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The sustainability of pension schemes

Srichander Ramaswamy*

Abstract

Poor financial market returns and low long-term real interest rates in recent years have created challenges for the sponsors of defined benefit pension schemes. At the same time, lower payroll tax revenues in a period of high unemployment, and rising fiscal deficits in many advanced economies as economic activity has fallen, are also testing the sustainability of pay-as-you-go public pension schemes. Amendments to pension accounting rules that require corporations to regularly report the valuation differences between their defined benefit pension assets and plan liabilities on their balance sheet have made investors more aware of the pension risk exposure for the sponsors of such schemes. This paper sheds light on what effects these developments are having on the design of occupational pension schemes, and also provides some estimates for the post-employment benefits that could be delivered by these schemes under different sets of assumptions. The paper concludes by providing some policy perspectives.

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1. Introduction

In many countries, pension provision is covered by a mandatory public scheme (usually referred to as social security schemes), which is often supplemented by occupational pension schemes. The extent to which occupational pension schemes supplement public schemes varies substantially among advanced economies. In emerging economies, the access to any form of pension coverage among the working population is quite limited – only around 10 to 25 percent (Schwarz, 2003). Among public pension schemes, some are funded, ie the pension liabilities are backed by pension assets; others are unfunded and referred to as pay-as-you-go (PAYG) schemes, ie the current pension payments are financed from contributions or payroll taxes paid by current employees. In advanced economies, when the pension assets relative to gross domestic product (GDP) are low, it usually implies that a large share of pension liabilities is tied to future government tax revenues.

Occupational pension schemes can be broadly classified into defined benefit (DB) schemes and defined contribution (DC) schemes. DB schemes offer the employees more measurable post-employment income benefits; but they lack the portability that DC schemes offer employees when they switch employers. In a DC plan, the amount of money that has to be contributed to the fund is specified, but the benefits payout will be known only at the time of retirement. The design of retirement plans can have effects on labour markets because they have important economic incentives associated with them that affect the embedded value in employment contracts, and through this, the employee turnover rates and the age-specific retirement rates (Friedberg, 2011).

The overarching objective of any pension scheme is to provide beneficiaries with an adequate income stream during the post-employment period. For funded schemes, this requires assessment of what the appropriate contribution rates (as a percentage of salaries) into the pension fund should be to deliver the expected retirement income stream. For DB schemes, any asset shortfall arising from poor investment returns on pension assets becomes a liability of the schemes' sponsor. For DC schemes, employees bear the risk that the post-employment income can be lower than what they had planned for.

For both state-sponsored unfunded DB schemes and occupational DB schemes, the contractual commitments that underpin the promised retirement income will serve as inputs to the actuarial calculations used to estimate the present value of pension liabilities. In addition to this, the actuarial calculations will involve a number of assumptions about the future value of financial, macroeconomic and demographic variables. Because of the inherent uncertainties involved in estimating these variables over the long term, investment decisions that deliver the contractual commitments with minimum risk to the pension sponsor for funded pension schemes can be extremely challenging. The regulatory restrictions on investments, and compliance with pension-related accounting standards, often add to these challenges. Yet, public awareness of these challenges and the costs they impose on the pension sponsor from these contractual commitments is limited.

The academic literature on the pension fund industry, which discusses some of these issues, is extensive (see Black (1989), Brown *et al* (2011), Dushi (2010) and Franzen (2010)). While concerns about the sustainability of many pension schemes have come to public attention in recent years, specific challenges these schemes face as a result of increasing longevity and changing demographics are not new (see Department for Works and Pensions (2010), Deutsche Bank Research (2011), Global Financial Stability Report (2005) and OECD (2005)). Yet, these papers provide little quantitative guidance as to what the trade-offs are between the contribution rates to the plan and the accrued pension benefits they offer so that these trade-offs can inform the design of sustainable pensions schemes.

The primary aim of this paper is to provide such a quantitative guidance for the design of sustainable pension schemes by taking a simple actuarial model to estimate the costs involved in supporting occupational DB schemes and public pension schemes while outlining the economic motivation behind the choice of the input variables in the model. The actuarial cost is referred to as the service cost and is expressed as a percentage of the salary bill. The service cost provides the basis for determining what the total contribution rate (as a per cent of salary) to the pension fund should be to meet the pension commitments.

The service cost can also be used to set the target return on pension assets in funded schemes if the contribution rate is fixed. Alternatively, given reasonable assumptions about the target returns on pension assets that can be generated, appropriate levels of the contribution rate required to support a certain level of pension payments as a per cent of the final salary can be estimated. This exercise will shed light on what might be sustainable pension promises that could then influence policy discussions on the design of occupational and public pension plans. The paper will also shed light on how proposed derivative market reforms and changes to pension accounting standards might influence occupational pension plan design and post-employment benefits. Although the analysis in this paper focuses on the major industrial economies, similar issues arise for emerging market economies (see Moreno and Santos (2008)).

In contrast to DB schemes, DC schemes do not require pension liabilities to be computed as the assets in such schemes are managed more like mutual funds. Therefore, the service cost concept does not apply to DC schemes. Nonetheless, plan beneficiaries may contribute to the DC scheme with certain expectations about the post-employment income they can receive by converting the pension assets into an annuity at the time of retirement. This paper also introduces a simple model for linking the contribution rates to DC plans to the expected retirement income they can deliver as a function of the final salary.

The rest of this paper is structured as follows. Section 2 provides the macroeconomic intuition behind the choice of the input variables in the actuarial model to be presented by examining how these variables have evolved in the past. Section 3 then discusses a commonly employed actuarial model for determining pension liabilities and service costs in DB schemes. The estimates of the service cost for plausible range of values for the input variables in the actuarial model are given in Section 4. The impact that a lower real GDP growth rate and an increase in the old-age dependency ratio can have on sovereign liabilities and on contribution rates to PAYG schemes are examined in Section 5. Section 6 highlights the challenges occupational pension plans are likely to face against the backdrop of changes in accounting standards for pension schemes and reforms in derivatives markets. As the design of pension plans will adapt to these changes, its implications for post-employment benefits are explored in Section 7. The final section highlights some policy issues and concludes.

2. The macroeconomic background

Pension funds fulfil an important role in the economy by channelling the current retirement savings into investments in financial assets, and subsequently transforming these assets into a predictable post-employment income. The rate of return on these financial assets – typically long-term bonds and equities – will play an important role in determining the level of the retirement income from DC plans, and the benefits that can be guaranteed in DB plans. A key variable that influences the rate of return on financial assets is the long-term real interest rate. Long-term real interest rates also influence the price of annuities when pension assets have to be converted into a predictable retirement income stream.

The task of valuing pension liabilities and establishing the appropriate level of contribution rates required to fund DB pension schemes for delivering the contractual retirement benefits is performed by actuaries. The inputs to the actuarial model employed for this purpose include among others, the long-term real interest rate, the rate of growth of real wages and the expected returns on financial assets. Over the long-term, the realised values of these variables will depend on two key macroeconomic variables – the growth rates of labour productivity and real GDP.

For example, using a simple model of the economy that demonstrates how labour and capital inputs are combined to produce output, the relationship between labour productivity and real wages can be established. In this setup, it can be shown that the changes in real wages are equal to the changes in labour share in GDP and changes in labour productivity (see Sharpe *et al* (2008)). Over the period 1970–2010, growth rate of real wages has been around 75% of the growth rate in labour productivity in the United Kingdom and the United States suggesting that the share of labour in GDP declined over this period (Table 1).

Table 1

Historical averages of a number of macroeconomic variables across countries

In per cent, annualised averages over the period 1970–2010

Country	Real GDP growth rate	Growth in labour productivity	Real wage growth[1]	Real interest rates[2]
France	2.3	2.5	1.7	3.0
Germany [3]	2.0	2.4	1.3	3.7
Italy	2.0	1.8	1.2	1.9
Japan	2.7	3.0	2.2	2.2
Netherlands	2.5	2.0	1.4	3.2
Sweden	2.1	1.6	1.4	2.6
United Kingdom	2.2	2.2	1.7	2.6
United States	2.8	1.7	1.3	2.9

[1] Real compensation per employee, deflator GDP; total economy. [2] Real long-term interest rates based on an aggregate measure of government bond yields of approximately 10-year maturity and deflated using the GDP deflator. [3] Data for Western Germany until 1991.

