Managing Risk Caused by Pension Investments in Company Stock

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Abstract

This paper uses simulation methods to determine the optimal mix of assets in a pension that has half of its assets in company stock. The optimal share is shown to vary with worker risk aversion, non-pension wealth, and the financial characteristics of the underlying stock. Relative to a strategy that blends company stock with all bonds, there are substantial efficiency gains from optimizing the mix of stock and bonds – particularly for workers with lower levels of risk aversion and substantial non-pension wealth holdings. The gains from optimizing also differ substantially across workers depending upon their company stock's mix of systematic and idiosyncratic rate of return risk.

I. Introduction.

Over the past 30 years, the U.S. private pension system has undergone two important changes. First, the defined benefit (DB) plan been replaced by the defined contribution (DC) plan as the predominant plan type. Between 1975 and 2005, the percentage of pension covered workers with a DC plan rose from 15 to 65 percent[1].

Another important change is the shift from trustee- to participant-directed plans. Among workers with DC plans, the percentage with participant directed plans grew from 15 to 86 between 1988 and 2005 [Even and Macpherson 2009]. In trustee-directed plans, all workers in a given pension contribute funds to a common pool and own a share of the fund. The trustee manages asset allocation on behalf of the employees. Workers are still subject to rate of return risk, but have no direct control over the asset allocation decision. In participant directed plans, each worker is given a choice of investments and must choose his own asset allocation. The primary advantage of this shift to participant direction is that each person can tailor the asset allocation based upon risk preferences, assets held outside the portfolio, and other relevant considerations. The potential disadvantage is that many workers may not have the financial sophistication required to make prudent asset allocation decisions.

With these two changes in the private pension system, the retirement income security of workers has become more closely tied to the performance of financial markets and the stakes are growing for workers in terms of their asset allocation decisions. For many workers, the asset allocation decision is complicated by the fact that their pension may require that a significant portion of their pension assets be invested in their employer's stock. For example, Holden et al

[1] See Employee Benefits Security Administration (2008), table E5.

(2008) estimate that 45 percent of 401(k) participants in 2007 were covered by a plan that included some company stock. Even and Macpherson (2004) report that, among DC plans with non-zero holdings of company stock, the average plan in the 1990s had 54 percent of assets invested in company stock.

Prior to the growth of participant direction, most workers could count on a professional to make asset allocation decisions for them. Now, the vast majority of workers must individually decide how to complement their holdings of company stock. Given the growing evidence that many workers lack the financial sophistication required to make simple decisions like what share of assets should be invested in equities, it is likely that they will have difficulty determining the optimal blend of assets for the company stock.

This paper uses simulation methods to determine how workers should fill out the remainder of their portfolios when a significant share of assets is in company stock. Not surprisingly, it finds that workers with higher levels of risk aversion or lower levels of non-pension wealth have an optimal mix that is more heavily weighted with bonds. The paper goes further and demonstrates that the optimal mix varies significantly depending upon the characteristics of the company stock. For example, if the company stock has a higher level of idiosyncratic risk, *ceteris paribus*, the worker should increase the bond weighting in the remainder of the portfolio.

The study also shows that the efficiency gains from optimizing the portfolio relative to a strategy that complements the company stock entirely with bonds are quite large for some workers. However, given the complexities of choosing the optimal blend, we are doubtful that most workers are capable of calculating their optimal holdings.

II. Background.

According to standard portfolio theory, holding a substantial share of assets in company stock leads to an inefficient portfolio because workers are exposed to idiosyncratic risk without an increase in expected returns. An obvious question is why employers would subject their workers to such efficiency losses by requiring that their workers hold company stock. However, several researchers have pointed out that there are some benefits from investing in company stock that may help offset these efficiency losses.[2] First, there are potential tax advantages to both the employer and employee from contributions being in the form of company stock instead of cash. Second, administration costs for company stock could be lower than that for mutual funds. Finally, increased employee ownership could have positive incentive effects for workers and help reduce the threat of a hostile take-over.

Pension holdings of company stock can be the result of several different practices. For example, a standalone employee stock ownership plan (ESOP) is a plan that is required to primarily in company stock. In some cases, an ESOP is combined with a 401(k) plan and the employer makes matching contributions in the form of company stock. In other cases, a 401(k) plan may include the company's stock as one of the investment options. Consequently, in some cases, the employee chooses to purchase the company stock; in other cases, the pension is structured in a way that mandates that part of the pension be invested in company stock.

