

Pension Fund Portfolio Management

Pension plans (also known as pension schemes or superannuation plans) manage assets that are used to provide workers with a flow of income during their retirement years. Because pension plans may control the largest pool of capital in the world, asset managers need to be aware of the goals and challenges of managing these plans. In a study of 13 developed countries, private and public pension plan assets totaled over \$26 trillion, averaging 76% of gross domestic product (GDP) (Towers Watson 2011). It is estimated that 58% of the world's workers are covered by some form of pension plan (Whitehouse 2007). The world's top 15 pension plans controlled over \$4,360 billion in assets in 2011 (see Exhibit 4.1).

In most of the developed world (North America, Europe, Japan, and Australia), life expectancy exceeds 80 years. Workers may start a career around age 20, work for approximately 40 years, and retire from work between ages 60 and 67. Workers need to save during their careers in order to maintain an adequate standard of living during retirement. It can be difficult for an individual worker to adequately plan for retirement, as investment returns and one's life expectancy are unknown. Depending on their chosen career and income, workers may lack either the ability to save or the investment knowledge to appropriately invest their assets.

There are a number of reasons why pension plans can be attractive, both for employers and for employees. Companies offering pension plans may be able to attract and retain higher-quality employees, while employees may seek out companies offering strong pension benefits. Employees value the income promised by a pension plan, which may be used as a substitute for their personal savings. In many countries, retirement plan assets grow on a tax-deferred basis. Employees' and employers' contributions to retirement plans are not taxed in the year that the contributions are made. The gains on the investment portfolio are not taxed in the year they are earned, but taxes are paid by employees when the assets are withdrawn during retirement. Ideally, the employee will pay a lower tax rate during retirement than during the working years, which further increases the tax benefit of pension plan investments.

In contrast to what occurs when employees individually save for retirement, pension funds have several advantages. First, the pension fund can hire internal staff and external managers who are highly trained in finance to watch the investment portfolio on a daily basis. Economies of scale are also earned by large pension plans, as larger investment sizes can reduce investment fees and afford a larger staff.

Pension plans can also make long-term investments, with a time horizon that may be as long as the lifetime of the youngest employee. Asset allocation decisions are made with the average employee in mind. When individual investors make

EXHIBIT 4.1 The World's Largest Pension Plan Sponsors, 2011

Fund	Country	Assets (\$ Million)
Government Pension Investment Fund	Japan	\$1,432,122
Government Pension Fund	Norway	\$ 550,858
Stichting Pensioenfond ABP	Netherlands	\$ 318,807
National Pension Service	Korea	\$ 289,418
Federal Retirement Thrift Investment Board	U.S.	\$ 264,013
California Public Employees' Retirement System	U.S.	\$ 214,387
Pension Fund Association for Local Government Officials ^a	Japan	\$ 189,633
Canada Pension Plan ^b	Canada	\$ 149,142
Employees Provident Fund	Malaysia	\$ 145,570
Central Provident Fund	Singapore	\$ 144,844
California State Teachers Retirement System	U.S.	\$ 138,888
New York State Common Retirement Fund	U.S.	\$ 133,023
Stichting Pensioenfond Zorg en Welijn PFZW	Netherlands	\$ 133,002
National Social Security Fund	China	\$ 129,789
Government Employees Pension Fund (GEPF) ^{a,b}	South Africa	\$ 128,232

^aEstimate.

^bAs of March 31, 2011.

Source: *Pensions & Investments*.

retirement investments, asset allocation becomes inherently more conservative over time, as the employee's lifetime is uncertain and the ability to fund investment losses during retirement is limited. **Mortality risk**, the age at which someone dies, is highly uncertain for an individual investor, but can be quite predictable when averaged over a large number of employees and retirees covered by a pension plan. Longer lifetimes require larger retirement assets. For an individual investor, spending rates may be conservative, again because the life span is uncertain. However, for a pension plan with known benefits, the asset allocation and benefit levels may not be significantly impacted by the death of a single beneficiary. **Longevity risk**, the risk that an individual will live longer than anticipated, affects different investors in different ways. For life insurance companies, the risk is that their beneficiaries die at a younger age than predicted, as the life insurance benefit will be paid at an earlier date and a higher present value. For individuals and pension plans, the risk is that lifetimes will be longer than anticipated, as retirement spending or retirement benefits will last for a longer time period, requiring a larger number of monthly benefit payments or months of retirement spending.

There are three basic types of pension plans: defined benefit, governmental social security plans, and defined contribution. Each plan varies in the asset management risks and rewards, and whether the employer, the employee, or taxpayers have the ultimate risk for the performance of the investment portfolio.

4.1 DEFINED BENEFIT PLANS

Defined benefit (DB) plans provide a guaranteed income to retirees, but can be risky for employers. In a **defined benefit plan**, the employer takes all of the investment risk while offering a guaranteed, formulaic benefit to retirees.

