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Network for Studies on Pensions, Aging and Retirement

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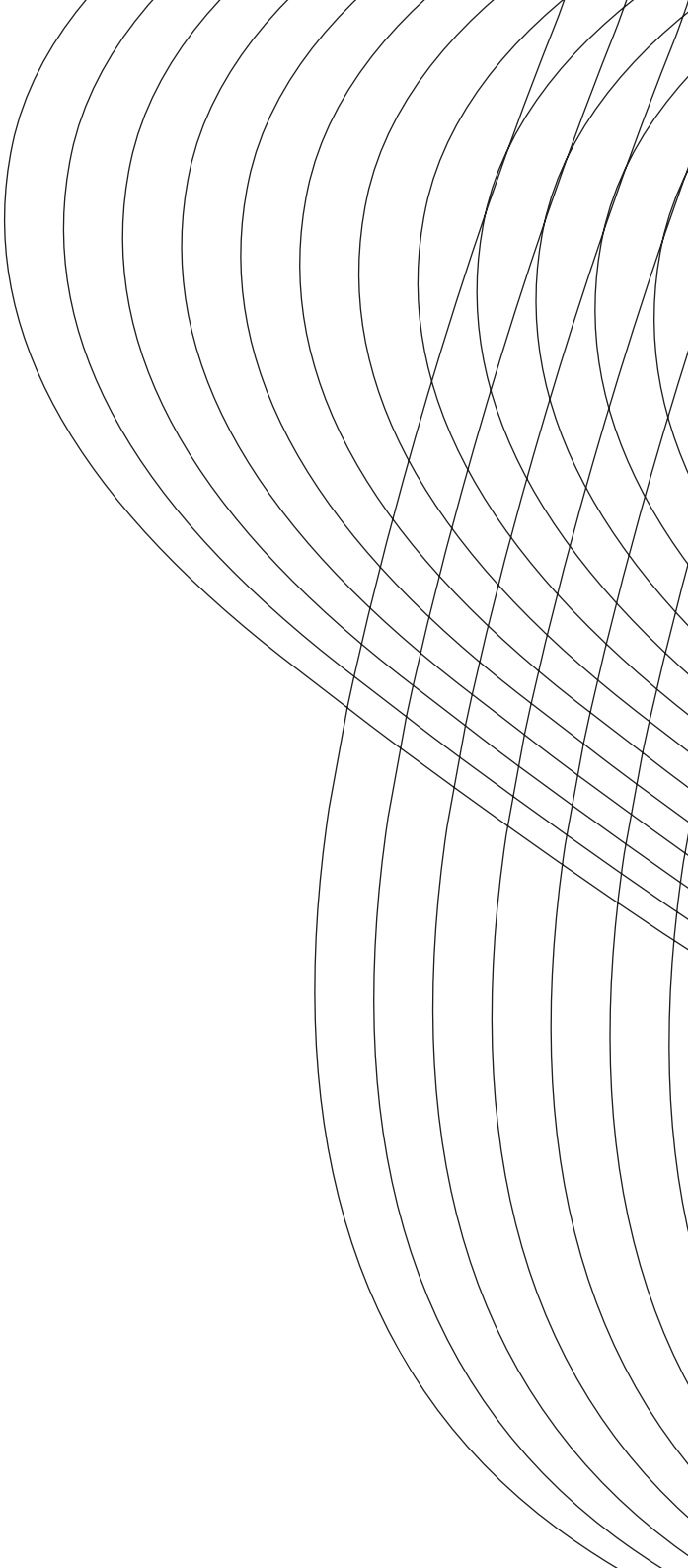
Jan Bonenkamp, Lex Meijdam, Eduard Ponds and Ed Westerhout

Reinventing intergenerational risk sharing



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PREFACE

Netspar stimulates debate and fundamental research in the field of pensions, aging and retirement. The aging of the population is front-page news, as many baby boomers are now moving into retirement. More generally, people live longer and in better health while at the same time families choose to have fewer children. Although the aging of the population often gets negative attention, with bleak pictures painted of the doubling of the ratio of the number of people aged 65 and older to the number of the working population during the next decades, it must, at the same time, be a boon to society that so many people are living longer and healthier lives. Can the falling number of working young afford to pay the pensions for a growing number of pensioners? Do people have to work a longer working week and postpone retirement? Or should the pensions be cut or the premiums paid by the working population be raised to afford social security for a growing group of pensioners? Should people be encouraged to take more responsibility for their own pension? What is the changing role of employers associations and trade unions in the organization of pensions? Can and are people prepared to undertake investment for their own pension, or are they happy to leave this to the pension funds? Who takes responsibility for the pension funds? How can a transparent and level playing field for pension funds and insurance companies be ensured? How should an acceptable trade-off be struck between social goals such as solidarity between young and old, or rich and poor, and individual freedom? But most important of all: how can the

benefits of living longer and healthier be harnessed for a happier and more prosperous society?

The Netspar Panel Papers aim to meet the demand for understanding the ever-expanding academic literature on the consequences of aging populations. They also aim to help give a better scientific underpinning of policy advice. They attempt to provide a survey of the latest and most relevant research, try to explain this in a non-technical manner and outline the implications for policy questions faced by Netspar's partners. Let there be no mistake. In many ways, formulating such a position paper is a tougher task than writing an academic paper or an op-ed piece. The authors have benefitted from the comments of the Editorial Board on various drafts and also from the discussions during the presentation of their paper at a Netspar Panel Meeting.

I hope the result helps reaching Netspar's aim to stimulate social innovation in addressing the challenges and opportunities raised by aging in an efficient and equitable manner and in an international setting.

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REINVENTING INTERGENERATIONAL RISK SHARING

Summary

This panel paper discusses the virtues of collective intergenerational risk sharing (IRS). The scope of IRS is large. It relates to *demographic risk* (longevity risk, fertility risk), *productivity risk* (wage risk, rate of return risk), *financial market risk* (risk of changes in the price of all financial assets including the equity premium) and *inflation risk*. Risk sharing in itself is beneficial as long as people are risk averse. The size of the benefits depends on several things, including the number of generations included in risk sharing (the length of the recovery period) and the development of capital markets. The more developed capital markets are, the more people can use the market to insure themselves against particular risks, and the less welfare improvement may stem from collective risk sharing. It is not plausible, however, to expect that all risks can be covered through capital markets.

Risk sharing is not only beneficial; it is also costly. In particular, risk sharing deteriorates the functioning of labor markets. Further, it opens the possibility of discontinuity risk: future generations may be unwilling to participate in a collective scheme that was decided upon when they were not born yet. The reason may have to do with a difference in preferences. The reason may also involve an overly large difference between what a future generation is required to contribute to the system and what it expects to get out of it.

There is a long literature on the benefits of intergenerational risk sharing. This literature establishes that the benefits can be

substantial. Estimates of the costs, involving either labor market distortions or discontinuity risk, are scarce. The few papers that compare benefits and costs conclude that the benefits of intergenerational risk sharing outweigh the costs. However, the fact that only a few papers have studied the combination of benefits and costs cautions against drawing too rigorous conclusions.

The world is not static, however, and a few important trends can be observed on the horizon. First and foremost is the trend of population ageing. The combination of low fertility and increasing longevity implies that in order to maintain a given amount of risk sharing per retiree, workers have to contribute more and more to pension schemes. Another important factor is increasing labour mobility. In addition, an increasing number of firms do not want to bear pension risks any longer; many firms have converted their pension schemes into private individual schemes or collective schemes in which the firm no longer acts as risk absorber. In these new schemes, participants have to bear all of the risks involved. The combination of these trends highlights the important lesson that an IRS arrangement needs to be open for flexible adjustments to changing preferences and circumstances.

This paper therefore concludes that collective pension arrangements need to be reinvented. In particular, the price of intergenerational risk sharing has increased and will likely increase further in future decades. This calls for downsizing the reach of intergenerational risk sharing. This does not represent a call for eliminating risk sharing, which would occur if collective pension arrangements were replaced with individual arrangements. The benefits of risk sharing are so large that such a reform would very likely be welfare-reducing.

What this paper is proposing is the development of new forms or arrangements of intergenerational risk sharing. As it has done

with pensions, the Netherlands has taken steps in this direction by transforming final-pay schemes into average-pay schemes and increasing the pension entitlement age. But other countries have made reforms as well.

Experience in other countries suggests the following:

1] Risk steering via flexible benefits can be applied to a rich variety of pension plan types, including PAYG-based schemes and funded schemes. The PAYG-DB plan type can be replaced by the notional DC plan type. The funded DB plan type can be reset in a funded collective DC plan type.

2] It is possible to maintain the prospect of a certain pension income. Denmark's ATP has a split-up between individual pension pots providing nominal annuities (amounting to a certain nominal pension) and a collective pot with a risky strategy aiming at providing indexation in the form of additional annuities allocated proportionally to the individual pots.

3] The horizon of intergenerational risk sharing via flexible benefits should preferably be long. A long smoothing period is crucial in order to spread large shocks by means of a sequence of small benefit adjustments. The longer the period of smoothing, the smaller will be the impact of specific shocks on income and consumption. A long smoothing period requires a stable and long-lasting risk-bearing collective. The need for a risk-bearing collective that is as deep and as broad as possible calls for a nationwide plan. Indeed, the institutional arrangements discussed for Denmark, Canada and Sweden do have a nationwide span. Risk smoothing can also be organized at the level of companies, branches of industry, or groups of professionals— but the life cycle of many if not all of these

collectives is limited in time and will fall short compared to the indefinite duration of a nation or of very big collectives such as the government, the health care or financial sector, construction, and so on.

4] Due to the long-term nature of pension provisions, risk sharing in collective pension plans requires flexible plan settings, with plan parameters that can be changed over time in response to new, unexpected trends and developments.

5] Pension arrangements and public debt are the main institutions with IRS at the national level. Ideally, countries should consider pensions and debt in an integral framework to evaluate what is the optimal size of IRS and which set of institutional arrangements works best to organize IRS. While the government may be better equipped to organize large-scale IRS, it also suffers from political risk. This argument is even more relevant in the midst of an economic crisis.

What can be learned from this review, specifically when we consider the plan changes from a Dutch perspective? In both the first- and second pillar, sustainability has already been increased considerably by switching to conditional pension benefits. In the first pillar, the formal retirement age has been linked explicitly to the longevity trend. The second pillar has moved in recent years from traditional DB to collective DC. The example of Denmark shows that it is possible to integrate pension guarantees into the pension scheme. The example of Canada shows that it is possible to have long smoothing periods— as long as the pension scheme operates on a large (in this case, national) scale. Given that the future is fundamentally uncertain, there must be room to change the plan parameters over time.

1. Introduction

Intergenerational risk sharing is often organized within specific institutions. This paper distinguishes institutions along two criteria, which gives rise to four prototypes. The first criterion is whether institutions do or do not accumulate wealth (*i.e.* whether they are funded or unfunded); the second is that the contract that is offered by pension institutions is actuarially fair or possibly non-actuarially fair. This typology proves to be very useful: it focuses on the core dimensions of pension contracts while covering a wide variety of real-world institutions.