Prior to 1996, federal rules required that workers who are over age 55 and have at least 10 years of plan participation be allowed to gradually diversify out of the company stock. The Pension Protection Act of 1996 changed the rules for diversification of employer stock holdings

[2] For a discussion of the literature on the potential benefits of investing in company stock, see Even and Macpherson (2004) and Brown, Liang, and Weisbenner (2006).

and may lead to reduced holdings of employer stock for some pension plans. When the new rules are completely phased in by the end of 2009, participants will be allowed to diversify their elective contributions at all times and any employer matching contributions after three years of service, regardless of age. These rules will not apply to standalone ESOP plans, plans that hold stock that is not publicly traded, or plans that have no employee contributions and are not integrated with a 401(k) plan. Consequently, while the new diversification rules may result in reduced holdings of company stock, some plans will be unaffected by the new rules and others could adjust their plan design to avoid the new diversification requirements.[3]

Several studies estimate the efficiency losses associated with pension investments in company stock. For example, Meulbroek (2005) uses the capital asset pricing model (CAPM) to estimate the value of company stock to an undiversified investor. For a 5-year holding period, she estimates that between one-half and one-third of a typical stock's value is lost due to the costs of non-diversification. Several other studies use simulation methods making specific assumptions about risk preferences to estimate the inefficiency of investing in employer stock [Brennan and Torous (1999), Poterba (2003)m and Brown et al. (2006)]. These studies differ in terms of the specific stocks used for the simulations, the type of assets that are mixed with the stock, and the holding or accumulation periods. Nevertheless, all of these studies find that the cost of holding heavy concentrations of employer stock can be quite high, especially for workers that have few assets outside of their pension. For example, Poterba (2003) estimates that the certainty equivalent of investing in the typical stock held in large DC plans over a 35-year work

[33] For details on the diversification requirements, see Prodoehl et al (2007).

career is only 27 cents for a worker with no wealth outside of the pension.[4] This certainty equivalent rises as wealth outside of the pension rises or worker risk aversion declines.

While the inefficiency of company stock holdings can be large, Brown, Liang and Weisbenner (2006) present simulations showing that naïve investors who follow a 1/n diversification strategy may be better off if their employers provide matching contributions as company stock. That is, if a worker follows the simple strategy of investing equal shares in all the pension's investment options, a match in company stock actually improves the portfolio performance for many workers given the typical options offered. However, sophisticated investors who allocate their investments optimally to maximize utility are made worse off.

Given the significance of company stock holdings, an obvious question is how workers should optimally allocate the remainder of their portfolio and the potential losses from making non-optimal choices. Not surprisingly, the answer to this question will vary significantly across workers and the type of company stock they hold. As an illustration of how important it is to consider the financial characteristics of the specific stock, Table 1 presents a sampling of the 25 largest pension plans (ranked by total assets) that held at least 25% of their assets in company stock.[5] For each of these plans, we calculated the rate of return on the company stock for calendar year 2008. As a benchmark, an investor holding a widely diversified portfolio of stocks like the S&P 500 would have had a return of -36.5% in 2008. However, the range of returns in large plans ranged from -77.1% to +19.9%. Workers in the financial sector took significant losses during 2008 whereas Walmart employees actually experienced gains. The question is whether the workers holding stock in these different types of companies could have

[4] This assumes constant relative risk aversion with a coefficient of 2.

[5] These plans were drawn from the 2006 IRS Form 5500 data.

improved the efficiency of their portfolios by following different strategies to help manage their risk exposure.

Existing research suggests that many workers exhibit behavior that is inconsistent with optimizing behavior. As mentioned previously, some research suggests that a significant group of workers pursue a naive 1/n diversification strategy.[6] Other studies point out that workers rarely reallocate their investments and may overreact to recent stock performance when making investment decisions.[7] Finally, some observers suggest that workers invest too little in equities and that women may be too conservative.[8]

III. Simulation Methods.

To estimate optimizing behavior for workers, we use a process very similar to that used by Poterba, Rauh, Venti, and Wise (forthcoming) (PRVW) in their examination of the efficiency effects of life-cycle funds. The methodology simulates a distribution of pension wealth at retirement for a worker who contributes to a pension plan starting at age 28 until a retirement at age 63. To generate an age-earnings profile of pension contributions, we use data from the 2007 Survey of Consumer Finances (SCF) for workers covered by a DC pension. For this sample of workers, we estimate a regression model of the pension contribution rate (defined as total pension contributions as a percentage of earnings) as a function of education, race, and sex, and third order polynomials in earnings and age. We estimate the age-contribution profile for a

[6]Benartzi and Thaler (2001) and Agnew (2006) both find evidence of 1/n investment behavior. Huberman and Jiang (2006) find that investors do not exhibit 1/n behavior.
[7]Benartzi (2001) and Huberman and Sengmueller (2004) discuss the effect of recent stock performance on investment behavior; Americks and Zeldes (2001) show that portfolio rebalancing is infrequent.
[8]See Papke (1998), Hinz et al (1997), and Sunden (1998). These studies provide conflicting evidence on whether women are more conservative investors.

worker that has the average characteristics of a DC covered worker in the SCF with a matching age-earnings profile.[9]

The resulting contribution profile is presented in Figure 1. The number of dollars contributed is the product of the age-specific contribution rate and earnings. The earnings profile starts at approximately $38,000, peaks at age 50 at about $53,000, then gradually fall to $43,000 by age 62. The contribution rate (expressed as a percentage of earnings) starts at 8.6% at age 28 and rises until age 62 where it peaks at 9.7%.

To evaluate the consequences of different asset allocations, we make the simplifying assumption that the worker can combine company stock with large stock and either indexed bonds yielding a 2 percent real rate of return, or long term bonds with returns matching the historical distribution.