Source: Ameco database; European Commission; OECD.

Excluding periods of unusual shocks (eg wars, bursts of unanticipated inflation, etc), the level of real long-term interest rates on government bonds in major currencies over many decades has been in the 2.5–3.5% range.[1] Over the past decade, however, it has been in the range 0–2%. Turner (2011) argues that this lowering of the long-term rate reflects the aggregate impact of many quite distinct policies – the investment of foreign exchange reserves, the regulation of the insurance and banking industry and valuation rules for pension funds. Such policies may also have made the long-term interest rate more procyclical – falling more when economic prospects weaken and rising more sharply when growth recovers. The rate of interest used to assess the sustainability of pension plans that will last for many decades should not be influenced by such cyclical or short-term fluctuations.

The expected return on riskier financial assets, such as equities, can be estimated using determinants of the equity prices using the Gordon model. In this model, the return on equities is equal to the ratio of adjusted dividends yields, which includes net share buybacks, plus the growth rate of equity prices. Over the long-term, the growth rate of equity prices can be assumed to be equal to the real GDP growth rate, and the adjusted dividend yields to be in the range 2.5–3% (Diamond (1999)).

[1] For example, Hicks (1958), who looked at two centuries of yields on the UK consols, found a range of 3–3.5% outside periods of war. See Turner (2011) for other references.

The economic intuition given above suggests that if long-term forecasts of real GDP growth rate and labour productivity growth are available, they can be used to provide a reasonable range of estimates for the input variables of the actuarial model. Such projections are available. For example, in the European Union (EU) and in the United States, the long-term real GDP growth rate over the next 50 years is expected be lower than what has been observed in the past. Specifically, these forecasts indicate that annual real GDP growth rate will be 1.4% in the EU and 2.1% in the United States (see, European Commission (2011) and Social Security Administration (2011)). While growth in labour productivity is expected to be roughly similar across the two regions, specifically 1.5% per annum in the EU and 1.7% in the United States, the contribution to GDP from the rate of growth of employment is projected to be 0.4% per annum in the United States, whereas in the EU it is expected to be –0.1% due a reduction in the size of the labour force. These estimates suggest that labour productivity growth will increasingly underpin economic growth in many countries experiencing a rapidly ageing population.

Given the long-term forecasts for the two macroeconomic variables and their economic relationship to the variables of interest in the actuarial analysis, the input variables to the actuarial model will be assumed to lie in the following range: long-term real interest rates 2–2.5%; real returns on equities 4.5–5.5%; and real wage growth rate 1–1.5%. Table 1 shows that real interest rates across a number of countries in the past have been on average 0.5% greater than the real GDP growth rate. This provides further support for the assumption that the average long-term real interest rate over the very long time period relevant for pension planning would be in the range 2–2.5%. Although this is above current depressed levels, it is below long-standing historical norms.

For mature PAYG schemes, the internal real rate of return will be equal to the sum of the rate of growth in the labour force and the rate of growth in labour productivity (see Orzag and Stiglitz (1999)). Therefore, the real GDP growth rate for the economy would be the appropriate expected return to be used in determining what the actuarially fair contribution rates to the scheme should be for the benefits being earned.

3. Actuarial model

When employees save for post-employment benefits through occupational pension plans, there are expectations about what this benefits payout should be. Defined benefit schemes as well as public pension schemes have explicit formulas for determining the post-employment income as a function of number of years of service and the final salary or the career average salary of the beneficiary. This section develops a simple model for the calculation of pension liabilities and service cost using the projected unit credit method that is usually employed by DB plans.[2] The projected unit credit method takes into account both wage-related and inflation-related salary increases, and assumes that the employee will work until official retirement age (Cairns (2003)). The following notations will be used for modelling the pension liabilities:

Official retirement age of an employee = T

Age of the ith employee in the pension scheme at time t = $x_i(t)$

Average long-term inflation rate = $\pi\%$

[2] The International Financial Reporting Standards for employee benefits requires that the pension liabilities and service cost of DB schemes are calculated using the projected unit credit method.

Annual real wage growth rate[3] = *g%*

Real yield on long-term bonds = *r%*

Pensionable salary of the *i*th employee in the scheme at time *t* = $S_i(t)$

Annuity factor (price of a unit of pension starting from the retirement age) = $A(T)$

Survival probability between *T* and *T+k* for an employee aged *T* = $p_e(T+k)$

Accrued benefits at time *t* of the *i*th employee = $b_i(t)$

Actuarial liability at time *t* of the *i*th employee = $L_i(t)$

The accrued benefits $b_i(t)$ for plan beneficiaries increase by a fixed percentage for each year of service, and this increase typically lies in the range 1.5% to 2% for many pension plans. Using the above notations, the accrued pension liability for the *i*th employee at time *t* under the projected unit credit method is given by,

$$L_i(t) = S_i(t) \times (1+g+\pi)^{T-x_i(t)} \times (1+r+\pi)^{x_i(t)-T} \times A(T) \times b_i(t)$$

Summing the liabilities over all the employees participating in the DB scheme, the pension liabilities to be reported on the scheme sponsors' balance sheet can be computed.

In the above equation, $A(T)$ is the annuity factor that is applicable to a scheme that includes the provision of surviving spouse pension. This annuity term, which will be different for male and female employees, has two components: the annuity factor $A_e(T)$ for the employee; and the annuity factor $A_w(T)$ for the surviving spouse.

The annuity factor for the employee will depend on the real yield and on the survival probabilities (derived from mortality tables for men and women), and is given by[4]

$$A_e(T) = \sum_{k=1}^{50} \frac{p_e(T+k)}{(1+r)^k}$$

If $p_w(T+k)$ denotes the survival probabilities for the widow or widower, the annuity factor for the surviving spouse is given by,

$$A_w(T) = \sum_{k=1}^{50} \frac{p_w(T+k)}{(1+r)^k}$$

The total annuity factor when granting a surviving spouse pension of 50% of the employee pension is given by,

$$A(T) = A_e(T) + 0.5 \times A_w(T)$$

For the plan sponsor, the cost of providing defined pension benefits will depend on how the liabilities increase when employees complete an additional year of service. At time *t*+1, the *i*th employees' pension liability is given by

$$L_i(t+1) = S_i(t+1) \times (1+g+\pi)^{T-x_i(t+1)} \times (1+r+\pi)^{x_i(t+1)-T} \times A(T) \times b_i(t+1)$$

[3] Actuaries often employ a wage profile, which is a function of the employee age, to determine the real wage increase. This is to account for career-related salary increases, which results in the non-inflationary wage adjustments for younger employees in the actuarial model to be higher than the real wage growth rate.

[4] Using the real yield for discounting implies that the annuity factor corresponds to one unit of real pension, ie annual pension payments will be adjusted to compensate for increase in inflation.

The cost of providing pension benefits is measured by the current service cost, which is the actuarial present value of pension benefits earned by employees for their services during the current year. Actuaries compute service cost as the present value of the new benefits earned by employees during the year, which is expressed as a percentage of the total annual pensionable salary expense. Assuming that there are *N* active employees, the service cost (SC) is given by

$$SC = \frac{1}{S(t)} \sum_{i=1}^{N} \left[(1+r+\pi)^{-1} L_i(t+1) - L_i(t) \right]$$

Because the employee's salary increases each year by the growth rate in real wages and inflation, the equation for service cost can be written as,

$$SC = \frac{1}{S(t)} \sum_{i=1}^{N} S_i(t) \times (1+g+\pi)^{T-x_i(t)} \times (1+r+\pi)^{x_i(t)-T} \times A(T) \times \left[b_i(t+1) - b_i(t) \right]$$

In the above equation, *S*(*t*) is the total pensionable salary paid at time *t*. Given that service cost is a point in time estimate, the time dependency in the equation for service cost can be dropped leading to,

$$SC = \sum_{i=1}^{N} S_i \times (1+g+\pi)^{T-x_i} \times (1+r+\pi)^{x_i-T} \times A(T) \times \Delta b$$

Here, S_i is the fraction of the total pensionable salary earned by the *i*th employee, and Δb is the accrued benefits earned for one year of service.