The risks covered in our analysis include *demographic risk* (longevity risk, fertility risk), *productivity risk* (wage risk, rate of return risk), *financial market risk* (risk of changes in the price of all financial assets including the equity premium) and *inflation risk*. Risks are defined as outcomes that deviate from earlier held expectations. One look at historical statistics suffices to conclude that these deviations can be very substantial and long-lasting. It is therefore not surprising that, according to a wide range of estimates, intergenerational risk sharing can increase welfare substantially.

Risk sharing is not a free lunch, however. Although each participant may benefit from a risk-sharing arrangement, the person who is required to make a transfer after the risk has materialized will generally lose because of the arrangement. This participant, if allowed, may choose to opt out of the arrangement, making the risk-sharing arrangement subject to discontinuity risk. If opting out is not allowed, it may still be an issue, although less severe: if the number of participants who wish to opt out is large enough, then opting out may be organized through the political process.

Risk-sharing institutions can take different forms, with the two most prominent examples being collective pension schemes and the government. But the two are not equivalent. Risk sharing through the government is subject to less discontinuity risk and can achieve a larger degree of intergenerational risk sharing. The other side of the coin is that government-run schemes are subject to political risk.

This paper argues that for the dominant form of intergenerational risk sharing in the post-war period (i.e. the traditional DB plan structure), the benefits and the costs of intergenerational risk sharing are changing over time, which calls for *reinventing* intergenerational risk sharing. Benefits have been increasing on account of the rise in longevity. Until recently, the age of pension eligibility has not kept up with the rise in longevity. Hence, the period to which risk sharing applies has lengthened. The costs of intergenerational risk sharing are increasing as well. The lengthening of the retirement period requires that contribution rates be increased, thereby aggravating labour market distortions. Furthermore, the factor labour is becoming increasingly mobile, which reinforces the distortionary nature of contributions to risk-sharing schemes. In addition, and related to these two factors, firms are increasingly less willing to act as risk absorbers: first, because pension schemes have matured over time and, second, because accounting principles require firms to make explicit the vulnerability of their financial position with respect to pension liabilities. As a consequence, firms are tending to reorganize pension schemes such that risks are shifted more to the participants in these schemes.

This paper argues that the change in the costs of risk sharing dominates the change in benefits. The welfare gain from a longer pension period is linear, but the welfare loss due to a higher

contribution rate is quadratic. As a consequence, the optimal degree of risk sharing decreases on account of the trends in demography and labour mobility. This explains the worldwide trend of privatization and reform of traditional defined-benefit schemes. But this process has not ended yet. The trend of population ageing will continue to affect economies in the future— to an even larger degree than it has in the past. The trend of increasing labour mobility is also likely to continue in the future: witness the ongoing process of globalization. This paper therefore argues that further reforms of risk-sharing institutions are needed.

The same trends may also explain why so many people support the idea of fully eliminating redistributive schemes such as collective pension schemes. This paper argues, however, that eliminating risk-sharing schemes is very different from downsizing them. Elimination of redistributive risk-sharing schemes can be considered as a typical case of overshooting: potentially turning the gains that may be reaped from a reform into a loss.

Reinventing risk-sharing institutions can take many forms. Countries differ in the solutions they have adopted to downsize their schemes. Notional defined-contribution schemes are becoming increasingly popular. The main difference from the traditional pay-as-you-go defined-benefit schemes from which they often originate is that they allocate a larger share of the risks to retirees. In this respect, the reforms that are undertaken in second-pillar pension schemes in the Netherlands fit into an international trend.

The rest of this paper is organized as follows. The next section develops a typology of pension schemes and describes how real-world institutions fit into this typology. Section 3 discusses risk sharing in collective schemes and elaborates on the consequences

of important trends for the scope of risk sharing. Section 4 illustrates the practice of reinventing risk sharing by discussing a number of country examples, including the Netherlands. Section 5 offers some concluding remarks.

2. Conceptual framework

2.1 Risk and risk sharing

This section first seeks to define the concept of risk. Often, risk is defined as a condition in which there is a possibility of an adverse deviation from a desired outcome. But financial risk, for example, is generally defined as the volatility of returns— and thus includes both potential worse-than-expected and potential better-than-expected returns. We define *risk* as the effect of uncertainty on objectives; it thus includes both negative and positive impacts on objectives, in line with the definition of financial risk.

We distinguish idiosyncratic risk from macroeconomic risk. *Idiosyncratic risk* refers to risk at the individual level; it is uncorrelated to a *macroeconomic risk*, which affects all individuals in a country at the moment that the risk is realized. An example of an idiosyncratic risk is individual mortality risk. Although this is an important risk on the individual level, if the group is sufficiently large, uncertainty is absent (or at least much smaller) on the aggregate level, due to the law of large numbers. In contrast, macroeconomic risks do not disappear on the aggregate level. Examples of macroeconomic risks are *demographic risk* (longevity risk, fertility risk), *productivity risk* (wage risk, rate of return risk), *financial market risk* (risk of changes in the price of all financial assets including the equity premium) and *inflation risk*.

Risk may be transferred from one individual to another who is more willing to bear the risk. An example is the process of hedging, where an individual can get protection against the risk of price changes in one asset by buying or selling another asset whose price changes in an offsetting direction. Another example of a transfer of risk is insurance, where risk is transferred through

a contract. In consideration of a specific payment (the premium) by one party, the second party contracts to indemnify the first party up to a certain limit for the specified loss that may or may not occur. A *swap* contract is also useful to transfer risk. A typical swap contract exchanges risk exposures between the contracting parties on economically fair terms.

We define *risk sharing* as an arrangement between (groups of) individuals to share the effect of uncertainty on objectives. That is, risk sharing smoothes the outcome for an individual across various possible future states of the world. An example of risk sharing is pooling or cooperative, non-profit insurance. Assuming that individuals are risk averse, this is *ex ante* (i.e., before the risk is realized) welfare enhancing. However, *ex post* (i.e. after the shock is realized) a risk-sharing arrangement will generally not be welfare enhancing for all participants. Ex post, there will generally be a transfer from one group of participants (who lose ex post) to another group of participants (who gain ex post). Therefore, the former group has an incentive to break the risk-sharing arrangement ex post. Due to this *time inconsistency* problem, risk sharing is only possible if there is some external force (a contract, a government) that ensures that the ex post transfer takes place, or if it can be safeguarded that the expected benefits of continuation of the insurance contract outweigh the costs of bringing up the required payment.

Due to their individual-specific nature, idiosyncratic risks can be shared by members of the same generation in a country. This is by definition not possible for aggregate (whether macroeconomic or demographic) risks. However, this type of risk may be shared between generations. This *intergenerational sharing* of macroeconomic risks is the topic of this paper. Below, we present a classification of the various forms of this type of risk sharing.

Before doing so, however, it should be noted that some of the macroeconomic risks mentioned above are country-specific— and can thus, in principle, also be shared between individuals in different countries. This *international risk sharing* is advocated by Shiller (1993), who proposes creating markets to allow trading of claims in shares on national incomes or government debt indexed to national income. If these markets were in existence, this would provide an alternative for intergenerational risk sharing. Shiller (1999) provides some calculations to illustrate the potential importance of international risk sharing. These calculations indicate that the standard deviation of the world change in real per capita GDP over long time intervals is about half of that of the within-country change. This would suggest that perhaps most of the utility gains that might be achieved by intergenerational risk sharing could be achieved alternatively by international risk sharing. Note, however, that even if markets for international risk sharing were existent, intergenerational risk sharing would not be completely redundant. There will always be global risks that cannot be shared internationally and can only be shared between generations.

2.2 Risk sharing versus redistribution

It is important to distinguish intergenerational risk sharing from intergenerational redistribution. Risk sharing is based on the assumption that ex ante there is no transfer between the generations. Ex post, intergenerational risk sharing generally implies transfers between generations. We speak of *intergenerational redistribution* when ex ante there is a transfer between generations. Intergenerational risk sharing can therefore be ex ante welfare-improving, but will imply an income loss for one party from an ex post perspective. In contrast,

intergenerational redistribution is welfare-lowering for one party also from an ex ante perspective. In reality, many institutional arrangements provide a mix of intergenerational risk sharing and intergenerational redistribution.

2.3 Types of intergenerational risk sharing

Table 2.1 shows our typology of risk sharing. It distinguishes two criteria. The first is funded versus unfunded. Unfunded contracts are contracts in which financial wealth is not transferred over time. An example is a risk arrangement where two parties agree that, conditional upon a certain event, one party will pay an amount of money to the other party. The contract may as well specify a payment if the event does not realize. In contrast, if a contract involves the accumulation of financial wealth, we will classify the contract as a funded one. Examples include not only pension contracts, where contributions are used to accumulate financial wealth, but also government debt, where expenditures are made by issuing government debt.

The second criterion is individual versus collective. An individual contract is actuarially fair. An actuarially fair contract can be organized in several ways. If capital markets function properly, an actuarially fair contract can be arranged through capital markets. Alternatively, institutions such as pension funds or the government can arrange such contracts. An individual contract as defined here does not exclude risk sharing but it restricts the sharing of risks to assets which are (potentially) tradable on capital markets. The risk sharing can be between different generations, as long as they are overlapping. Here, overlapping means that the generations that decide to share risks are alive both at the time they make the contract and at the time the pay-outs due to the contract have to be made.

Table 2.1: Typology of pension plans

	Individual plans	Collective plans
Funded	Individual DC	Funded DB, Collective DC
Unfunded	Swap, Intergenerational risk trading	PAYG DB, Notional DC

A collective contract, on the other hand, is not necessarily actuarially fair. Hence, it cannot be organized through capital markets. Only collective institutions such as pension funds and the government are able to organize such contracts – for example, a contract that shares risks inter-generationally between non-overlapping generations. Such a contract is not actuarially fair: at birth, a generation will find out that it pays a below actuarially fair price for the contract or a price that is higher than actuarially fair, dependent on the history of shocks throughout the life of the institution until the generation's birth. Indeed, intergenerational risk sharing between non-overlapping generations requires a collective contract.

The next section describes in more detail the types of contracts that correspond to each of the four possibilities in Table 2.1.

Collective, unfunded

If risk sharing involves yet unborn future generations with whom no contract can be signed, it is in general not possible to organize it through capital markets. This type of risk sharing can be realized, however, via institutional arrangements. For example, young workers may provide insurance to old retirees who are very vulnerable to financial market risk by guaranteeing a minimum return on their savings. That is, they promise to pay a transfer to the elderly if the return on savings falls below a certain threshold. In return, they expect the next generation of young to

do the same if the return on financial markets is low when they are old themselves. This type of inter-temporal risk sharing can be viewed as a conditional *pay-as-you-go (PAYG)* scheme and involves an infinite sequence of *overlapping generations*: the current young take over part of the risk of the current old, and the next generation of young takes over the risk of the current young when they are old, and so forth.[1] This differs fundamentally from risk sharing in individual contracts, which involves overlapping generations only.

Introducing a conditional PAYG scheme implies a windfall gain for the first generation of elderly, who get insurance for free. Moreover, risk sharing via such a scheme is limited by the well-known problems of PAYG schemes: it can only work if the young generation can be sure that the next generation of young will pay for them if the risk realizes (i.e., if there is no *discontinuity risk*). With voluntary participation, this requires that the costs of the transfer are always lower than the benefit of being insured. This may be the case if the risk is large and risk aversion is high (Westerhout, 2011; Beetsma et al., 2012). If this is not the case, the potential welfare gain can only be realized if there is an external enforcement mechanism. The government could act as this enforcement mechanism by making participation mandatory, but this is limited by political constraints. Moreover, the size of the transfers necessary in case the risk realizes depends strongly on the relative size of the generations (i.e., the scheme is vulnerable to *demographic risk*).

