Financial Economics Principles Applied to Public Pension Plans

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November 11, 2016

[Working Paper]

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Abstract

Working from basic principles of economics, financial economics, and public finance, we develop implications for the financial management of public pension plans. We address the measurement of plan liabilities and cost, funding, investment of plan assets, financial reporting, benefit design and risk sharing.

Our analysis seeks to maximize efficiency and preserve intergenerational equity.

We conclude that full funding based on default-free discount rates is efficient and fair across generations. Investing so as to hedge accrued liabilities facilitates the maintenance of full funding across time, minimizes risk-adjusted costs, and avoids potentially costly and/or futile risk taking.

Hedging is more effective when plan design incorporates market principles and avoids off-market equivalences and options. Plan design that deviates from market measurements may be justified if it adds more value to the employer-employee relationship than it might otherwise destroy.

Risk-sharing plans that incorporate individual preferences are found to be superior to risk-sharing plan designs that treat all cohort members in unison.

Introduction

The purpose of this document is to state explicitly how financial economics applies to public pension plans, serving to extend the "Pension Actuary's Guide to Financial Economics" (Joint AAA/SOA Task Force on Financial Economics and the Actuarial Model, 2006) ("the Guide"). Unlike the Guide, this document is less a tutorial and more a declaration of principles. Explanatory materials are cited as references; first among them is the Guide. Although the Guide did not directly address public plans, many of the same financial principles apply to both corporate and public pension plans.

Why Financial Economics Applies to the Financial Management of Public Pension Plans

The principles and tools of financial economics are the underlying basis on which trillions of dollars of financial instruments are traded and valued. Public pension plans represent but a small fraction of the world's total financial activities. The financial institutions that comprise the capital markets recognize that financial economics is their unifying science. We agree with this view and assert its applicability to public and private defined benefit pension plans.

Financial economics applies to both traded and nontraded financial instruments. Pension plans are non-traded financial instruments with cash flows that can be estimated (in terms of amount, timing and risk).

Financial economics valuation is applied to both financial assets and liabilities, since every financial liability is another party's financial asset; and it is applied as well to instruments that have characteristics of both (e.g., swaps).Uses of financial economics include determining fair market value; hedging, managing and measuring risk; and assessing value relative to other financial opportunities for trading and investment.

Economists understand that the "cost" of a pension plan in a period is the market value of benefits earned by employees. Cost is not the amount that is contributed to a plan, which can be higher or lower than the cost.

For further discussion regarding the applicability of financial economics to public pension plans, see Minahan (2014) and Bader (2015).

How this Paper is Organized

The rest of this document includes the following sections, which, paralleling the Guide, begin with general principles of economics. This is followed by principles of financial economics and public finance and then by specific applications to public pension plans:

1. *Economic principles.* These principles describe how economic actors behave and the conditions necessary for optimal economic outcomes. These principles apply well beyond public or private pension plans.
2. *Financial economics principles.* These principles describe the functioning of capital markets (e.g., how financial markets price future cash flows).
3. *Public finance principles.* Intergenerational equity is discussed and applied. This principle applies to the governmental arena, creating important distinction vis-à-vis private corporations.
4. *Measurement of liabilities and costs.* This section addresses actuarial measurements driven by the preceding principles.
5. *Funding*. The economic purpose is discussed, as is the sharing of deficit payment among generations of taxpayers. A distinction is made between actuarial and political processes.
6. *Investment*. Economic principles are applied to the investment of assets held by the pension trust.
7. *Financial reporting.* The purpose and elements of financial reporting necessary to satisfy the preceding principles are discussed.
8. *Benefit design*. Elements of the benefit promise desirable for economic efficiency are discussed.
9. *Risk sharing.* Benefit design elements to facilitate the sharing of risk are discussed.

1: Economic Principles

Principals and Agents – *principals* (owners) are those individuals who, with respect to economic transactions and enterprises, bear the risks and costs (i.e., have skin in the game). *Agents* (e.g., enterprise managers and transactional brokers) are those who serve, and often have the discretion to make decisions that affect the wealth and well-being of, the principals. Although agents have the duty of allegiance to their principals, the division of roles can lead to conflicts of interest.