To simulate the distribution of wealth at retirement under different asset allocation choices, we must specify a process for generating asset returns. We use historical returns on large stock and long term government bonds drawn from Ibbotson and Associates for 1926 through 2008.

To generate simulated returns for company stock, we first select pension plans with at least $100 million in assets that hold some assets in company stock from the 1998 IRS Form 5500 data. The reason we chose 1998 is that it is the last year that the Form 5500 provides a CUSIP for the stock held in the pension plan. For the plans with valid CUSIPs, we draw monthly asset returns from CRSP and keep all the plans that have at least 24 months of returns

[9] The age-earnings profile for the average worker was calculated by estimating an earnings regression with controls for a third order polynomial in age, education, race, and sex. The average characteristics of a worker with a DC plan in the SCF are then used to generate a predicted age-earnings profile that is substituted into the contribution equation to generate the age-contribution profile.

data between 1990 and 2008. We then use these company stock returns to estimate the following Fama-French three factor model of asset returns for each of the stocks.

$$(1) \qquad R_{it} - R_{ft} = \alpha_i + \beta_{1i}\left(R_{mt} - R_{ft}\right) + \beta_{2i}(SMB_t) + \beta_{3i}(HML_t) + \varepsilon_{it}$$

That is, we regress the excess return for stock i in period t (stock return minus risk free return) on the excess market return (S&P 500 minus risk free rate), the difference between the return on small and large capitalization stocks (SMB), and the difference in the returns on high and low book-to-market stocks (HML). Monthly data for the three factors are drawn from Kenneth French's data library.[10]

To simulate asset returns for a particular company stock, for each of the 35 years of the worker's simulated career we make a random draw (with replacement) of a year of returns and the corresponding factors used in our three factor model. We predict a return for the relevant company stock by substituting the corresponding factors into the Fama-French 3 factor equation for that stock and combining it with a random draw from a normal distribution corresponding to the stock's residual variance.[11] This simulated return for the company stock is then bundled with the corresponding random draw for government bonds and large stocks. This process is repeated 10,000 times for each asset allocation considered to generate a distribution of wealth at retirement.

[10] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

[11] Since the three factor model is estimated with monthly data and the simulations are based upon annual data, we convert the residual variance estimate to an annual value by multiplying by 12 under the assumption that the errors are independent and identically distributed.

Like PVRW, in order to compare the desirability of different asset allocations, we calculate expected utility by assuming a utility function with constant relative risk aversion (CRRA):

$$(2) \qquad U(W) = \frac{W^{1-\alpha}}{1-\alpha}$$

where α is the household's coefficient of relative risk aversion (with higher values of α indicating greater risk aversion) and W is wealth at retirement. The individual is risk neutral if $\alpha = 0$ and has log utility if $\alpha = 1$.

Wealth at retirement is assumed to consist of two parts – pension and non-pension wealth (W_p and W_{np}). The expected utility of a given asset allocation is evaluated by computing the average utility from the 10,000 simulations of a workers' contribution history and returns. These utility levels can be compared for a given level of risk aversion and other wealth to determine the dominant strategy. Moreover, the expected utility can be used to generate a certainty equivalent wealth level (Z) that represents the level of certain wealth at retirement that would generate the same expected level of utility. For a given asset allocation strategy that generates expected utility of Ω the certainty equivalent of a given asset allocation strategy (net of non-pension wealth) can be calculated as:

$$(3) \qquad Z = [\Omega(1-\alpha)]^{\frac{1}{1-\alpha}} - W_{np}$$

The above certainty equivalent represents the amount of certain pension wealth at retirement (in addition to the non-pension wealth) that is needed to achieve a given level of utility. Like PVRW, we assume the non-pension wealth is nonstochastic.

Our simulations compare several asset allocation strategies for each of our randomly sampled company stocks under different assumptions about risk aversion, other wealth holdings, and expenses for managing assets. To simplify the analysis, we assume that one-half of the pension assets are always invested in company stock and the other half is invested in some mix of large stock and either indexed or long term government bonds. While the average share of assets invested in company stock among plans that have some company stock holdings is approximately 50%, we admit that the assumption that half of the assets are invested in company stock for each pension and across the life-cycle is not an accurate reflection of reality. However, this assumption simplifies matters considerably and allows us to focus on how factors other than the share of assets in company stock affect optimal behavior.

IV. Results.

Following PVRW, we consider a baseline and high asset management expense assumption. We also consider a scenario where equity returns are reduced by 300 basis points because some argue that the equity premium is likely to decline from historical levels.

As a benchmark for comparison, Table 2 provides a summary of pension wealth at retirement (in 2007 dollars) for four extreme asset allocations: (1) all indexed bonds yielding a 2 percent real rate of return; (2) all long term government bonds which averaged a 3.0% real rate of return over the sampling period; (3) all in the S&P 500; and (4) all in one of 88 stocks that we sample representing the types of stock held in DC plans. Since there is a distribution of pension wealth for each company stock choice, we compute the relevant statistic for each stock and then average across the stocks. That is, for example, the first percentile of pension wealth reported for the company stock distribution represents the mean value of the 88 different estimates of the first percentile.