A notional *defined-contribution* (DC) scheme is very similar to a PAYG scheme. The benefit provided under a notional DC scheme

1 So instead of a direct (conditional) compensation by a contemporaneous generation, they receive a claim on the system. This is an example of what Bovenberg and Van Ewijk (2012) call an open account.

may depend on the rate of return on some financial asset, but may be made a function of other variables as well. This is similar to the benefit provided under a PAYG scheme, which may be price-indexed or wage-indexed (i.e. a function of the rate of price inflation or the rate of wage growth). Moreover, a Bismarckian PAYG scheme lets the benefit be a function of the number of years worked or the income earned on the labor market. Unlike the *defined-benefit* (DB) PAYG scheme (the most common type of PAYG scheme in the post-war period), the notional DC scheme does not guarantee a (nominal or indexed) benefit. Rather, the notional DC scheme lets the pension benefit take over the role of contributions in the PAYG DB scheme as risk absorber.[2]

Collective, funded

Theoretically, it is optimal to share shocks with as many generations as possible (Gordon and Varian, 1988; Ball and Mankiw, 2007). However, this requires a mechanism to spread shocks over non-overlapping generations. *Funding* is such a mechanism: instead of using direct transfers, in this case risks are shared by contributions to and withdrawals from a fund. For example, the large productivity risk that results from disasters that occur very infrequently in a country (Barro, 2006) can be shared between generations via an arrangement in which all generations in that country contribute to a fund (which is invested on the world capital market), but only the generation that is hit by a disaster is allowed to withdraw (a certain amount) from the fund. So intergenerational risk sharing through funding (i.e., via the capital market) creates additional possibilities for welfare

2 Throughout this paper we take a rather broad definition of a defined benefit (DB) pension scheme. Thus, a defined (guaranteed) benefit can be promised in nominal terms, price-indexed terms or wage-indexed terms.

enhancement, as risks can be shared with more, non-overlapping generations. However, it cannot be guaranteed that there is sufficient capital in the fund when a disaster happens. Hence, the risk-sharing arrangement only works if the fund is allowed to turn negative. So, also in this case, the risk-sharing arrangement can only work if the discontinuity risk can be eliminated.

Individual, unfunded

An example of an individual unfunded plan is a swap contract, which specifies transfers, conditional upon the difference between the realization of some interest rate and the expectation thereof at the time the contract was made. These contracts are voluntary and actuarially fair. In this example, capital markets are sufficiently well-developed, and contracts can be organized on capital markets.

To improve the intergenerational risk reallocation, Cui and Ponds (2014) propose market-based voluntary risk trading among the coexisting generations via an innovative swap market wherein participants trade equity-related returns for wage-linked returns, and vice versa. Typically, the young will sell wage growth risk and buy equity risk exposure minus a premium. This premium is set by a market maker, who collects all relevant information regarding the demand and supply of individuals in risk exposure at different premium levels. Cui and Ponds find that there always appears to be a market for equity-wage swaps among the co-existing generations and that the market-clearing premium from this risk trading may vary, depending on multiple-state variables (the development in the economy, in demographics and in human and financial capital). This type of swap market is effective in improving the welfare of both younger and older individuals because of a flexible adjustment of the mix over the life cycle to

preferred risk exposure and because of a more complete market with wage-linked returns. The equity-wage swap structure is also useful for funded pension plans.

Individual, funded

This type of contract shares risks between overlapping generations. If these generations are affected differently by the risk, there is a basis for risk sharing. In principle, risk sharing that involves overlapping generations only can be realized via market transactions (i.e. the risk can in principle be shared via *trade* of risk-bearing assets on the market). For example, young workers will in general have more human capital and be less vulnerable to financial market risk than older workers and retirees, who have a lower stock of human capital and have accumulated more financial capital. The extra financial market risk of the elderly can be shared if the elderly sell risk-bearing assets to the young.[3] The other way around, young workers can in principle share the productivity risk on their human capital with older individuals by trading wage-indexed bonds. However, financial markets are incomplete in reality, and this type of risk sharing does not easily arise because of a lack of tradability of human capital (see Constantinides et al., 2002). Therefore, instead of using trade as an instrument for intergenerational risk sharing, this kind of risk sharing is often organized via an institutional arrangement (i.e., an *institutional hedge*). For example, wage risk and financial market risk can be shared in a pension arrangement in which participants only hold claims on each other.[4] In case of institutional hedging, it may be difficult to objectively price the

3 Of course, this becomes less attractive if the risks on human capital and financial capital are correlated, as argued by Benzoni et al. (2007).

4 This is what Bovenberg and van Ewijk (2012) call a *collective closed account*. See, for example, Hollanders (2012), chapter 5.

risk contract if it is not traded on the market. This may give rise to non-transparent transfers of wealth between participants.

Currently, pension funds provide long-term guarantees to plan members. These guarantees are associated with asset market risk, inflation risk and longevity risk. The guarantees for the current elderly actually are provided by the current young generation, whereas the guarantees for the current young, in turn, have to be delivered by the future young. Therefore, the age composition of the fund affects the implicit prices of the provided guarantees within the fund. Moreover, the implied risk exposure in the asset mix of the fund may not be the preferred exposure for the individual plan participants. Van Binsbergen et al. (2013) propose replacing this set of implicit guarantees by a nationwide system with explicit pricing and trading of long-term guarantees. Assume a collective plan in which individuals must participate. The savings are invested in a default asset mix. Individuals are given the option of trading in standardized guarantees— for example, a 30-year price-indexed annuity. There is a national clearing market to set the single prices for these guarantees.

2.4 Examples of risk-sharing arrangements

Henceforth, we abstract from intergenerational risk sharing via the market and concentrate on institutional risk-sharing arrangements. Institutional risk sharing takes place on various levels. For example, there are all kinds of informal risk-sharing arrangements within the family (Kotlikoff and Spivak, 1981), especially in developing countries (Galasso et al., 2009). Although these familial arrangements may be important, the focus in this paper is on intergenerational risk sharing via formal institutions such as pension schemes (both first- and second-pillar pensions) and fiscal policy (in particular, government debt).

We will not explicitly discuss *why* intergenerational risk sharing takes place. The reason is that this is often not completely clear. Risk sharing may result from an arrangement that was not deliberately set up as a means for welfare-enhancing risk sharing. Risk sharing may result as a 'by product' if there is an altruistic relation between the generations. If, for example, children care about their parents and transfer to them an amount of money that depends on their relative wealth position, this effectively provides an insurance against the risk of a low return on savings. This risk-sharing arrangement may also result 'by accidence' in case of a PAYG scheme, when politicians decide on the size of the transfer taking into account the utility of currently living generations (Hollanders, 2012).[5]

Now we present a few examples of institutional arrangements that generate intergenerational risk sharing.

A PAYG pension scheme

A PAYG scheme is often primarily seen as an instrument for intergenerational redistribution. However, it also provides risk sharing, both intra-generationally (see, for example, Fehr and Habermann, 2008) and inter-generationally (see, for example, Matsen and Thøgersen, 2004). A PAYG scheme allows generations to share productivity (wage) risk. The extent to which this is realized depends on the design of the PAYG scheme (see e.g. Kruse, 2002).

With a *fixed contribution rate* (as a percentage of wage income), a generation basically trades part of its wage risk for a share in the wage risk of the subsequent generation, which

5 On the other hand, politicians who only care for current generations may try to exploit future generations. In case of PAYG pensions, this may lead to an intergenerational transfer scheme that is larger than optimal (D'Amato and Galasso, 2010).

is in principle welfare enhancing (unless wages of subsequent generations are perfectly correlated). This is not a free lunch, however. PAYG schemes distort savings and labor supply, leading to adverse welfare effects that may well outweigh the benefits of intergenerational risk sharing (Krueger and Kubler, 2006; Nishiyama and Smetters, 2007). Moreover, PAYG schemes are vulnerable to demographic risks.

With a DB PAYG scheme, it is not the retirees but the working generations that bear the demographic risk: if the dependency ratio rises, working generations will have to contribute more to the scheme in order to maintain the benefit at the predefined level. The extent to which wage risk is shared inter-generationally within a DB scheme depends on the way the benefit is defined. With a fully wage-indexed benefit, the wage risk is shared in the same way as with a scheme with a fixed contribution rate– and the only difference lies in who bears the demographic risk. But if the defined benefit is not indexed at all, there is no intergenerational sharing of the wage risk: if the wage of a generation turns out to be low, that generation pays the same contributions to finance the defined benefit for the retired generation as in the case of a high wage.

A funded pension scheme

In case of a funded pension scheme, contributions are invested in the financial market and are thus vulnerable to financial market risk. If the pension scheme is of the (individual) DC type, it provides no intergenerational risk sharing at all. Such a pension fund is equivalent to private savings. Intergenerational risk sharing is introduced if the benefit is pre-defined in some way, as this introduces conditional transfers between generations. In principle, a DB funded pension scheme can be viewed as a

mix of an individual DC scheme and a conditional PAYG scheme. If, for example, an absolute level of the benefit is guaranteed on the basis of the contributions paid, this shifts the financial market risk to the subsequent generations: if the return is low, the subsequent generation will have to contribute more than the actuarially fair contribution necessary to accumulate their pension rights. If the defined benefit is wage-indexed, this introduces an additional intergenerational risk-sharing component. Then, not only do working generations share in the financial market risk of previous generations, but also retirees share in the wage risk of subsequent generations. This can be welfare enhancing and even allows for optimal intergenerational sharing of wage risk and financial market risk (Bovenberg and Beetsma, 2009). The introduction of the conditional PAYG scheme comes at a cost, however, as it introduces demographic risk and discontinuity risk. This limits the scope for intergenerational risk sharing (Cui et al., 2011; Westerhout, 2011; Beetsma et al., 2012).

Government debt and tax – transfer schemes

Just like a PAYG pension, government debt is often primarily viewed as intergenerational redistribution.[6] However, when the government's debt policy is dependent upon the realization of a stochastic shock, this can allow for intergenerational risk sharing. For example, the government can compensate a generation if a rare disaster hits the economy, and can finance the costs of this by issuing government debt that is gradually paid off by future generations. The large increase in government expenditures after the recent financial crisis can be viewed as an example of this. The issuing of government debt allows the burden of a disaster to be spread over (and thus the risk to be shared with) more

6 We abstract from the possibility that Ricardian equivalence holds.

generations. Yet, the amount of debt a government can create (and thus the amount of risk sharing it can provide) is limited: in theory a government cannot issue more debt than the present value of the primary surpluses it can realize in the future. This is the well-known no-Ponzi Game condition.[7] This present value is hard to determine in practice, and it is the financial market's estimate of this present value that determines how much a government can borrow. As soon as the market senses that the government may not be able to raise sufficiently large primary surpluses in the future, the interest on government bonds will rise. This will reduce the present value of the primary surpluses and may thus make the government insolvent.