Defined this way, the service cost provides an estimate of how the contribution rate for the pension plan (expressed as a percentage of total pensionable salary) should be set in order to ensure that pension fund assets match pension liabilities. Implicit in this statement is the assumption that the return on pension assets is equal to the rate at which future pension liabilities are discounted. This is because pension liabilities at time *t*+1 will increase by the nominal discount rate assuming that no additional benefits are earned by employees, and when pension assets also increase at the same rate, assets and liabilities of the pension fund will be equal at *t*+1 if they were also equal at time *t*. Alternatively, when returns on pension assets are greater (lower) than this discount rate, the contribution rate required to match assets and liabilities will be lower (higher) than the actuarial service cost.

Considering that the contribution rate required to fund the pension scheme will be a function of the returns that can be generated on plan assets, actuaries use the expected real rate of return on pension fund assets as the real discount rate for computing the service cost.[5] In PAYG schemes, the appropriate real discount rate to be used for determining the service cost would be the real GDP growth rate for reasons given in Section 2.

The actual contribution rate to a funded scheme in any particular year will also depend on the coverage ratio of the fund, which is the ratio of the market value of the pension assets to the actuarial present value of pension liabilities, including both active and retired employees. The coverage ratio indicates the extent to which current pension fund assets cover the pension liabilities. When the coverage ratio is close to 100%, ie when the assets and liabilities are nearly equal, the contribution rate will be equal to the service cost if the return on pension assets is equal to the discount rate used for valuing pension liabilities.

[5] For reporting the pension liabilities of DB schemes on the balance sheet, both International Accounting Standards 19 and Statement of Financial Accounting Standards 158 require that the rate of return on a high-quality fixed income bond of maturity similar to the pension obligations be used as the appropriate discount rate in the actuarial model.

4. Representative service cost estimates

The equation for service cost presented above can provide useful insights on how changes to the different input variables might affect the estimate of this cost. For example, the level of real yield and the real wage growth rate as well as the difference between these two variables influence the estimate of service cost. When the real wage growth rate is significantly below the level of long-term real yield, service cost will be low. On the other hand, if real wage growth rate is assumed to be equal to the real yield over the long term, the service cost will primarily be influenced by the annuity factor as the increase in accrued benefits can be treated as a constant.

The annuity factor in turn will be influenced by the level of real yield, changes in longevity and the retirement age. Both lower real yields and an increase in longevity will make annuity factor higher; and increasing the retirement age will make it lower. Inflation rate plays a less important role in the estimate of service cost because inflation-related salary increases are offset by increased discount rates on future pension liabilities. This section provides estimates of the service cost for DB schemes for representative values of the input variables in the actuarial model. Taking an economy-wide perspective, these estimates are then put in the context of current contribution rates to a number of public pension schemes.

4.1 Input variables

For DB schemes, the input variables in the service cost equation will be determined by the pension scheme's actuaries. The values of some of these input variables will be identical across all schemes whose liabilities are denominated in the same currency. For example, estimates of the long-term inflation rate and real yield are based on market data, and the survival probabilities used in the model are derived from published mortality tables (though these can exhibit regional differences).[6] Other variables are scheme-specific and are provided by the scheme sponsor. The scheme-specific input variables include the age distribution of the employees and their spouses, the accrued benefits earned per year of service, the maximum accrued benefits that an employee can earn and the current salaries of the employees.

At an economy-wide level, the following assumptions will be made for some of the scheme-specific input variables of the actuarial model.

(a) The spouse of a male employee is 4 years younger.

(b) The average age of employees is 43 years with the age distribution shown in Graph 1, left-hand panel.

(c) Employees enter service at an average age of 23, and benefits do not accrue after 40 years of service.[7]

(d) Salaries increase linearly as a function of age and irrespective of gender, with a 20-year old employee earning 50% of the salary of an employee whose age is 65 years.[8]

(e) Retirement age for all employees is 65 years.

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[6] In this paper, the interim life tables for the United Kingdom based on data for the years 2007–09 have been used to compute the survival probabilities.

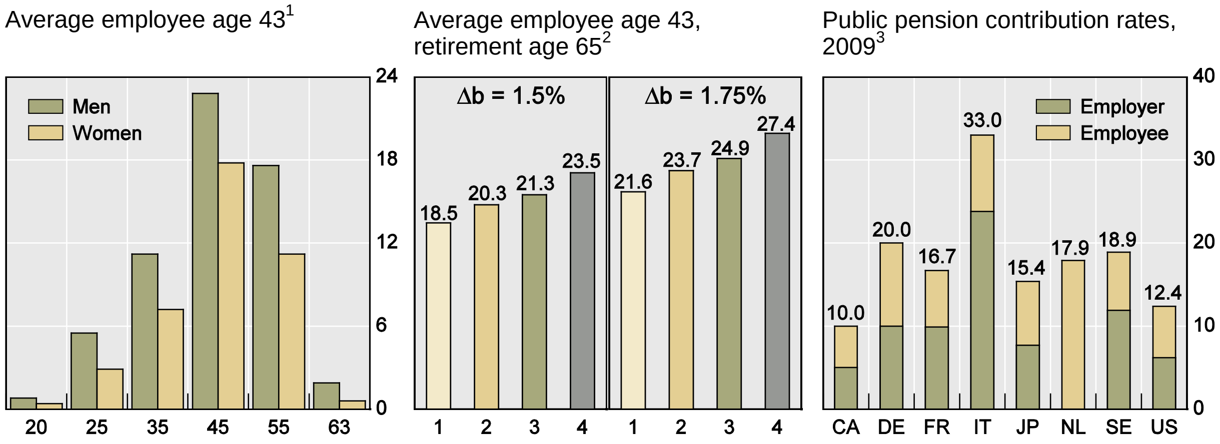
[7] This would cap the maximum accrued benefits to 60% of final pensionable salary when Δb=1.5% per year, and to 70% of final salary when Δb=1.75% per year.

[8] The underlying assumption here is that an employee's real wages will grow at an average rate of 1.5% per annum over the employment period.

Graph 1

Service cost estimates and contribution rates of public schemes

In per cent



CA = Canada; DE = Germany; FR = France; IT = Italy; JP = Japan; NL = Netherlands; SE = Sweden; US = United States.

[1] Employee age and gender distribution is based on a large public sector company in the European Union as of 2010. [2] Light brown bar 1 denotes service cost for g=1% and r=2.5%; dark brown bar 2 denotes service cost for g=1.5% and r=2.5%; green bar 3 denotes service cost for g=1% and r=2%; and grey bar 4 denotes service cost for g=1.5% and r=2%. Inflation rate is assumed to be 3%. [3] As a percentage of gross salaries.

Sources: OECD; Authors' calculations.

Drawing on the macroeconomic assessment presented in Section 2, the average real wage growth rate will be assumed to lie in the range 1–1.5%, and the long-term real interest rates to be in the range 2–2.5%. The long-term inflation rate will be assumed to be 3%.[9]

The accrued benefits per year of service earned by an employee, which is a contractual agreement in the occupational DB pension schemes, can vary across scheme sponsors. In general, DB schemes tend to limit accrued benefits to be capped either at 60% or 70% of the pensionable salary indexed to inflation. Assuming that an average employee will have 40 years of active service, these caps would translate into accrued benefits per year of 1.5% and 1.75%, respectively. These estimates compare well with observed data for occupational pension schemes in the United Kingdom, which typically accrue benefits at a rate of 1.67% per year. In Canada, public DB plans accrue benefits at the rate of 2% per year with maximum benefits capped at 70%, and the retirement income being linked to the average salary over the last 5 years of service.