For example, consider an employer that offers a retirement benefit of 1.5% of salary for each year the employee worked before retirement. If the salary to which the benefits apply is \$50,000 and the employee has worked for 40 years, the retiree will be paid retirement benefits in the amount of \$30,000 per year ($1.5\% \times 40 \text{ years} \times \$50,000$) for the rest of the retiree's life. This provides the worker with a **retirement income-replacement ratio** of 60%, which is the pension benefit as a portion of final salary.

DB plans are not **portable**, meaning that benefits earned at one employer do not continue to accrue at another employer. In many cases, workers who die before retirement age receive no benefits from a DB plan and their heirs receive no lump sum or recurring benefit payments. DB plans reward workers who spend their entire career with a single employer. Contrast an employee who worked for 40 years at one firm to another employee who worked 20 years at each of two employers. Each employer provides a benefit of 1.5% of the average of the final five years of salary multiplied by the number of years of service. The worker started with an income of \$15,787 in 1971, and retired in 2011 with an income of \$50,000 after receiving annual salary increases of 3% over 40 years. If the worker served her entire career with one employer, the annual benefit would be \$28,302 ($1.5\% \times 40 \text{ years} \times$ the final five-year salary average of \$47,171). The benefits would be quite different had she worked for two employers. The retiree worked at the first employer from 1971 to 1991, with an average annual salary in the final five years of \$26,117. The annual benefits of \$7,835 ($1.5\% \times 20 \text{ years} \times \$26,117$) are determined in 1991, but not paid until retirement in 2011. The second employer pays annual benefits in the amount of \$14,151 ($1.5\% \times 20 \text{ years} \times \$47,171$). Compared to the annual benefit of \$28,302 after working the entire career for a single employer, the employee splitting careers between two firms earns an annual pension of only \$21,986 (\$7,835 plus \$14,151), which is \$6,316 per year less than if she had worked for a single firm.

A lack of portability may be an even greater issue for an employee who works a large number of jobs in a career, as many firms have vesting periods of five to 10 years. An employee must work for the entire **vesting period** in order to earn any retirement benefits. In a worst-case scenario, consider an employee who worked for 45 years, serving nine years at each of five employers. If each employer required a minimum of 10 years of service to qualify for a DB pension, the employee would have earned no retirement benefits, even after working for 45 years at firms offering DB plans.

4.1.1 Defining Liabilities: Accumulated Benefit Obligation and Projected Benefit Obligation

It can be challenging to model the liability of an employer's DB plan. Defining the liability is important, as employers need to reserve assets each year to plan for future benefit payments. A number of assumptions need to be made to calculate the amount owed in retiree benefits. These assumptions include:

- The amount of employee turnover and the years of service at the date of separation
- Average wages at retirement, which requires the current wage, estimated retirement age, and annual wage inflation from today until retirement

- The assumed age of worker death, as the number of years of benefits to be paid is the difference between the age at retirement and the age at death
- The number of current employees, hiring plans, and the anticipated age of all employees

The **accumulated benefit obligation (ABO)** is the present value of the amount of benefits currently accumulated by workers and retirees. This number may be very small for a young firm with young workers, such as a four-year-old technology start-up filled with young college graduates. In this scenario, current workers have had only four years to accrue benefits and the firm may not anticipate retirements for another 40 years. Their ABO is relatively easy to calculate, as the number of workers, their tenure, and average salary are all known. Of course, future wage growth and the average employee life span need to be assumed.

The **projected benefit obligation (PBO)** is the present value of the amount of benefits assumed to be paid to all future retirees of the firm. This number is much more challenging to calculate, as the number of workers at the firm in the future, employee turnover levels, and years of service are unknowns. As long as the firm has current employees, the PBO is always greater than or equal to the ABO. When the firm and its employees are young, the ABO may be much smaller than the PBO. For example, the PBO may assume 40 years of service, while employees at the young firm have accrued only four years of service. In a mature firm with a large number of retirees and an older workforce, the ABO will be of a similar magnitude to the PBO. The difference between the ABO and the PBO is primarily based on the current versus future salaries and years of service of current employees.

4.1.2 Funded Status and Surplus Risk

The **funded status** of a pension plan is the amount of the plan's current assets compared to its PBO. The funded status may be expressed in terms of currency, such as €2 billion underfunded, or in percentage terms, such as 70% funded (or 30% underfunded) if a plan's assets are 70% of the PBO. Plans should strive to be close to 100% funded. Overfunded plans, such as those with assets of 120% of PBO, may attract attention from employees who would like to earn larger benefits, or from corporate merger partners who may wish to disband the pension and keep the surplus value. Underfunded plans, such as those where assets are 70% of the PBO, may require larger employer contributions and attract regulatory scrutiny.