Principals and agents are defined in the context of specific decisions and transactions. For example, an employee, when performing employment duties, is an agent of the employer. When negotiating his or her own salary, however, he or she is a principal acting on his or her own behalf.

In the context of public pension plans, principals include public employees, taxpayers, users of government services, and bondholders. Agents include elected officials, union representatives, plan trustees, and those hired by the trustees, including investment managers, auditors and actuaries. Thus, actuaries are agents hired by agents, which adds an additional layer of potential conflict.

Individual Preferences and Institutional Objectives – economists view risk/reward preferences as traits of individuals. Institutions are viewed as agents that pass enterprise risks and rewards through to their principals. Economists model individuals as

maximizing expected utility and institutions as maximizing value. As such, institutions do not have risk/reward preferences of their own; they exist to maximize value, reflecting the market price for risk (Fisher, 1930). Risk taking should only be undertaken by an institution in order to add value beyond the value that could be realized by the institution's principals acting on their own.

Efficiency – Pareto efficiency, or Pareto optimality, is a state of allocation of resources such that no individual can be made better off without making at least one individual worse off. When inefficiency exists, it is possible to improve the well-being of some without injuring others. Transactions that decrease efficiency destroy value, creating deadweight losses, and should be avoided. Institutions maximize value by exploiting profitable opportunities and by minimizing deadweight costs. Just as in mechanics, friction is the enemy of efficiency. Financial frictions may be created by things such as transaction costs, taxes, lack of transparency, actuarial smoothing, regulatory barriers and costly bankruptcy.[1]

Transparency – transparency describes an ideal condition in which all interested parties have costless access to the best information. In a related sense, transparency refers to the ability of market participants to see through to the economic realities of an enterprise or a transaction. Rational decision makers operating in a transparent environment are able to be efficient. Lack of transparency is costly. Transparency is necessary so that principals may hold decision-making agents accountable.

[1] For a discussion of Pareto efficiency in a pension actuarial context, see Gold (2003).

2: Financial Economics Principles

Law of One Price (Arbitrage-Free Pricing) – if two or more seemingly different financial instruments or strategies produce the same cash flows in all states of nature, they will have identical present values (the Guide). If traded, they should trade at identical prices, enforced by arbitrage.[2] Market frictions (e.g., bid-ask spreads) may make this relationship less than perfect, but prices cannot drift far without correction by the market.

Valuation of Cash Flows – the price (value) of cash flows is determined by the properties (amount, timing and likelihood of payment) of those cash flows and not by how those cash flows may be financed (Bader and Gold, 2003). Traded financial instruments are priced by the market. Nontraded financial instruments, like pension promises, must be valued by reference to traded instruments with similar cash flow properties. Such a valuation represents the best estimate of (a) the arbitrage-free market price (if traded), (b) the price at which informed buyers and sellers would transact in a private exchange, and (c) the cost of hedging all risks.

Cost and the Efficient Allocation of Risk – as a matter of efficiency, risk should be borne by the party most willing to hold it – expressed as that party's willingness to charge the least for bearing that risk. The cheapest price for tradable risks is found in deep liquid markets. Anyone less willing to hold a risk should dispose of the risk at the market price. If two risk-averse parties share a risk, the less-averse party should accept the risk and receive compensation from the other. If the less-averse party is, however, more risk averse than the market, as implied

[2] Where traders sell (or short) an expensive security and buy a cheap security to earn a risk-free profit.

by the market price, the risk should be disposed of in the market with a gain in Pareto efficiency. Conversely, holding risk that the market will bear at lower cost implies deadweight loss.

Efficient Borrowing – means borrowing from the cheapest lender. If there is any credit risk, borrowing from rational nondiversified lenders is more expensive than borrowing from diversified lenders (e.g., commercial banks and bond investors). Underfunded pension plans force employees to become nondiversified lenders to plan sponsors. If employees are rational (and sponsor guarantees are less than perfect), they will demand additional compensation for making nondiversifiable risky loans, thereby imposing a loss on the sponsors. If employees are fooled into lending at below-market rates, they bear the loss. These are unnecessary deadweight losses (Bader, 2004).

