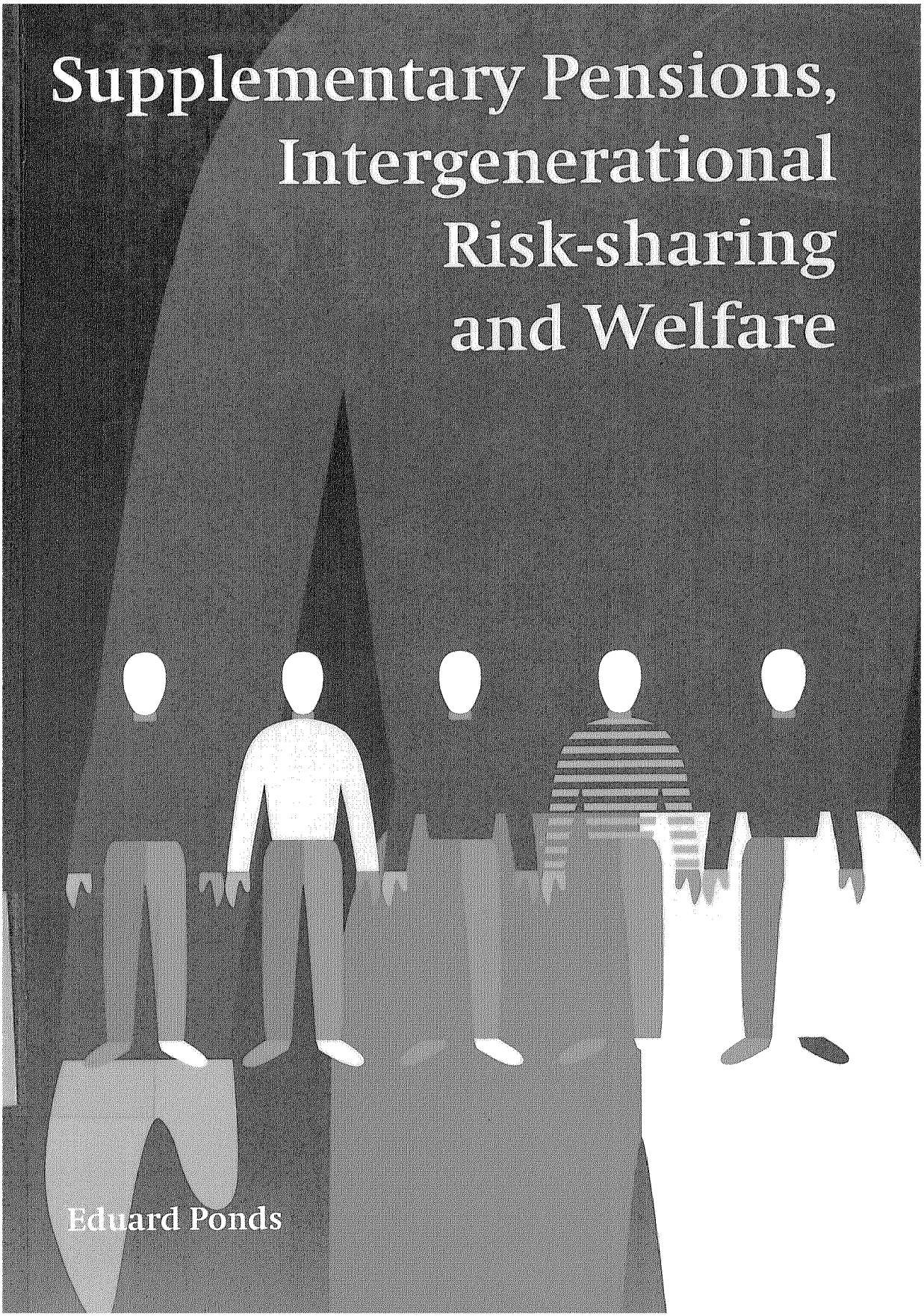
Supplementary Pensions, Intergenerational Risk-sharing and Welfare



Eduard Ponds

SUPPLEMENTARY PENSIONS, INTERGENERATIONAL RISK-SHARING AND WELFARE

Eduard H.M. Ponds

SUPPLEMENTARY PENSIONS, INTERGENERATIONAL RISK-SHARING AND WELFARE

PROEFSCHRIFT

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"Most economists using a standard life-cycle analysis would probably agree that the primary objective of a pension system is to provide a standard of living in retirement comparable with that enjoyed during the working years."

