of the rest of the firm. Equities have higher expected returns, but their returns are more volatile. For a poorly funded firm or a firm with low profitability, the variability in returns can translate into variability in contributions. This can be costly. In previous work, I showed that

[25] All the financial variables are divided by the average level of the firm's assets over the previous ten years. This makes the numbers for very large firms comparable with the numbers for very small firms.

firm's with more volatile cash flows avoided defined benefit plans to avoid the variability in required contributions (Petersen, 1994). If a firm would prefer to sponsor a defined benefit plan for other reasons (i.e., labor market factors), they can still reduce the volatility of the contributions by hedging the liabilities. By investing the pension assets in fixed income securities, the net asset value (pension assets minus pension liabilities) and thus contributions will vary less.

The last measure of risk I look at is the correlation between the firm's income and the stock market return. A firm whose income is negatively correlated with the stock market return may actually be able to lower the riskiness of their pension contributions by investing in the high risk asset -- equities. For this firm, investing in equities may actually be a hedge. When the value of the pension assets falls (i.e., when the stock market has low returns), this is exactly when our hypothetical firm has high income. Thus its pension contributions would be high when it has high income and low when it has low income. A switch from stocks to bonds for this firm could actually increase its risk. Although the empirical correlations between a firm's income and the stock return in our sample range from -0.97 to 0.96, this correlation has no effect on how the firm allocates its pension assets.

The last financial control I examined was the firm's tax paying status. We already have the firm's average income in the regression. By including the firm's average tax payments (also scaled by assets), we can proxy for the firm's average tax rate. Firms with higher tax rates gain more by fully funding their plans and then investing the assets in fixed income securities. The evidence in support of this hypothesis is weak at best. I do find that firm's with greater tax payments do invest less in stock. Increasing the firm's tax payments from the 25th to the 75th percentile lowers the assets allocated to stocks by two percentage points. However, the standard error of this estimate is so large that we cannot statistically distinguish this result from zero.[26]

[26] I also tried the ratio of the firms tax payments to its income over the last ten years as well as last year. Neither variable is correlated with the fraction of pension assets invested in stocks. Friedman (1983) finds similar results.

## THE DISCOUNT RATE CHOICE.

The firm's choice of a discount rate in part determines the value of the liabilities it reports for funding purposes on the Form 5500.[27] The firm does not have unlimited discretion in choosing its discount rate. However, given the ambiguity in the nature of the pension promise, there is some latitude in the rates firms can choose. Over the four years examined (1988-1991), the discount rates chosen by firms essentially ranged from seven to 10 percent.[28] The mean discount rate (8.4 percent) is approximately equal to the rates on long term fixed income securities at this time. The average pension discount rate chosen by the plans is identical to the average yield on ten year government bonds (8.4 percent). Pension liabilities, however, are riskier than government bonds -- at least to the corporation -- and thus should be discounted at a greater rate. The pension discount rate, however, is significantly less than the yield on the safest corporate bonds. The average yields on AAA corporate bonds averaged 9.4 or 100 basis points above the average discount rates chosen by the pension plans. Since the pension liabilities, at least from the perspective of the firm, should be viewed as risky or riskier than AAA corporate bonds, it is surprising that the discount rates chosen by the pension plans are smaller.

Although the level of pension discount rates is close to the level of interest rates on long term debt, the two series are not highly correlated. The discount rate data spans just over three years. However, by comparing the discount rate to bond yields, we can get a sense of how closely the movements of the two series are correlated. Not only are the pension discount rates not highly correlated with market interest rates, but the correlations are negative. The correlation between the pension discount rates and the yield on ten year government bonds is -0.078. When the discount rates are compared to AAA corporate bonds,

---

[27] The pension plans may report separate interest rates for discounting the pension promise of preretirement and postretirement participants. I used the pre-retirement interest rate. However, the correlation between the pre- and postretirement discount rates is 0.95.

[28] After correcting outliers resulting from keypunch errors (discount rates of 60 percent or more) the actual range was from 1 to 11 percent. However, 99.2 percent of the observations were in the seven to 10 percent range.

a similar finding arises. The correlation is -0.058. A partial explanation of the low correlation between the pension discount rates and market interest rates is the low frequency with which pension discount rates are changed. Between the 1988 Form 5500 filing and the 1990 Form 5500 filing, 78 percent of the pension plans did not change their discount rates. Since most of the discount rates are constant, they will have small time series correlations with most variables. The negative association arises because market interest rates fell over this period -- the ten year government bond yield falls by more than a percent -- while the discount rates chosen by pension funds rose very slightly.