The funded status of pension plans can vary sharply over time, as shown in Exhibit 4.2. The assets of the plan grow with employer contributions, decline with retiree benefit payments, and change daily with returns to the investment portfolio. The PBO also changes over time, as the present value factor is based on corporate bond yields. As corporate bond yields rise, the PBO declines. Conversely, declines in corporate bond yields lead to an increasing PBO.

The Citigroup Pension Liability Index tracks corporate bond yields that can be used to discount future values of the PBO. At December 31, 2009, the discount rate was 5.98%, while the duration of PBO benefits was estimated at 16.2 years. By year-end 2011, the discount rate had fallen to 4.40%. The pension plan's PBO can be compared to a short position in corporate bonds, which will change in value by the approximate amount of $-1 \times \text{change in yields} \times \text{duration}$. Over this two-year

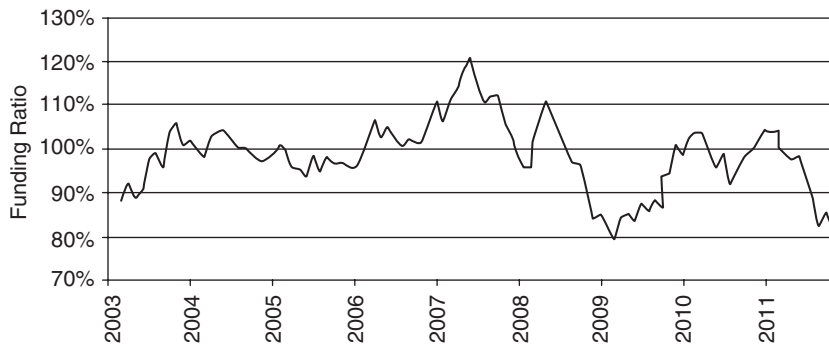


EXHIBIT 4.2 Estimated Funding Ratio of UK Pension Schemes
Source: The Purple Book (2011).

period, the 1.58% decline in corporate bond yields has led to an increase of 25.6% ($-1 \times 1.58\% \times 16.2$) in the present value of the PBO, assuming that duration and future benefit assumptions remain unchanged.

The **surplus** of a pension plan is the amount of assets in excess of the PBO. The **surplus risk** of a pension plan is the tracking error of the assets relative to the present value of the liabilities. Consider the example in Exhibit 4.3, where assets are invested 60% in the S&P 500 and 40% in the Barclays Aggregate Bond Index. The liabilities are assumed to have a duration of 16.2 years and a discount rate tracked by the Citigroup Pension Liability Index. From 1997 to 2011, the volatility of the asset portfolio was 11.9%, while the volatility of liabilities based only on the change in corporate bond yields was 9.9%. Because assets and liabilities had a correlation of -0.26 over this time period, the surplus risk was even higher, as the volatility of the annual difference between asset and liability returns was 17.4%.

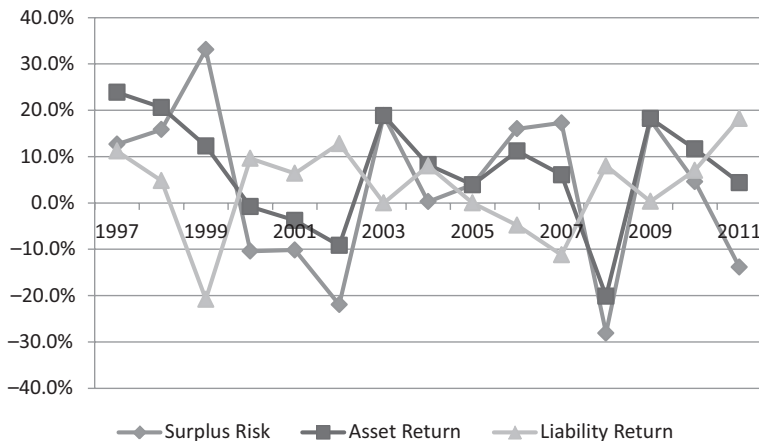


EXHIBIT 4.3 The Volatility of Pension Assets and Liabilities Creates Surplus Risk
Source: Authors' calculations based on returns to the S&P 500, Barclays Aggregate Bond Index, and the Citigroup Pension Liability Index.

4.1.3 Why Defined Benefit Plans Are Withering

Each pension plan has a **required return assumption** that is used to calculate the employer's annual contribution. As shown in Exhibit 4.4, all of the 126 U.S. public pension plans surveyed by the National Association of State Retirement Administrators (NASRA) and the National Council on Teacher Retirement (NCTR) used return assumptions between 7% and 8.5% in 2010, with over 44% using an estimate of 8%. Should long-term investment returns fall below this assumed return, either the plan will become underfunded or additional employer contributions will be required. The required return is also a key driver of asset allocation, as investment policy is set in an attempt to earn the required return. That is, plans with higher required return assumptions may pursue a more aggressive asset allocation in order to earn the investment profits needed to justify both the current level of benefits promised as well as the employer contributions.