The ranking of the four asset choices based on mean pension wealth at retirement places company stock in first place, the S&P 500 in second, long term government bonds in third, and indexed bonds last. These rankings persist with higher expense assumptions and even if equity returns are reduced by 300 basis points. Ranking the assets on risk reverses the order. Investing in company stock is the highest risk choice and indexed bonds are riskless.

To evaluate asset allocate strategies, we estimate the certainty equivalents associated with each. We further estimate the certainty equivalent associated with mixing the different types of company stock with either indexed bonds, long term government bonds, or the S&P500. The company stock simulations assume that one-half of the portfolio is in company stock and the remainder is in one of the other assets.

Table 3 summarizes the certainty equivalents of the different strategies. All the simulations assume $120,000 of non-pension wealth and are repeated for three levels of risk aversion (α=1,2,4) and either baseline expenses, or high expenses with equity returns reduced by 300 basis points. Because each company stock has its own return distribution and corresponding certainty equivalent, we present statistics summarizing the distribution of certainty equivalents across the company stocks. We use the riskless strategy (100 percent indexed bonds) as the benchmark. For the benchmark, we present the certainty equivalent in dollars. For all other investment strategies, we present a certainty equivalent ratio (CER) that reflects the ratio of that strategy's certainty equivalent to the benchmark. A CER above unity implies that the strategy dominates the benchmark.

Consistent with earlier studies, the simulations reveal that company stock holdings can result in considerable efficiency losses, particularly for the risk averse. For moderately risk averse people (α =1), a 100 percent investment in the average company stock has a certainty equivalent that matches that of indexed bonds (i.e., the mean certainty equivalent across the stocks considered is unity). On the other hand, the 5th and 95th percentiles of the distribution of CERs are .33 and 1.77. As risk aversion increases (e.g. α =4), the CER of a 100 percent investment in company stock drops to a mean of .34 with the 5th and 95th percentiles at .14 and .49. If equity returns are decreased by 300 basis points and management expenses increased, the CERs drop further.

The bottom half of table 3 compares strategies for balancing a portfolio with half of its assets in company stock with each of the three other asset choices. A comparison the mean CERs across investment strategies suggests that mixing company stock with the S&P 500 may be the dominant strategy for most types of company stock held in DC plans, except for the most risk averse workers (α =4) when equity returns are reduced by 300 basis points. However, the dominant strategy potentially differs for each stock.

To further investigate the issue of how workers should optimize their portfolios and the consequences of optimizing, we perform additional simulations that calculate the CER that would result if the company stock is combined with either (1) a mix of indexed bonds and the S&P 500; or (2) a mix of long term government bonds with the S&P 500. For each case, we consider 11 possible mixes of the other two assets by varying the percent in bonds (either indexed or nominal) in 5% increments. For example, we hold company stock constant at 50% of the portfolio, and then mix it with anywhere between 50% and 0% of indexed bonds, with the remainder in the S&P 500. We then choose the optimal strategy by searching for the highest

CER among these mixtures. The exercise is repeated for a mixture of nominal bonds with the S&P 500.

Table 4 reveals the optimal mix of company stock with the S&P 500 and bonds for three levels of risk aversion (α =1,2 and 4) and two levels of non-pension wealth ($0 and $120,000). If the option is to add indexed bonds and the S&P500 to the portfolio holding company stock, workers with low levels of risk aversion (α =1) and moderate levels of non-pension wealth ($120,000) should blend their company stock with only the S&P 500 (no bonds) for every company stock in our sample unless the equity premium is reduced by 300 basis points.

As risk aversion rises, non-pension wealth falls, or the equity premium is reduced, the optimal blend shifts towards more bonds. In the extreme case where α=4 and the equity premium is reduced by 300 basis points, the optimal blend with the company stock is over 40 percent bonds (less than 10 percent S&P 500) for the majority of company stocks considered. In the extreme case where equity returns are reduced by 300 basis points, workers have zero non-pension wealth, and α=4, over 95 percent of the stocks we consider should be mixed almost entirely with bonds.

Overall, the evidence suggests that the optimal mix of assets to add to a portfolio with 50% company stock varies substantially according to the worker's non-pension wealth, the financial characteristics of the stock, and the worker's risk aversion. Most workers will not have the financial sophistication to consider all the relevant issues. The question then becomes how much can be gained from optimizing?

To examine the potential efficiency gains from optimizing a portfolio that has one-half its assets in company stock, we consider a portfolio that has the remaining half in government bonds as the benchmark and then estimate the increase in the CER that results from optimizing the other half of the portfolio. Not surprisingly, the improvement in the CER that is possible from optimizing relative to the benchmark (either indexed or nominal bonds) is smaller when conditions make the bond choice more likely to be optimal (i.e., when risk aversion is greater, or when equity returns or non-pension wealth are lower). On the one extreme, where non-pension wealth is $120,000 and risk aversion is low (α=1), the average gain in the CER from optimizing is .506 across the company stocks considered. That is, compared to mixing the company stock with all bonds, optimizing increases the CER by about one-half. On the other extreme, if equity returns are reduced 300 basis points and the worker is risk averse (α=4, the gains from optimizing are essentially zero because the optimal strategy for such workers almost always includes mixing company stock with all bonds.