In Section II we discussed why the discount rate, in principle, may depend upon the financial condition of the firm as well as the funding status and asset allocation of the pension plan. We now empirically examine this question. For the subsample of plans which report a discount rate, we estimate the discount rate as a function of the profitability, riskiness, and tax paying status of the plan's sponsor. In addition, we include the funding status and the asset allocation of the pension plan.[29]

The asset allocation of the plan assets is correlated with the discount rates which plans choose. Firms which allocate more of their assets to stock and bonds, instead of cash, use higher discount rates on average (see Table IV). This relationship is statistically very significant, although it is small economically. Changing the allocation from all cash (short term fixed income securities) to all equities, raises the predicted discount rate by just over five basis points. This is a small number. Shifting the assets to bonds instead of stock, raises the predicted discount rate by more, even though the expected return on bonds is significantly below the expected return on stocks. To put these numbers into perspective, we can compare them to the historic returns on cash, bonds, and stocks.[30] If pension plans used the expected return on their

[29] Most of the pension plan discount rates are missing on the 1989 Form 5500. Thus the sample effectively includes only plan fillings for 1988 and 1990.

[30] The average return on stocks over the 1926 to 1988 period has been 12.1 percent. The return on Treasury bills has been 3.6 percent. This difference, 8.5 percent, is the risk premium paid to owners of equity. The average return on bonds are between these numbers. The average return on government bonds has been 4.7 percent, while the average return on corporate bonds has been 5.3 percent (Ibbotson Associates, Inc., 1989).

assets as a discount rate, then the coefficient on the percentage of assets in stocks should be 8.5 and the coefficient on the percentage of assets on bonds should be between 1.1 and 1.7.

Table IV:
DISCOUNT RATE CHOICE BY PENSION PLANS
Plan Level Data

| Coefficient | I | II |
|---|---|---|
| Percent of Assets in Stock | 0.055[1] | -0.103 |
| | (0.023) | (0.071) |
| Percent of Assets in Bonds | 0.083[1] | -0.020 |
| | (0.019) | (0.054) |
| Funding Status | -0.173[1] | -0.001 |
| | (0.027) | (0.070) |
| Zero Contribution | 0.059[1] | 0.017 |
| (0,1) | (0.013) | (0.036) |
| Benefit/Assets | 0.157[1] | -0.027 |
| | (0.049) | (0.122) |
| Benefit/Assets > 0.5 | -0.058 | 0.047 |
| (0,1) | (0.041) | (0.099) |
| Nonvested Participants | -0.126[1] | 0.030 |
| (% of total participants) | (0.027) | (0.078) |
| Plan subject to a Collectively | -0.079[1] | 0.020 |
| Bargained Agreement (0,1) | (0.013) | (0.033) |
| $\frac{\text{Income}}{\text{Avg(Assets)}}$ | | 0.179 |
| | | (0.221) |
| $\frac{\text{Avg(Income)}}{\text{Avg(Assets)}}$ | | -0.395 |
| | | (1.015) |
| $\frac{\text{Std Dev(Income)}}{\text{Avg(Assets)}}$ | | 0.000 |
| | | (0.518) |
| $\rho$(Income, Stock Returns) | | 0.040 |
| | | (0.034) |
| $\frac{\text{Avg(Tax Payments)}}{\text{Avg(Assets)}}$ | | -2.621 |
| | | (1.163) |
| Year the plan started | 0.000 | -0.002 |
| | (0.000) | (0.001) |

| | | |
|---|---|---|
| Constant | 8.401[1]<br>(0.057) | 8.507<br>(0.420) |
| Year dummies | 3 | 3 |
| Industry dummies | 8 | 8 |
| $R^2$ | 0.067 | 0.064 |
| Number of Observations | 13,603 | 1,561 |

Notes:

The dependent variable is the discount rate chosen by the pension plan for discounting its current liabilities. The mean discount rate is 8.4 percent. Bonds include both government and corporate bonds. Funding status is defined as the assets of the plan divided by its liabilities. It is set equal to one for defined contribution plans. The variable nonvested participant was set equal to zero for defined contribution plans. ESOPs were not included in these regressions. To limit the influence observations with extreme values of the funding ratio, I capped this variable at its 1st (0.36) and 99th percentile (1.56). The averages, standard deviations, and correlations are calculated using ten years of data predating the filing of the Form 5500. Thus a Form 5500 filed in 1988, would use financial data from 1978 to 1987. The stock return in the correlation is the stock return on the value weighted market index (Source: Form 5500s and Compustat)

[1] Coefficient is statistically different from zero at the 1 percent level.