Plan sponsors, whether in the public or private sector, are increasingly becoming concerned about the affordability of DB plans. While corporate plan sponsors use a corporate bond yield as the discount rate, public plans use the required return assumption as the discount rate. The calculations underlying Exhibit 4.3 show an average annual return on assets of 6.4% from 1997 to 2011, while the present value of liabilities increased by an annual average of 2.8% during a time of declining interest rates. This means that, over a 15-year period, asset returns exceeded liability returns by only 3.6% per year for corporate plans. When the public plan sponsor is making contributions based on an 8% required return, actual returns of 6.4% per year will lead to declining funded ratios over time.

Regulatory changes, at least in the United States, are also making corporate DB plans less attractive. The Pension Protection Act of 2006 requires that corporate employers disclose the plan's funded status to plan participants. The Act also requires employer contributions to be commensurate with the funding status, with underfunded plans requiring greater contributions and overfunded plans requiring

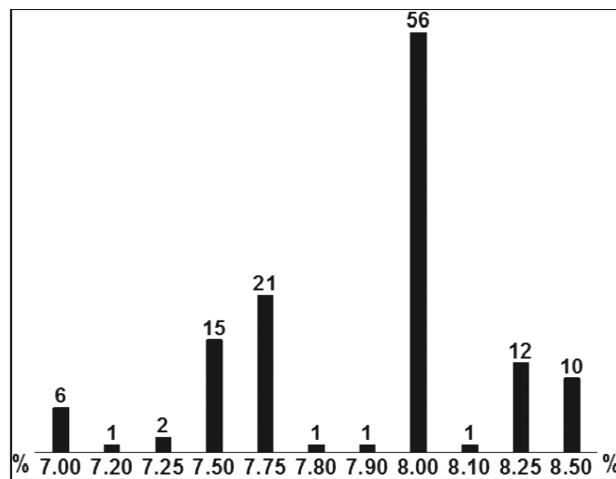


EXHIBIT 4.4 Distribution of Investment Return Assumptions, Fiscal Year (FY) 2010
Source: Public Fund Survey of the NASRA and the NCTR.

lower contributions. Underfunded plans must increase required contributions by an amount that projects the plan to be fully funded within seven years.

Investors are also concerned about the risk of investing in the equity securities of companies with underfunded pensions. The funded status of U.S. pension plans is now required to be disclosed on corporate balance sheets. Merton (2006) states that companies with large pension deficits may trade at lower multiples of earnings and book value, exhibit higher betas, and may experience higher stock price volatility. The higher beta caused by pension risks can increase the firm's weighted average cost of capital by up to 2.7%, which makes it more difficult to find profitable operating investments.

Employees are also concerned about DB plans. The declining number of DB plans offered by companies and their lack of portability make such plans less relevant today. Employees are working at a greater number of firms during their careers than did previous generations. The U.S. Bureau of Labor Statistics (BLS 2010) estimates that Americans born between 1957 and 1964 held an average of 11 jobs before the age of 44, and only 12% of this population held four or fewer jobs during the first half of their career. It is therefore difficult for the majority of younger workers to accrue meaningful retirement income under a DB system.

As a result, as shown in Exhibit 4.5, DB plans are declining as a share of assets among U.S. pension plans.

Should a plan sponsor no longer wish to offer a DB plan to its employees, it has the option to freeze or terminate the plan. As a less drastic measure, the employer may move to a two-tier structure, offering newly hired employees a less generous pension benefit than previously hired employees. A **frozen pension plan** is one where employees scheduled to receive DB pension benefits will no longer continue to accrue additional years of service in the plan. An employee with 20 years of service when the plan is frozen might retire five years later with 25 years of service but the benefits would be tied to only 20 years of service. A **terminated pension plan** is no longer operated by the employer. Once a plan has been terminated, all assets will leave the control of the employer and either be paid out in lump sums to employees or be used to purchase annuities that will pay future benefits to retirees. Freezing or terminating pension plans is extremely popular in the United Kingdom, where *The Purple Book* (2011) estimates that only 16% of UK plans are open to new participants and allow current participants to continue to accrue benefits. Olsen (2012) states that “46% of U.S. corporate DB plans are active and open to new hires, while 24% are closed, 24% are frozen and 1% are being terminated.”

EXHIBIT 4.5 Defined Benefit Assets of the Top 1,000 U.S. Pension Plans Are Losing Share over Time

	2002	2004	2006	2008	2010
Total plan assets (\$ million)	4,329,015	5,351,019	6,487,729	6,395,807	6,561,617
Total DB assets	3,243,189	3,969,566	4,776,551	4,618,163	4,651,389
Total non-DB assets	1,085,826	1,381,453	1,711,178	1,777,644	1,910,229
% non-DB assets	25.1%	25.8%	26.4%	27.8%	29.1%

Source: Author's calculations, *Pensions & Investments*.