The gains from optimizing also vary depending on the characteristics of the underlying company stock. To get an overall picture of the factors that influence the gains from optimizing relative to blending company stock with 100 percent bonds, we compute the CER gain for different levels of risk aversion (α=1,2,4) combined with different assumptions about non-pension wealth ($0, $120,000, $360,000) and historical or reduced equity returns. For each level of risk aversion, we regress the estimate of the CER gains from optimizing for each of the 88 company stocks on the stocks' estimated Fama-French factor loads (i.e., the coefficients on the excess market return, SMB, and HML from equation 1), the standard deviation of the regression residual, the assumed value for non-pension wealth, and a dummy variable indicating whether equity returns are reduced from historical levels. The standard deviation of the regression residual is measured on an annualized basis. Other than the dummy variables representing expense and non-pension wealth assumptions, control variables are measured as deviations from means. Since control variables are measured as deviations from means, the intercept for a particular regression reflects the mean increase in the CER from optimizing for the reference group (historical equity returns and zero non-pension wealth).

Table 7 presents the estimated coefficients from these regressions. The regressions confirm the earlier conclusion that the gain from optimizing relative to mixing the company stock with all bonds is greatest for the least risk averse and reduced if management expenses are increased for stocks or if equity returns are reduced. The results also show that the financial characteristics of the company stock are important in determining the gains from optimizing. As the idiosyncratic risk on a stock rises (i.e., the standard deviation of the regression residual), the gains from optimizing are reduced because such risk pushes the optimal choice towards bonds. However, the effect of idiosyncratic risk on the efficiency gains for the more risk averse are much smaller because their optimal strategy is almost 100 percent bonds regardless of the level of idiosyncratic risk.

V. Summary and Conclusions.

The inefficiencies generated by restrictions that employees invest in company stock are well known. This study provides further evidence on the size of those losses and extends earlier work by showing how workers can help minimize the damage. The results suggest that the damage is greatest for the most risk averse workers and those with lower wealth outside of their pension.

The study also shows that, relative to a strategy that mixes company stock with only bonds, optimizing the rest of the portfolio by selecting the appropriate mix of a diversified index of stock and bonds can yield significant improvements in the certainty equivalent of wealth at retirement -- particularly for those with relatively low risk aversion and those with substantial holdings outside of their pension. As an example, the average gain from optimizing the portfolio for workers with moderate levels of risk aversion (α =1) and $120,000 of non-pension wealth is about one-half of the wealth generated from investing in indexed bonds throughout the career. The gains relative to the all bond strategy are quite small for all types of stock when risk aversion reaches higher levels.

The gains from optimizing vary substantially across stock types. Among workers with moderate levels of risk aversion and $120,000 of non-pension wealth, the gains in the certainty equivalent from optimizing relative to the all bond strategy range from 34 to 87 percent.

Overall, the results suggest that there is no simple rule of thumb for workers who are trying to best manage the risk associated with restricted investments in company stock. The extreme cases are easy – if a person holds substantial non-pension wealth and has relatively low levels of risk aversion, she should invest the remainder of the pension in a diversified stock index. At the other extreme, those with little wealth outside the pension who are risk averse should invest the remainder in bonds. The intermediate cases are much more complicated and it is difficult to imagine that unsophisticated investors will be able to properly optimize their portfolios.

It is important to recognize that our study abstracts from several complicating factors that could cause the damage from company stock be either over- or understated. First, we ignore any correlation between company stock returns and labor income. To the extent that the two are positively correlated, the damage from company stock would be greater. Second, we ignore the diversification requirements for workers over age 55 and the new rules implemented with the Pension Protection Act of 2006. The ability to diversify out of company stock will obviously reduce some of the efficiency losses if workers properly diversify. Finally, we ignore the fact that the share of assets held in company stock will vary across time and across people. There are several ways that our study could be extended to address these issues leaving the door open for future research.

Unless policy prohibits employers from restricting that some of the pension assets be invested in company stock, there will be substantial efficiency losses – especially for the risk averse with little non-pension wealth. Moreover, the complexity of the optimization problem makes it difficult to use financial education to eliminate the efficiency losses. Despite these efficiency losses, there are potential efficiency gains to the employment relationship or tax gains that may be more than adequate to offset the efficiency losses. To the extent that the gains come from improved employee incentives, the argument for restricting investments in company stock are weakened. To the extent that the gains come from tax considerations, one might argue that the tax structure should be altered to discourage practices that put worker retirement wealth at risk.

