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Pension funds and value-based generational accounting

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Abstract

The raison d'être of wage-indexed defined benefit pension funds is to provide insurance against standard-of-living risk after retirement, based on intergenerational risk sharing. Pension funds necessarily have to accept mismatch risk in providing this kind of insurance. Mismatch risk taken by the pension fund is risk for the fund's stakeholders. We combine the value-based approach and the method of generational accounting to analyze the economic value of the stakes of the different generations and the issue of who gains and who loses (transfers of value between generations) from alternative funding and indexation policies. Rules concerning the allocation of a funding surplus or funding shortage in particular are decisive to the direction and to the size of transfers of value between stakeholders. We put forward two criteria to evaluate alternative policies employed by pension funds: the funding policy and allocation rules must give an *ex ante* fair compensation for risk taken by generations and the sustainability of a pension plan must be checked with respect to *ex post* redistributive effects for current and future generations. Value-based generational accounting provides a tool for testing a pension fund policy for these two criteria.

1 Introduction

Funding decisions in pension funds in the past have been dominated by the traditional actuarial approach. The main goal of this approach is to arrive at stability in the course of the contribution rate and the funding ratio over time. The approach is typically grounded on rules of thumb as to valuation and accounting issues. The valuation of indexed pension liabilities is usually based on a fixed discount rate that is related to the assumed real rate of return on assets. Risk may be recognized by the actuarial approach; however, prudence is taken into account by a subjective downward adjusting of the discount rate. The actuarial approach leads to a self-constructed representation of the solvency position of the pension fund without any link to financial markets. Moreover, the practice of defining investment and funding policy in terms of expected values without adequate notice of the risks involved may easily lead to transfers of value between stakeholders, which may be not intended.

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These transfers can be between the sponsoring company of a fund (shareholders) and the fund participants. They may also be between the different groups of stakeholders, such as between workers and pensioners and between current and future participants.

The actuarial approach recently has been heavily criticized (see, for example, Exley *et al.*, 1997; Bader and Gold, 2002; Chapman *et al.*, 2001). The approach contrasts sharply with the worldwide trend in accounting standards towards more transparency through market-based reporting based on fair value principles. Fair value implies that a pension fund liability has to be seen as a financial contract. A pension promise is a bond-like asset to the plan member and has to be valued as a bond. The fair value approach relies on methods of financial theory and techniques prevailing in financial markets. The main goal is to make an objective analysis of the solvency position of the pension fund and the implied risks in meeting the promised pension benefits. Fair value analysis implies that risk management by pension funds is essentially management of mismatch risk over time (Ponds and Quix, 2003).

The fair value approach is based on economic principles. The application of economic principles makes it possible to restate funding issues of pension funds in terms of 'economic value'. Economic value implies risk-adjusted valuation of future outcomes. This paper deals with the insights of the application of a value-based approach for pension fund issues, in particular regarding the issue of intergenerational risk sharing.

The structure of the paper is as follows. First we discuss basic principles of the application of financial economics to pension funds. These principles question the relevance of pension funds (Section 2). We argue that the relevance of pension funds is related to insurance aspects based on intergenerational risk sharing (Sections 3 and 4) and discuss the vulnerability of this kind of risk sharing (Section 5). We propose value-based generational accounting as a suitable method to evaluate a pension fund policy based on intergenerational risk sharing (Section 6). We put forward two criteria to arrive at a fair and sustainable contract (Section 7). Finally we evaluate a number of alternative pension deals making use of these two criteria (Section 8).

2 Economic principles and pension funding

In this section we discuss some insights of the application of basic economic principles to pension funding issues (compare Bader and Gold, 2002; Chapman *et al.*, 2001; Exley, 2001; Exley *et al.*, 1997; Gold, 2000; Jarvis *et al.*, 2001; Pesando, 1992; Sharpe, 1976; Steenkamp, 1998).

2.1 Value of pension liabilities

The market value of pension liabilities is not known because these liabilities are not traded freely in the market. The value of liabilities can be determined by looking at the price at which a reference portfolio is traded in a liquid market. A reference portfolio has cash flows that match the benefit cash flows of the pension liability in amount and timing. The matching portfolio for nominal liabilities is an appropriate mix of (zero-coupon) nominal bonds. Indexed liabilities can be matched by a mix

of (zero-coupon) indexed bonds. The value of the future cash flows of a pension liability can be determined by using the discount rate curve embedded in the matching portfolio. The economic value of nominal liabilities can be derived by using the nominal yield curve, the economic value of indexed liabilities by using the real yield curve.

2.2 Defined-benefit pensions are deferred wage income

In a well-functioning labor market, total wage income paid to workers will reflect equilibrium in the supply and demand for labor, via the wage bargaining process. Firms may or may not offer defined benefit pension schemes to their employees, however the total compensation paid to workers with the same productivity will be equivalent. The cost of defined-benefit schemes has to be seen as part of the total offered wage compensation to workers. Defined-benefit pensions are deferred wages. If the costs of pension benefits are correctly taken into account, then the total compensation offered to workers (cash wages plus pension benefits) should be the same, whatever pension benefit is provided (Bulow, 1982; Ippolito, 1987; Pesando, 1992).

How should the costs of pension benefits be calculated in order to realize a fair exchange in economic value terms between wage income now and future pension income as deferred wage income? The bond-like nature of the pension promise suggests that the 'cost price' of new accrued liabilities has to be equal to the present value of the associated increase in future benefit cash flows,¹ where the present value is based on the nominal or real yield curve, depending on the nature of the liability.

2.3 Pension fund savings substitute for individual retirement savings

The Life Cycle Hypothesis is the central theorem of economic analysis in explaining how rational individuals allocate their life-time earnings between consumption and retirement savings over their life cycle. They are basically indifferent as to the form in which retirement savings are held: individual retirement savings on a voluntary basis (in the form of direct investment in the capital market or voluntary savings via life insurance companies) or mandatory savings via employer-sponsored pension fund savings (defined benefit as well as defined contribution schemes). Rational individuals will always correct mandatory savings via pension fund schemes by adjusting downward correspondingly the size of their individual savings. The Life Cycle Hypothesis implies that pension fund savings are substituted for individual savings,

¹ A neutral exchange in value terms between wages and pension benefits on an individual level would imply that older workers have to accept decreasing cash wages as they are getting older. The pension promise each year will become more valuable as the remaining time to retirement shortens, so the paid contribution from gross wages would increase each year. In real life, the trade-off between wages and pension benefits will generally take place at the level of the employee group as a whole, rather than at the level of the individual worker. Workers usually pay the same fraction of wages as contributions to the pension fund. This favours older and long-term workers at the expense of younger and short-term workers as explained by the 'implicit pension contract' approach (compare Ippolito, 1987). The value-based approach as proposed in this paper can also be used to measure the size of value transfers between young and short-term workers and long-term older workers due to the use of a levelled contribution rate.

leaving the total retirement savings unaffected (Feldstein, 1978).² A very sizeable pension fund scheme may even lead in the extreme to borrowing by individuals in their working period in order to pay for preferred consumption level.

Hence, the funding of defined-benefit schemes has no impact on consumption and savings on the whole.

2.4 Pension fund savings have no impact on the allocation of total wealth regarding preferred return–risk trade-off

From the perspective of an individual plan member, a defined benefit pension will represent a substantial allocation of their personal wealth into a bond-like asset. The mandatory participation into the plan may disturb their preferred exposure to the return–risk trade-off offered by the market. If so, the plan participant will reorganize their total portfolio of personal assets and liabilities, such that the new allocation of their total personal wealth meets their preferences.

Pension funds promising defined benefit pensions create bond-like assets, which in turn lead to less individual retirement wealth and this reduced individual wealth will be held in more risky assets.

2.5 The economic value of taking mismatch risk by pension funds is zero

The economic value of pension debt is not affected by the composition of the asset mix held by the pension fund. The asset mix is decisive to the riskiness of the fund, i.e. the size of mismatch risk on the balance sheet. A pension fund holding all its wealth in the matching portfolio has no mismatch risk. Any change in the value of liabilities due to a change in the yield curve or due to indexation goes along with an equal change in the value of assets in the matching portfolio. The next year funding ratio equals the initial funding ratio. Mismatch risk is absent.

Any deviation between the asset mix and the matching portfolio will lead to mismatch risk. In general, the higher the expected return of the asset mix and thus the higher next-year expected funding ratio, the larger the mismatch risk. The economic approach leads to the fundamental insight that the net gain of taking mismatch risk in economic value terms is nil. On balance the higher investment return is fully offset by the higher risk. Why is this so? All assets have an expected return $E[R]$ equal to the risk-free rate R_F plus a risk adjustment, the risk premium RP (compare Figure 1). The risk premium for a specific asset is determined by two factors: [1] the risk aversion prevailing in the market, and [2] the volatility of the cash flows of the assets (or more accurately the systematic part of the volatility determined by the covariance of the volatility of the assets' cash flows with the volatility of the market portfolio). The higher the risk aversion in the market and/or the higher the volatility of the cash flows of the asset, the higher the risk premium must be in order to get investors to hold this asset. Hence, the economic value of a risk-free asset offering with certainty the risk-free rate R_F as return has to be the same as the economic value of a risky asset

² The introduction or increase of a public pension scheme financed on a pay-as-you-go basis (PAYG) will lead to a decrease in aggregate savings and capital formation.