4.2 Service cost estimates

Taking the above range of values for the input variables to be representative of actuarial assumptions in occupational pension schemes, the estimate of the service cost across this range of input values in the actuarial model can be computed. The input variables selected for this purpose include: accrued benefit factor; growth rate of real wages; and long-term real interest rates at which liabilities are discounted. Estimates of the service cost under different assumptions for these selected input variables suggest that service cost can lie in the range 18–27% (Graph 1, centre panel). For example, a service cost of 21% would represent an occupational pension scheme with the following actuarial model parameters: r=2%; g=1%;

[9] This compares well with the average annual inflation rate of 2.8% in the United States during 1986–2010. A higher or lower inflation rate assumption will have no material impact on the service cost.

Δb=1.5%; π=3%; T=65 years; and average employee age 43 years. If the accrued benefit factor had been 0.25% higher, service cost for the scheme would rise to nearly 25%.

The service cost estimates shown in Graph 1, centre panel assume that plan assets are invested in long-term bonds justifying the choice of the long-term real interest rate as the discount factor. In practice, pension fund assets are likely to be invested in bonds and equities through a fiduciary so that expected return on plan assets will be higher than the long-term real interest rate. But managing the fund assets through a fiduciary will also incur administrative expenses. Suppose the expected real rate of return on plan assets (net of administrative costs) is assumed to be 3%,[10] then the service cost for an occupational DB plan with g=1% and Δb=1.5% will drop to 17.8%. In this estimate, the annuity term $A(T)$ in the actuarial model is assumed to be priced using the real long-term interest rate of 2%. This is because the plan sponsor may buy an inflation-indexed annuity bond to hedge the longevity risk when the employee retires, and this bond will be priced in the market by discounting the expected cash flows of such a bond using the term structure of real interest rates.

Attempts by plan sponsors to hedge the longevity risk in DB schemes, however, will lead to an increase in the service cost. The estimates of service cost presented in this section rely on observed mortality rates over the period 2007–09. This is because actuarial estimates of the DB plan liabilities and service cost that are compliant with accounting standards for reporting employee benefits require only current mortality rates to be used in the calculations. But an insurance company that sells the annuity product will price the longevity risk to account for declining mortality rates.

Current projections of mortality rates suggest that they are likely to fall by 1–2% per annum over the next few decades (Continuous Mortality Investigation (2011)). If mortality rates are assumed to decline over the next 20 years at the rate of 1.5% per year, then the cost of buying an annuity that incorporates improvements in longevity into the pricing formula will go up by 10% compared to the estimate based on the 2007–09 mortality rates. This will have the implication that the actual service cost for a funded DB scheme that generates a real return on assets of 3% per annum will be 10% higher than the 17.8% estimate, ie the service cost will be 19.5% of a representative employee's current salary assuming that g=1% and Δb=1.5% if declining mortality rates were priced into the actuarial calculations.

4.3 Comparison with public pension contribution rates

To get a sense of how the contribution rates implied by these service cost estimates compare with those observed for actual pension plans, Graph 1 (right-hand panel) shows the contribution rates of public pension schemes that offer defined benefits for which such data is available. This comparison shows that public pension contribution rates across a number of countries are on average lower than the actuarial estimates of service cost that would be required if these schemes were designed to pay 60% of the final salary indexed to inflation as pension after 40 years of service.

In general, a lower contribution rate for the public schemes relative to the estimates for the occupational DB schemes might be due to the lower accrued benefits offered by the scheme. This could be because the public scheme may fall under the social security scheme in some countries which is intended to provide only a first pillar of the retirement income. This may then be supplemented by occupational pension schemes as in the Netherlands or in the United States. Contribution rates to public pension schemes can also be lower when the accrued benefits are applied to career average salaries rather than to the final salary to

[10] This estimate is based on the assumption that equity risk premium over long-term bond returns is 3% per annum, administrative expenses are 0.5% per annum, long-term real interest rates are 2%, and the plan assets have an equal share of bonds and equities.

compute the retirement income.[11] For example, if real wages are assumed to grow at 1.5% per annum and an employee has 40 years of active service, then the career average salary will be 75% of the employee's final salary. This would result in the service cost for career average DB schemes to be lower by about 25% for the assumed growth rate in real wages compared to final salary schemes that provide the same accrued benefits for each year of service. Post-employment benefits will also be correspondingly lower by 25%. When real wages grow at an annual rate of 1%, then the service costs for career average schemes will be only 20% lower than final salary schemes.

In countries where public pensions are not supplemented by other schemes, low contribution rates could be interpreted either as offering only modest post-employment benefits or that these schemes are underfunded relative to the benefits that are being promised. The next section provides some insights on how funding requirements for PAYG schemes can build up if contributions are consistently lower than the implicit service costs of these schemes.

5. Public pensions and sovereign liabilities

In PAYG public pension schemes, current employee contributions and tax revenues are used to meet pension payments (OECD (2011a)). In periods of high unemployment, lower tax revenues and pension contributions received may require governments to temporarily fund pension payments by issuing public debt. While the ability of governments to honour its commitments on public pensions is usually taken for granted, questions can be raised about the implications this may have on sovereign liabilities if economic activity remains subdued for an extended period of time. As the size of these pension liabilities is not reported on sovereign balance sheets, there are challenges to assessing whether such commitments can be met under more adverse macroeconomic scenarios.

Some insights on public pension funding requirements can be gained by examining the share of public pension contribution revenues in GDP and taxes. Across a range of countries, they are on average around 5% of GDP and 16% of taxes (Graph 2, left-hand panel). These figures can be used to get a sense of how the implicit liabilities of public pensions might build up over time on sovereign balance sheets if the current contribution rates in PAYG schemes turn out to be consistently lower than their service costs. To know whether contribution rates are lower than the service costs, information on two scheme-specific variables will be required. They are: the accrued benefits for one year of service; and if the scheme links pensions to career average salaries or the final salary. For PAYG schemes, these variables tend to vary widely across countries depending on whether such schemes are supplemented by other forms of retirement savings. Moreover, information on the specific values of these variables is not easily available across all countries.

An alternative approach to assess the potential liability build up on sovereign balance sheets from PAYG schemes is to estimate how the service costs of these schemes may increase as a result of the lower GDP growth rate projections over the long-term. As the implicit rate of return on PAYG schemes will be equal to the real GDP growth rate of the economy, this will be the appropriate real yield to be used in the actuarial model for determining the service cost. Suppose current contribution rates to these schemes were set to be equal to their service costs under the assumption that over the long-term real GDP growth rate would be 2.5% per annum. Estimates of the service cost for Δb=1.5% in Graph 1, centre panel suggest that when the real discount rate is lowered by 0.5%, say to reflect a revision in the long-term

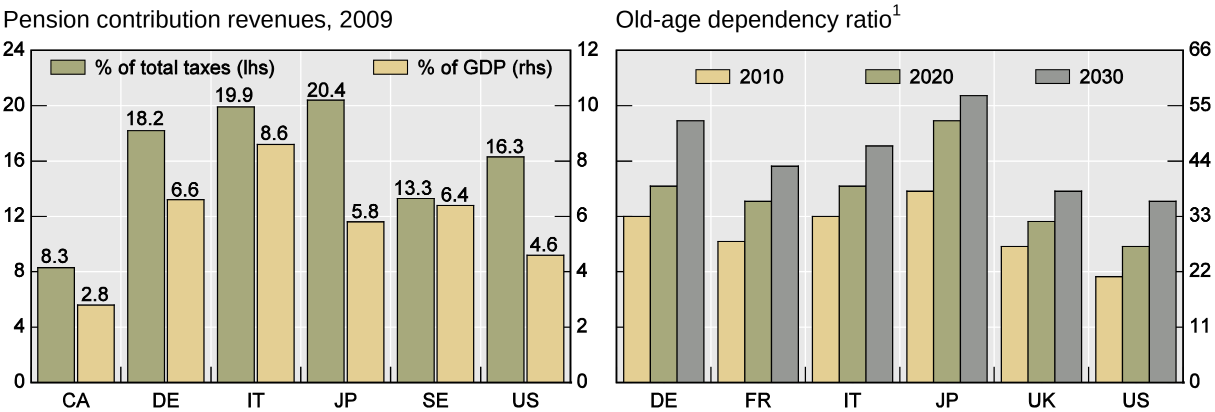
[11] In a career average DB scheme, past earnings are adjusted for inflation to compute the career average salary. In this setup, an employee who gets only inflation compensation and no real wage increase over his career will have the same pension under both the career average scheme and the final salary scheme.