If the only point in choosing a discount rate is to value the liabilities, then only the (systematic) riskiness of the liability should matter. The riskier the underlying assets, the riskier the pension's promise. The positive coefficients on the percentage of assets invested in stocks and bonds is loosely consistent with this argument. The funding status also affects the riskiness of the pension promise, for the firm, and thus should have an indirect effect on the correct discount rate. Better funded pension plans are less likely to default on their pension promises. Empirically I find that better funded pension plans do choose lower discount rates (see Table IV). However, the magnitude of this effect is again tiny. Raising the funding status from 10 percent underfunded to 10 percent overfunded lowers the discount rate by only three basis points -- an imperceptible change.

Firms may also alter their chosen discount rates to manage their required pension contributions. Thus firms which would like to contribute more to their pension plans have an incentive to choose a lower discount rate which will inflate the stated value of liabilities. If this were true, however, firms with overfunded pension plans and those for whom the tax savings are greatest would be the ones with the strongest incentives to choose lower discount rates. As discussed above firms with overfunded plans do

choose higher discount rates, but only marginally so. The tax paying status of the firm also influences its choice of discount rates. To control for the financial condition of the firm, I included measures of the firm's profitability, riskiness, and tax paying status as above. The only variable which has a statistically significant effect on the choice of the discount rate is the firm's tax payment.[31] Firms with higher tax payments, holding income constant, choose a lower discount rates. Once again, however, the magnitude of this effect is small. Increasing a firm's tax payments from 1.7 percent of assets (the 25th percentile) to 5.1 percent of assets (the 75th percentile) lowers the chosen discount rate by only nine basis points. A statistically significant finding, but once again not large in magnitude.

# CONCLUSIONS.

Financially the reason defined benefit pension plans differ from defined contribution plans is they are part of the firm. If this is true, the financial management should be integrated with other financial decisions the firm makes. Decisions regarding the management of a defined benefit pension plan will affect and be affected by the firm's investment decisions, tax paying status, and risk management strategy. Defined contribution plans, on the other hand, are separate entities. Decisions regarding the management of defined contribution plans are independent of the firm's finances. This paper finds evidence supporting this view of the pension plan. The asset allocation decision of defined benefit plans is correlated with the firm's finances. More profitable and less risky firms invest more of their pension assets in equities than in bonds or cash.

The theory surrounding the funding and asset allocation of pension plans has been motivated by two opposing objectives. According to the theory, solvent, low risk, and highly taxable firms were motivated by a desire to lower the present value of their tax payments. These firms should fund their pension plans

[31] The sample for which I have both discount rates and which I was able to match with financial data is significantly smaller then the sample for which I have discount rates. The small sample size means that there is low power and thus most of the coefficients are zero. Thus the results in column II of Table IV should be interpreted with caution.

to the maximum and invest the assets in high yield (tax disfavored) assets such as bonds. For less profitable, high risk, and lightly taxed firms the theory argues they should be motivated by a desire to shift their liability to the PBGC. These firms should fund their plans no more than required and should invest the assets in high risk assets.

The evidence in this paper is consistent with neither theory. Instead the asset allocation chosen by pension plans is driven by the firm's desire to manage its risks. The firms which invest their pension assets in risky assets are the most profitable and least risky firms and they have the most overfunded pension plans. These are the firms for whom the volatility associated with equity investments is least costly. Firms which find volatility in the net assets of the pension plan, and thus in their contributions, disruptive are more likely to invest in low risk assets. This finding is consistent with the finding that the optimal allocation of risk also influences the type of pension plan (defined benefit or defined contribution) a firm sponsors.