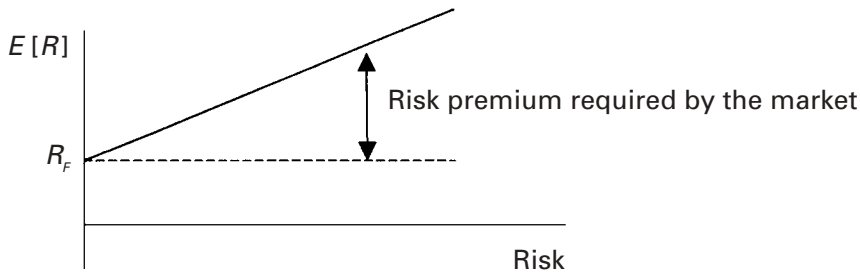


Figure 1. Return–risk trade-off

promising an expected return $E[R]$, where the difference $E[R] - R_F$ equals the market-required risk premium RP . If this is not valid, the market will react by adjusting the price of the asset so that the riskiness of the asset is met by the required compensation by the market.³

Thus, investing in risky assets by pension funds does not add economic value. This also implies that asset-allocation by pension funds does not reduce the economic costs of promised defined benefits.

2.6 Mismatch risk taken by the pension fund is risk for the stakeholders

Economic analysis looks through the institutional veil of the pension fund. Mismatch risk taken by the pension fund is risk for the stakeholders of the pension fund. This risk shifting may go unnoticed when the pension fund is seen as the bearer of risk and also as the beneficiary of the risk premiums, i.e. the expected excess return. Risks of pension funds, however, are borne by the fund's stakeholders, not by the pension fund. A pension fund therefore must not be analyzed in isolation, but always in relation to the impact on the wealth of the fund stakeholders, in particular those who ultimately bear the funding risk.⁴

Rational stakeholders are able to look through the institutional veil of the pension fund and will adjust their own individual savings in response to any change in risk taking by the fund. For the sake of argument, let us make a distinction between two extreme risk-bearing positions: [i] all the funding risk is borne by the shareholders of the sponsoring company (or companies in case of an industry pension fund), or [ii] all

³ It is not risk or volatility per se that is rewarded in a well-functioning market – only the risk of doing badly in bad times (Sharpe, 1995). Stocks give a high return in good times, when many other risky assets are also high returning and consumption levels are high. The additional utility of high-returning stocks in good times is low. Stock returns will be low in bad times, when many assets are doing badly. Assets that pay off a low return when times are bad and consumption levels are low are less desirable than those that also will pay off in bad times so that consumption levels can be maintained. Risk-free assets pay off a certain return in good and bad times. Risky assets that pay a good return in good times and a bad return in bad times must offer a premium to induce investors to hold them instead of a risk-free asset. The risk premium is the market compensation for the willingness to take the risk of doing badly in bad times. The magnitude of the premium reflects the average risk aversion prevailing in the market.

⁴ The government clearly is a stakeholder too. First because of the impact of tax-deductible contributions and taxable pension income on tax revenues, and secondly because of the impact of shocks in the funding ratio on the macro economy via purchasing power effects (contributions and indexation), labor market (wedge) and national wealth. The government as stakeholder is not explored in this paper, but see Ewijk van and van de Ven (2003).

the funding risk is borne by the plan participants. In practice, usually a combination of these two extreme positions will prevail.

[i] Shareholders

Rational shareholders are basically indifferent between holding equities directly (stocks of the companies) or indirectly via company pension funds. These two alternatives are substitutes because the company absorbs all funding risk, so any funding shortfall or funding surplus will lead to a corresponding change in the shareholders wealth of the company. Therefore, rational investors will adjust their portfolio of risky assets whenever the pension fund changes the asset mix towards more or less risky assets.

[ii] Plan participants

The second extreme position allocates all funding risks to plan participants. Underfunding will lead to an increase in contribution rate and a cut in indexation in order to restore the funding ratio towards the aimed level. Overfunding will result in lower contribution rates and improvements of pensions. A pension fund taking more mismatch risk may have the prospect of a lower expected contribution rate and a higher pension income for the participants. Therefore, more funding risks due to taking a greater mismatch position will impact directly on the expected wage income and expected pension income and their riskiness, and hence on the wealth position of the stakeholders and their risk exposure. However, individuals can also realize these wealth effects directly by appropriate holdings in the capital market. Rational stakeholders will re-arrange their portfolio of financial assets (including their stakes in the pension fund) whenever the pension fund changes the mismatch position, so that the total portfolio of the individuals will still meet their preferences as to the trade-off between return and risk.

2.7 Pension fund as a zero-sum game between stakeholders

Chapman, Gordon, and Speed (2001) apply the value-based approach to strategic decision making within a company pension fund. They model the fund not as a self-contained fund but simultaneously alongside the company. The stakes of the various parties aggregate to 100% of the assets of the company, including the assets of the pension scheme. Strategic decisions as to the investments, contribution rate and indexation have no impact on the total economic value of the combined stakes of the stakeholders. However, these decisions may well lead to transfers of value between the stakeholders. How and to what extent will depend on rules concerning the allocation of a funding shortage or funding surplus. Chapman *et al.* investigate different allocation rules and make clear that the pension fund must be seen as a zero-sum game.⁵ The value-based approach clarifies who gains and who loses from changes in strategic policy variables.

⁵ An important underlying assumption of the zero-sum game model is that all non-systematic (diversifiable) risks have been diversified. If this were not so, there would clearly be financial transactions that could produce mutual gains in utility through risk pooling which is a positive-sum game.

We employ the value-based approach for a pension fund based on intergenerational risk sharing. This kind of risk sharing is already dominant in the Netherlands and its importance is expected to increase further (see Section 4).

2.8 Are pension funds irrelevant?

In the preceding we have discussed implications of economic principles for pension fund issues:

- Defined benefit pensions must be seen as bond-like assets and have to be valued like bonds. The economic value of a defined benefit pension promise is equal to the present value of future benefit cash flows, discounted using either the nominal yield curve (nominal liabilities) or the real yield curve (indexed liabilities).
- Defined benefit pensions are deferred wage income. Contributions must reflect the economic value of new accrued liabilities (“cost price”) in order to realize a neutral exchange in economic value terms between wage income now and pension income later.
- Pension fund savings have no impact on total wealth (savings) preferred by rational individuals, because rational fund participants will substitute mandatory pension fund savings for individual retirement savings.
- Pension funds also have no impact on the allocation of total wealth to risky assets. Pension funds create bond-like assets for the plan members. These assets may disturb the preferred allocation of individual wealth to risky assets. Rational individuals respond by reorganizing their personal portfolio of total wealth in order to restore the preferred exposure to risk.
- A shift toward a more risky asset mix by the pension fund does not add economic value because the higher investment return is offset by the higher risk.
- Changes in the asset mix of the pension fund will be overruled by the risk-bearing stakeholders. In response to a change in risk exposure via the pension fund, they will re-arrange their own holdings of risky assets in such a way that the preferred trade-off between risk and return is restored.
- Alternatives to the pension fund policy strategy produce no economic value; however, they may well lead to transfers of value between the stakeholders (zero-sum game).

The natural conclusion following from the application of economic principles is that pension funds are not relevant, because they have no impact on the aggregate economy, no impact on total economic value, no impact on the welfare of their stakeholders and also no impact on the preferred return–risk trade-off.

So, why do pension funds exist at all? One has to recognize that economic analysis makes use of rigorous assumptions that may not be valid in reality. First of all, economic analysis assumes that financial markets are complete and the economic equivalence between various investment alternatives faced by individuals assumes perfect markets. As to completeness, in real life the private market fails to provide preferred insurance against retirement income risks, in particular standard-of-living

risk. We argue in the next section that the *raison d'être* of pension funds is rooted in providing insurance against standard-of-living risk during retirement based on intergenerational risk sharing. This kind of insurance is not available in the market. Moreover defined-benefit schemes overcome failures of the insurance market due to adverse selection problems, high costs and lack of real annuities. A second group of arguments might be found in paternalistic motives as individual decision making is plagued by myopia and bounded rationality. This may motivate social security and employer-sponsored schemes with mandatory participation, however not defined-benefit schemes *per se*. A third group of arguments can be found in the ability of pension funds to realize a better return–risk trade-off than individuals can realize. This may be first because bundled pension wealth can exploit financial markets inefficiencies that individuals cannot. Regarding this, pension funds have no added value compared with other institutional investors like investment funds. Secondly, and more meaningful, one may point to the behavior of asset return over time.

If we make the reasonable assumption that returns are independent and identically distributed then investment opportunities in the short term would be the same as in the long term. Pension funds have a strong belief that they are able to improve the long-run trade-off between return and mismatch risk due to mean-reverting properties of risky assets (in particular stocks). The long-term nature of promised pension benefits puts pension funds in an excellent position to take advantage of the implementation of a long-horizon investment policy. They can exploit time-variation in asset returns and to realize a better long-run trade-off between return and risk than the one-year trade-off offered by the market. This would suggest pension funds should explicitly take a long-term oriented exposure to mismatch risk because this will be of benefit to the stakeholders. The issue of the presence of mean reversion is disputed in the economic literature. A lot of research has been done regarding mean reversion in historical time series. There is evidence that it may exist, but then it would require a keen policy to be exploited.⁶ We will not explore the claimed benefits of supposed mean reversion⁷ for two reasons. The core task of pension funds is to provide standard-of-living risk insurance. Assumptions as to behavior of asset prices have an impact on the funding process, not in achieving the core task. Secondly, young individuals can achieve the same time horizon effects through their own personal investment policies.