GDP growth forecast from 2.5 to 2% per annum, then the service cost will rise by 15%. That is, a service cost of 10% will increase to 11.5% when real GDP growth rate is projected to be 0.5% lower.

Graph 2

Public pensions and demographic trends

In per cent



CA = Canada; DE = Germany; FR = France; IT = Italy; JP = Japan; SE = Sweden; UK = United Kingdom; US = United States.

[1] The old-age dependency ratio is the ratio of the population aged 65 years or over to the population aged 20-64 years. All ratios are presented as number of dependents per 100 persons of working age (20-64).

Sources: OECD; United Nations.

This information can be used to assess the potential build-up of sovereign liabilities from PAYG pension schemes when the contribution rates to these schemes remain consistently below their service costs. For example, if PAYG schemes were to deposit the contributions received over a 10-year period to a notional account that accrues interest at the rate of growth of real GDP, then the market value of this notional account would be lower than the pension liabilities accrued over this period by an amount equal to 150% of the annual pension contribution revenues. The figures in Graph 2, left-hand panel can be used to calculate what this amount will be as a per cent of GDP and taxes for individual countries.

While public pension schemes are contractual commitments of the state, sovereign states also have the legislative power to change these contracts. Exercising this option would effectively mean that governments could either alter the accrued benefit factor for each year of service or change pension benefits to be based on career average salaries rather than the final salary to reduce the debt burden going forward. One should therefore treat the actuarial analysis performed here to translate possible shortfalls in contribution rates into sovereign liabilities as simply a means to draw attention to the challenges to the sustainability of current public pension provisions. Because demographics also play an important role in the serviceability of PAYG schemes, particular attention has to be paid to developments in this area (Poole (2005)). Data on demographic trends suggest that in many developed economies, the share of the population aged 65 years or over for every 100 persons of working age (20–64 years) will increase by around 20% over the next 10 years, and by around 50% over the next 20 years from now (Graph 2, right-hand panel).

The projected increase in the old-age dependency ratio can be used to draw some inferences on how this will affect the serviceability of PAYG schemes. If one makes the assumption that current pension payments can be fully financed from payroll taxes or public pension contributions, these contributions will have to rise by more than 20% from current levels by 2020, and by nearly 50% by 2030. For example, if current public pension contribution rate is assumed to be 20% of salaries, it will have to rise to 30% of salaries in 2030 to service PAYG schemes.

6. Challenges facing DB plan sponsors

Unlike PAYG public pensions, occupational pension schemes that are of DC or DB type are funded. In a DC scheme where the employers' liability is limited to making annual contributions to the pension fund, returns on the funds' assets will have an important bearing on retirement benefits. This is because employees in a DC pension scheme hold a certain share of assets in a mutual fund-type structure; and there are no notional liabilities associated with such a fund. By contrast, DB schemes compute actuarial estimates of the pension liabilities, and employers have the obligation to make additional contributions when pension assets fall short of the liabilities.

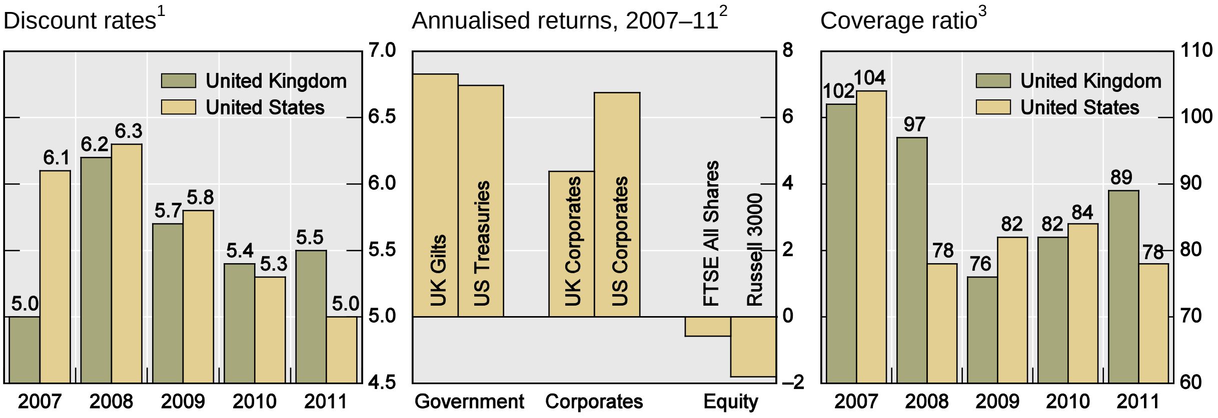
Since the amount of underfunding in a DB scheme becomes a liability on the pension sponsors' balance sheet, financial position and cash flows of an entity offering such a scheme would be affected by changes in the funding level of the plans' assets. Poor investment returns on pension fund assets in the period 2001–03 and subsequently during the financial crisis have drawn attention to this risk. But falling yield levels since 2008 and changes in pension accounting standards, which now gives specific guidance on what discount rates should to be used for valuing pension liabilities, have been even more influential in alerting pension sponsors to this risk. This is because the market value of pension liabilities goes up when the discount rate used to value them falls; and as the duration of the pension liabilities is typically greater than those of the pension assets, the market value of liabilities rise faster than those of assets leading to a funding shortfall.

Lower returns generated on pension assets compared to the discount rate used to value pension liabilities can also result in a funding shortfall. For example, the average annual discount rates used by plan sponsors in the United Kingdom and the United States in the period 2007–11 have been in excess of 5% (Graph 3, left-hand panel). While returns on fixed income assets over this period have exceeded this level, poor equity market performance would have made the returns on plan assets invested in both these asset classes to be below the average discount rates over 2007–11 (Graph 3, centre panel).

Graph 3

Discount rates, funding levels and asset market returns

In per cent



[1] Average discount rates used by FTSE 350 companies in the United Kingdom and S&P 500 companies in the United States for valuing pension liabilities; [2] Based on total return indices over the period January 2007 to September 2011; [3] Ratio of plan assets over plan liabilities of DB schemes for companies in the FTSE 350 and S&P 500 index.

Sources: Barclays; Bloomberg; Mercer; Pension Capital Strategies; Standard & Poor's.

When the return shortfall on plan assets relative to the discount rate, as well as any net increase in pension liabilities over pension assets due to a decline in the discount rates over the reporting period, are not compensated by the plan sponsor through extraordinary pension contributions, DB plan assets would fall short of liabilities. Indeed, many DB schemes are now underfunded with aggregate funding levels estimated to be below 90% of plan liabilities in the United Kingdom and below 80% in the United States (Graph 3, right-hand panel).

One factor that might be contributing to the better funding levels of UK pension funds in 2011 compared to US pension funds could be the smaller decline in discount rates over the period 2007–11 (20 basis points versus 80 basis points in the United States). Another factor could be the lower exposure to equities among UK pension funds: US pension funds typically have an exposure close to 60% to equities (see OECD (2011b)) whereas in the United Kingdom it is typically less than 50%.

The funding shortfalls faced by companies sponsoring DB plans resulting from low market interest rates and poor financial market returns will now come under greater investor scrutiny in view of the proposed amendments to accounting standards for reporting employee benefits. Indeed, the recent amendments to the International Accounting Standard 19 (IAS 19) are intended to provide investors and other users of financial statements with a clearer picture of how an entity's obligations resulting from the provision of DB plans affect its financial position and cash flows (see Box 1). These amendments, which will be effective from January 2013, make important improvements by (see IFRS (2011)):

- eliminating the option to defer the recognition of actuarial gains and losses on DB pension plans using the "corridor method";
- requiring immediate recognition of all gains and losses on DB plans, including those from remeasurement effects, in the other comprehensive income statement; and
- enhancing the disclosure requirements for DB plans by providing better information about its characteristics and risks that firms are exposed to through participation in those plans.