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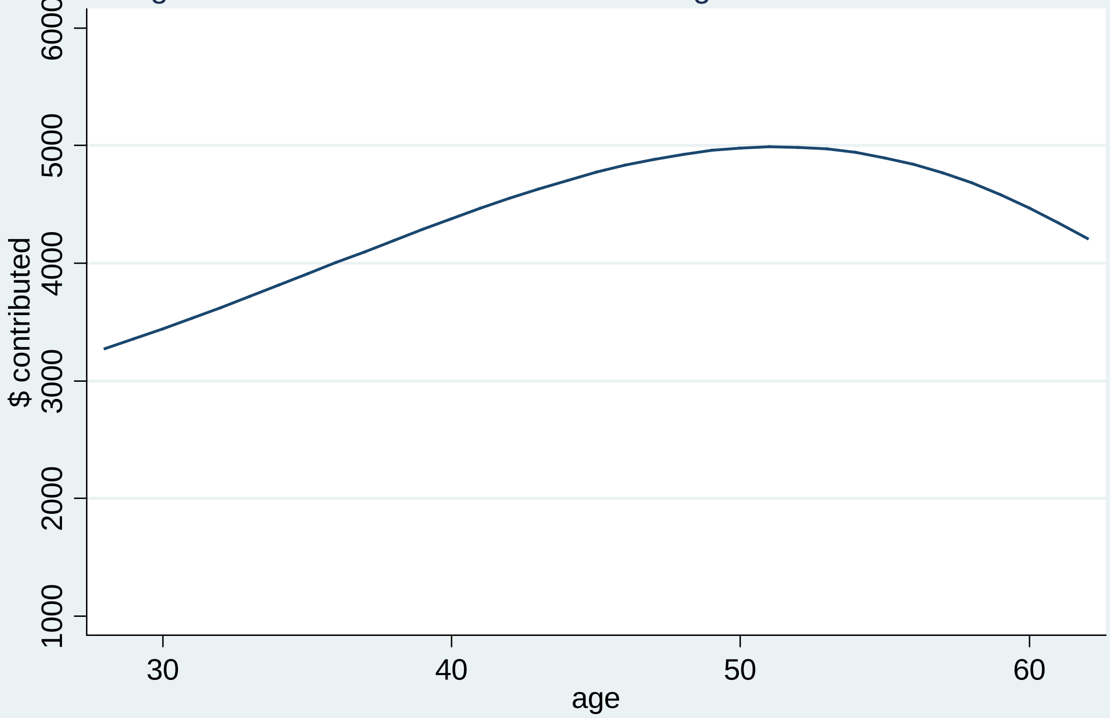
Figure 1. Contribution Profile for Average Worker with a DC Plan.



Estimated using 2007 Survey of Consumer Finances. See text for details.

Table 1. Large Pension Plans with Company Stock in 2006.[a]

	Pension Assets (in billions of $)	% of Assets in Company Stock	Assets per participant	% return on company stock during 2008
GE savings and security	$26.5	60.7%	$104,809	-54.0%
Exxon Mobil Savings Plan	$21.6	68.2%	$491,677	-13.2%
Procter and Gamble profit sharing trust and employee stock ownership plan.	$16.2	90.5%	$406,504	-13.8%
JP Morgan Chase 401k savings plan	$13.6	27.7%	$81,596	-25.2%
Chevron employee savings investment plan.	$13.4	55.4%	$377,540	-18.4%
Citigroup 401k Plan	$13.0	31.8%	$75,738	-75.9%
Wells Fargo & Company 401k plan	$12.1	43.4%	$69,103	2.1%
Bank of American 401k plan	$9.8	42.0%	$67,929	-62.9%
Wal-Mart profit sharing and 401k plan	$8.9	47.1%	$11,104	19.9%
3M voluntary investment plan and employee stock ownership plan	$7.3	30.8%	$155,329	-29.9%
AT&T Savings and security plan	$6.7	51.0%	$64,035	-28.0%
Science Applications International corporation retirement plan.	$6.3	33.2%	$140,217	-3.2%
Merrill Lynch and Co., Inc 401k savings and investment plan	$5.6	27.4%	$107,986	-77.1%
Target corporation 401k plan	$4.9	57.4%	$38,193	-30.0%
J.C. Penney Corporation Inc. savings, profit-sharing and stock	$4.6	33.6%	$39,664	-54.1%
The savings and profit sharing fund of Allstate Employees	$4.4	37.0%	$106,570	-34.6%
Southern Company employee savings plan	$4.2	55.1%	$136,747	0.0%
American Express incentive savings plan	$3.2	30.5%	$86,282	-63.7%
Merrill Lynch and Co., Inc. retirement accumulation plan.	$2.9	38.5%	$69,567	-77.1%
Costco 401k retirement plan	$2.9	28.6%	$31,872	-24.0%
Standard and Poor 500 (Value Weighted)	--	--	--	-36.5%

[a] Represents sampling of largest plans with at least 25% of assets in company stock from 2006 form 5500 data.

Table 2. Pension Wealth at Retirement under Alternative Investment Assumptions.

Explanation: Estimated pension wealth for a person with average earnings that makes average contributions to a DC plan from age 28 through age 62. Baseline expenses are 32 basis points for stocks and nominal government bonds and 40 basis points for indexed bonds. High expenses are 100 basis points for all asset types. Simulations reflect historical real returns from 1926-2008. For asset choices that lead to uncertain returns, percentiles of the return distribution are presented (p1-p90) along with the mean.