⁶ Campbell and Viceira (2002) have detected mean-reversion in stock returns. They found that the equity premium is slow-moving over time where a small number of variables have predictive power regarding the trend in the course of the equity premium. A gradual resetting of the strategic asset allocation responding to the signals of the predictive variables may have improved in the past the trade-off between returns and risk. These findings may be used by pension funds as a guideline for time-varying composition of the strategic mix. The implementation should be gradual and slow moving over time. Market timing is crucial, the findings cannot be used for short-term tactical asset allocation. Exley *et al.* (2002) warn that the found predictive power of variables like the dividend-yield may stem from statistical bias in the estimation procedure.

⁷ Presupposing the existence of time-variation in asset returns and volatility, Ponds and Quix (2003) offer an analysis regarding pension fund policy for the short and long term within a traditional ALM framework.

3 Incompleteness and retirement income risks: Insurance aspects of pension funds

Individuals face serious problems with respect to dealing with retirement income risks. A young individual, starting on their career, has to deal with the three uncertainties below:

- [a] uncertainty as to the size and pattern of life-time earnings (wage path),
- [b] uncertainty as to the return on retirement savings,
- [c] uncertainty as to the life-span.

These uncertainties present difficulties for individuals in spreading life-time resources according to the preferred life-time consumption profile. During retirement, one can ultimately determine whether the wealth accumulated reflects either the preferred level of savings or undersaving or oversaving. Individuals therefore are exposed to standard-of-living risk during retirement. The private insurance market and the financial markets fail to provide assets which give protection against standard-of-living risk. This can be well illustrated by a quotation of Samuelson in which he refers to his younger years, during which he wanted to make provisions for retirement:

[T]wo of the three features that I wanted in a retirement provision were just not available.
 [1] Not knowing just when I should die, I wanted an *annuity for life*. This, my friendly Prudential agent had long been glad to sell me ...
 [2] Not knowing what the future price level would do, I wanted a *real* annuity. This was just not available ...
 [3] Noticing that the average real level of consumption was rising in the modern mixed economies ... my final unreasonable demand was for an annuity that would leave me for life at the *same percentile level* of the working age population's real living as I had become accustomed to.
 There was no way I could get these three wishes. (Samuelson, 1983: 279)

Several decades later, the second and third wish of Samuelson still cannot be realized in the private market.⁸

A wage-related indexed defined-benefit scheme offers protection for the three uncertainties mentioned above. Why should this be so? The pension income is related to the wage-path during the career (average wage) or to final-pay, so workers have the prospect of a standard-of-living during retirement comparable to the pre-retirement period. The pension income will be received as long as the retiree lives. The risks as to future wages and future rate of return are shifted from the individual participant to the collectivity of risk-bearing parties, which have to absorb the mismatch risk of the fund.

4 Risk-shifting from employers to plan participants: trends towards more defined contribution and more intergenerational risk sharing

A pension fund providing standard-of-living risk insurance is necessarily exposed to mismatch risk. A defined-benefit pension fund with wage-indexed liabilities can only realize a risk-free position by holding assets in wage-indexed bonds. Evidently,

⁸ Since the 1950s, serious progress has been made regarding the use of modern finance theory to design financial products that fit the life-cycle issues households face. These new financial instruments, however, presuppose high skills, skills that ordinary people do not have (Bodie, 2003).

this cannot be realized because wage-indexed bonds are not available. At best, the pension fund may aim to hold the minimum-variance portfolio regarding mismatch risk.

This raises the fundamental question: Who is absorbing the mismatch risk of a defined-benefit scheme? In practice, one can find a rich diversity with respect to this issue, because the stakeholders are free in making rules as to who should bear the funding risk. Currently, one may observe a trend towards more risk taking by plan members, i.e. intergenerational risk sharing and towards less risk taking by companies/shareholders.

In *company pension plans*, it is usually prescribed that the sponsoring firm is solely responsible for the funding position. The funding risks are borne by the shareholders of the firm. Companies are now considering changing this practice. They fear the impact of the new international accounting standards to be implemented within a few years. The new accounting rules imply first that assets and liabilities of the company pension fund have to be settled on a fair value base and secondly that the balance of the pension fund have to be integrated into the company balance sheet. The reported financial position of companies will become very volatile due to the volatility of pension fund assets and liabilities measured on a fair value base (the underlying economic position should be unaffected by accounting conventions). Company management, therefore, aims to restrict the impact of pension fund risks for their performance and financial position. One route is to minimize mismatch risk by holding (indexed) bonds (Boots). Companies in the UK also react by closing defined-benefit schemes and offering defined contribution schemes to their employees as an alternative. This implies riskshifting from the company to individual workers.⁹ Dutch companies have considered moving to an average-wage plan with conditional indexation (Bunicich, 2003). The yearly contributions paid by the sponsor will be equal to the 'cost price' of newly accrued rights. The funding risks have to be absorbed by adjusting the offered indexation to all members. This change in risk bearing can be seen as risk shifting from the company shareholders to the plan participants. This can also be interpreted as a shift towards intergenerational risk sharing between workers, retirees and future participants. The speed at which indexation policy is adjusted in order to absorb a funding shortage or surplus is decisive to how much funding risk is borne by current workers and current pensioners and how much funding risk is shifted forward to future participants.

Funding risks in *industry pension funds* typically are shared between the sponsoring firms and the members of the plan, including workers and retirees. The contributions are divided between employees and employers according to a fixed proportion. Indexation is conditional, usually in relation to the funding ratio. Most pension schemes in the Netherlands are industry pension funds. A discussion is going on to come to an explicit pension deal with respect to the issue of risk bearing. Such an explicit deal will clarify the key question: Who bears, and when and to what extent

⁹ The reality is often that the contributions paid to defined contribution arrangements are insufficient to provide the level of benefits previously offered by defined-benefit arrangements. Thus, the switch to defined contributions is primarily a cost-cutting exercise. This may be partly offset by the positive benefits of being no longer exposed to the default risk of the sponsor of a company pension fund.

the funding risks? Dutch industry pension funds and their stakeholders aim to realize an explicit deal on risk bearing, which gives the prospect of a balanced and fair distribution of risks to employers and to young and old plan members, i.e. inter-generational risk sharing. This will imply in practice some combination of risk taking by current members by adjustments in contribution rate and indexation policy and risk shifting towards future participants. This issue will be discussed more in detail in Section 8.

Thus, there is a trend toward closing of defined-benefit schemes and a trend that the remaining defined-benefit schemes will rely more and more on intergenerational risk sharing. We will move on now to discuss the fact that a contract based on intergenerational risk sharing is vulnerable because its sustainability depends critically on the willingness of young and future generations to participate.

5 Limits to intergenerational risk sharing

Economic literature points to intergenerational risk sharing as a way to overcome the private market failure to provide for preferred retirement income insurance. Intergenerational risk sharing usually is analyzed in the face of uncertainty with respect to factor rewards: wages and rental income (Gordon and Varian, 1988; Shiller, 1999; Ponds, 1995). Long-term wage risk and rental-income risk are not diversifiable within an age-cohort because these risks affect individuals of the same age simultaneously. From a long-term perspective, wage income and rental income are negatively correlated.¹⁰ This suggests that risk sharing between generations provides an opportunity for welfare improvement. This would imply a system of redistributive transfers between (young) workers holding human capital wealth in the form of wages and older and retired individuals holding pension savings. The income redistribution *ex post* will be from high rental income to low wage income, and vice versa. Intergenerational risk sharing may also be of relevance in relation to the future wage path. Wage-path risk creates uncertainty as to the future income level and the future standard-of-living. Lucky generations with high wage growth are able to support less lucky generations. A system of retirement income insurance with wage-related benefits and covering succeeding generations of workers may be a welfare improvement *ex ante* for the involved generations.

The private market fails to provide insurance products based on intergenerational risk sharing. The reason for this is straightforward: current and future generations are not both alive prior to the outcome of the income risks. The current young generation is not able to precommit the future young generation to a hedge contract, although from an *ex ante* perspective both generations may benefit. Whenever the current young generation of workers wants to commit itself to an insurance contract, the other party to the hedge is not born. By the time the next young generation is able to commit to the contract, the outcome *ex post* of the contract will be known. The support of the future young generation will be contingent on the *ex post* outcome

¹⁰ Intergenerational risk sharing may also be of relevance for shocks for which wages and rental income are positively correlated. This would require a contract long enough to transfer resources from periods with a high-income level to periods with a low-income level.

of the contract. They may not accept voluntarily a contract that will lead to a loss of welfare for them.