Although this paper is not about savings, its results are useful in the debate over the optimal way for individuals to invest their pension assets. The past decade and a half has seen a pervasive shift away from defined benefit plans and toward defined contribution plans (Petersen, 1994). The perception that defined contribution plans invest in assets with lower risk and thus lower expected return has raised the concern that these pensions do not provide as well for retirement. It is true that low risk assets have a lower expected return. However, this does not imply that investing in low risk and thus low return assets is a poor investment choice. The correct choice can only be dictated by an individual's own tolerance for risk. High expected return assets will leave an individual with greater wealth in retirement, on average. However, high risk also means there are states of the world where an investor would have been wealthier by investing in the low risk asset. Those individuals who sold their stock in December of 1987 and December of 1929 are examples.

Empirically the difference between the asset allocation of defined benefit and defined contribution plans which we find in our sample is not great. Most of the difference we do find can be attributed to differences in the characteristics of the pension plan such as the maturity of the liabilities. In addition, when

we compare plans where the asset allocation decision is made by the individual versus cases where it is not, we do find that individual directed investments are more conservative (i.e., less money is invested in stocks), but the magnitude of the difference is small.

References

Allen, Steven, Robert Clark, and Daniel Summer, "Post-Retirement Adjustments of Pension Benefits." *Journal of Human Resources* 21 (1986): 118-137.

Black, Fischer, "The Tax Consequences of Long Run Pension Policy." *Financial Analysts Journal* (1980): 17-23.

Black, Fischer, "Should You Use Stocks to Hedge Your Pension Liability?" *Financial Analysts Journal* (1989): 10-12.

Bodie, Zvi, Jay O. Light, Randall Morck, and Robert A. Taggart Jr., "Funding and Asset Allocation in Corporate Pension Plans: An Empirical Investigation." in *Issues in Pension Economics*. Edited by Zvi Bodie, John Shoven, and David A. Wise. Chicago, IL: University of Chicago Press, 1987.

Brealey, Richard, and Stewart Myers, *Principles of Corporate Finance*. New York, NY: McGraw Hill, Inc., 1991.

Feldstein, Martin and Randal Mørck, "Pension Funding Decisions, Interest Rate Assumptions, and Share Prices" in *Financial Aspects of the United States Pension System*. Edited by Zvi Bodie and John B. Shoven. Chicago, IL: University of Chicago Press, 1983.

Friedman, Benjamin, "Pension Funding, Pension Asset Allocation, and Corporate Finance: Evidence from Individual Company Data" in *Financial Aspects of the United States Pension System*. Edited by Zvi Bodie and John B. Shoven. Chicago, IL: University of Chicago Press, 1983.

Ibbotson Associates, Inc. *Stocks, Bonds, Bills, and Inflation 1989 Yearbook*, Ibbotson Associates, Inc. Chicago, 1989.

Ippolito, Richard A., "The Role of Risk in a Tax Arbitrage Pension Portfolio." *Financial Analysts Journal* (1990): 24-32.

Kruse, Douglas, "Pension substitution in the 1980s: Why the Shift Toward Defined Contribution Pension Plans?" NBER Working Paper # 3882, (1991)

Markowitz, Harry, "Portfolio Selection" *Journal of Finance* 7, (1952): 77-91.

Modigliani, Franco and Merton Miller, "The Cost of Capital, Corporate Finance, and the Theory of Investment." *American Economic Review* 48, (1958): 261-297.

Modigliani, Franco and Merton Miller, "Dividend Policy, Growth, and the Value of Shares." *Journal of Business* 34, (1961): 411-433.

Marcus, Alan, "Corporate Pension Policy and the Value of PBGC Insurance," in *Issues in Pension Economics*. Edited by Zvi Bodie, John Shoven, and David A. Wise. Chicago, IL: University of Chicago Press, 1987.

Petersen, Mitchell, "Cash flow Variability and Pension Plan Choice: A Role for Operating Leverage."

*Journal of Financial Economics* 35, (1994): 361-383.

Petersen, Mitchell, "Pension Reversions and Worker-Stockholder Wealth Transfers." *Quarterly Journal of Economics* 57, (1992): 1035-1056.

Sharpe, William F., "Corporate Pension Funding Policy." *Journal of Financial Economics* 3, (1976): 183-194.

Tepper, Irwin, "Taxation and Corporate Pension Policy." *Journal of Finance* 36, (1981): 1-13.