3: Public Finance Principles

Intergenerational Equity – each generation of taxpayers pays contemporaneously for services received (Robinson, 1998). A police officer's total compensation should be paid by those he or she protects. Thus, it should be part of the entity's *operating budget* funded by current revenues. The cost of a newly built police station, however, appears on the *capital budget* and may be financed over time by the issuance of debt. Debt service becomes part of the annual operating budget, which allows generations of taxpayers to pay for a police station that serves them all.

Intergenerational equity is achieved when deferred compensation costs are measured and paid for on the basis of the properties (amount, timing and likelihood of payment) of the future payouts being earned today. Basing this measurement on the properties of other cash flows (e.g., expected investment returns) necessarily misstates (over or under) the value of currently earned deferred compensation, making it impossible to implement this fundamental public finance principle.

Underfunded and Overfunded Pension Plans – Underfunded pension plans (i.e., those with assets less than the accrued benefits measured at default-free rates) generally violate the principle of intergenerational equity (Gold, 2000). Current taxpayers are borrowing from their employees. Future taxpayers will be obligated to pay for services previously rendered. Overfunded pension plans would also generally violate the principle of intergenerational equity. Current taxpayers would be paying for services to be received by future taxpayers.

Operating Budget Stability – is a practical public finance objective rather than a public finance principle. It is difficult to manage an operating budget that includes volatile defined benefit pension contributions. Stable funding status can be facilitated by asset liability matching. The volatility of current and future service costs, highly sensitive to changing interest rates, can be mitigated, but not eliminated, by plan design, total compensation management, or interest rate hedging in the capital markets or by offsetting other interest rate exposure in the operating budget.

Efficient Delivery of Public Services – is also more an objective than a principle. A major function of government is to provide its residents with services they cannot efficiently provide or purchase for themselves and to fund the cost of those services by collecting taxes. Governments often have several objectives, all of which are facilitated by efficient financial management. When financial management is inefficient (in a Pareto sense), governments are missing an opportunity to improve services without raising taxes or to cut taxes without cutting services. And financial management can be efficient only if the cost of deferred benefits, such as pensions, is accurately and transparently measured.

4: Measurement of Liabilities and Costs

Pension benefits earned as of any date are defined by the plan, often enacted as statutes by state and local legislatures. In most cases, benefits will be based on employment and salaries not guaranteed beyond the current date or the end of the current union contract. Consistent with the principles of employment and contract economics (Gold, 2005), the cash flows forming the basis for correctly measured costs and liabilities are determined in accordance with the traditional unit credit (TUC) actuarial cost model.

The Guide references three liability definitions:

- **Market liability:** "the market value of a *reference portfolio* ... of traded securities" that "matches the benefit stream in amount, timing and probability of payment."
- **Solvency liability:** "the market value of a *defeasance portfolio* ... of risk-free traded securities (e.g., U.S. Treasuries)" that "matches the ... benefit stream in amount and timing ... but payment is assumed to be certain."
- **Budget liability:** "The traditional actuarial accrued liability used to budget cash contributions over a period of years." This measure discounts liability cash flows at the expected rate of return on assets, and incorporates the use of an actuarial cost method under which contributions do not necessarily align with the accrual of benefits. The budget liability, according to financial economics, has no economic meaning.

"Probability of payment" is the likelihood that the pension will be paid in full as promised, and this depends on the level of dedicated collateral (i.e., plan assets) and on the sponsor's credit (i.e., its ability and willingness to make up any shortfalls).

The market liability and solvency liability will be the same when collateral and sponsor credit are sufficient to render the pension promise effectively guaranteed (i.e., "secure"). If the sponsor credit is not strong, the pension promise may still be secure if the plan is fully funded (on a solvency basis) with assets matched to the liability. If the sponsor credit is strong, an underfunded pension promise may still be secure.

If the sponsor credit is weak and the plan is underfunded, full payment of the pension promise is not certain. The market liability is less than the solvency liability, with the difference representing the value of a "default put," the reduction in value arising because the pension won't be paid fully as promised in certain circumstances.

Market liability should be used for a sponsor's financial reporting (see below). Solvency liability should be used for measuring the degree to which current assets collateralize promised benefits, and thus should be the basis for determining contributions. (Brown and Pennacchi 2015).