4.1.4 Asset Allocation and Liability-Driven Investing

Pension plan sponsors have conflicting goals when designing the asset allocation of the plan. The first goal is to earn a high return on pension assets, which will be used to reduce the employer's long-term contributions required to fund employee benefits. The second goal is to minimize the degree of underfunding or the amount of surplus risk incurred in the plan.

As can be seen in Exhibit 4.6, a survey of 1,000 U.S. DB pension plans shows that allocations to equity investments have fallen from 2002 to 2010, while alternative investments have risen from 11% to 19% of DB plan assets. Consistent with the data on endowments and foundations from Chapter 2, pension plans with larger amounts of assets have larger allocations to alternative investments. Prequin (2011) reports that public pensions comprise 29% of private equity assets, while 13% comes from private pensions and an additional 21% is invested by endowments and foundations. Similarly, nearly half of global investment in infrastructure comes from these investors, including 20% from public pensions, 16% from private pensions, 8% from superannuation plans, and 8% from endowments and foundations.

As assets of U.S. DB plans have risen from \$3,243 billion in 2002 to \$4,651 billion in 2010, the dollar amount invested in alternative assets has exploded. While survey data can be incomplete, the authors' analysis of data provided by *Pensions & Investments (P&I)* shows that U.S. DB plans had over \$225 billion invested in alternatives in 2002 and over \$612 billion in 2010. In 2002, the *P&I* survey had limited categories for alternative investments, with allocations dominated by \$105 billion in real estate and \$73 billion in private equity. By 2010, the number of alternative investment categories tracked by the survey had more than doubled. While real estate (\$192 billion) and private equity (\$293 billion) remained the largest allocations, hedge funds and funds of funds had risen to \$120 billion. Furthermore, real assets, including timber, commodities, oil and gas, and infrastructure, had attracted over \$40 billion in pension investments, despite not being included in the 2004 survey.

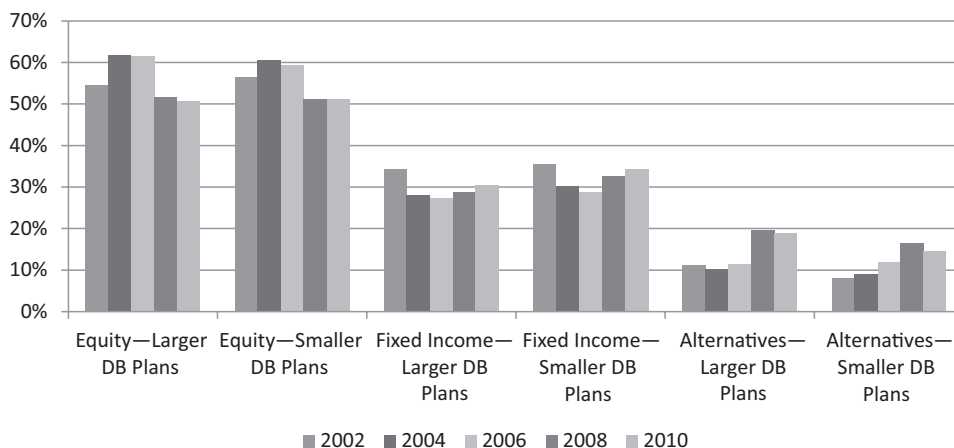


EXHIBIT 4.6 Asset Allocation of Larger DB Plans (\$10 Billion or Greater AUM) and Smaller DB Plans (Under \$10 Billion AUM)

Source: Authors' calculations, *Pensions & Investments*.

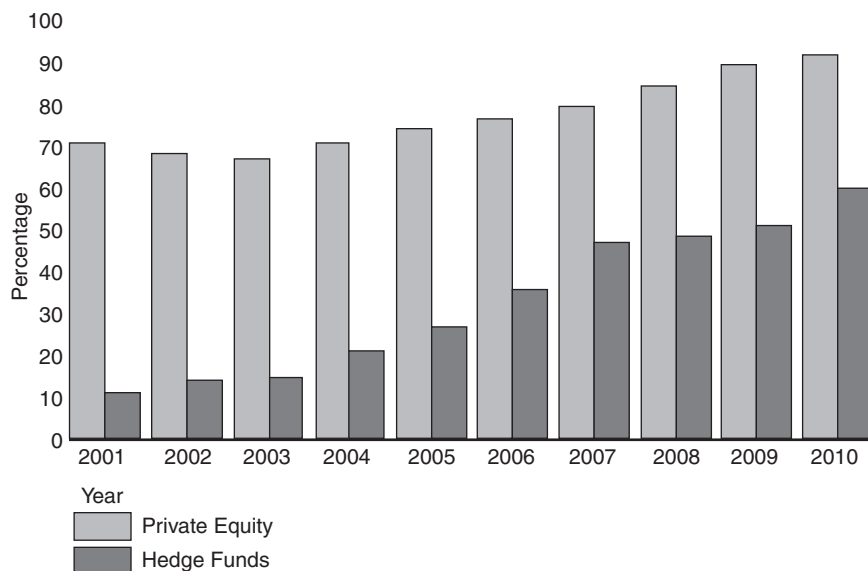


EXHIBIT 4.7 Share of Large U.S. DB Plans (\$1 Billion or more AUM) Investing in Hedge Funds and Private Equity from 2001 to 2010

Source: GAO (2012), GAO analysis of *Pensions & Investments* annual survey data, 2001–2010.