A funded defined-benefit scheme is an ideal instrument for organizing intergenerational risk sharing.¹¹ The commitment of future generations is imposed by the requirement of mandatory participation. However, there are limits to intergenerational risk pooling between current and future plan members just as there are with private market arrangements based on risk sharing between generations. The future participants of pension plans will have the incentive to withdraw themselves when the *ex post* outcome of the pension deal is disadvantageous to them. Then they may prefer to offer their labor elsewhere. The more mobile the younger workers are, the more vulnerable a pension fund with intergenerational risk sharing is. The ability of risk to be transferred to future generations must be a function of the inefficiencies in the labor and production markets. If a new generation of Dutch workers, faced with an accrued deficit in the pension system, can work in Germany without this burden, or choose to work in another industry, or to work for a start up company without these obligations, then intergenerational transfer is limited. It is the frictional costs preventing such movement of labor that allow the intergenerational model to exist.

This implies that the reach of risk sharing with future participants has to be restricted. We recognize this conclusion in our second criterion to evaluate pension funds on the issue of sustainability (see Sections 7 and 8).

6 Value-based generational accounting

6.1 Public finance

Generational accounting is a method explored by public finance economists as a tool for investigating intergenerational distributional effects of fiscal policy (Auerbach *et al.*, 1999). Generational accounting is based on the government's intertemporal budget constraint, which requires that either the current or the future generations pay for the government spending by taxes. The government's net wealth (including debt) plus the present value of the government's net receipt from all current and future generations, must be sufficient to pay for the present value of the government's current and future consumption. The generational accounting method can be employed for calculating the present value changes in net life-time income of generations, both living and future, resulting from changes in fiscal policy. Generational accounting reveals the zero-sum feature of the intertemporal budget constraint of government finance: what some generations receive as an increase in net-life-time income will

¹¹ The government is also an ideal institution to organize intergenerational risk sharing by distributing index-bonds. The government has indexed assets in the form of tax revenues from wage income and rental income. The issuing of index-bonds will therefore create a more or less matched position between tax receipts and the costs of index-bonds. Index-bonds can be helpful for individuals looking for retirement income insurance, when the offered revenue on these bonds is related to the growth rate in standard-of-living. Merton (1983) proposes the issuance of consumption-indexed bonds. The revenue is related to the growth rate in aggregate consumption per capita. Ponds (1995) suggests the issuing of income-indexed bonds where the offered return is related to the growth rate in national income per capita. Bohn (2001) discusses risk-sharing properties amongst generations of bonds indexed to wages and demographic variables.

have to be paid for by some other generations who will experience a decrease in net-life-time income. Planned increase or decrease in government debt can be used for tax smoothing in time in order to realize a sustainable fiscal policy (van Ewijk *et al.*, 2000).

6.2 Pension funds

Equally, the method of generational accounting may be of use to evaluate the policy of pension funds covering current and future participants. Two similarities with public finance can be discerned. Pension funds also face an intertemporal budget constraint, as the promised benefits have to be backed by current and future contributions and returns on paid contributions. Secondly, as the government uses the tax instrument to close the budget over time, adjustments in contribution and indexation rates are the fund's instruments to close the balance over time.

We combine the method of generational accounting with the value-based approach in order to assess the impact of pension funding for the generations and to control for a fair treatment of involved generations.

A value-based approach is able to correct expected future benefits and contributions of a cohort for the risks allocated to this cohort according to the rules of the pension deal. The perceived risks comprise contribution rate risk and indexation risk. The approach also will show the zero-sum character of the deal. The total economic value to be distributed amongst the generations is equal to the value of pension fund assets. Alternative funding and risk-allocation rules have no impact on total economic value but may lead to transfers of value between the age cohorts.

6.3 Cohort

An important variable explored for the goal of value-based generational accounting is the current economic value of the size of the stake of a cohort one period from now (this can be either one year or a number of years).

The size of the stake of a cohort one period from now, abbreviated as s_1 , is defined as:

s_1 = value of accrued rights at the end of period 1 (including indexation and new accrued rights due to the new year(s) of service) plus benefits to be received during period 1.

The economic value at $t=0$ of s_1 , abbreviated as $V[s_1]$, is calculated by a risk-adjusted discounting of the possible outcomes for s_1 , each of them weighted with their probability. We may employ either the deflator technique or the method of risk-neutral valuation,¹² however both will produce the same result for $V[s_1]$.

$$V[s_1] = \text{Economic value of } s_1 \text{ at } t=0$$

We define the change in economic value for a cohort, abbreviated as Δv_1 , as the difference between the economic value of stake₁ $V[s_1]$ minus the economic value of

¹² For a comparison of the deflator method and the method of risk-neutral valuation see Jarvis *et al.* (2001) and Barrie and Hibbert (2002).

paid contributions in $t=1$, abbreviated as $V[c_1]$, minus the value of the stake of the cohort at $t=0$, abbreviated as s_0 . So:

$$\Delta v_1 = V[s_1] - V[c_1] - s_0$$

The change in economic value for a cohort will be zero when the cohort has the prospect of an adequate compensation for the part of the mismatch risk the cohort has to take:

$$\Delta v_1 = 0 \quad \text{when risk taken by cohort is compensated by the offered risk premium}$$

6.4 Aggregate

The aforementioned variables in capitals stand for the sum of the cohorts, so:

$$S_0 = \sum s_0$$

$$S_1 = \sum s_1$$

$$V[S_1] = \sum V[s_1]$$

$$C_1 = \sum c_1$$

$$\Delta V_1 = \sum \Delta v_1$$

The period-end balance of the pension fund expressed in economic value terms at $t=0$ reads as follows (before the payment of the benefit in period 1; the benefit in $t=1$ is still included in $V[S_1]$):

| | |
|----------|----------|
| A_0 | $V[S_1]$ |
| $V[C_1]$ | $V[R_1]$ |
| $V[A_1]$ | $V[A_1]$ |

The term A_0 reflects the economic value of assets at $t=0$; the term $V[S_1]$ stands for the sum of economic value of the stakes of all cohorts at the end of period 1 (including the benefit to be paid in period 1); $V[A_1]$ reflects the economic value assets at the end of period 1 being the sum of the value of assets already present A_0 plus the value of the paid contributions $V[C_1]$; and finally the term $V[R_1]$ denotes the economic value of the funding residue at the end of period 1. The term $V[R_1]$ may be zero, negative or positive.

We interpret the economic value of the residue $V[R_1]$ as the economic value of the intergenerational contract. A funding residue implies that the closing of the balance between assets and liabilities is shifted forward in time and has to be done in the period(s) following period 1. The difference between the initial funding residue R_0 which is equal to $A_0 - S_0$, and the value of the residue at the end of period 1, $V[R_1]$, reflects the change in the economic value of the intergenerational contract, abbreviated as $\Delta V[Contract_1]$:

$$\Delta V[Contract_1] = V[R_1] - R_0$$

The change in economic value of all cohorts plus the change in the economic value of the contract adds up to zero:

$$\Delta V_1 + \Delta V[\text{Contract}_1] = 0$$

7 Criteria for a fair and sustainable defined-benefit scheme

The funding risks have to be absorbed by one or more of the involved generations according to the rules specified in the pension deal. The rules may have impact on the economic value of the stakes of the cohorts. This highlights the need to assess the impact of the rules on the net-wealth position of the covered age-cohorts in order to check the aspects of fair treatment of the cohorts and of a sustainable contract of risk sharing.

We propose two criteria for a sustainable contract based on generational risk sharing:

1 *Ex ante* fair compensation for risk taking:

Generations bearing risk have to receive an adequate compensation for the funding risk they are taking. Funding risks will arise when the pension fund shifts from the risk-free mix to a risky mix. This gives the pension fund prospects of a higher expected return and hence a higher expected funding ratio, where the increase in the expected funding ratio the following year relates to the risk premium the market offers for the risk taken by the fund. The increase in the expected funding ratio can be used to compensate the risk-bearing parties for the risks they are exposed to.

- The *indexation policy* as to accrued rights can be made conditional on the funding ratio. The plan participants can be compensated for the riskiness with respect to the offered indexation by giving them the prospect of a higher expected indexation than the reference variable, usually the wage-inflation.
- *Workers* may absorb part of the funding risks by paying additional contributions in case of a funding shortage and receiving a contribution cut in case of a funding surplus. The prospect of a higher expected funding ratio implies that the workers on average will have the prospect of contribution cuts, where the expected cut, and the resulting expected increase in wage income net of contributions, offers compensation for the risk taken by workers.
- *Future participants* are exposed to funding risk when the pension deal prescribes that part of the funding risk is shifted forward in time. This is acceptable from a perspective of generational fairness if the expected net increase in the funding ratio provides enough compensation for the risk shifted forward towards future participants.

2 Sustainable *ex post* effects:

Rules for funding and risk allocation may guarantee generational fairness *ex ante*. *Ex post*, however, the actual outcomes of the relevant variables (value of the stake at the end of period 1, received benefits, paid contributions and the residue) usually will deviate from the expected outcomes. Sign and magnitude of

the deviations between actual and expected outcomes depend on the realization of the risks involved. We will make use of option premiums to assess the size of *ex post* deviations.¹³ These premiums can be derived by restating the pension fund balance with help of the put–call parity (see also Sharpe, 1976; Blake, 1998).¹⁴

The period-end balance of the pension fund balance reads as:

$$\begin{array}{c|c} \hline A_0(1 + R_A) & S_1 \\ \hline C_1 & R_1 \\ \hline A_1 & A_1 \\ \hline \end{array}$$

The term R_A reflects the rate of return on assets. The total period-end value of the assets A_1 may be larger than the period-end value of the sum of the cohort's stakes S_1 , resulting in a residue R_1 being positive. The risk-bearing stakeholders have a call on this residue and the residue will be distributed amongst them according to the risk-allocation rules of the pension deal. When assets fall short of the total value of the stakes, a negative residue results. The stakeholders, having written a put on a negative residue, must bear the funding shortage.