In order to spread risks optimally (that is, over as many generations as possible), a government should not only issue debt after a disaster takes place (thereby sharing risks with future generations); it should also ensure that risks are shared with generations born before the shock takes place. That is, all generations that are not hit by a shock should also contribute to the risk-sharing arrangement. This implies that government debt may become negative (i.e., the government becomes a net bond holder) if a relatively large sequence of generations is not hit by a disaster.

A government's tax-transfer policy may also include elements of risk sharing via PAYG (i.e., sharing of inter-temporal risks via transfers). Assume, for example, that the government taxes funded pensions according to the EET (exempt-exempt-tax) regime. That is, pension contributions are tax exempt, the investment returns of the pension fund are tax exempt, but the pension benefits are taxed. This not only implies that tax revenues are postponed, but it also means that the government shares in

7 The no-Ponzi game condition essentially means that the government does not service its debt (principal and interest) by issuing new debt on a regular basis.

the financial market risk of the pension fund:[8] if the financial market return is low, tax revenues will be low. If this leads to higher tax rates, then working generations de facto share in the financial market risk of previous generations. They do not receive a direct compensation for this, but (assuming that the policy is continued) they know that future generations will share in their financial market risk.

2.5 Literature overview

We have classified pension arrangements with intergenerational risk sharing into four types: individual funded plans, collective funded plans, individual unfunded plans and collective unfunded plans. This section presents for each of these types what we consider to be the most important studies (see Table 2.2 below). As mentioned earlier, the primary focus of this paper is on the sharing of aggregate risks rather than idiosyncratic risks. Therefore, the list only contains studies that deal with the sharing of aggregate risks. For each study in the table, we mention the type of risk sharing that is discussed, provide a short description of the content and present its main result.

Most of the literature on risk sharing focuses on arrangements that cannot be organized by private markets. There are a few exceptions, though. With respect to funded schemes, Teulings and De Vries (2006) analyze generational accounts that allow for optimal consumption smoothing over the life cycle. Van Binsbergen (2013) studies explicit pricing and trading of guarantees as an alternative to risk sharing through funded pension plans. Regarding unfunded plans, Cui and Ponds (2014) propose a swap

8 Moreover, EET taxation implies a significant subsidy on pension savings because tax rates during retirement are generally much lower than during the working life (see Westerhout et al., 2004).

market (without collateral) to exchange equity and wage risks. This may also apply to funded plans.

Several papers study the role of intergenerational risk sharing in the context of collective unfunded pension schemes, building on early contributions of Enders and Lapan (1982) and Gordon and Varian (1988). The main lesson that can be drawn from this literature is that the welfare-improving role of an unfunded pension plan depends greatly on the endogeneity of the capital stock (i.e., partial equilibrium versus general equilibrium). Most studies that focus on a partial-equilibrium setting find that unfunded social security improves welfare (see e.g., Demange, 2002; Enders and Lapan, 1982; Gordon and Varian, 1988; Matsen and Thøgersen, 2004; Van Hemert, 2005). However, when allowance is made for general-equilibrium effects, the main conclusion is that the negative crowding-out effects of social security outweigh any positive risk-sharing effect (see, e.g., Krueger and Kubler, 2006; Imrohoroglu et al., 1999; Olovsson, 2010; Sánchez-Marcos and Sánchez-Martín, 2006).

Several studies analyze intergenerational risk sharing in the context of a collective funded pension scheme. One part of this literature takes a theoretical perspective, exploring the extent to which a funded pension scheme can organize optimal intergenerational risk sharing (see e.g., Allen and Gale, 1997; Ball and Mankiw, 2007; Beetsma and Bovenberg, 2009; Beetsma and Romp, 2013; Beetsma et al., 2013; Bohn, 2009; Gordon and Varian, 1988). Other studies deal with more real-world pension contracts and quantify the welfare gains of risk sharing (see e.g., Bonenkamp and Westerhout, forthcoming; Bovenberg et al., 2007; Cui et al., 2011; Gollier, 2008; Mehlkopf, 2011; Ponds, 1995). Although this last type of study differs a lot in terms of the model used and the parameter values chosen, all of these studies find

positive welfare effects, ranging from a lower bound of 2 to 3 percent (in terms of consumption-equivalent variation) as found by Cui et al. (2011) to an upper bound of 19 percent as reported by Gollier (2008).

Table 2.2: Selected list of studies on intergenerational risk sharing

Study	Type of risk sharing	Short description	Main result
Allen and Gale (1997)	Funded, collective	Studies the welfare consequences of intertemporal smoothing of aggregate risks	A long-lived financial intermediary can implement intertemporal smoothing and increase welfare of all agents (compared to the market equilibrium).
Ball and Mankiw (2007)	Funded, collective	Compares the optimal allocation of risk in a private economy without intergenerational risk sharing and a first-best economy with unlimited risk-sharing opportunities	Shows that a properly designed social security scheme can replicate the first-best economy.
Beetsma and Bovenberg (2009)	Funded and unfunded, collective	Investigates whether a pension system with an unfunded first pillar and a funded second pillar can replicate first-best intergenerational redistribution and risk sharing	The combination of a PAYG scheme with a funded part in which benefits are tied to prices or wages can achieve the first-best.
Beetsma, Romp and Vos (2013)	Funded and unfunded, collective	Same research question as in Beetsma and Bovenberg (2009), but their model is extended with endogenous labour supply	With endogenous labour supply, only a wage-indexed funded scheme combined with an unfunded first pillar can achieve the first-best.
Bohn (2009)	Funded and unfunded, collective	Analyzes the extent to which real-world social security policies (notably safe debt and safe pensions) contribute to an (ex ante) efficient allocation of aggregate risks	For standard model assumptions real-world social security policies typically impose not enough productivity risk on retirees and too much on future generations.

Study	Type of risk sharing	Short description	Main result
Bonenkamp and Westerhout	Funded, collective	Trades the welfare gain from risk sharing against the welfare loss from labor-supply distortions	The net welfare gain amounts to 3% (in terms of consumption-equivalent variation).
Bovenberg, Koijen, Nijman and Teulings (2007)	Funded, collective	Surveys the academic literature on optimal saving and investment over an individual's life cycle, and explores how collective pension plans help to relieve market incompleteness	Collective plans are welfare-improving by completing the market with intergenerational risk sharing, but this form of risk sharing also introduces new types of constraints.
Cui and Ponds (2014)	Unfunded and funded, individual	Analyzes intergenerational risk trading via an equity-wage swap	Proposed swap market is effective as welfare increases because of a flexible adjustment of the investment mix over the life cycle to the preferred risk-exposure and because of a more complete market with wage-linked returns.
Cui, de Jong and Ponds (2011)	Funded, collective	Analyzes risk sharing between generations in a variety of realistic collective funded pension schemes, where pension benefits and contributions both may depend on the funding ratio and asset returns	Well-structured collective plans with constancy as to risk-allocation rules and asset allocation outperform the optimal individual benchmark with flexibility in saving rate and asset allocation over the life cycle.
De Haan and Van der Lecq (2012)	Funded, collective	Considers the effects upon risk and return of a move towards generational accounts	Moving towards generational accounts will increase risk and lower returns.
Demange (2002)	Unfunded, collective	Studies the interim and ex ante efficiency aspects of dynamic stochastic economies	Risk sharing may be welfare-increasing.

Study	Type of risk sharing	Short description	Main result
Enders and Lapan (1982)	Unfunded, collective	Analyzes a PAYG plan under uncertainty to examine its effects on private savings, labor/leisure choice, and social welfare	PAYG plan is a welfare improvement, as the plan reduces uncertainty via pooling of risk across generations.
Fehr (2009)	Funded and unfunded, collective	Reviews the literature on CGE models with aggregate uncertainty	–
Feldstein and Ranguelova (2001)	Unfunded, collective	Analyzes the risk and return properties of a PAYG scheme and a DC scheme	The DC scheme outperforms the PAYG scheme for a range of specifications.
Gollier (2008)	Funded, collective	Analyzes efficient policy rules of collective pension plans regarding risk sharing and asset allocation.	Intergenerational risk sharing is welfare improving by raising the collective risk exposure and so getting prospect on a higher return for all.
Gordon and Varian (1988)	Funded and unfunded, collective	Analyzes government policies in transferring risk between generations (via taxation, social security, debt)	Intergenerational risk sharing via debt, taxation and social security has the potential to create first-order welfare improvements, and provides a non-Keynesian motivation for role for the government.
Gottardi and Kubler (2011)	Unfunded, collective	Studies the effects of a PAYG scheme on risk sharing, capital crowding out and the price of land	A PAYG scheme is welfare-increasing.
Krueger and Kubler (2006)	Unfunded, collective	Assesses the risk sharing and capital crowding-out effect of a PAYG scheme	A PAYG scheme is welfare-reducing.
Imrohoroglu, Imrohoroglu and Joines (1999)	Unfunded, collective	Assesses the risk sharing and capital crowding-out effect of a PAYG scheme	A PAYG scheme is welfare-reducing.
Matsen and Thøgersen (2004)	Funded and unfunded, collective	Studies the optimal mix between a funded and an unfunded scheme	The optimal pension scheme has a funded and an unfunded part.

Study	Type of risk sharing	Short description	Main result
Olovsson (2010)	Unfunded, collective	The risk-sharing gains of social security systems with wage-indexed benefits are traded against the negative crowding-out effects of these systems on the capital stock	The welfare gain is up to 15% (in terms of consumption-equivalent variation) without transitions and negative effects with transitions.
Ponds (1995)	Funded, collective	Early study on addressing welfare aspects of intergenerational risk sharing in real existing pension fund plans	Sustainability critically depends on the trade-off between welfare gain of insurance and welfare loss of shared negative shocks from the past or due to ageing-related reform
Sánchez-Marcos and Sánchez-Martín (2006)	Unfunded, collective	Compares the insurance gains of PAYG-DB pension systems against their crowding-out effects in case of demographic uncertainty	Insurance gains are outweighed by crowding-out effects.
Shiller (1999)	Unfunded, funded, collective	Analyzes role of intergenerational, intragenerational and international risk sharing in designing efficient social security schemes	Risk sharing in general is strongly welfare improving; analysis supports all kinds of risk sharing arrangements, funded as well as unfunded, with active government involvement.
Siegmann (2011)	Funded, collective	Computes minimum funding ratios for a funded DB-plan for which expected utility for plan members is equal to utility in an individual DC plan	Depending on risk aversion and the level of sophistication assumed for the DC scheme, the minimum acceptable funding ratios appear to be quite low, ranging between 0.87 and 1.20 in nominal terms.
Teulings and De Vries (2006)	Funded, individual	Discusses generational accounts	Generational accounts feature transparent property rights and allow for consumption smoothing over the life cycle.

Study	Type of risk sharing	Short description	Main result
Van Binsbergen, Broeders, De Jong and Koijen (2013)	Funded, individual	Analyzes intergenerational risk trading via a standardized long-term real annuity	The trading of long-term real annuities between plan participants of individual pension funds improves welfare, as it enables risk sharing across all pension plans instead of risk sharing within (old and young) plans, and as it contributes to consumption smoothing over the life cycle.
Van Bommel (2007)	Funded, collective	Analyzes limitations of intergenerational risk sharing via financial intermediaries	Not only underfunding but also overfunding may limit the reach of intergenerational risk sharing, as overfunding may lead to liquidation of the plan.
Van Hemert (2005)	Unfunded, collective	Explores how the participation decision by young members of a pension scheme restricts the possibilities for intergenerational risk sharing	Risk sharing may or may not be possible, depending on access of households to capital markets.