The U.S. Government Accountability Office (GAO 2012) discusses the trends of U.S. pension plan investments in private equity and hedge funds. As shown in Exhibit 4.7, while the majority of large U.S. DB plans have invested in private equity for over a decade, hedge fund investments are relatively new, with half of plans making their first investment in hedge funds in the past 10 years. Plans invested in private equity averaged a 9% allocation, while those invested in hedge funds had allocations larger than 5% of assets. As with endowments and foundations, larger plans were more likely to invest in alternative assets than smaller and midsize plans.

While investing in equity and alternative investments may earn higher long-term returns, these risky assets are subject to substantial short-term volatility, whether measured against a benchmark of zero, the plan’s required return, or the change in the present value of the plan’s liabilities. Companies wishing to reduce surplus risk may have a very large fixed-income allocation. While this reduces surplus risk, the large fixed-income allocation reduces the likely return on assets, which increases the plan sponsor’s long-term contributions.

Liability-driven investing (LDI) seeks to reduce surplus volatility by building a portfolio of assets that produces returns that are highly correlated with the change in the plan’s liabilities. The simplest way to immunize pension liabilities is to invest in a corporate bond portfolio with a duration matching that of the liabilities. Other ways to reduce surplus risk include derivatives overlays, such as a swap receiving long-duration bond returns or a swaption that increases in value as interest rates decline. (See Exhibit 4.8.)

Meder and Staub (2007) discuss the asset allocation necessary to hedge the ABO and PBO exposures. The ABO does not count future benefit accruals; it simply

Percentage of Pensions Employing a Liability-Driven Investing Strategy

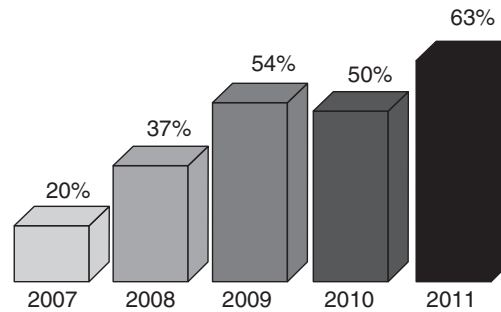


EXHIBIT 4.8 Poll Results of Pension Management Research Panel Liability-Driven Investing Survey

Source: “5th Annual Liability-Driven Investing (LDI) Poll: More Plan Sponsors Using LDI Than in Years Past,” SEI Institutional Solutions, December 2011.

has exposure to declining nominal bond rates, which increases the present value of benefit payments. The PBO is more complicated, as future wage inflation may be correlated to both equities and inflation rates. One suggested asset allocation is 85% nominal bonds, 5% real bonds, and 10% equities. Employers with younger workers would have a higher allocation to equities. Plans may offer retirees a **cost of living adjustment (COLA)**, which increases the benefits paid to employees along with the rate of inflation. For example, consider a retiree earning a pension of \$2,000 per month. After five years of 4% inflation rates and a 75% COLA (75% of 4%), the retiree’s pension will have risen by 3% per year to \$2,318 per month. Plans offering benefits with large percentage COLA adjustments would need to have large allocations to inflation-protected bonds, in order to reduce surplus risk. **Inflation-protected bonds** earn a nominal coupon, while the principal value rises with the rate of inflation. Due to the superior hedging capabilities of real bonds, their total return tends to be very low. In 2012, the real return of 15-year U.S. Treasury Inflation-Protected Securities (TIPS) was negative.

Investors, then, may wish to protect their portfolios against inflation without earning the low real returns offered by inflation-protected bonds. A growing number of investors are turning to real assets to gain inflation protection while attempting to earn higher returns than offered by inflation-protected bonds, such as TIPS. In addition to the automatic inflation protection offered by TIPS, Martin (2010) demonstrates that a number of real assets can serve as long-horizon inflation hedges, including commodities, timber, and farmland. While equities are not a good hedge against long-horizon inflation, it is uncertain whether infrastructure, real estate, or intellectual property investments are good hedges against inflation. Specific investment characteristics, such as fixed-rate debt and revenues tied to inflation, improve the ability of infrastructure or real estate to serve as an inflation hedge. Assets with fixed-rate leases and variable-rate debt may actually be hurt by inflation, even though they are real assets, such as real estate or infrastructure.