The periodic cost (or just "cost") is the value of benefits earned in a period. A market value should be used for financial reporting, and a solvency value for funding.

5: Funding

The segregation of pension fund assets from the plan sponsor has two effects:

- Benefit security (collateral) – fund assets are committed first to the provision of benefits promised to plan participants.
- Intergenerational equity – taxes paid currently can be used to pay for benefits earned contemporaneously, even though those benefits may not be paid for many years. This reservoir attribute makes intergenerational equity possible. Taxpayers can pay the full cost of services they receive, including deferred compensation.

Full funding[3] of the solvency liability is necessary to achieve full benefit security and intergenerational equity.[4] All other actuarial cost methods fail to meet these objectives. The use of discount rates based on expected returns on risky assets (budget liability) leads to funding insufficient to meet these objectives.

Actual funds that differ from the value of accrued benefits (surpluses and deficits) give rise to a political problem rather than an actuarial one. Who (which generation or which constituency – taxpayers or participants) owns the surplus or must make up the deficit?

Relatively small surpluses provide a cushion for benefits being earned (valuation timing) and for emerging gains and losses. Larger surpluses become fodder for the political process, with the current generation likely to increase benefits and/or take funding holidays.

Deficits must be shared across generations, with some combination of prospective benefit reductions and contribution increases. Traditional actuarial amortization techniques (e.g., level dollars over future work life or level percentage of future payroll) presume to answer the treatment of deficits, but they are merely conventions, not inherently actuarial or economic. Despite the seemingly actuarial features of most amortization schemes, this is a policy matter. Actuaries should be cautious in providing guidance that does not acknowledge the difference between policy and the mechanics of calculation.

Financial economics implies that to balance contributions, intergenerational equity and total compensation one should (a) keep the pension plan fully funded on a solvency basis, (b) fully hedge the solvency liability (as much as possible), and (c) contribute the solvency normal cost every year. The market liability would then equal the solvency liability, and contributions would equal cost.

6: Investment

Defined benefit plans are funded in order to provide benefit security and a means to allow taxpayers to pay today for benefits that will not be paid for many years into the future. Pension investment strategy must be consistent with this funding rationale.

Because the periodic cost of a pension plan is the value of benefits earned in the period, pension investments do not make benefits more or less expensive. Institutions best serve their constituent principals by maximizing risk-adjusted value, and investment in risky assets does not increase risk-adjusted value. A public pension plan best serves its principals (participants and taxpayers) by matching assets and accrued liabilities, thus maintaining full funding and avoiding increased default risk and other deadweight costs (Bader, 2004).

The accrued liabilities of most defined benefit plans in the public sector can be matched by bonds, real and nominal, determined in accordance with plan provisions, including applicable post-retirement cost-of-living adjustments. Investments in risky assets (e.g., equities) weaken the benefit security of participants and, in U.S. and similar tax regimes, increase the risk-adjusted after-tax pension cost to local taxpayers (Bader and Gold, 2007). Further, risks are imposed on principals, at least some of whom do not understand, are not aware of, and/or do not want to incur these risks. Thus, investment in risky assets destroys value (i.e., it is not Pareto optimal).

In practice, public pension plans engage in numerous economically inefficient activities

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[3] "Full funding" is defined as the minimum amount that makes the payment of accrued benefits not dependent on the plan sponsor.

[4] Funding targets require default-free discount rates, even though financial reporting measures liabilities and costs using discount rates that reflect likelihood of payment. See Brown and Pennacchi (2015).

versus the simple approach of matching assets and liabilities.

7: Financial Reporting

The Governmental Accounting Standards Board (GASB) states that public-sector financial reporting objectives include accountability, decision usefulness and assessment of interperiod equity (GASB, 2012).

Accountability – derives from the taxpayers' right to know (GASB, 2009) how good a steward government has been with respect to public resources. Taxes are the primary source of those resources, and labor constitutes the single largest expenditure (salaries and deferred compensation).