For DC schemes, the amendments to IAS 19 simply clarify that the employer's only obligation is to make contributions covering the current service period of the employee and not for past service. Employer contributions to a DC plan are therefore limited to a single balance sheet reporting item, where this cost is expensed in the income statement.

The proposed changes to IAS 19 will lower the profit and loss (P&L) volatility of companies that participate in DB schemes and report under IFRS. For example, companies that currently amortise pension surplus or deficits, which now flow through the P&L, will have to recognise this in the other comprehensive income (OCI) from 2013. But the reporting changes that require all gains and losses to be immediately recognised through OCI, and the removal of the corridor approach under which only funding deficits or surplus in excess of 10% had to be amortised over the remaining service life of active employees, are likely to increase companies' balance sheet volatility. This increase in volatility will depend on how large the DB liabilities are relative to the market capitalisation of the company. For some companies, like British Airways and British Telecom, pension liabilities exceed their market capitalisation suggesting that the volatility impact will be larger. But on average, DB pension obligations of companies reporting under IFRS vary between one-quarter to one-third of their market capitalisation (Graph 4, left-hand panel).

Box 1

Recent amendments to IAS 19

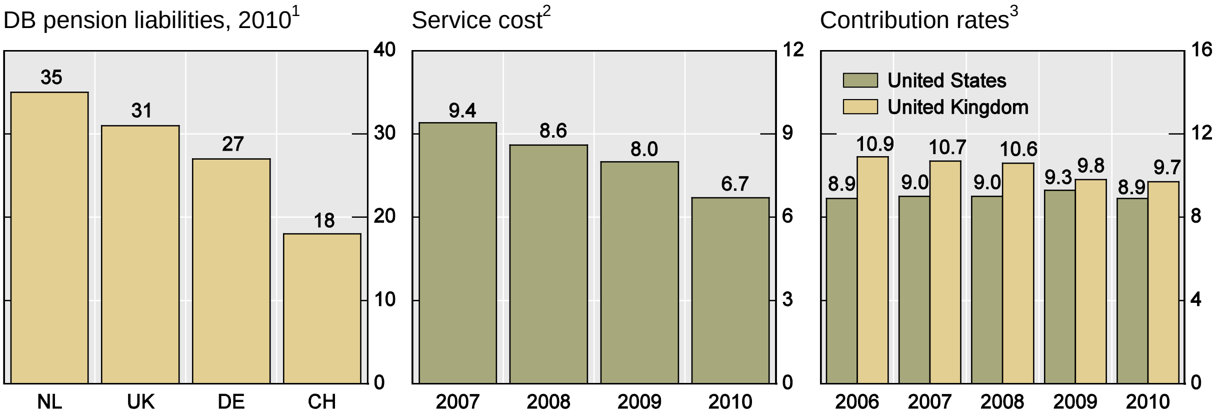
In June 2011, the International Accounting Standards Board (IASB) published amendments to IAS 19, accounting standards for employee benefits, which will come into effect in January 2013. These amendments will alter the way in which companies reporting under International Financial Reporting Standards (IFRS) will present their risks and costs of providing for DB pension plans. For example, companies will have to split the presentation of the pension costs between the profit and loss (P&L) and other comprehensive income (OCI) statements; and companies will have to provide more disclosures in their financial statements on the risks and characterises of their DB plans. These changes can be broadly categorised under measurement of cost and disclosure requirements, which are summarised below.

Measurement of cost has been made more transparent by splitting it into three components: service cost; net interest; and remeasurement effects. Service cost includes current and past service costs, and any changes in DB liabilities resulting from curtailment or settlement effects. Service cost of the DB plan will flow through the P&L. Net interest income or expense on the DB plans' surplus or deficit, measured using the discount rate applied for valuing plan liabilities, is to be reported in the P&L. The remeasurement effects that are to be recognised in the OCI include the impact of gains and losses from changes in assumptions used to measure DB liabilities, and any difference between the actual return on plan assets and the interest income on plan assets computed using the applicable discount rate. Option is given for this item in the OCI to be either accumulated as a separate item in equity or to be transferred to retained earnings.

Plan disclosures have been expanded to include more information about the risks the DB plan poses to the entity, particularly by providing information on how they may affect the amounts, timing and uncertainty of the entity's cash flows. Additional disclosure requirements include disaggregation of plan assets to provide exposures to different asset classes, information on the maturity profile and the duration of the plan liabilities, and information on the sensitivity of DB liabilities from changes to significant actuarial assumptions.

Graph 4

Pension liabilities, reported service costs and DC plan contributions



NL = Netherlands; UK = United Kingdom; DE = Germany; CH = Switzerland.

[1] Relative to the market capitalisation of companies reporting under IFRS, in per cent; [2] Total service costs of FTSE 350 companies, in pound sterling, billions; [3] Average annual total contribution rates to DC plans as a per cent of salary.

Sources: Aegon; UK National Statistics; Pension Capital Strategies; Vanguard.

The amendments to IAS 19 might create incentives for companies with large DB pension liabilities to lower potential balance sheet volatility by reducing the allocation to equities (CGFS (2011)). Moreover, as the P&L statement will only capture the net interest income on the pension surplus or deficit, incentives to increase the share of equities as a means to boost earnings by recording higher expected returns on these holdings will no longer exist.

Yet, other regulatory reforms in financial markets might dampen DB pension sponsors' desire to increase the share of fixed income assets in their portfolio, which are often done in combination with liability matching strategies to reduce the duration mismatch between pension assets and pension liabilities by taking exposures to long-dated interest rate swaps. This is because such strategies may require the company to maintain larger liquidity buffers to meet more frequent margin calls when these derivative trades shift to central counterparties, and thus make DB schemes expensive to fund.

For example, pension fund investment mandates would typically involve replicating broad benchmark indices. An aggregate index of government and corporate bonds would have duration of 5−6 years. As the duration of DB plan liabilities can typically be in the range 15–18 years (see Watson Wyatt (2009)), liability matching techniques would require buying interest rate swaps that extend duration of pension fund assets by about 10 years. A 50 basis point increase in interest rates would trigger a margin call that is 5% of the net asset value of the pension assets.[12] Maintaining liquidity buffers to meet such margin calls would reduce portfolio yield, and therefore return on pension assets. If large margin calls require bond sales, they would also be costly as such asset sales will occur at a time when bond prices have fallen.

7. Implications for plan beneficiaries

The paper so far highlighted a number of challenges that confront sponsors of public and occupational pension schemes that offer beneficiaries defined benefits. For funded schemes these challenges include: low pension coverage ratios resulting from an extended period of poor financial market returns followed by very low long-term interest rates; and its consequences for earnings and balance sheet volatility of companies that sponsor DB schemes in view of the changes in accounting rules for reporting the liabilities associated with those schemes. The key challenges that confront state-sponsored pension schemes include: improvements in longevity, rising old-age dependency ratio and the risk of lower payroll taxes as unemployment levels remain high against the backdrop of weak macroeconomic growth outlook.

Many of these challenges are not new. Poor financial market returns and low interest rates in the early part of the last decade had already brought about some changes to pension plan design and asset allocation. In particular, many DB scheme sponsors employed financial engineering techniques to better match duration of plan assets to plan liabilities. At the same time, there has been a gradual shift out of DB schemes with new employees of many companies being offered access to only DC schemes. For plan sponsors, DC schemes are more tractable in terms of the contributions rates that are required to fund these schemes.

The trend noted above, ie offering new employees participation in DC schemes only, has been most evident in the United Kingdom. For example, the total service costs (ie actual amounts paid to meet pension commitments in pound sterling) of FTSE 350 companies have declined by 39% from 2007 to 2010 (Pension Capital Strategies (2011)), which can be interpreted as a gradual shift out of DB schemes (Graph 4, centre panel). Moreover, 56% of the active members participating in occupational DB schemes in the United Kingdom are enrolled in schemes that are closed to new members. This could also be interpreted as a gradual phasing out of DB schemes in favour of DC schemes (Office for National Statistics (2011)).