	Baseline Expenses	High Expenses	Equity Returns Reduced 300 Points and High Expenses
100% Indexed Bonds	$201,229	$181,587	$181,587
100% Bonds			
p1	$104,433	$94,153	$94,153
p10	$142,806	$127,905	$127,905
p50	$223,539	$198,369	$198,369
p90	$365,043	$321,760	$321,760
mean	$242,720	$214,994	$214,994
100% S&P500			
p1	$87,397	$78,721	$52,758
p10	$183,970	$162,578	$99,407
p50	$503,628	$437,728	$246,787
p90	$1,498,209	$1,291,217	$682,095
mean	$732,541	$634,052	$345,108
100% company stock			
p1	$4,208	$4,208	$4,208
p10	$16,710	$16,116	$14,175
p50	$109,883	$100,661	$72,177
p90	$1,433,456	$1,250,688	$641,679
mean	$2,118,433	$1,822,666	$658,571

Table 3. Certainty Equivalent of Alternative Investment Strategies with and without Company Stock.

Explanation. Certainty equivalents are provided for different investment strategies for 3 levels of risk aversion (α=1,2,4) assuming \$120,000 of nonpension wealth. The certainty equivalent is provided for indexed bonds and all other values represent the ratio of the certainty equivalent for a given strategy to that for indexed bonds. The portfolios with company stock are assumed have 50% of assets in company stock.

	Baseline Expenses			Equity Returns Reduced 300 Points and High Expenses		
	α=1	α=2	α=4	α=1	α=2	α=4
100% Indexed bonds	\$201,229	\$201,229	\$201,229	\$181,587	\$181,587	\$181,587
100% lt govt bonds	1.15	1.10	1.02	1.13	1.09	1.02
100% Stock	2.74	2.16	1.52	1.53	1.29	1.00
100% Company Stock						
p5	0.33	0.21	0.14	0.32	0.20	0.14
p50	0.77	0.60	0.34	0.75	0.51	0.32
p95	1.77	0.85	0.49	1.12	0.66	0.45
mean	1.00	0.56	0.34	0.72	0.47	0.31
50% company stock with indexed bonds						
p5	0.71	0.61	0.47	0.68	0.59	0.47
p50	1.36	1.12	0.88	1.06	0.93	0.76
p95	3.25	1.94	1.12	2.13	1.43	0.91
mean	1.52	1.16	0.84	1.16	0.94	0.72
50% company stock with government bonds						
p5	0.76	0.64	0.48	0.72	0.61	0.47
p50	1.45	1.17	0.89	1.13	0.96	0.78
p95	3.43	1.99	1.13	2.24	1.46	0.92
mean	1.62	1.20	0.85	1.23	0.98	0.73
50% company stock with SP500						
p5	1.05	0.78	0.53	0.79	0.62	0.43
p50	1.96	1.42	0.91	1.21	0.96	0.69
p95	4.13	2.00	1.08	2.18	1.24	0.79
mean	2.13	1.36	0.85	1.23	0.92	0.64

Table 4. Optimal Asset Mix in Pensions with 50% of Portfolio Invested in Company Stock.

Explanation: Statistics represent percentage of pension plans with optimal allocation of bonds falling into various ranges. Results are based on simulations using a 5% sample of pension plans holding company stock and assuming that company stock is one-half of the pension portfolio.

	Indexed bonds			Long term government bonds		
	Baseline Expenses	High Expenses	Equity Returns Reduced 300 Points and High Expenses	Baseline Expenses	High Expenses	Equity Returns Reduced 300 Points and High Expenses
			α=1, No non-pension wealth			
0%	97.7%	96.6%	31.8%	94.3%	94.3%	13.6%
1% to 9%	1.1%	2.3%	10.2%	0.0%	0.0%	4.5%
10% to 19%	1.1%	1.1%	19.3%	4.5%	4.5%	13.6%
20% to 29%	0.0%	0.0%	17.0%	1.1%	1.1%	20.5%
30% to 39%	0.0%	0.0%	8.0%	0.0%	0.0%	22.7%
40% to 50%	0.0%	0.0%	13.6%	0.0%	0.0%	25.0%
			α=2, No non-pension wealth			
0%	26.1%	25.0%	0.0%	18.2%	18.2%	0.0%
1% to 9%	6.8%	6.8%	0.0%	6.8%	8.0%	0.0%
10% to 19%	18.2%	18.2%	3.4%	17.0%	15.9%	1.1%
20% to 29%	20.5%	21.6%	5.7%	23.9%	25.0%	5.7%
30% to 39%	13.6%	12.5%	9.1%	17.0%	15.9%	8.0%
40% to 50%	14.8%	15.9%	81.8%	17.0%	17.0%	85.2%
			α=4, No non-pension wealth			
0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1% to 9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
10% to 19%	3.4%	3.4%	0.0%	3.4%	3.4%	0.0%
20% to 29%	5.7%	5.7%	0.0%	6.8%	6.8%	0.0%
30% to 39%	9.1%	8.0%	1.1%	11.4%	11.4%	2.3%
40% to 50%	81.8%	83.0%	98.9%	78.4%	78.4%	97.7%
			α=1, \$120,000 of non-pension wealth			
0%	100.0%	100.0%	84.1%	97.7%	97.7%	53.4%
1% to 9%	0.0%	0.0%	3.4%	2.3%	2.3%	11.4%
10% to 19%	0.0%	0.0%	2.3%	0.0%	0.0%	11.4%
20% to 29%	0.0%	0.0%	4.5%	0.0%	0.0%	11.4%
30% to 39%	0.0%	0.0%	2.3%	0.0%	0.0%	3.4%
40% to 50%	0.0%	0.0%	3.4%	0.0%	0.0%	9.1%
			α=2, \$120,000 of non-pension wealth			
0%	81.8%	84.1%	19.3%	69.3%	72.7%	5.7%
1% to 9%	5.7%	3.4%	6.8%	8.0%	8.0%	8.0%
10% to 19%	2.3%	3.4%	10.2%	10.2%	6.8%	8.0%
20% to 29%	8.0%	6.8%	17.0%	4.5%	4.5%	13.6%
30% to 39%	0.0%	0.0%	15.9%	5.7%	5.7%	15.9%
40% to 50%	2.3%	2.3%	30.7%	2.3%	2.3%	48.9%
			α=4, \$120,000 of non-pension wealth			
0%	21.6%	23.9%	1.1%	18.2%	18.2%	0.0%
1% to 9%	9.1%	8.0%	0.0%	3.4%	8.0%	1.1%
10% to 19%	13.6%	15.9%	4.5%	13.6%	13.6%	1.1%
20% to 29%	17.0%	15.9%	8.0%	25.0%	21.6%	4.5%
30% to 39%	15.9%	15.9%	6.8%	17.0%	19.3%	10.2%
40% to 50%	22.7%	20.5%	79.5%	22.7%	19.3%	83.0%