We can rewrite the pension fund balance in terms of the period-end values of the call and the put as follows:

$$A_1 - S_1 = R_1 = Call - Put$$

The expression above can be rewritten in economic value terms, resulting in:

$$A_0 + V[C_1] - V[S_1] = V[R_1] = V[Call] - V[Put]$$

$V[Call]$ and $V[Put]$ reflect the economic value of the period-end payouts of the call option and put option. The magnitude of the two variables $V[Call]$ and $V[Put]$, which also might be interpreted as option premiums, are determined by the following factors:

- the funding policy of the pension fund, i.e. the initial wealth position A_0 , value of contributions $V[C_1]$ and the mismatch risk taken (the riskiness of the asset mix);
- the economic value of the total stakes of the cohorts at the end of period 1, $V[S_1]$.

We interpret the magnitude of the option premiums as a criterion to evaluate the sustainability of the scheme. The higher the call and put premiums, the larger the overfunding respectively the underfunding one period from now may be and the

¹³ A traditional ALM model also may be of use to explore stochastically the *ex post* deviations.

¹⁴ The put–call parity states that the pay-out of a risk-free asset, say bonds B , can be replicated by holding a portfolio consisting of a risky asset, say stocks A , plus holding a put on the risky asset and by writing a call on the risky asset where the exercise price of the put and the call both are equal to the (end) value of the risk-free asset B . Define $PV[P]$ and $PV[C]$ as the present value of the put and call at the time of exercise. The put–call parity can now be expressed as: $B = A + PV[P] - PV[C]$.

A defined-benefit liability can be seen as a bond, so the benefit payout can be replicated by holding an appropriate combination of the pension fund assets and options on these assets. This finding can be used to restate the balance of the pension fund in terms of a put–call parity from $A = L + R$ into $A = L + PV[C] - PV[P]$.

more the pension fund result will have impact on the wealth of the involved cohorts. The sustainability may be at stake when the put premium has a high value. A high put value indicates a high loss potential for future and young cohorts in bad times. Future cohorts then may refuse to pay for these losses.¹⁵

8 Results of value-based generational accounting

8.1 Introduction

Regarding the relevance of value-based generational accounting within a stylized representation of a pension fund, we will first describe the characteristics of the model and the pension fund (Sections 8.2–8.5). Then we will highlight the two key differences between the actuarial approach and the value-based approach. These are related firstly to the asset mix that may or may not add value to the stakeholders (Section 8.5), and secondly to the contribution rate that may or may not capture the expected excess return of assets over liabilities (Section 8.6). Subsequently we mimic the funding practice of pension funds in the Netherlands in the two recent decades and we show this practice may have implied hidden transfers of value between the stakeholders (Section 8.7). Finally we explore risk-allocation rules that meet our two criteria presented in the preceding section (Section 8.8).

8.2 Settings of the model

This section demonstrates value-based generational accounting in a one-period model with only one type of risk. The risk is related to the rate of return on the assets (being either the risk regarding the nominal rate of return or the risk regarding the real rate of return; this is the nominal rate of return minus the growth rate of wages). We distinguish two states of nature for the economy. The economy may go either up or down, with probabilities being 0.6 and 0.4 respectively. This simple setting allows us to disentangle the relevance of value-based generational accounting for pension funds.

We can adjust the model towards a multi-period model with more sources of risk in order to capture more aspects of the reality faced by pension funds. However, this will lead to far more complexity without adding greater understanding and it does not lead to any changes in the basic conclusions, which can already be derived in a simple setting. Why is this? Two answers. First, a multi-period model in essence is a sequence of one-year periods. Secondly, the relevant risk for pension funds is mismatch risk. The size of the mismatch risk is determined largely by the decisions regarding the asset mix. Adding more sources of risk would only add more channels through which economic uncertainties influence the mismatch risk.

¹⁵ The young may still prefer to participate in a plan with a shortage because of the benefits of the offered insurance. The necessary condition for the support of the young is that the disutility associated with the income loss is outweighed by the gain in utility of being insured against retirement income risks. We have not undertaken welfare analysis in this paper, so the net change in utility due to variation in pension fund policy has not been explored (see Ponds, 1995 for this type of analysis). The goal of the paper is to demonstrate the relevance of value-based generational accounting.

8.3 Economic variables

The pension fund faces the following economic variables. It is assumed the market offers only three investment portfolios: the minimum variance portfolio consisting of 100% nominal bonds, the risky mix of 100% stocks and a moderate risky mix composed of a mixture of nominal bonds and stocks.

| | |
|--------------------------|-------|
| Price inflation | = 2 % |
| Wage growth (nominal) | = 3 % |
| Real wage growth | = 1 % |
| Nominal rate of interest | = 5 % |
| Real rate of interest | = 3 % |

Nominal rate of return investment portfolios:

- Minimum variance portfolio = 5 %
- Moderate risky portfolio = 6 %
- Risky mix = 8 %

8.4 Characteristics pension fund

The pension fund has the following features:

- *Pension plan*: Average-wage plan with wage-indexed liabilities.
- *Discount rate liabilities*: The relevant discount rate has to be derived from the matching portfolio, which ideally would consist of wage-indexed bonds. The market does not offer these bonds. The pension fund derives the relevant discount rate by using the real yield curve prevailing in the market and subsequently subtracting the expected growth rate of real wages. It is assumed that the real yield for the term corresponding to the duration of the liabilities is 3% and the real wage growth is 1%, so the discount rate used by the fund is 2%.
- *Liabilities*: The accrued rights of the pensioners amount to a fraction of 52% of the total liabilities, the complement of 48% is the fraction relating to the workers. The pension fund is mature: the duration of liabilities is 18 years.
- *Asset mix*: The pension fund distinguishes four kinds of asset mix. These are the three investment portfolios available in the market and a virtual portfolio, the so-called risk-free mix, consisting of 100% wage-indexed bonds. Holding assets in the virtual portfolio would lead to a pension fund balance sheet free of mismatch risk. The rate of return on assets always will match the growth rate of the liabilities. The pension fund evaluates the three available investment opportunities in terms of excess return and mismatch risk. Excess return is defined as the difference between the expected nominal asset return minus the growth rate of the liabilities of 5%, being the sum of the 2% discount rate and the 3% wage growth. Mismatch risk is defined simply as the standard deviation of the excess return:

1 Risk-free asset mix (100% wage-indexed bonds)

| | |
|---------------------------------|-------|
| Expected nominal rate of return | = 5 % |
| Excess return | = 0 % |
| Mismatch risk (st. dev.) | = 0 % |

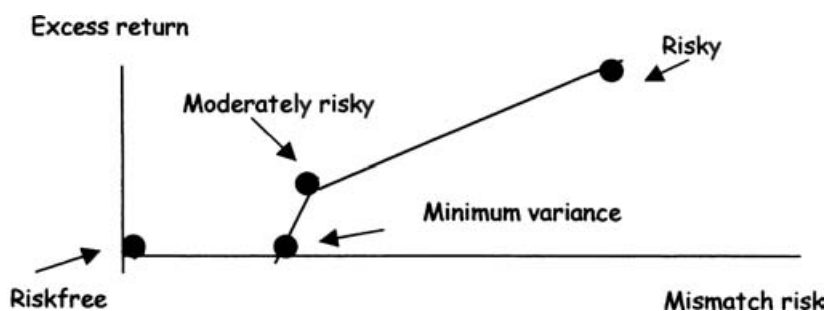


Figure 2. Pension fund efficient set in terms of excess return and mismatch risk

2 *Minimum variance mix (100% nominal bonds)*

Expected rate of return = 5%
 Excess return = 0%
 Mismatch risk (st. dev.) = 2.5%

3 *Moderate risky asset mix*

Expected rate of return = 6%
 Excess return = 1%
 Mismatch risk (st. dev.) = 3.4%

4 *Risky asset mix*

Expected rate of return = 8%
 Excess return = 3%
 Mismatch risk (st. dev.) = 10.2%

The opportunities of the pension fund can be represented by constructing the efficient set in terms of excess return and mismatch risk, compare Figure 2. The solid line is the efficient set to be constructed out of the three available investment opportunities. Portfolios on the dotted line cannot be reached because the risk-free mix is not available.

The excess return of the risky mix is 3%, which is three times higher than the 1% excess return of the moderately risky mix. The (systematic part of the) mismatch risk of the risky mix is also 3 times higher than the moderate mix, 10.2 resp. 3.4. The market offers a one-to-one trade-off between excess return and mismatch risk for this part of the efficient set. Holding a portfolio consisting of the moderate risky and the minimum variance mix gives a better trade-off between additional return and additional risk.

- *Funding ratio*: The initial funding ratio is 100%.
- *Basic contribution rate*: The base rate has to fund new accrued rights due to additional years of service of workers. The pension fund considers two options in calculating the base rate:
 - 1 The base contribution rate has to meet the economic cost ('cost price') of new rights based on the discount rate, i.e. the *real rate of interest net of real wages*.
 - 2 The setting of the contribution rate may anticipate the *real rate of return on assets net of real wage growth*. This option leads to a lower contribution rate compared with the first option.