3. From theory to practice

3.1 Optimal intergenerational risk sharing in an ideal world

Young generations are endowed with relatively large amounts of human capital, but have not yet accumulated much financial capital. Old generations usually possess a lot of financial capital, but have already depleted part of their human capital. Without any risk sharing, the young are vulnerable to wage risk, which affects the return on their human capital, but not very vulnerable to inflation risk and financial market risk, which both affect the return on financial capital. Also longevity risk affects the return to financial capital: an unexpected increase in longevity lowers the annuity value of the already accumulated stock of pension wealth. Similarly, without any risk sharing, the old are vulnerable to inflation, valuation and longevity risk, but not too vulnerable to labour income risk. For the sake of brevity, we henceforth use the term capital income risk, to denote the combination of inflation risk, valuation risk and longevity risk.

An optimal risk-sharing scheme transfers part of labour income risk to the old and part of capital income risk to the young. Here, the term risk sharing refers to risk sharing that cannot be undertaken on a voluntary basis. It is thus a collective type of risk sharing. The no-risk-sharing case, serving as a benchmark against which we can compare the case with risk sharing, thus allows for private risk sharing (as is the case with individual DC accounts). Naturally, we assess the welfare properties of pension schemes from an ex ante viewpoint. Indeed, what is optimal ex post depends entirely on the weights given to specific generations in the social welfare function. The ex ante approach adopted here does not need to specify generational weights, and focuses exclusively upon the efficiency aspects of pension schemes.

An interesting question is what part of risks should be transferred to the other generation? It can easily be shown that, under CRRA preferences, the consumption of the young and the old should respond equally in relative terms to aggregate shocks (Bohn, 2009). Hence, if an adverse aggregate shock forces aggregate consumption to be reduced by one percent, consumption of the young and the old should both decline by one percent. This allows us to pinpoint the size of the transfers between the young and the old.

This result for the case where risk aversion is unrelated to age does not, however, carry over to the case where risk aversion is different for the old and the young. For example, suppose households exhibit habit formation, which means that younger agents are more risk tolerant than older agents are because they have more time to adjust their habits to unexpected shocks. For this case, Bohn derives that the consumption of the old should exhibit a smaller response to an aggregate shock than the consumption of the young does. He does not quantify the difference between the habit formation case and the CRRA case, but suggests that the difference can be substantial.

More generally, with CRRA preferences, the exposure to labour income risk and capital income risk should be constant over the household's life cycle (Bovenberg and Van Ewijk, 2012). This result echoes the findings of Merton (1969) and Samuelson (1969). However, with habit formation preferences, older generations should be less exposed to risk than the young, as habit formation makes the old more risk averse.

The opportunities for risk sharing can be further increased by including future yet unborn generations into the risk-sharing scheme. Indeed, this reduces the part of a shock that has to be borne by currently living generations and, as a consequence,

allows for an increase in risk exposure (see the pioneering work of Gordon and Varian, 1988, and Ball and Mankiw, 2007). All generations can benefit from the risk-sharing scheme in which they participate if lump-sum transfers are used as an instrument of redistribution. As Bovenberg and Mehlkopf (2013) show, the exact distribution of welfare gains over generations depends on the fairness criterion that is being used.

The pension scheme with optimal intergenerational risk sharing serves as a useful benchmark. However, the scheme cannot be found in reality. Below, we assess the benefits that are due to intergenerational risk sharing in real-world pension schemes. These benefits are in welfare terms. Hence, they measure the extent to which intergenerational risk sharing would add to society's welfare by comparing the welfare effects of collective pension schemes (with intergenerational risk sharing) with those of a similar individual pension scheme (without intergenerational risk sharing). This says nothing about the allocation of benefits over different generations; a gain at the aggregate level may imply losses for typical cohorts. Indeed, society's welfare is simply the sum of the welfare of all generations involved. Furthermore, real-world pension schemes may also imply welfare losses, as they distort labour supply decisions, for example, or may induce suboptimal consumption smoothing. By measuring the costs also in welfare terms, we offer an integrated view of the benefits and costs of pension schemes with intergenerational risk sharing.

3.2 Benefits

Basically, the size of the benefits from intergenerational risk sharing depends on three factors: the number of generations involved in the risk-sharing scheme, the number and type of risks

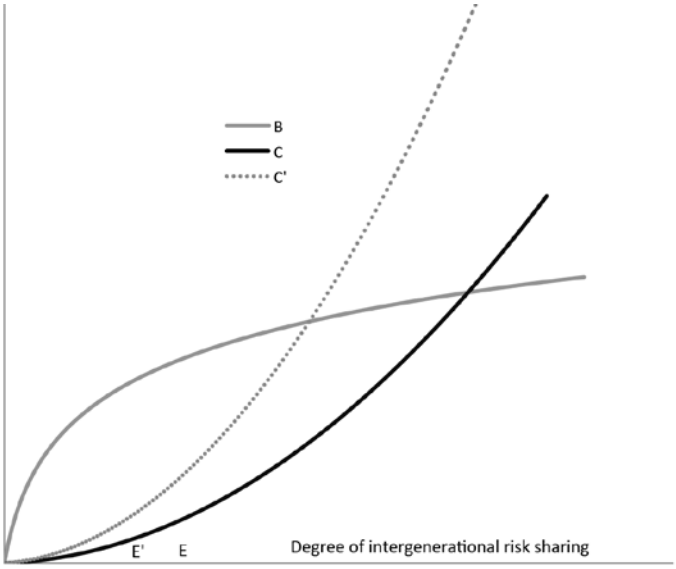
that are included in the scheme and the properties of the scheme that would be encountered by a person who would opt out of the risk-sharing scheme.

Regarding the first factor, a scheme that includes all generations (that is, all current generations and all generations who are not born yet) allows for maximum benefits from risk sharing. Indeed, a first-best risk-sharing scheme involves *all* future generations. The lower the number of generations involved, the less beneficial risk sharing will be.

As to the second factor, maximum benefits will be reaped by a scheme that insures against capital market risks, the wage risk, the risk of living longer and longevity risk. Schemes that protect against a subset of the series of risk factors are less beneficial in this respect. An example might be pension schemes that feature nominal benefits or price-indexed benefits. In both cases, a wage shock has no effect upon the level of pension benefits, implying that wage earners have to bear all of the shock.

The third factor that determines how beneficial risk sharing is in a risk-sharing scheme concerns the scheme available to the person opting out of the risk-sharing scheme. The case where someone who does not participate in a risk-sharing scheme can rely on well-established financial markets is very different from the case where financial markets are not very well developed. In the latter case, the non-participant faces constraints to his personal savings and insurance plan, which would be avoided by participating in the risk-sharing scheme. Hence, although financial markets cannot achieve the same amount of risk sharing as collective risk-sharing schemes do, it is true that a higher level of sophistication of financial markets reduces the benefits from intergenerational risk sharing.

Figure 3.1: Benefits and costs of IRS in collective schemes



3.3 Costs

In an ideal world, intergenerational risk sharing proceeds without costs. In a more realistic setting, two problems emerge. One is that it is in general not possible to disconnect pension contributions or taxes from income. Indeed, the lower the income of a worker is, the higher the probability will be that the required amount of pension contributions cannot be collected. Hence, pension contributions and taxes are mostly related to income. Unless pension benefits are related to income in the same way as pension contributions, this income dependency of contributions distorts the labour supply decision of workers. Indeed, it reduces the price of leisure, inducing workers to demand more leisure and to supply less labour than would occur in an ideal world.

Partly related to the first problem is the problem of discontinuity risk. Any intergenerational risk-sharing scheme that shares risks with future generations is subject to the risk that future generations will not pay the amount that the scheme requires them to pay. This occurs for several reasons: one is that the scheme carries over such a large amount of debt that future generations are incapable of paying the amounts required. Another is that future generations have different preferences. Hence, they may decide on a collective basis that they will not pay the amounts required. A third reason is that members of future generations may supply less labour than expected, reducing the amount of pension contributions below the level that was expected. If future generations indeed step out, contribution rates will have to be increased even further, thereby adding to the welfare cost of the pension contribution rate.

3.4 Optimal intergenerational risk sharing in an imperfect world

Let us assume that the benefits and costs from intergenerational risk sharing have the usual properties: *i.e.* the benefits are increasing in the degree of risk sharing, but the marginal benefits are decreasing, the costs and marginal costs are increasing in the degree of risk sharing and the marginal benefits exceed the costs at the point of zero risk sharing. Figure 3.1 illustrates this. The horizontal axis measures the degree of intergenerational risk sharing. The grey line (B) measures the benefits from intergenerational risk sharing and the black line (C) measures the costs, both in utility terms. If the degree of intergenerational risk sharing equals E, the two curves have equal slope and social welfare is at its maximum.

Note that we do not suggest that the benefits and costs of intergenerational risk sharing are constant through time.

On the contrary, we will argue that the benefits and costs of intergenerational risk sharing have changed during recent times and may continue to do so in the future. The primary reason for a change in benefits is the increase in longevity. Given that the age of pension eligibility does not move one-to-one with changes in life expectancy, risk sharing has increased over time. More specifically, if the degree of risk sharing remains constant over time, then increasing longevity increases the amount of risk sharing by lengthening the period over which the gains from intergenerational risk sharing can be reaped.

The costs of risk sharing are changing as well, for several reasons– the most important of which is population ageing. The combination of low fertility and increasing longevity implies that in order to maintain a given amount of risk sharing per retiree, workers have to contribute more and more to the pension system. The increase in the pension contribution rate aggravates labour market distortions and makes the cost curve in Figure 3.1 tilt upwards. Another important factor is that labour becomes increasingly mobile. This increases the elasticity of the contribution base with respect to the contribution rate, and also makes the cost curve tilt upwards. In addition, increasing numbers of firms no longer want to bear pension risks; many firms have converted their pension schemes into private schemes or collective schemes in which the firm no longer acts as risk absorber. Hence, participants in these new schemes have to bear all of the risks involved. If workers are required to bear more risks, this will also (depending on the amount of risk sharing per retiree) tilt the cost curve upward. Figure 3.1 represents the upward tilt of the cost curve as a change from the solid curve (C) towards the dotted curve (C′). Hence, the optimal amount of risk sharing, where marginal benefits and marginal costs coincide, shifts to the left: from

point E to point E′. The trends of increasing longevity, increasing labour mobility and decreasing willingness of firms to act as a risk absorber thus all call for less intergenerational risk sharing.

Obviously, this conclusion hinges upon the assumed shape of the functions that measure the benefits and costs of intergenerational risk sharing. Indeed, if the benefit curve was assumed to be convex and the cost curve concave, our conclusions might be invalid. However, such assumptions would deviate completely from such basic economic principles as decreasing marginal utility of consumption and increasing marginal disutility of taxation. Furthermore, the precise shape of the two curves and the shift that the trends considered will bring about, hinge on the specific model that is being used. For example, the functions that relate utility to the benefits from IRS and the costs attached to IRS are important— as is the function that relates the pension contribution base to the rate of pension contributions. Our knowledge of the precise form of these functions is scarce and would certainly be a useful object for further investigation.