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[12] The market value of an interest rate swap that extends the duration of a bond portfolio by 10 years will fall by 10% if the level of interest rates increases by 1%.

The recent financial crisis seems to have added further impetus to the shift towards DC schemes for occupational pension plans. And there is evidence now that the shift from DB to DC schemes is also happening in other countries. For example, compared to 2009 the share of DB assets in total pension fund assets in 2010 decreased in Korea by 7.1 percentage points, in Turkey by 4.5 percentage points and in New Zealand by 4 percentage points (OECD (2011b)). Some large Canadian institutions have announced that they will not offer DB plans to new hires.

From an employee perspective, the key question is what the implications will be for post-employment benefits as a consequence of a continued shift from DB to DC schemes. To answer this, it is instructive to examine how contribution rates to a DC plan might differ from those of DB plans. In the United Kingdom, the total contributions (employer and employee) to DC schemes is less than one-half of those for DB schemes – around 9% of salaries compared to around 20% of salaries for DB schemes (Graph 4, right-hand panel). In the United States, total contribution rates to DC schemes, which fall under the 401(k) plan, are also around 10% of salaries (Vanguard (2011)).

Box 2

Computing retirement income from DC plan contributions

Let r_{dc} denote the total contribution rate to the DC plan each year as a per cent of the current salary. Assume rate of growth of nominal wages to be $g+\pi$ where g is the real wage growth rate, and π the rate of inflation. Suppose the rate of annual return on pension fund assets exceed nominal wage growth rate by r_e, then the market value (MV) of DC plan assets at the time of retirement will be given by

$$MV = r_{dc} \times \sum_{t=35}^{64} (1+g+r_e+\pi)^{65-t} \times (1+g+\pi)^{t-35}$$

In the above equation, it is assumed that the employee will make contributions to the DC plan over a 30-year period, from age 35 to 65 years. At the age of 35 years, the employee's salary is assumed to be $1.

The final salary (FS) at the time of retirement is given by

$$FS = (1+g+\pi)^{65-35}$$

Denoting by A(T) the cost of purchasing an annuity at the time of retirement that pays one unit of pension indexed to inflation and a 50% surviving spouse pension (see Section 3), the inflation indexed retirement income (RI) as a percent of the employee's final salary is given by

$$RI = \frac{MV \times 100}{FS \times A(T)}$$

After simplification, one can show that a first order approximation of the above equation is given by

$$RI = \frac{r_{dc} \times 100}{A(T)} \times \sum_{t=35}^{64} (1+r_e)^{65-t}$$

The above equation shows that the retirement income as a per cent of final salary is a function of the real long-term interest rate (to compute the annuity factor), and the excess returns that can be generated on DC plan assets over the wage growth rate.

Lower contribution rates to DC schemes will have the implication that post-employment benefits will be less than those provided by many existing DB schemes. Moreover, as employers' liabilities in a DC scheme are limited to the annual contributions they make, poor investment performance of the DC scheme assets will have a direct bearing on post-employment benefits. As a result, the estimate of the post-employment benefits for a DC scheme will depend on the assumptions made about the returns that can be generated on the schemes' assets for a given contribution rate. Furthermore, when plan assets are annuitized at the time of retirement, the level of long-term real interest rates at that time will influence the annuity computation, and through this the post-retirement income as a percentage of the final salary. These risks will be borne by the plan beneficiary in the DC scheme.

Assuming that salaries will be adjusted for inflation, the estimate of the retirement income from a DC scheme will be determined by the growth rate of real wages and the real rate of return on DC plan assets. In fact, what matters for the retirement income estimate (as a function of the final salary) is the real return in excess of the real wage increase that can be generated on the DC plan assets (see Box 2). Taking the long-term real yield to be either 2% or 2.5% (for converting DC plan assets into an annuity), Table 2 shows the estimates of the post-employment income from DC schemes for a range of contribution rates and excess returns on plan assets over the wage growth rate.

Table 2

Estimates of post-employment income from DC plans as a per cent of final salary[1]

Total contribution rate as per cent of salary	**Long-term real yield = 2%**[2]			**Long-term real yield = 2.5%**[2]		
	1.0%[3]	**1.5%**[3]	**2.0%**[3]	**1.0%**[3]	**1.5%**[3]	**2.0%**[3]
25 to 65 years[4]						
Rate = 9%	25.4	28.2	31.5	26.7	29.7	33.1
Rate = 12%	33.8	37.6	42.0	35.6	39.5	44.1
Rate = 15%	42.3	47.0	52.5	44.5	49.4	55.1
Rate = 18%	50.7	56.4	63.0	53.3	59.3	66.2
Rate = 21%	59.2	65.8	73.5	62.2	69.2	77.2
35 to 65 years[5]						
Rate = 9%	18.1	19.6	21.2	19.0	20.6	22.3
Rate = 12%	24.1	26.1	28.3	25.4	27.4	29.7
Rate = 15%	30.1	32.6	35.4	31.7	34.3	37.2
Rate = 18%	36.2	39.1	42.4	38.0	41.2	44.6
Rate = 21%	42.2	45.7	49.5	44.4	48.0	52.1

[1] Final salary pension indexed to inflation and includes surviving spouse pension of 50% of the employee pension. [2] Real yields for converting plan assets into an annuity at the time of retirement. [3] Excess return net of administrative fees on the plan assets over wage growth rate in real terms. [4] Contribution to DC plan for 40 years between 25 to 65 years. [5] Contribution to DC plan for 30 years between 35 to 65 years.

Source: Author's calculations.

For a member contributing 9% of the salary each year to the DC scheme for 40 years, the retirement income will be 25% of final salary if returns on plan assets are assumed to be one percentage point higher than wage growth rate and annuities are sold at 2% real yield using current mortality rates. If contributions to DC schemes were to double to 18% of salaries but are instead made over only a 30-year period, the retirement income will be 39% of final salary even if returns on fund assets net of administrative expenses were assumed to exceed wage growth rate by 1.5%.

Securing a retirement income that is 25% of final salary under the first scenario might face additional challenges as this will depend on how the risk factors relevant for the pricing of the annuity bond evolve. The principal factors that determine annuity payments are the survival probabilities and interest rates (see Dowd *et al* (2011)). Improvements in longevity will make survival probabilities higher, and therefore annuity payments lower. The retirement income estimates here are based on mortality rates for the period 2007–09. The pricing of an annuity bond, on the other hand, will be based on projected mortality rates, which are typically assumed to fall 1–2% each year. This will lower the actual inflation-indexed retirement income by 10% from the estimates given in Table 2 for an employee retiring now and converting plan assets into an annuity. For an employee retiring in 10 years from now, the price of the annuity bond will increase by another 5% to account for the projected decline in mortality rates. Moreover, if long-term real interest rates are 0.5% lower than the 2% rate used in the calculations here, the retirement income will be reduced by an additional 12%.

8. Summary and policy issues

A weak macroeconomic environment and unusually low real interest rates in many countries have put the funding challenges faced by occupational and public pension schemes in the spotlight. This paper took a simple actuarial model to quantify how the cost of funding DB pension schemes increase as the real rate of return in asset markets falls. If real returns on pension assets are assumed to be lower by 0.5% compared to their historical averages, service costs of DB schemes would be 15% higher than in the past for the same benefit payments. Converting final salary pension schemes to career average schemes (and not altering the percentages applied) would lower pensions by 20–25% assuming that real wages grow at the rate of 1–1.5% per annum.