4.2 GOVERNMENTAL SOCIAL SECURITY PLANS

Government social security plans may provide retirement income to all previously employed citizens of a specific country, regardless of whether the worker was employed in the public sector or in the private sector. The main requirement for earning benefits from these systems is that retirees must have worked for a minimum amount of time, such as 10 years over the course of a career, and paid contributions into the system. Social security benefits are typically portable, meaning that employees continue to accrue service credits whenever they are paying contributions into the system, regardless of the number of employers in a career. Some employees, especially of governmental entities, do not receive these benefits, as neither employees nor their employers paid the required contribution. Whitehouse (2007) estimates that the average retirement benefit in 24 high-income Organization for Economic Cooperation and Development (OECD) countries is 31% of average earnings.

DB plans often have benefits explicitly tied to employee income, without a cap on the amount of benefits that may be earned. Social security plans are quite different, in that there are caps on earnings, which means that retirees with lower career-average incomes may earn a higher retirement income-replacement ratio than higher-income retirees. U.S. workers retiring in 2012 at the age of 66 were eligible for a maximum monthly retirement benefit of \$2,513. This maximum benefit is paid to higher-income workers, such as those with incomes over \$110,100 in 2012. The Investment Company Institute (ICI 2011) quotes U.S. Congressional Budget Office (CBO) estimates of a retirement income-replacement ratio of 71% for the lowest quintile of U.S. workers, which declines to just 31% for the highest quintile of workers. Social security systems may also provide income security to the dependents of workers, paying benefits to the spouse or children of workers who die or become disabled during their working years.

4.3 DEFINED CONTRIBUTION PLANS

During times of low investment returns and rising amounts of regulatory pressure, many employers no longer choose to offer DB plans. Employers that do not offer DB plans will not see surplus risk on their balance sheets, and the contributions to employee retirement plans will be less variable. These employers will not see pension costs rise during times of low investment returns; however, they will also not earn the upside during times of high investment returns. Towers Watson (2011) estimates that global pension assets in 2010 were 56% defined benefit (DB) plans and 44% defined contribution (DC) plans. The mix between DB and DC plans varies widely by country, with 81% of Australian assets invested in DC plans, whereas 98% of Japanese assets are in DB plans. Using ICI (2011) estimates, U.S. DB plan assets of \$8,300 billion are now smaller than the combined \$4,500 billion in DC assets and \$4,700 billion in individual retirement accounts.

The most common alternative retirement plan offered by employers is a **defined contribution plan**, where the employer makes a stated contribution to each covered employee on a regular basis. In a DC plan, there is no surplus risk for the employer, as assets always match liabilities. A common structure for a DC plan is one in

which an employer offers each employee an annual amount of 3% of salary, with perhaps a **matching contribution** of 50% of the amount contributed by the employee. For example, an employee will contribute 6% of salary to the DC plan, while the employer will contribute 3% plus a matching contribution of 3% (50% of 6%). This employee would place 12% of salary into a retirement account.

In contrast to DB plans, DC plans are portable, meaning that the employer contributions become the asset of the employee once the vesting period is completed. This portability is better for employees who work multiple jobs in a career, and for employees who work for firms that may not have the financial strength to pay long-term pension benefits in the amount promised. When leaving an employer, the employee is able to roll over the balance in the DC plan into the plan offered by the next employer or into an individual retirement account. Given that DC plans are personal accounts, the employee contribution, investment gains, and vested portion of employer contributions can be given to the employee's heirs should the employee die before retirement.

In a DB plan, the longevity risk is incurred by the employer. The employee is guaranteed the monthly benefit for life, whether that life is longer or shorter than anticipated. This means that employees cannot outlive their assets. In a DC plan, however, there is no guarantee as to the amount of assets accumulated or the amount of monthly income in retirement, meaning that longevity risks directly impact the employee. Employees with low contributions, low investment returns, or long lives may have a significant probability of "living too long," meaning that their assets may be exhausted or their spending rate curtailed in their final years of life. Employees need to plan for at least 20 years of retirement income, as Maginn et al. (2007) estimate that, in the United States, a 65-year-old couple has a 78% chance that at least one of them will live beyond age 85.

The employer makes the asset allocation decisions in a DB plan, but asset allocation decisions in DC plans are made by the employees, typically using the fund choices provided by the employer. The employer may offer a range of investment choices, such as up to 20 mutual funds. However, it is the employee's decision as to how much to contribute to the retirement account, as well as how to allocate the assets across the allowed investment choices. Leaving the decision making to employees, most of whom are not trained in making investment decisions, can lead to a wide variety of employee outcomes. Some employees may retire without any retirement assets, either because they did not choose to participate in the plan or because they were allowed to invest all of their assets in their employer's stock, which ended up worthless at the end of a bankruptcy proceeding. Some employers may offer the option of a brokerage window, which allows employees to invest in a broader variety of mutual funds, or even individual stocks. While employees with a high degree of financial sophistication can benefit from a brokerage window, the sheer number of options or the ability to concentrate risk in more narrow investments can cause excessive risk for some plan participants.