- *Rules risk allocation*: The end-of-period funding ratio may deviate from 100% due to the riskiness of the (real) rate of return on assets. The period-end residue R_1 is allocated to the risk-bearing parties as follows, where $a + b + c = 1$:

$$R_1 = a[\text{additional indexation}] + b[\text{additional contributions}] \\ + c[\text{change in value contract of generational risk pooling}].$$

We can distinguish 4 alternatives in the allocation of the residue towards stakeholders:

- 1 $a=0, b=0, c=1$: all risk is shifted forward in time to subsequent generations; the value of the contract at the end of period is equal to R_1 ;
- 2 $a=0, b=1, c=0$: all risk is absorbed by active members via paying or receiving additional contributions equal to R_1 ;
- 3 $a=1, b=0, c=0$: all risk is borne by adjusting the indexation rate, so that the total indexation is equal to the aimed wage indexation plus the pension fund residue;
- 4 $0 < a < 1, 0 < b < 1, 0 < c < 1$, and $a + b + c = 1$: the rules of risk allocation distribute the fund residue to adjustments in indexation, contributions and contract.

8.5 Variants asset mix

It has been common wisdom amongst actuaries and pension fund governors that a risky asset mix has to be preferred above a mix free of mismatch risk or above the minimum variance portfolio. The reasoning is as follows. Due to the long-term nature of promised pension benefits, pension funds are able to follow a long-horizon investment policy. A risky asset mix may well lead to a high average return and hence a high funding ratio in the long run. The high funding ratio to be expected in the long run will offset the higher exposure to mismatch risk, so that shortfall risk is modest or will even disappear in the very long run. Stakeholders will benefit from a high funding ratio because of the prospect of contribution cuts and a generous indexation policy.

The value-based approach challenges traditional convention by clarifying that alternative positions regarding the trade-off between return and risk does not add economic value. A well-functioning capital market offers a one-to-one exchange between return and risk. A pension fund may aim to realize a higher funding ratio; however, there is a one-to-one relationship between the increase in the funding ratio and the increase in mismatch risk.

We compare four alternatives regarding the asset mix. The results as to the key variables are displayed in Table 1.

Parameters model:

- Mix: 1 variant 'risk-free' mix
- 2 variant 'minimum variance' mix
- 3 variant 'moderate risky' mix
- 4 variant 'risky' mix

Base contribution rate: The base rate is set equal to the cost price of new accrued liabilities (option 1).

Table 1. *Variants asset mix*

| Variant | riskfree | min variance | moderate | risky |
|-------------------------------|------------|--------------|------------|------------|
| Policy | | | | |
| Mix | riskfree | min variance | moderate | risky |
| Return | 5% | 5% | 6% | 8% |
| Contribution | cost price | cost price | cost price | cost price |
| Base rate | 19.5% | 19.5% | 19.5% | 19.5% |
| Risk allocation | | | | |
| <i>a</i> | 0 | 0 | 0 | 0 |
| <i>b</i> | 0 | 0 | 0 | 0 |
| <i>c</i> | 1 | 1 | 1 | 1 |
| Initial values at $t=0$ | | | | |
| FR_0 | 100% | 100% | 100% | 100% |
| R_0 | 0 | 0 | 0 | 0 |
| Expected outcomes at $t=1$ | | | | |
| $E[FR_1]$ | 100.0% | 100.0% | 100.9% | 102.8% |
| $E[R_1]$ | 0 | 0 | 1451 | 4352 |
| Economic value at $t=0$ | | | | |
| $V[FR_1]$ | 95.2% | 95.2% | 95.2% | 95.2% |
| $V[R_1]$ | 0 | 0 | 0 | 0 |
| $V[call]$ as % S_0 | 0.0% | 1.7% | 2.4% | 7.1% |
| $V[put]$ as % of S_0 | 0.0% | -1.7% | -2.4% | -7.1% |
| Transfers of value* | | | | |
| $\Delta V[\text{workers}]$ | 0% | 0% | 0% | 0% |
| $\Delta V[\text{pensioners}]$ | 0% | 0% | 0% | 0% |
| $\Delta V[\text{contract}]$ | 0% | 0% | 0% | 0% |
| Sum | 0% | 0% | 0% | 0% |

Note: * as % of S_0 .

Indexation: The indexation is according to the aimed level, i.e. the nominal wage growth.

Risk allocation: The risk regarding the residue is allocated to the future, i.e. subsequent generations:

$$a=0, b=0 \text{ and } c=1.$$

We comment on the results of Table 1. In the variant 'risk free', the risk-free asset mix in combination with a base contribution rate equal to the cost price will lead in the up-state as well as in the down-state to a year-end funding ratio of 100%. The expected year-end funding ratio, $E[FR_1]$, is equal to 100%. The actual and expected outcomes for the year-end residue, R_1 respectively $E[R_1]$, are zero, so the economic value of next-year residue, $V[R_1]$, is also zero. The economic value of the funding ratio, $V[FR_1]$, is 95.2%. This is exactly equal to the risk-free discounted value of the expected year-end value of the funding ratio of 100%. The risk-free mix is not available. The minimum variance portfolio minimizes the exposure to mismatch risk. Excess return is zero, so the expected values of funding ratio and residue are the same as in the 'risk-free' variant. The variants 'moderately risky' and 'risky' both give

prospect of a return higher than the risk-free rate of 5%. This explains why the expected funding ratio and the expected residue are both greater than 100%. These results can only be realized by taking more mismatch risk. Discounting the year-end outcomes by adjusting for the involved risk gives the same results in terms of economic value. The economic value of the funding ratio of the variants 'moderately risky' and 'risky' both is 95.2% and the economic value of the residue for both these two variants is zero. Hence, these results show that taking mismatch risk does not add value.

Taking mismatch risk makes the year-end values of the funding ratio and the residue volatile. The actual outcomes of the residue will be negative in the down-state due to a poor return. A positive residue will result in the up-state with a high return. This explains why in the three risky variants the put and call premiums deviate from zero. Risk allocation states that mismatch risk may be shifted forward in time and has to be borne by subsequent generations. The symmetry in the reported values of the option premiums makes clear that the expected increase in the funding ratio provides a fair compensation for the risk taken by the subsequent generations. Furthermore we would draw your attention to the difference in size of the option premiums. The premiums differ in magnitude in proportion to the magnitude of the systematic mismatch risk of the three mixes. The excess return and mismatch risk of the risky mix are three times those of the moderately risky mix. This is reflected in the magnitude of the option premiums, which are also three times higher for the risky mix compared to the moderately risky mix.

8.6 Variants base contribution rate

In setting the contribution rate, it is common for actuaries to take into account the expected rate of return. The sum of contributions and expected return on assets has to match the future benefits, so goes the argument. However the risk involved is not taken into account. In this section therefore, we study the effect of setting the base contribution rate according to the expected real rate of return on assets (option 2) compared with setting the base contribution rate according to the real rate of interest (option 1).

Parameters model:

Mix: The pension fund will invest according to the moderate asset mix. This gives a real rate of return of 3%.

Base contribution rate: We study three variants.

- [1] The first variant, called 'cost price', reflects economic principles. The base contribution rate is equal to the cost price of new accrued liabilities because of one year of additional service, calculated with the real rate of interest of 2%. The contribution rate in this variant is equal to 19.5%.
- [2] The contribution rate in the second variant, named 'return1', also has to fund new accrued liabilities because of one year of additional service. The discount rate used is now the real rate of return on the asset mix of 3%. The base contribution rate in this variant is equal to 13.4%.

Table 2. *Variants contribution rate*

| Variant | cost price | return1 | return35 |
|----------------------------|------------|----------|----------|
| Policy | | | |
| Mix | moderate | moderate | moderate |
| Return | 6% | 6% | 6% |
| Contribution | cost price | return1 | return35 |
| Base rate | 19.5% | 13.4% | 11.8% |
| Risk allocation | | | |
| <i>a</i> | 0 | 0 | 0 |
| <i>b</i> | 0 | 0 | 0 |
| <i>c</i> | 1 | 1 | 1 |
| Initial values at $t=0$ | | | |
| FR_0 | 100% | 100% | 100% |
| R_0 | 0 | 0 | 0 |
| Expected outcomes at $t=1$ | | | |
| $E[FR_1]$ | 100.9% | 100.0% | 99.8% |
| $E[R_1]$ | 1451 | 0 | -371 |
| Economic value at $t=0$ | | | |
| $V[FR_1]$ | 95.2% | 94.3% | 94.1% |
| $V[R_1]$ | 0 | -1382 | -1735 |
| $V[call]$ as % of S_0 | 2.4% | 1.9% | 1.8% |
| $V[put]$ as % of S_0 | -2.4% | -2.8% | -3.0% |
| Transfers of value* | | | |
| $\Delta V[workers]$ | 0.0% | 1.0% | 1.2% |
| $\Delta V[pensioners]$ | 0.0% | 0.0% | 0.0% |
| $\Delta V[contract]$ | 0.0% | -1.0% | -1.2% |
| Sum | 0.0% | 0.0% | 0.0% |

Note: * as % of S_0 .