Wrapping things up, we argue that there is a case for lowering the ambition level of redistributive schemes. This would reduce the welfare costs of these schemes more than the associated gains and would thus increase social welfare. By reducing the size of the scheme itself, a part of both the benefits and the costs attached to these schemes will be lost. Note that the ambition level should not go all the way to zero. We argue that by eliminating entirely the pensions that are provided by collective schemes, the net welfare gain would be smaller than maximal. Actually, eliminating rather than reducing pensions might even change the sign of the welfare effect, achieving a welfare loss rather than a welfare gain.

3.5 What are optimal institutions to organize risk sharing?

It is useful to define two cases for which we address the question of what are the optimal institutions to organize risk sharing. The first case is that of risk sharing between overlapping generations. This relates to the individual funded scheme, one of the four prototype forms of intergenerational risk sharing distinguished in section 1. To be more precise, in this case of overlapping generations, the two generations that enter into a risk-sharing contract are both alive at the time they sign the contract and at the time the eventual risk sharing will actually take place. The second case is then that of risk sharing between non-overlapping generations. This relates to the funded and unfunded collective schemes that were distinguished in section 1. Typical for this case is the case where a young and an old cohort could both benefit from risk sharing, but the young cohort was not born yet when the contract had to be signed.

Overlapping generations

Capital markets can help individuals to engage in this type of risk-sharing contract. Capital markets may not be sufficiently well-developed, however. The government could play a role in this and improve the conditions for a better functioning of the capital markets. Alternatively, public institutions (such as public pension schemes or the government) could organize the risk sharing. This may be a more direct way of organizing risk sharing, as it does not hinge upon private parties getting interested in participating in these markets. A drawback, however, is that private capital markets have more potential to fine-tune the products to the preferences of the workers. Heterogeneity of preferences would call for a private capital market solution rather than the "one size fits all" approach offered by public institutions. This is not meant

to suggest that all pension funds offer the same type of pension. Indeed, pension funds differ in the generosity of their pensions and their risk characteristics. Individual participants have few possibilities to take advantage of these differences, however, because of the legal obligation to participate in a typical pension fund.

Non-overlapping generations

In the second case, generations do not overlap. In this case, private capital markets cannot play a role. It is thus public institutions that must do the job. This could be the government or pension funds in which workers are obliged to participate. The latter could be company pension funds or sectoral pension funds. Employers are engaged in intergenerational risk sharing in two ways. Employers in a sector in which a sectoral pension fund is active pay part of the contributions to the scheme and automatically add to the risk sharing if the contribution rate is raised. Employers that have their own company pension fund can make higher contributions if the financial position of the company pension fund deteriorates. The case of a national pension scheme is covered by that of the government, since both serve the worker population of the whole country and differ in this respect from both company pension funds and sectoral pension funds. The pension contracts organized by a national pension scheme can be funded or unfunded. The case of public debt is also covered. Public debt implies risk sharing between non-overlapping generations, is organized through the government budget and treats people covered by different pension funds the same.
The costs that risk-sharing schemes impose on labour markets differ between the three cases distinguished. In the case of a company pension fund, overly high contribution rates may

induce workers to switch to another firm in the same sector of industry. If the worker is covered by a sectoral pension scheme, switching to another firm in the same sector is no option. In order to escape high pension contributions, the worker needs to switch to another sector of industry. In many cases, moving to a different sector will feature higher transition costs than moving to a different firm in the same sector. It is easier to start performing the job you are educated in at a different firm than it is to start a completely new profession (Bohn, 2012). Probably, the size of a pension fund is relevant as well. A small pension fund that covers relatively few workers faces relatively high labour mobility and, hence, a high discontinuity risk. If risk sharing is organized by the government, the problem of too-high pension contributions cannot be solved by moving to a different firm or moving to a different sector. Solutions that do work include becoming self-employed, withdrawing from the labour market or emigrating to a country with more favourable conditions. Compared to the cases of a company pension fund and a sectoral pension fund, the case of the government is the one where transition costs will be largest and the risk of discontinuity smallest. The government thus has more potential than sectoral pension funds do to raise the pension contribution rate, and much more potential than company pension funds.

A different argument against sectoral and company pension schemes is that they do not imply a level playing field. Indeed, workers and employers in different firms and sectors can define different contracts. This flexibility may be beneficial, as it is a way to accommodate heterogeneous preferences. The solidarity implied by the schemes may not be the ideal form of solidarity, however, as it is restricted to the group of persons covered by the same pension scheme. A related issue is the (non-)

coverage of the self-employed. There is no obvious reason to leave the self-employed out of schemes that aim to share risks between generations. Moreover, limiting solidarity to people who share the same occupation has no logical basis. In previous times, you were born as a mineworker, as your father and grandfather were mineworkers as well— and so forth for other occupations. Nowadays, there is much more flexibility in the types of occupation that people choose; the correlation between the types of occupation of fathers and sons must have become smaller, although we are not aware of any empirical study of this hypothesis.

Currently, we are not aware of any research that explores the lack of intergenerational risk sharing that is due to the decentralized set-up of the second pillar in the Netherlands. Based on the increase in the numbers of self-employed, we would expect that this issue has gained importance over time. The variety in investment policies also fuels the expectation that the issue has gained importance. Again, we are not aware of any research that focuses on these issues. This would then be an interesting topic for future research.

3.6 Risk sharing in practice: government versus pension funds

In practice, the risk-sharing characteristics of pension contracts depend on the way the government sector and the occupational pension funds deal with the effects of macroeconomic shocks. For pension funds these policy rules are generally better defined than for the government, where existing policies can always be overruled by new democratic majorities. In the Netherlands, the actual decisions taken by the board of a pension fund (which consists of representatives of employers, employees and occasionally retirees) are often based on formulated principles,

although there always remains some discretionary power of decision. Many pension funds use explicit rules regarding how to adjust contributions, indexation promises or the portfolio mix after a shock in the level of funding.

The Dutch government engages in risk sharing through its debt policy (risk sharing between current and future generations) and through its tax and expenditure policies (risk sharing between currently living generations). Many government expenditures, such as public old-age benefits, are explicitly or implicitly linked to aggregate wages. Therefore, a general increase in wages also fosters these public expenditures, which have to be covered by increasing taxes or raising public debt. In this way, the government transfers human capital risk of current workers and future generations to current retirees. Like occupational pensions, public old-age pensions also provide insurance against aggregate longevity risk. Also this risk is imposed on the human capital of the currently young (when financed by raising taxes) or the future generations (when financed by raising debt and future taxes).

Apart from this, occupational pensions in the Netherlands are subject to the EET fiscal treatment. Under this regime, pension contributions as well as interest earned on pension wealth remain untaxed, while pension benefits are taxed. An implication of the EET treatment is that the government also shares capital market risks between current and future generations. If pension funds, for example, increase the tax-deductible contributions after a negative wealth shock, this worsens the sustainability of Dutch public finances. As long as a part of this sustainability gap is financed by raising the budget deficit, the government transfers capital market risks to future generations along this fiscal channel.

To overcome discontinuity problems, the risk-sharing opportunities for the government and pension funds are restricted by

legal regulations. EU fiscal rules prescribe that public debt should in principle not exceed 60% of GDP, while the budget deficit should not be higher than 3% of GDP, unless there are exceptional economic circumstances (such as the current situation). Hence, for countries that have deficit and debt levels that are close to or even above these threshold values (such as the Netherlands at the moment), the ability to share risks with future generations becomes rather limited. Also Dutch pension funds are subject to strict solvency rules. In practice, the supervisor adopts two minimum boundaries for the nominal funding ratios. The first minimum is 125%.[9] The buffer of 25% should be sufficient to ensure that the funding ratio will fall below 100% on average only once every 40 years. If the funding ratio of a pension fund is below this minimum funding ratio, the fund should adopt policies to ensure that it will meet the minimum funding ratio within 15 years' time. The second minimum funding ratio is 105%. If the funding ratio of a pension fund falls below 105%, the fund is required to formulate a recovery plan that specifies how it will ensure that the level of 105% is restored within three years.[10]

How important in practice are these different channels of intergenerational risk sharing via the government and pension funds? Is the Dutch government the dominant party in sharing risks across generations or is most of the risk sharing done by pension funds? Bettendorf and Knaap (2012) provide some indicative answers to these questions, in their study of the effects of macroeconomic and demographic shocks on different cohorts in the Dutch economy. The effects of the shocks are simulated using

9 The minimum funding ratio of 125% is an average across pension funds because it is risk based, and thus depends on the portfolio composition of the pension fund.

10 In 2008, when the funding ratios of many pension funds dropped below 105%, this short-term recovery period was temporarily extended to five years.

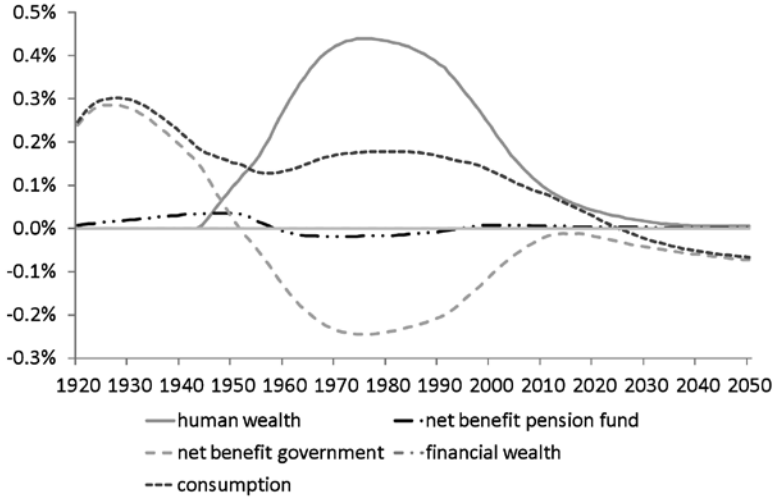
an overlapping-generations model that contains most features of the Dutch economy. They look both at the direct impact of shocks on agents' human and financial wealth and at the redistribution that is carried out by the Dutch government and the pension system. They come to the following conclusions:

- The government and occupational pension funds generally act to insure shocks across cohorts (i.e., they redistribute from the 'winners' to the 'losers'), but the insurance role of the former is much larger than that of the latter. The changes the government causes in the wealth of cohorts are several times larger than those caused by pension funds.
- Most of the insurance provided by Dutch pension institutions takes place between currently living generations. The amount of intergenerational risk sharing with future generations is rather limited.[11]
- The government mainly transfers productivity shocks from workers to retirees; occupational pension schemes mainly transfer financial shocks.

We can illustrate their findings with a temporary shock to productivity and a one-time shock to financial wealth. As shown in Figure 3.2, a temporary shock to productivity initially affects wages (solid line), particularly those of the generations with the highest participation rates (i.e., generations born around 1970). The government takes part of the wage increases away through taxes, resulting in a decline in the net government profit for the working generations (dashed line). As a second effect, wage-indexed transfers such as first-pillar and second-pillar pension

11 This is in line with the recent contribution of Hasanhodzic and Kotlikoff (2013), who show that in the US intergenerational risk sharing with the unborn is rather limited.