Decision Usefulness – Public pension financial reporting is intended to inform many constituent decision makers, including taxpayers, lenders, employees and elected officials. Pertinent decisions include salary increases, pension benefit designs, taxes, bond issuance and pricing, and investment of pension assets. The market values of pension assets and of benefits earned to date are facts that should inform these decisions. Actuarial methods and assumptions, designed to facilitate smooth budgeting, obscure these facts. Basic questions such as "What is the total compensation being earned this year?" "What is the impact of a proposed pay increase?" "What is the difference between the cash contributions to the plan and the newly accrued pensions earned?" and "Are plan assets sufficient to pay for benefits earned to date?" cannot be answered without good information about the market value of benefits already accrued and currently accruing (Gold and Latter, 2009).

Assessment of Interperiod Equity – Are taxpayers today paying for the services they are receiving today? If past services have been over- or underpaid for by earlier taxpayers, how are those surpluses or deficits being apportioned across current and future generations? A comparison of the market value of accrued benefits to the market value of plan assets is necessary to assess the current state of interperiod equity attributable to past events. A comparison of cash contributions to the market value of newly earned benefits is necessary to assess the intergenerational impact of current activities.

Financial Economics Approach to Financial Reporting – includes the market value of benefits accrued to date, the market value of benefits accrued in the reporting period and the market value of associated assets. The traditional unit credit actuarial method best achieves these objectives. Liabilities and costs should reflect the risk of default of the underlying promise. Additionally, the default-free value of the accrued benefits and current costs should be disclosed.

For the sake of transparency, measured liabilities and costs should be measured showing their solvency values, with an explicit adjustment for the estimated value of any default put. Since public pension plans are represented to government employees as providing a secure pension at retirement, and since pensioners are not efficient diversified lenders (as noted in the section "Financial Economics Principles"), sponsors arguably should manage the plans to deliver the claimed default-free promise (i.e., with no default put). But if that is not in fact the case, participants and other stakeholders should know this.

8: Benefit Design

Benefit Economics – Defined benefits are financial instruments issued by the plan sponsor to its employees in lieu of current pay; these are assets for the employees and liabilities for the sponsor.

Some features of these instruments (e.g., predictable cash flows) will match securities commonly traded in the capital markets. Other features (e.g., those related to longevity and embedded options) may not be readily matched.

The employee and the plan sponsor must value the matchable aspects very similarly to each other and to their market value. For example, a dollar certain to be paid next month has the same value to the recipient regardless of its source—a pension dollar, a Social Security dollar and a dollar of bank interest are equally valuable. Similarly, a dollar certain to be paid next month has the same value to the payer regardless of its destination—a pension dollar, a supplier dollar and a dollar of debt service are equally burdensome.

Suppose instead that the mean amount is one dollar but that the actual amount could be less or more. The deviation is unhedgeable and does not correlate with anything of value to the employee or the employer. What happens to the value of the asset held by the employee and the value of the employer's obligation? Although most practitioners understand that the value of the employee asset is now less, as Day (2004) demonstrates, the sponsor's liability is now greater. The sum of the decrease in the asset value and the increase in the value of the obligation is a deadweight loss.

Likewise, benefit designs that do not incorporate such random risks are more efficient than designs that do.

Although defined benefit plans may destroy value by imposing unhedgeable risks on their sponsors and employees, plans can create value through longevity pooling, workforce management and tax preferences (to the extent that society finds career savings and lifetime income worthy of such preferences).

Benefit Design Implications – Benefit designs that are hedgeable are generally more efficient than those that are not. To the extent possible, benefits should be designed to be hedgeable, reducing the costly wedge between sponsor and employee valuations. Off-market specifications are always inefficient because they provide less value to the recipient than cost to the payer.

However, there is a strong exception to this. Benefit design features that facilitate workforce management (attraction, retention and disposition of employees) may add value to the sponsor and its employees combined. This case can be made for vesting schedules, early-retirement windows and so on.

9: Risk Sharing

The traditional defined benefit plan provides fixed benefits and fixed employee contribution rates. The performance risks of the plan are borne by the plan sponsor. The most significant risks are attributable to a mismatch between plan assets and liabilities. In contrast, defined contribution plans fix employer contributions; performance risks are borne by the plan participants.