[3] The base contribution rate in the third variant, the so-called ‘return35’, is determined for a 35-year period. The present value of the accrued rights during this period has to be matched by the present value of contributions during this period. The discount factor is the expected real rate of return on assets of 3%. The contribution rate to be charged each year over the 35-year period is equal to 11.8%. In fact, the contribution rate according to this variant is more or less an average of the sequence of 35 one-year contribution rates that follow from the preceding variant ‘return1’.

Indexation: The indexation accords to the aimed level, i.e. the nominal wage growth.

Risk allocation: The risk regarding the residue is allocated to the future, i.e. to subsequent generations:

$$a=0, b=0 \text{ and } c=1.$$

Table 2 shows the key results. The settings of the ‘cost price’ variant are the same as the variant ‘moderately risky’, commented on already in Section 8.5. The expected year-end residue in variant ‘return1’ is zero; however, the economic value of the

residue is negative. Furthermore, one may observe a transfer of value from future generations to current workers. The transfer is expressed as a percentage of the value of the stakes of the stakeholders at $t=0$. This transfer stems from the appropriation of the expected excess return on assets by workers, whereas the associated mismatch risk is shifted forward to the subsequent generations. This split explains why in economic value terms current workers gain and subsequent generations lose. Future generations lose economic value because they have to bear the funding risk without being compensated for the risk they are taking.

The base contribution in variant 'return35' is 11.8% and falls short of the 13.8% in the 'return1' variant, explaining the larger size of the transfer of value between current workers and subsequent generations. The expected outcome of the residue is now negative.

8.7 Funding characteristics of Dutch pension funds and implied transfers of value

We apply the method of value-based generational accounting to study the effects of funding practice typically used by Dutch pension funds during the 1980s and the 1990s.

Dutch pension funds usually have set the base contribution rate according to the aforementioned variant 'return35'. The asset allocation can be characterized as moderately risky. The course of the average funding ratio of Dutch funds (fair value) during the period 1990–2003 first follows a path of steady increase up to more than 130% in 1999 and a serious fallback below 100% thereafter, due to the drop in stock prices. Dutch funds usually have no explicit rules regarding the allocation of funding surpluses and shortages. Many pension funds only have a vague statement in their regulations regarding the indexation policy: 'indexation will be given unless the solvency position of the fund is inadequate'. The pension fund board of trustees preferred to follow a discretionary policy, giving maximum freedom. The absence of explicit rules led to a lot of discussion as to the allocation of the residue. During the prosperous years up to 1999, pension fund governors applied serious cuts in the contribution rate or even repaid formerly paid contributions. The pensioners were increasingly complaining that the contribution cuts and restitutions would eat away the reserves for future indexation. The recent drop in the funding ratios of many funds has led to a serious conflict between the stakeholders regarding the issue of who has to pay for the recovery of the funding ratio. The current situation can be characterized as 'policy inertia'. The employees and labor unions together are standing firm in resisting high increases in the contribution rate. They prefer a long amortization period to correct the funding deficit. They hold the firm belief that the long-run funding ratio will improve due to the expected high rate of return of a mix with a substantial proportion of stocks. Pensioners not represented on the Board of the pension fund fear serious cuts in the indexation rate.

We have mimicked the Dutch practice with our model in order to show that the Dutch practice did have implied transfers of value, which probably were not explicitly intended. The features of Dutch funds are captured as follows. The allocation of the mix is the 'moderately risky' mix. The base contribution rate is set according to

Table 3. *Transfers of value between stakeholders in Dutch pension funds*

| Stakeholders | Initial funding ratio | | |
|-------------------------|-----------------------|--------|--------|
| | 90 % | 100 % | 110 % |
| ΔV [workers] | +0.4 % | +1.3 % | +2.4 % |
| ΔV [pensioners] | -0.5 % | -0.2 % | 0.0 % |
| ΔV [contract] | +0.1 % | -1.1 % | -2.4 % |
| Sum | 0 % | 0 % | 0 % |

variant 'return35'. The indexation is aimed to follow wage inflation. A surplus is allocated to workers via contributions cuts calculated on a basis of an amortization period of ten years. Contribution charges are required from workers in case of a shortage, but the amortization period is set equal to 35 years. Full indexation is given when the funding ratio is above 100 %. No indexation is given when the funding ratio is below 100 %.

Parameters of the Dutch case (=mimic policy pension funds 1980–2002)

Mix: moderately risky

Contributions:

Base rate: variant 'return35'

Cuts: if funding ratio > 100 %, then amortization period is 10 years

Charges: if funding ratio < 100 %, then amortization period is 35 years

Indexation policy:

Full indexation if funding ratio > 100 %

No indexation if funding ratio < 100 %

Table 3 lists the transfers of value between stakeholders for three initial funding ratios as a result of the mimicked Dutch fund practice.

Workers are the real winners in the Dutch case. There are two reasons for this. Firstly, the contribution rate is set according to variant 'return35', that is below 'cost price'. The workers appropriate the excess return but shift the involved risk forward in time. The second reason stems from the asymmetry in the amortization period to calculate cuts and charges, 10 resp. 35 years. The pensioners lose economic value because they do not benefit from a funding surplus whereas they have to accept an indexation cut in times of a funding shortage. The subsequent generations are also, on balance, losers. They bear a substantial part of the mismatch risk but they receive a too low compensation for their risk taking. Clearly, the Dutch case fails to meet the criterion of being *ex ante* fair to the stakeholders.

Figure 3 shows the result in transfers of value (vertical axis) amongst the current stakeholders, which have been divided according to age-cohort (horizontal axis). The figure shows that the mimicked Dutch funding practice implies transfers of value to workers from pensioners and future age-cohorts. The latter group is not shown in the figure, but their loss in economic value is equal to the difference in area in the upper section (workers) minus the area in the section below zero (pensioners).

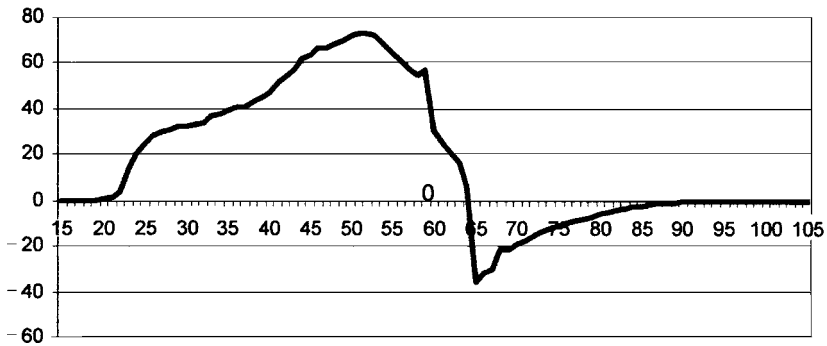


Figure 3. Transfers of value between age-cohorts initial funding ratio = 100 %

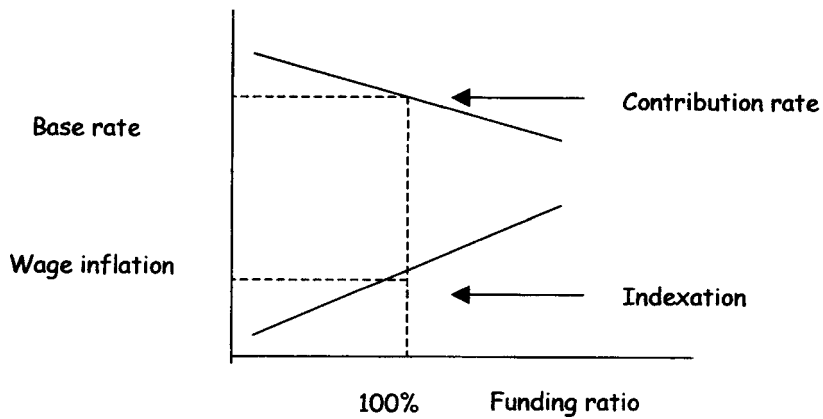


Figure 4. Policy ladder

8.8 Fairness and sustainability

Dutch pension funds currently suffer from low funding ratios below 100% (fair value) and conflicts between stakeholders leading to policy inertia. There is still widespread support amongst the stakeholders for the maintenance of defined-benefit schemes. All parties involved, however, recognize the need for a fundamental reshaping of the funding process and risk sharing to enhance long-term sustainability.

A resolution may be found in the appliance of value-based generational accounting, aimed at meeting the two criteria proposed in Section 8, i.e. *ex ante* fair compensation for risk taking and *ex post* sustainable effects.

The first criterion can be met by introducing the so-called policy ladder (Ponds, 2003). The goal of the ladder is to arrive at explicit rules regarding risk allocation. The ladder is quite simple (see Figure 4). When the funding ratio happens to be equal to 100%, the contribution rate is equal to the base rate and the indexation equals the wage inflation. There will be cuts and charges regarding the base contribution rate and indexation rate when the funding ratio deviates from 100%. The gradients of the two lines in Figure 4 are decisive regarding the size of the *ex post* effects for actual

contribution rate and actual paid-out indexation. The steeper the gradients, the more mismatch risk is absorbed by current stakeholders and less by subsequent generations. We apply the additional rule that in case of discontinuity of the pension fund, the pension fund wealth at hand is distributed amongst the stakeholders in proportion to their accrued rights.