Figure 3.2: Redistribution effects from a productivity shock



Source: Bettendorf and Knaap, 2012); discounted, expected, lifetime net benefit change from a temporary shock on productivity, expressed as a percentage of consumption on the base path (no shock). The change is split into human wealth, pension funds, and net government profit. Financial wealth is not affected.

benefits go up. Along this channel, the government and the pension fund redistribute the effect of the productivity shock away from the initial recipients (working generations) to the initially unaffected generations (retirees). Notice that the government sector does most of this redistribution.

4. Reinventing intergenerational risk sharing: new practices

Recently we have witnessed the renewal and even the introduction of new forms of risk sharing between generations. These innovative plans may act as role models in the 21th century in re-engineering the design of intergenerational risk sharing. Recall the scheme introduced in section 2.

Table 4.1: Reinventing intergenerational risk sharing

	Individual plans	Collective plans
Funded	Individual DC	Funded DB, Collective DC
Unfunded	Swap, Intergenerational risk trading	PAYG DB, Notional DC

4.1 Notional DC plans: Sweden

The Notional DC plan structure has recently been introduced in various countries (Sweden, Italy). This new plan structure replaces the traditional PAYG- DB plan type, in which the contribution rate is adjusted to accommodate the contribution proceeds at the cost of promised benefits. Without reform, the process of ageing would lead to an unsustainable increase in the contribution rate for the traditional plan. The most striking features of the new notional DC plan are that the contribution rate is fixed and that the sustainability of the plan is organized by smoothing the finance burden in the long run over many generations via structural adjustments in the indexation policy.[12] A notional DC plan structure is able to spread demographic shocks over many

12 Recently, also the term Nonfinancial Defined Contribution has been used. A thorough exposition of the features of NDC plans is found in Holzmann et al. (2012). See also Palmer (2006).

generations. As the system is steering towards a long-term balance between contributions and benefits, a buffer is needed to absorb deviations between benefits and contributions from year to year.

The transition from a traditional DB plan to a notional DC plan type implies *redesigning intergenerational risk sharing*. A PAYG-DB plan captures (demographic) shocks primarily in the contribution rate, which implies different implicit returns for the various generations. A notional DC plan explicitly aims at equality in the implicit return for the generations by smoothing shocks over a longer time period over many age-cohorts.

The basic idea behind a Notional Defined Contribution (NDC) system is to design a PAYG system that mimics a financial account scheme in which workers contribute during their working life and draw benefits after retiring. Unlike financial account schemes, however, contributions to a NDC system are not invested in financial assets; this means that the returns on these contributions do not depend on stock market or bond returns. The system is notional, in that contributions flow to the national social security administration, which uses them to cover current pension benefits. The notional returns on these defined contributions are exogenously set, and typically coincide with some long-term average of per-capita growth rate of GDP or growth rate of the wage sum. Once a worker retires, the total capitalized value of his/her lifetime contributions is transformed into a pension benefit in the form of a real or nominal annuity. This annuity typically will depend, among other things, on life expectancy and retirement age.

The scheme in Figure 4.1 reports the notional liabilities and notional assets that can be discerned for an NDC plan. The liabilities are composed of the notional accounts wealth K of

Figure 4.1: "Notional" balance sheet components

Notional assets	Notional liabilities
PA	$K = \Sigma K_x$
FA	$B = \Sigma B_x$
PV[A]	PV[L]

with:
K = accumulated notional capital of all working cohorts
B = PV granted annuities of all retired cohorts
PA = PV Future Contributions –/– PV Future notional Capital
FA = buffer

the working cohorts and the present value B of the expected pension payments of the retired cohorts. The 'assets' consist of the contribution asset PA, being the present value of the future contributions over the horizon considered minus the corresponding present value of new entitlements, and a buffer with financial assets FA (for example, as inheritance of the old plan). This buffer may be inherited from the abolished old plan or it might be the result of an explicit policy to build up a buffer.

The development over time of total 'assets', PV [A], and 'liabilities', PV [L], will not necessarily be in balance.[13] An automatic balance mechanism might be formulated beforehand – such as the one that is operative in Sweden, for example. Let

13 Typical reasons for being out of balance may include the following: ex post mortality rates deviate from the ex ante values used to compute life expectancy for newly granted annuities; annuities may cost more (or less) than thought ex ante– for example, because persons with higher than average incomes (and contributions) may live longer, and the conversion factor has not taken this sufficiently into consideration; and the realized return in the reserve fund remains for several years far beyond the assumed rate of return used when setting the contribution rate, leading to a surplus or a shortage that somehow must be absorbed in the liabilities.

the deviation between the two sides of the NDC balance sheet be measured as follows:

$$\rho = PV[A]/PV[L] - 1$$

Then the value ρ stands for the factor with which the accounts of workers and annuities of pensioners need to be adjusted to restore balance. This process is known as the automatic balancing mechanism (ABM).

The ABM mechanism is described as follows. If $PV[A]/PV[L] < 1$, regardless of the cause, account values of workers and the annuities of pensioners are given a lower rate of return in order to bring the system back into financial equilibrium. On the other hand, the system distributes a higher rate of return to participants if $PV[A]/PV[L] > 1$.

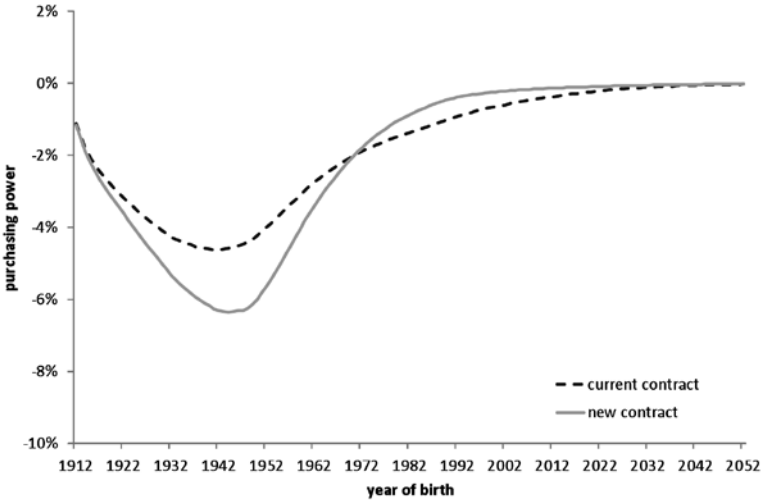
Countries with an NDC plan may have the explicit purpose to build up a reserve fund, which can be taken into account when defining the balancing mechanism.

4.2 Collective DC plan: The Netherlands

Funded traditional DB plans such as second-pillar employer-sponsored plans have been the norm since the fifties in the Netherlands, Switzerland and the Anglo-Saxon countries (UK, US and Canada). This type of plan has been on the retreat, however, since the eighties. Gradually, private sector DB plans have been replaced by individual DC plans, especially in the UK and the US. Public sector pension plans in these two countries have maintained their defined-benefit structure, and funding risks typically have to be borne by (generations of) taxpayers.

The Netherlands is in the process of adapting the traditional DB plan structure into a collective DC plan structure. One of the key principles in the new plan setting is to stabilize the contribution rate in the future, which necessarily implies that

Figure 4.2: Distribution of wealth shock in the new and old pension contract



Source: Bovenberg and Van Ewijk (2011)

shocks will be absorbed by the pension entitlements. This implies a change in the risk-bearing base, and thus a *redesign of the nature of intergenerational risk sharing*. Risk steering via flexible contributions implies that risk is borne by the human capital of current and future workers. The new form of risk steering via adjustable benefits implies that risk is borne not only by accrued benefits (thus, by benefits already accrued by current retirees and current workers), but also (depending on the smoothing period) by to-be-accrued benefits covered by the accrual in the coming years.

Figure 4.2 shows how this policy distributes the funding deficit over pension fund members. The figure indicates, for current and future cohorts, the loss of purchasing power as a result of the drop in the funding ratio from 145% at the end of 2007 to its current

level of about 100%. The solid line reflects the impact of the new contract, the dashed one the impact on cohorts of the current contract. This figure is based on the assumption that in the new contract contributions are fixed, while in the current there is some risk steering going on via flexible contributions. Moreover, in the new contract the recovery period has been limited from 15 to ten years. Consequently, compared to the current contract, the new contract imposes a larger share of the burden of a shock on current generations (rather than future generations).

Notice that the cohorts born around 1945 are those with the largest loss (about 6.5% in the new contract). These generations have the largest stock of pension entitlements, and therefore suffer most from cuts in these entitlements. The loss of the elderly is lower because these generations will in general not survive the entire period of indexation cuts. The loss of the younger cohorts is relatively low, as these cohorts have not yet accumulated a large stock of pension entitlements (Bovenberg and Van Ewijk, 2011).

Currently, many Dutch pension funds already base their indexation policy on the financial position of the fund. They often use an indexation ladder with an upper limit based on a pension fund's required funding ratio. In the new contract, this conditionality of indexation promises will be made more explicit in the pension law. According to the most recent proposal, a pivot funding ratio will be identified— an example being the required funding ratio as defined by the Dutch Central Bank as supervisor. This required funding ratio will have a direct link with the risk taken in the funding policy. Any underfunding below the pivot funding ratio has to be absorbed within ten years. Indexation might be given, providing this is allowed within the framing of restoring the ratio in ten years' time. When the funding ratio is above the pivot funding ratio, a smoothing period longer than ten

years is allowed. Pension funds probably will aim at an indexation rate that is sustainable for the very long period, ideally covering the period implied by accrued rights (around 80 years ahead).

The new contract thus continues to exploit risk sharing, as this indexation policy smoothes shocks to asset returns and life expectancy over time.

4.3 The Canadian Pension Plan as an in-between plan

The Canadian Pension Plan (CPP) is an interesting case, as it contains elements that relate to both a collective DC and a notional DC plan setting. The plan is partly funded and partly unfunded.

Canada reformed in 1997 the PAYG-financed public pension system to cope with the challenge of population ageing. The country started to prefund and invest the accumulated assets in equities. The reform was sparked by the government actuary's 1995 report on the program, which projected a sharp rise in benefit payments. Without reform, the PAYG contribution rate would rise from 5.6% to 14.2%. The proposed prefunding implies an immediate increase of the contribution rate to 9.9%. At this rate, contributions will exceed payments until 2020. After 2020, the sum of accumulated wealth, contributions and investment returns is expected to lead to an increasing funding ratio over time, eventually reaching 31% in 2075. The ratio of contributions to benefits would be 87%, which is lower than the 100% that would result from a full PAYG financing strategy. When the funding level of the Plan increases, then contributions would comprise a decreasing proportion of expenditures, as a greater part of the expenditures burden can be covered by investment earnings.