On the other hand, a diligent saver with good investment returns can potentially earn a larger retirement benefit in a DC plan than in a DB plan. In the earlier example, the employee started with a salary of \$15,787 and worked for 40 years, before retiring at a final salary of \$50,000 with a single-employer DB pension plan income of \$28,302. The same employee, when covered by a DC plan, could have invested 6% of her salary and earned employer contributions in a similar amount. Assuming

salary raises of 3% per year, investment returns of 8% per year, and annual contributions in the amount of 12% of salary, the employee would have accumulated over \$699,000 at retirement. This amount includes employee and employer contributions of approximately \$71,400 each over the course of the career, and over \$550,000 in investment earnings. With a spending rate of just 4.05%, the employee would earn the same amount as the DB pension plan income of \$28,302. If the DC account earned annual returns of at least 4.05% during retirement, the nominal value of the retirement account would either be stable or rising for the rest of the employee's life. The principal balance, at the date of death, would be passed on to the retiree's heirs. In contrast, most DB plans do not offer value to the family of the retiree, unless there is a promise to pay some portion of the pension income for the rest of the spouse's life. For a diligent saver who was blessed with high investment returns over the course of a career, the DC plan is far superior to a DB plan, in terms of both portability and the ability to pass significant assets along to heirs. Unfortunately, many DC plan participants either save too little or invest too conservatively, and end up faced with the prospect of earning far fewer benefits from the DC plan than if the employee had worked for a single employer offering a DB plan. When plan participants have the ability to withdraw from or borrow against the assets in the DC plan before retirement, it becomes even more difficult to accumulate the assets necessary to ensure a strong income during retirement.

Given that employees are making their own investment decisions, many employers offer simple fund choices for DC plan participants. In some cases, employees are allowed only the choice to allocate assets across domestic stocks, domestic bonds, cash, and global stocks. Other plans will allow participants to invest in equity securities of the employer, as well as over 20 funds in a variety of geographies or asset classes.

Employees do not generally allocate DC plan assets in the same careful way that professional managers allocate DB plan assets. Employees often invest in just a single fund, resulting in a 100% equity or 100% cash allocation, or they diversify contributions equally across all investment choices. Employees also do not rebalance frequently or change allocations when their investment needs become more conservative as retirement approaches. This lack of rebalancing results in a **drifting asset allocation**, where the highest-returning asset classes grow as a share of the portfolio. For example, an employee may have decided at age 30 to direct 70% of contributions to an equity fund and 30% to a fixed-income fund, given his investment needs at the time. If stock returns were substantially higher than bond returns over the next 20 years, the now 50-year-old employee may find himself with an 85% equity, 15% fixed income portfolio at a time when a 60% equity, 40% bond mix is more appropriate for his circumstances.

Due to a lack of investor sophistication as well as regulatory restrictions, most DC plan participants do not have the ability to directly invest in alternative investments. When alternative investment choices are offered in DC plans, they typically focus on commodities or real estate. It is quite rare for individual employees to be able to invest in private equity or hedge funds through DC plans.

After the Pension Protection Act of 2006, many employers made changes to their DC plans' designs in order to alleviate a number of problems with DC plan investments. In the past, employers may not have mandated DC plan participation, and when they did, all employee contributions were placed in cash, unless otherwise

directed by the employee. Recently, employers have been automatically enrolling new employees in DC plans, setting the employee contribution at 1% to 3% of salary, and automatically increasing annual contributions by one-third of the employee's salary increase. For example, an employee contributing 2% of salary would have a contribution rate of 4% after earning 3% salary increases for two years. Finally, the default investment option may now be a target-date fund, rather than cash.

A **target-date fund** allows employees to choose a single investment option for the course of their career, without worrying about rebalancing or changing investment needs. A young employee hired in 2012 might invest in a target-date fund, anticipating a retirement in the year 2050, while an employee approaching retirement may be invested in a fund targeting a retirement date of 2020. The 2050 target-date fund assumes that a young employee with an average risk tolerance may be invested 85% in equity and 15% in fixed income. This asset allocation would be regularly rebalanced by the fund manager, becoming more conservative over time. Ultimately, the 2050 fund (in 2040) would resemble the 2020 fund (today), with an asset allocation of 50% equity and 50% fixed income, matching the investment needs of an individual approaching retirement. Target-date funds are often managed as a fund of funds structure, with a mutual fund company allocating assets to between three and 20 mutual funds managed by the mutual fund firm. In this structure, funds with private equity, hedge funds, commodity, or real estate investments may be included in the target-date products at allocations between 5% and 20%. Jewell (2011) quotes a Morningstar survey estimating that target-date funds now hold over \$340 billion. ICI (2011) estimates that 10% of DC plan assets in 2011 were invested in target-date funds, while Casey Quirk estimates that nearly half of all U.S. DC assets will be held in target-date funds by 2020 (Steyer 2011).