The ladder guarantees that the stakeholders' interests are treated in symmetry. Furthermore, a policy ladder prevents policy inertia. It is always clear who takes part, and when and to what extent in the mismatch risk of the fund. It is always obvious to whom the funding shortage or surplus belongs.

The second criterion will become more and more relevant as Dutch funds face several trends that may be critical for the reach of the intergenerational risk sharing. The first trend to be noted is that Dutch funds will become more mature. The ratio of pension liabilities to total wages is projected to go up from 2.6 to 4.5. A decrease in the funding ratio of 1% would require an additional contribution of 4.5% of salary in the future instead of the current 2.6%. Furthermore, future young may adopt a more critical attitude due to more individualism and heterogeneity, and higher education. Intra-Europe labor mobility will provide more opportunities for new workers to avoid high burden of contributions.

The challenge to Dutch pension funds is how to accomplish their ultimate goal, i.e. providing standard-of-living risk insurance, with a fair and sustainable system of risk exposure and risk allocation.

This will imply first being cautious about mismatch risk, or even minimizing mismatch risk by holding the minimum variance portfolio. Secondly, a sustainable set of risk-allocation rules. We explore four different alternatives regarding the slopes of the policy ladder. These alternatives differ as to the size of the risk-allocation parameters a , b and c . The variant 'future' implies that all mismatch risk is shifted forward in time and have to be borne by future generations. The gradients of the slopes are zero. The variant 'current' states that a funding shortage or surplus is divided equally between current workers and current pensioners. The future generations bear no risk. The slopes have a steep gradient. The variant 'equal split' divides a funding residue amongst the three groups of stakeholders in equal one-third proportions. Finally, the variant 'collective DC' provides an alternative way of risk taking by workers. The contribution rate is no longer used for risk absorption. This variant recognizes that the recovery capacity of the contribution instrument in Dutch funds is already low and will decrease further due to increasing maturity in the coming years. Workers in this variant now participate in risk taking, as the indexation of their accrued rights is the same as for pensioners. The name 'collective DC' is chosen because the variant has some similarities with an individual DC, i.e. a fixed premium rate but uncertain pension result, but the risks are borne collectively by the plan participants in line with the size of their accrued liabilities.

Parameters:

Mix = minimum variance portfolio

Base contribution rate = 'cost price' new accrued rights due to one year of service

Indexation = aimed level is wage inflation

Table 4. *Variants policy ladder*

| Variant | future | current | equal split | coll DC |
|--|--------------|--------------|--------------|--------------|
| Policy | | | | |
| Mix | min variance | min variance | min variance | min variance |
| Return | 5% | 5% | 5% | 5% |
| Contribution | cost price | cost price | cost price | cost price |
| Base rate | 19.5% | 19.5% | 19.5% | 19.5% |
| Risk allocation | | | | |
| <i>a</i> | 0 | 0.5 | 0.33 | 0.33* |
| <i>b</i> | 0 | 0.5 | 0.33 | 0 |
| <i>c</i> | 1 | 0 | 0.33 | 0.33 |
| <i>Note:</i> * accrued rights of workers and pensioners. | | | | |
| Initial values at $t=0$ | | | | |
| FR_0 | 100% | 100% | 100% | 100% |
| R_0 | 0 | 0 | 0 | 0 |
| Expected outcomes at $t=1$ | | | | |
| $E[FR_1]$ | 100.9% | 100.0% | 100.0% | 100.0% |
| $E[R_1]$ | 1451 | 0 | 0 | 0 |
| $E[\text{contribution rate}]$ | 19.5% | 19.5% | 19.5% | 19.5% |
| $E[\text{indexation}]$ | 3.0% | 3.0% | 3.0% | 3.0% |
| Economic value at $t=0$ | | | | |
| $V[FR_1]$ | 95.2% | 95.2% | 95.2% | 95.2% |
| $V[R_1]$ | 0 | 0 | 0 | 0 |
| $V[\text{call}]$ | 2.37% | 0.76% | 1.01% | 1.14% |
| $V[\text{put}]$ | -2.37% | -0.76% | -1.01% | -1.14% |
| Transfers of value* | | | | |
| $\Delta V[\text{workers}]$ | 0.0% | 0.0% | 0.0% | 0.0% |
| $\Delta V[\text{pensioners}]$ | 0.0% | 0.0% | 0.0% | 0.0% |
| $\Delta V[\text{contract}]$ | 0.0% | 0.0% | 0.0% | 0.0% |
| Sum | 0.0% | 0.0% | 0.0% | 0.0% |
| <i>Note:</i> * as % of S_0 . | | | | |
| Δ indexation up | 0% | 1.35% | 0.89% | 0.95% |
| Δ indexation down | 0% | -2.02% | -1.33% | -1.42% |
| Δ contribution up | 0% | -9.19% | -6.07% | 0.00% |
| Δ contribution down | 0% | 13.79% | 9.10% | 0.00% |

Risk allocation:

| | | | |
|--------------------------|------------|----------|----------|
| Variant 'future': | $a=0$ | $b=0$ | $c=1$ |
| Variant 'current': | $a=0.5$ | $b=0.5$ | $c=0$ |
| Variant 'equal split': | $a=0.33$ | $b=0.33$ | $c=0.33$ |
| Variant 'collective DC': | $a=0.33^*$ | $c=0.33$ | |

* conditional indexation applies to accrued rights of workers and pensioners

Table 4 displays the results for the key variables. The table also shows the size of the outcomes in the up-state and down-state for the contribution rate and the offered indexation as percentage of the wage inflation. Note first of all that none of the variants implies any transfer of value amongst the stakeholders. This results from the

application of the policy ladder. Hence, all variants meet the first criterion as to an *ex ante* fair compensation for risk taking. The variant 'future' allocates all risk to the future generations. The option premiums therefore show up the highest values of all of the four variants. The variant 'current' allocates all risk to current participants. In the down-state, the indexation cut is -2.1% and the additional contribution charge is $+13.8\%$. In the up-state, additional indexation of $+1.4\%$ will be given and the contribution cut is equal to -9.2% .

The variants 'future' and 'current' both meet the first criterion, however the *ex post* effects may be too large. The variant 'equal split' distributes a funding residue equally to workers, pensioners and future members in order to reduce the *ex post* effects. Contribution effects remain still large due to the high maturity of the fund. This will have a disruptive effect on the purchasing power of workers and the functioning of the labor market. Therefore, the variant 'collective DC' is introduced. This variant performs better in meeting the second criterion. Mismatch risk is absorbed by workers via adjustments in the value of accrued rights, not in disposable income.

9 Conclusions

Chapman, Gordon, and Speed (2001) use a value-based approach to assess the economic value of the claims of the stakeholders in a company pension fund. This approach is also used to determine changes in the value of the stakes for alternative funding and indexation policies. The value-based approach reveals that a pension fund has to be seen as a zero-sum game between the stakeholders.

In this paper we employ the value-based approach to evaluate an industry pension fund that typically is based on intergenerational risk sharing, i.e. risk sharing between current workers, current pensioners and future participants. We signal that company pension funds tend to shift risk from employers to plan members: one may observe a trend from defined-benefit to defined-contribution and a trend that remaining defined-benefit schemes will rely increasingly on risk sharing between generations. The intergenerational risk-sharing nature of pension funds is clarified and the relevance of generational accounting is explained. We combine the value-based approach and generational accounting in a model to analyze a pension fund in terms of the economic value of the stakes of the different generations and the issue of who gains and who loses (transfers of value between generations) from alternative funding and indexation policies. Rules concerning the allocation of a funding surplus or funding shortage in particular are decisive to the direction and to the size of transfers of value between stakeholders. We put forward two criteria to evaluate alternative policies employed by pension funds: [1] the funding policy and allocation rules must give an *ex ante* fair compensation for risk taken by generations; and [2] the sustainability of a pension plan must be checked with respect to *ex post* redistributive effects for current and future generations. Value-based generational accounting provides a tool for testing a pension fund policy for these two criteria.

We derive as main conclusions:

- 1 The relevance of wage-indexed defined benefit pension funds is rooted in providing insurance against standard-of-living risk during retirement income, where

- the provided insurance is based on intergenerational risk sharing; this kind of insurance is not available in the market.
- 2 A pension fund providing standard-of-living insurance is necessarily exposed to mismatch risk; a pension fund is not able to eliminate mismatch risk because the matching portfolio consisting of wage-indexed bonds is not available in the market; risk sharing amongst fund stakeholders is essentially the sharing of mismatch risk.
 - 3 Policy implications of value-based generational accounting contrast sharply with those of the traditional actuarial approach.
 - 4 The base contribution rate must reflect the economic cost price of new accrued liabilities in order to avoid transfers of value to workers at the expense of the other stakeholders.
 - 5 A pension fund taking (more) mismatch risk does not add economic value.
 - 6 Funding practice of Dutch pension funds has implied hidden transfers of value to workers at the cost of pensioners and future participants.
 - 7 A pension fund policy can be said to be *ex ante* fair for future generations when the economic value of the funding residue remains unchanged.
 - 8 An *ex ante* fair and *ex post* sustainable pension fund contract requires a policy ladder based on explicit rules regarding risk allocation between stakeholders and holding assets in the minimum variance portfolio.

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