The organization of the reform was assigned to a national pension fund, named the Canada Pension Plan. Legislation was

Table 4.2: Schedule of CPP contribution rates

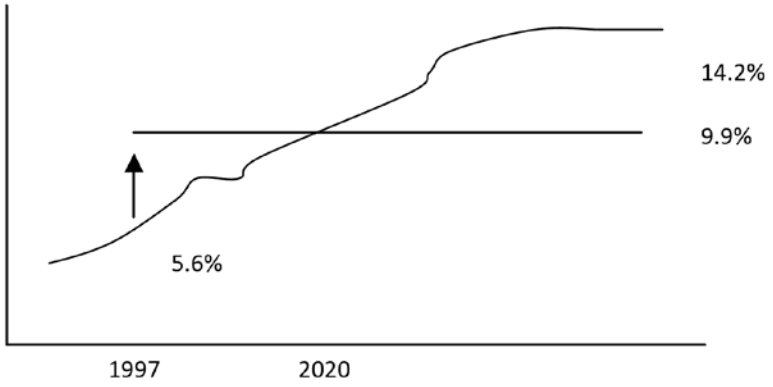
Finance base	Contribution rate	Funding ratio	Contribution/ Benefits
PAYG	5.6% (1995) to 14.2% (2075)	0%	100%
Partial funding	9.9%	31% (2075)	87%

Source: Office of the Chief Actuary, Canada, 2007.

agreed upon to make the CPP as independent of the government as possible.

As to the management of financial risks, the CPP (and any other government-backed financial plan) should be handled quite differently than an employer-sponsored pension fund. The standard measure of the solvency position of a private sector pension fund is the funding ratio. Accounting rules require that assets and liabilities should be based on market valuation, rendering the funding ratio of a DB pension fund with risky investments very volatile. In government-backed programs, the basic solvency measure is whether the current contribution rate is sufficient to warrant the payments of benefits over a very long horizon (even up to 100 years, as in the Canadian CPP). The reason why government-backed programs can be evaluated this way is because the government is presumed to continue indefinitely. Given this very long horizon, a nationwide pension fund is in an ideal position to take long-term risk and to exploit the benefits of intergenerational risk sharing, as shocks can be smoothed out over very long periods, even 100 years. This will result in a very stable contribution rate and very stable benefit levels. Deep shocks such as the recent credit crisis or the oil crises in the seventies would have a very moderate effect on the reported solvency position of CPP. The changes required in the contribution rate and benefit

Figure 4.3: The PAYG contribution rate and the steady-state contribution rate



levels would be small, while over the 100-year period the solvency would still be guaranteed.

The main threat facing a national pension scheme is political risk[14], as politicians may plunder the fund for short-term considerations (e.g. lowering the contribution rate or more creating generous benefit levels) or may force the national pension fund to invest in specific projects. Moreover, a large scheme such as a national pension scheme may be used by the government as a tool of redistribution. Although the scheme may not have been introduced for that purpose, politicians will be inclined to use the scheme for this purpose if a need for redistribution arises and if participants to the scheme are not able to vote with their feet.

14 The plan is administered by *Human Resources and Social Development Canada* on behalf of employees in all *provinces and territories* except Quebec, which operates an equivalent plan, the *Quebec Pension Plan*. Changes to the CPP require the approval of at least two-thirds of the Canadian provinces representing at least two-thirds of the country's population.

4.4 Individual DC with collective components: Denmark's ATP plan

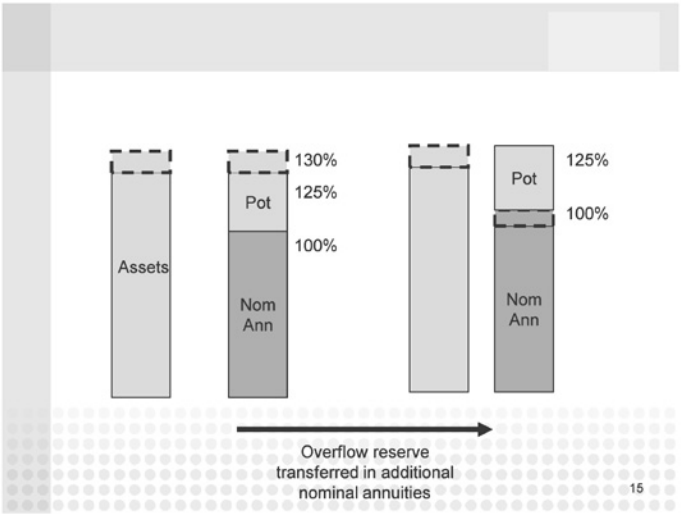
The first pillar in Denmark consists of two parts[15], the most relevant of which is the second part, which is a funded supplement for Danish workers, serviced by the semi-public financial instution ATP. This plan effectively can be interpreted as a mixture of individual DC and collective DC.

All Danish employees are mandatory participants in this ATP pension plan.[16] Effectively, 86% of the population aged 16 to 65 and 98% of the over-50s were contributing to the ATP in 2006. The contribution rate is around 1% of salary. Contributions are divided in two parts: a guaranteed contribution and a bonus contribution, with 80% going to the guarantee and 20% going to the bonus. The member acquires a guaranteed nominal pension based on the guaranteed contribution, while the bonus contribution is allocated to a collective reserve. This reserve pot is aimed for the future indexation of pension rights. The larger the reserve, the greater is the capacity to take risk with the reserve pot– and so the greater the expected long-term return. ATP's bonus policy stipulates that pensions may be increased if the funding ratio (total assets divided by guaranteed benefits) exceeds 120%. All pensions and all pension rights are increased by the same percentage, which is determined by the overflow of the reserve pot.

15 The second-pillar plans are organised predominantly as individual defined-contribution plans, often bound by industry-wide collective agreements for groups of employees (industry, company).

16 Compare Kryger E.M (2009), Preisel, Jarner & Eliasen (2008, 2009).

Figure 4.4: Reserve overflow is used for additional nominal annuities.



The following features stand out:

1] All pension guarantees are fully hedged by long date interest rate swaps or similar transactions. The horizon of the plan is on average much longer than the duration of the nominal guarantees. ATP as investor for the very long term is therefore able to exploit features of the yield curve, which is not possible for most other investors. With a positively-sloped yield curve, long market rates, for example, offer higher risk premiums.

2] The reserve pot is invested on behalf of all participants. There are no explicit property rights. The plan just defines when there is overflow, and stipulates that this overflow should be paid to participants in relation to the size of the nominal guarantees.

3] The long-term nature of the plan makes it possible to invest the bonus pot in long-term illiquid investment strategies and projects that typically are not open for regular investors.

5. Concluding remarks

The literature states not only that intergenerational risk sharing is potentially welfare-improving, but also that there are limits to its reach. The literature is not very outspoken as to what the optimal size of IRS might be, how this relates to country-specific factors and via which institutional arrangements IRS preferably should be organized. The primary arrangements for IRS are the handling of government debt over time and pension plans. Pension plans pre-eminently are appropriate for IRS, as the long-term nature of pension provisions enables risk smoothing not only over time, but also between young and old generations, because of their varying stakes in human and financial capital.

The pension plans of most countries have their roots in the 1930s, or directly after the end of World War II. Many countries started up a PAYG-based DB plan as the first-pillar plan. This was supplemented with a funded plan, which often also took the form of a DB plan organized via a pension fund, as in the Netherlands, the Anglo-Saxon countries or Switzerland. The plans often contained components of intergenerational risk sharing, but not always intentionally. Indeed, the risk sharing itself was more of a by-product of the plan design rather than something explicitly aimed at.

A main feature of traditional DB plans is that benefits are paid out as promised and that pension contributions are the primary instrument to warrant the financial soundness of those plans. The effectiveness of this strategy has eroded over time. As to PAYG-based plans, the ageing of the population (due to the falling fertility rate and the longevity trend) leads to increasing contribution rates, which tend to reach unsustainable levels. As to funded DB plans, the strong increase of the pension liabilities in

maturing pension plans in relation to the size of the sponsoring firms undermines the effectiveness of contribution adjustments as a means of controlling for the solvency position of the pension funds.

A natural response to this would be to downsize intergenerational risk sharing in pension plans or even to eliminate it by moving from collective pension plans to individual funded plans (as in Chile). This would reduce welfare on account of the lost benefits from IRS. Moreover, individual plans may lead to too-high risk exposure for the individuals.

An alternative route is to redesign IRS-based arrangements by moving to pension plans with flexible benefits instead of flexible contributions. In real life, various pension plans indeed have changed to a plan setting featuring benefit adjustments instead of contribution adjustments as the primary instrument to keep financial balance. This paper has discussed a number of country examples of reinvented pension plans to illustrate this reform. What are the main policy implications from this discussion?

1] Risk steering via flexible benefits can be applied to a rich variety of pension plan types. The PAYG-DB plan type can be replaced by the notional DC plan type. The funded DB plan type can be reset in a funded collective DC plan type.

2] A main lesson is also to keep a balance between aims and instruments. Pension plans must find a position between preferences for a certain pension income, on the one hand, and a pension that keeps pace with economic growth and inflation, on the other. Denmark's ATP has a split-up between individual pension pots providing nominal annuities (and so a certain nominal pension) and a collective pot with a risky strategy aiming at providing indexation in the form of additional annuities allocated proportionally to the individual pots.

3] The horizon of intergenerational risk sharing via flexible benefits should preferably be long. A long smoothing period is crucial to spread large shocks by means of a sequence of small benefit adjustments. The longer the period of smoothing, the smaller will be the impact of specific shocks on income and consumption. A long smoothing period requires a stable and long-lasting risk-bearing collective. The need for a risk-bearing collective, as deep and as broad as possible, calls for a nationwide plan. Indeed, the institutional arrangements discussed for Denmark, Canada and Sweden do have a nationwide span. Risk smoothing can also be organized on the level of companies, branches of industry, or groups of professionals, but the life cycle of many if not all of these collectives is limited in time, and will fall short compared to the indefinite duration of a nation or very big collectives such as the government, the health care or financial sector, construction, and so on. Discontinuity risk is an issue with long smoothing periods, but to a lesser extent, the larger the scale of the pension fund. How precisely discontinuity risk relates to the operating scale, is something that has rarely been investigated. It would be useful to explore this in future research.

4] Due to the long-term nature of pension provisions, risk sharing in collective pension plans requires flexible plan settings (i.e. plan parameters can be changed over time as to adapt to new, unexpected trends and developments).

5] Pension arrangements and public debt are the main institutions that engage in IRS. Ideally, countries should consider pensions and debt in an integral framework to evaluate what is the optimal size of IRS and which set of institutional arrangements works best to organize IRS.

What can be learned from this review, specifically when we consider the plan changes from a Dutch perspective? In both the first- and second pillar, sustainability already has been increased considerably by switching to conditional pension benefits. In the first pillar, the formal retirement age has been linked explicitly to the longevity trend. The second pillar already has moved in recent years from traditional DB to collective DC. The example of Denmark shows that it is possible to include pension guarantees in the pension scheme. The example of Canada shows that it is possible to have long smoothing periods as long as the pension scheme operates on a large– in this case national– scale. Given that the future is fundamentally uncertain, there must be room to change the plan parameters over time.

Another question is whether after pension schemes have been made less generous, further reforms will no longer be required. That, in our opinion, may be a bridge too far. Flexibility is an essential part of the reinvented pension scheme.

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Reinventing intergenerational risk sharing

This panel paper by Jan Bonenkamp (CPB), Lex Meijdam (TiU), Eduard Ponds (APG & TiU) and Ed Westerhout (CPB) discusses the virtues of collective intergenerational risk sharing (IRS). The combination of trends in society highlights the important lesson that an IRS arrangement needs to be open for flexible adjustments to changing preferences and circumstances: collective pension arrangements must be reinvented. This paper proposes the development of new forms or arrangements of intergenerational risk sharing.