Declining mortality rates will put further upward pressure on the contribution rates needed to fund these schemes. When the expected increases in longevity are priced into the actuarial model for computing the service cost, this cost is likely to be 10% higher than estimates presented in the paper. Increasing longevity as well as demographic changes that point to a rise in the old-age dependency ratio poses challenges to the sustainability of PAYG schemes. The projected increase in old-age dependency ratio suggests that in many countries the contributions to PAYG schemes have to increase by 20% from current levels in 2020 to pay pensions. But as PAYG schemes that service current pensions from employee contributions and taxes do not report the contractual pension liabilities, estimating the funding shortfalls these schemes might face going forward is a challenge.

In contrast to PAYG schemes and some funded public pension schemes, occupational DB schemes have to comply with accounting standards to report the market value of their pension liabilities and the assets that back them so that potential funding shortfalls faced by these schemes can be quantified. Unusually low real interest rates and poor financial market returns in the past decade have had an adverse impact on the coverage ratio of these schemes through the valuation effects on liabilities and lower returns on pension assets. Estimates of the coverage ratio of occupational DB schemes based on these returns would point to a funding deficit of 10 to 20 per cent against their pension liabilities. The size of any deficit that eventually materialises over the long lives of these schemes, however, would depend on future returns – which are unknown.

For occupational DB schemes that face large funding shortfalls, employer contributions will have to rise to improve the coverage ratio of these schemes. At the same time, increasing longevity and falling real yields against the backdrop of a weak macroeconomic environment are raising the service costs of DB schemes and adding to the upward pressures on required contribution rates. Recent amendments to pension accounting standards, which require companies to provide more disclosures in their financial statements on the risks the DB scheme poses to the entity and to report the net gains or losses from their DB pension plans on their balance sheet, are likely to accelerate the shift out of occupational DB plans into DC plans. This is because DC plans limit the contractual liabilities of employers to the contribution rates to be paid for the current service period of the employee.

A progressive shift from DB to DC schemes can have material implications for post-employment benefits because it exposes employees to the investment risks on the pension assets. In addition to this risk, beneficiaries of DC plans will also be exposed to the principal risk factors that determine annuity payments, namely level of real interest rates and the projections of mortality rates into the future when the actual annuity payments will be made. Using a simple model to estimate the retirement income from DC schemes, the numerical results presented in Table 2 showed that when contributions to DC schemes are 18% of salaries over a 30-year period and the returns net of administrative expenses on plan assets are 2% higher than the rate at which wages grow, post-employment benefits from a DC scheme would roughly be 43% of the final salary.[13] The excess return assumption of 2% is based on the following input variables in the model to compute retirement income for DC plans: real yield on long-term bonds is 2%; equity risk premium over the returns on long-term government bonds is 3%; plan assets have an equal share of bonds and equities; administrative expenses are 0.5% of plan assets; and the annual real wage growth rate is 1.25%.

The quantitative analysis presented in this paper provides some insights on the possible trade-offs that may be available for public policy on the design of sustainable pension schemes. For example, the internal rate of return on the notional assets of PAYG schemes will be approximately equal to the rate of real GDP growth of the local economy, which is expected to be 2% or lower in advanced economies. The actuarial model showed that service cost of a pension scheme will be high when the rate of return on the pension assets is low. A funded public pension scheme, on the other hand, will be able to raise the level of return on pension fund assets by investing them in higher growth markets. Estimates using the actuarial model suggest that a 50 basis points increase in real returns lowers the service cost of the pension scheme by 15%. Funded pension schemes therefore offer the prospect of lowering service costs and to be able to better align the pension benefits offered by these schemes to the contribution rates received.

Public policy may also be needed to develop efficient markets for pricing annuity risk as occupational DC plans become the preferred post-employment benefit scheme offered by employers. Efficient markets for pricing annuities will in turn depend on how the market for managing and hedging longevity risk develops. As more employers progressively shift towards DC schemes for providing post-employment benefits, regulatory policies might be needed to restrict the range of permissible investment options available for plan assets to avoid unintended risks being taken by the plan beneficiaries, and to set mandatory minimum contribution rates for participating in DC schemes. Finally, considering that plan beneficiaries in DC schemes are exposed to interest rate risk at the time of converting plan assets into an annuity, the pros and cons of providing insurance policies that guarantee a minimum real yield at which these assets can be converted into an annuity will have to be examined.

[13] This estimate includes a surviving spouse pension of 50% of the employee pension and assumes that pensions are indexed to inflation.

References

Black, F (1989): "Should you use stocks to hedge your pension liability?", Financial Analysts Journal, vol 45, no 1, pp 10-12.

Brown, J R, R Clark and J Rauh (2011): "The economics of state and local pensions", *Journal of Pension Economics and Finance*, vol 10, no 2, pp. 161-172, April.

Cairns, A (2003): "Pension fund mathematics", *Discussion paper, PI-0315*, The Pensions Institute, London.

Committee on the Global Financial System (2011): "Fixed income strategies of insurance companies and pension funds", *CGFS Papers no 44*, July.

Continuous Mortality Investigation (2011): "The CMI mortality projections model, CMI_2011", *Working Paper 55*, September.

Department for Work and Pensions (2010): "A sustainable state pension: when the state pension age will increase to 66", November.

Deutsche Bank Research (2011): "Retirement pensions and sovereign debt in the euro area", EU Monitor 83, August.

Diamond, P (1999): "What stock market returns to expect for the future?", *Center for Retirement Research*, Boston College, no 2, September.

Dowd, K, D Blake and A Cairns (2011): "A computationally efficient algorithm for estimating the distribution of future annuity values under interest-rate and longevity risks", *North American Actuarial Journal*, vol 15, no 2, pp 237-247.

Dushi, I, L Friedberg and A Webb (2010): "The impact of aggregate mortality risk on defined benefit pension plans", *Journal of Pension Economics and Finance*, no 9, pp 481-503.

European Commission (2011): "The 2012 ageing report: underlying assumptions and projection methodologies", European Economy, no 4, September.

Franzen, D (2010): "Managing investment risk in defined benefit pension funds", *OECD Working Papers on Insurance and Private Pensions*, no 38.

Friedberg, L (2011): "Labor market aspects of state and local retirement plans: a review of evidence and a blueprint for future research", *Journal of Pension Economics and Finance*, vol 10, no 2, pp. 337-361, April.

Global Financial Stability Report (2005): "Risk management and the pension fund industry", Chapter III, IMF, March.

Hicks, J (1958): "The yield on consols", Paper read to the Manchester Statistical Society in March 1958 and submitted in evidence to the Radcliffe Committee. Revised and reprinted in *Critical Essays in Monetary Theory*, Oxford University Press 1967.

IFRS (2011): "International Accounting Standard 19: Employee benefits", June.

Moreno, R and M Santos (2008): "Pension systems in EMEs: implications for capital flows and financial markets", in *BIS Papers*, no 44, pp 45–69.

OECD (2005): *Ageing and pension system reform: Implications for financial markets and economic policies*, Financial Market Trends, November.

OECD (2011a): *Pensions at a glance 2011: Retirement income systems in OECD and G20 countries*.

OECD (2011b): "Pension markets in focus", Issue 8, July.

Office for National Statistics (2011): "Chapter 6: Private pensions*", Pension trends*, UK National Statistics.

Orzsag, P and J Stiglitz (1999): “Rethinking pension reform: Ten myths about social security systems”, presented at the conference on *New Ideas About Old Age Security*, The World Bank, 14-15 September.

Pension Capital Strategies (2011): “The FTSE 350 and their pension disclosures”, September.

Poole, W (2005): “Demographic challenges to state pension systems around the world”, presentation at the Culver-Stockton College, 24 February.

Schwarz, A (2003): “Old age security and social pensions”, World Bank.

Sharpe, A, J-F Arsenault and P Harrison (2008): “The relationship between labour productivity and real wage growth in Canada and OECD countries”, *Centre for the Study of Living Standards*, Research Report no 2008-8.

Social Security Administration (2011): “The 2011 OASDI Trustees report”, May.

Turner, P (2011): “Is the long-term interest rate a policy victim, a policy variable or a policy lodestar?”, *BIS Working Papers*, no 367, December.

Vanguard (2011): “How America saves: A report on Vanguard 2010 defined contribution plan data”.

Watson Wyatt (2009): “Funded status watch report”, November.