Table 5. Improvements in Certainty Equivalent Ratios from Optimizing Portfolio.

Explanation: The certainty equivalent ratio (CER) represents the ratio of the certainty for a given investment strategy relative to the strategy that would be invested entirely in indexed bonds. Improvements in the CER reflect the change in the CER that results if a person switches from a portfolio consisting of a 50/50 mix of company stock and bonds to a portfolio with one-half company stock and the other half in the optimal mixture between bonds and the S&P 500. Simulations are repeated for 88 different stocks representing a 5 percent random sample of stocks held in large DC plans.

		Baseline expenses			High expenses and equity returns reduced by 300 basis points		
		α=1	α=2	α=4	α=1	α=2	α=4
				Non-pension wealth=0			
Indexed bonds							
	p5	0.210	0.000	0.000	0.000	0.000	0.000
	p50	0.487	0.055	0.000	0.036	0.000	0.000
	p95	0.659	0.215	0.040	0.110	0.022	0.000
	mean	0.452	0.075	0.005	0.045	0.003	0.000
Bonds							
	p5	0.153	0.000	0.000	0.000	0.000	0.000
	p50	0.411	0.046	0.000	0.015	0.000	0.000
	p95	0.530	0.193	0.049	0.073	0.019	0.002
	mean	0.373	0.066	0.007	0.023	0.003	0.000
				Non-pension wealth=$120,000			
Indexed bonds							
	p5	0.336	0.041	0.000	0.022	0.000	0.000
	p50	0.641	0.212	0.032	0.112	0.015	0.000
	p95	0.869	0.366	0.161	0.172	0.084	0.018
	mean	0.607	0.214	0.047	0.108	0.024	0.003
Bonds							
	p5	0.275	0.019	0.000	0.002	0.000	0.000
	p50	0.535	0.166	0.029	0.060	0.005	0.000
	p95	0.728	0.314	0.145	0.116	0.056	0.014
	mean	0.506	0.174	0.042	0.060	0.013	0.002

Table 6. Determinants of Gains from Optimizing Relative to Mixing Company Stock with all Bonds.

Explanation: Coefficients are from a regression of the increased in the certainty equivalent ratio (CER) associated with choosing the optimal mix between the SP500 and bonds relative to the strategy that mixes the company stock with all bonds. The improvement in the CER varies across the 88 stocks and the 6 simulations performed for each stock resulting in 528 observations for each level of risk aversion considered (α=1,2,4).

	α=1	α=2	α=4
Characteristics of company stock:			
Coefficients from Fama-French regression:			
Excess market returns	0.0138	-0.0665	-0.039
	(1.04)	(8.16)	(8.22)
Small minus Big capitalization	0.0593	-0.0136	-0.0115
	(4.96)	(1.85)	(2.69)
High minus low book to value ratios.	0.0894	0.00431	-0.00364
	(11.60)	(0.90)	(1.31)
Standard deviation of residual from Fama-French regression	-0.665	-0.387	-0.0678
	(4.22)	(3.99)	(1.20)
Dummy variables reflecting simulation assumptions			
Equity returns reduced 300 basis points & high expenses	-0.5	-0.186	-0.0562
	(50.20)	(30.40)	(15.70)
Non-pension wealth=$120,000	0.109	0.0799	0.0219
	(8.97)	(10.60)	(5.00)
Non-pension wealth=$360,000	0.22	0.177	0.0728
	(18.00)	(23.60)	(16.60)
Intercept	0.49	0.124	0.0288
	(48.30)	(19.80)	(7.90)
Observations	528	528	528
R-squared	0.86	0.77	0.57