In recent years, a new, primarily defined benefit design has emerged under which the plan sponsor and its participants share performance risk, most significantly those attributable to mismatches between plan assets and liabilities.[5] When performance is good, plan benefits may be increased and employee and employer contributions decreased. With bad performance, benefits may be decreased and contributions increased. The expressed rationale for such designs rests on the following:

- Investing in risky assets lowers the cost of retirement benefits.
- Mismatch risk has become greater than plan sponsors are willing to accept.
- Defined contribution plans impose too much risk on employees.

Financial economics denies the first of these premises. The cost of the plan is the cost of the benefits provided. Investment success or failure in both defined benefit and defined contribution plans may make benefits more or less affordable but not more or less

[5] New Brunswick adopted a risk-sharing plan akin to similar Netherlands plans (Munnell and Sass, 2013).

expensive (Bader, 2014). When risks are deemed undesirable to both parties in a contractual context, the risks should be disposed of most efficiently. The most efficient (cheapest) place to dispose of investment risk is the capital markets. In a retirement plan context, this amounts to not taking mismatch risk.

Providing fixed benefits without incurring mismatch risk may seem expensive. In theory, plan principals can take investment risks elsewhere, and this has been shown to be tax efficient (Bader and Gold, 2007). In practice, however, many plan participants do not have significant investment assets outside of their retirement savings and would prefer to take some risks in the expectation of larger benefits. These preferences are highly individualistic and vary significantly over the course of a career and beyond.

While traditional defined benefit plan designs do not impose investment risk on employees, risk-sharing designs impose these risks more or less uniformly across employee populations, ignoring individual risk preferences and tolerances.

An efficient design based on the idea that employees have varying risk preferences, and not on the idea that risky investments make benefits cheaper, is a variable annuity where individuals choose how much risk they wish to take. Employee benefit accruals and eventual payouts are denominated in units, which represent individual investment choices. A plan sponsor pays the cost of fixed benefits at a level measured in accordance with the cost principles of financial economics. Plan assets would be invested accordingly. Employees, however, may be offered the opportunity to exchange their fixed denominated benefits for variable unit benefits, and plan assets are invested to reflect these choices. Such a plan has been dubbed a Retirement Shares Plan (Fuerst, 2006).

Conclusion: Efficient Plan Management

Managing a defined benefit public pension plan in an economically efficient manner, without violating intergenerational equity, requires the following:

- Keeping the pension plan fully funded on a solvency liability basis[6]
- Fully hedging the solvency liability, as much as possible, and not taking investment risk

The market value of the liability will then equal the solvency value.

In contrast, when the pension plan is not fully funded on a solvency basis, the resulting deficit is ultimately covered by some combination of the following:

- *Taxpayers* (current and/or future) paying more
- *Recipients of government services* (current and/or future) getting less
- *Employees* (current and/or future) getting reduced total compensation
- *Sponsor bondholders* getting less than what was promised (i.e., default)
- *Pension beneficiaries* getting less than what was promised (i.e., default)
- *Other jurisdictions* getting a bailout by the state and/or federal government

Excess returns, which might be obtained by taking investment risk, do not reduce the deficit shared by the above constituencies, because risk taking itself does not add value. While ex-post the deficit will certainly be reduced if a risky investment turns out well, the risk itself had a cost borne by one or more of the listed parties, who would have lost had the risk materialized.

Who would lose (from the list) is a political decision, not an actuarial one. If a solvency

[6] This implies contributing the solvency liability normal cost every year, adjusted as necessary for any actuarial or investment gains and losses.

liability deficit is not large, the burden likely will fall on the first three listed sources, violating intergenerational equity but protecting the pension promise.

But if a solvency liability deficit is large, the security of the pension promise itself comes into doubt. In that case, the market liability is less than the solvency liability, reflecting the impaired value of the pension promise. If employees are fully aware that the pension promise is not something they can 100 percent rely on, they should value it even less than the market value, since they cannot hedge or diversify the risk (as a market investor could). When this happens, the cost of the benefit to the sponsor is clearly more than its value to employees, the difference being a deadweight loss (i.e., Pareto inefficient). Employees would then be better off receiving in cash the market value normal cost of an impaired pension promise than the impaired promise itself.

In conclusion, defined benefit public pension plans can be efficiently managed according to economic principles, financial economics principles and public finance principles, as outlined in this paper, by fully funding them (on a solvency basis) and investing assets to hedge the liability.

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