R.C. Merton (1983)

CONTENTS

PART II SUPPLEMENTARY PENSIONS IN THE NETHERLANDS AND EVALUATION OF REFORM PROPOSALS

1 General introduction

1.1 An introduction to the theme of the study

The supplementary pension scheme in the Netherlands is largely organized as a funded defined-benefit plan with wage-related benefits (mainly final-pay). The general theme of the study is an analysis of the welfare-enhancing properties of funded defined-benefit plans. Such a plan provides post-retirement real income insurance related to the standard of living enjoyed during labour time. As will be set out, the unique feature of the insurance offered is that it is based on collective risk-bearing, in particular intergenerational risk-sharing between the insured workers. This kind of insurance cannot be organizedwithin the private (insurance) market. Nowadays discussion is taking place with respect to reforming the defined-benefit plans currently in operation. However, workers covered may evaluate reform as a loss in welfare. Reform will end or moderate the unique retirement-income insurance offered by the supplementary scheme.

Theoretical literature has produced intense discussion on the rationale of a public scheme financed on a pay-as-you-go basis. This rationale has often been said to rely on its ability to establish (or to improve) intergenerational risk-sharing. Far less attention is paid to intergenerational risk-sharing within a funded defined-benefit plan. Usually it is stated that the funding risks concerning existing pension rights are for account of the employer. This is typical of the literature oriented towards the supplementary scheme in the USA. In the case of the Netherlands however, funding risks can also be borne by active workers. Risks of relevance to the funding of a defined-benefit plan are the future wage path and the rate of return on investment. The plans in operation offer a rich diversity with respect to risk-bearing because the sponsors are free in making rules concerning the nature of this risk-bearing. In many plans, active workers and employers/shareholders, as

the plan's sponsors, jointly share the funding risks. Analytically one can distinguish as the two extremes: - funding risks are to be borne completely by active workers, so one can refer to intergenerational risk-sharing; or - funding risks are completely to be borne by the shareholders of the sponsor firm(s). Nevertheless, funded defined-benefit schemes are characterized in this study primarily as intergenerational insurance contracts, implying risk-sharing between overlapping generations of workers. Firms may indeed, in the first instance, also participate in risk-taking. In the long run however, wages must be competitive with labour costs abroad. Therefore firms will try to shift the additional labour costs to the workers via reduced wages so that total labour costs remain unchanged.

A serious weakness of an intergenerational insurance contract is that the contract may not be optimal ex post for future generations. The participation of future young generations is contingent on the outcome ex post of the contract. These future young workers will not accept voluntarily a contract that will lead to a loss in welfare for them. Young workers are more mobile than the older part of the labour force and the retirees. Hence, young workers are always able to withhold their participation to a defined-benefit plan which experiences a large shortage. Therefore, mobile labour may shift the funding risks of defined-benefit plans to the retirees themselves. The worst-case scenario of a defined-benefit plan is that a position of structural underfunding is realised, whereas sponsors are not present anymore to supplement the shortage of the pension fund. Accumulated pension rights by the elderly then can not be expired. Up to now, defined-benefit plans in the Netherlands have not been subject to this problem. However, it may become manifest in the future. The *process of aging* will lead to an increase in the financing burden of defined-benefit plans currently in operation. This implies that the costs of the scheme for future generations will increase. The scheme then is no longer actuarially fair for them, i.e the present value of premiums they must pay will exceed the present value of benefits to be received by them at retirement. It may therefore be in the interest of the current active generations to accept a reform of the current plans in order to make the system less unfair for the future young generations and so to avoid that the intergenerational contract may break down at some moment in the future. The derived analytical framework of intergenerational risk-sharing is used to assess reform. Reform proposals are evaluated on the trade-off in welfare terms between the loss in retirement income insurance and the gain in life-time income.

In the Netherlands, a discussion is going on in support of substituting the present structure of defined-benefit plans (mainly final-pay plans) for defined-contribution plans. This reform should anticipate the trend towards *more diversity amongst individuals*. However, there is still broad support amongst Dutch employees for maintaining the final-pay scheme. Apparently, the insurance offered by the final-pay plan is a reflection of the preferences of the participating workers. If this actually is the case, the workers will evaluate this reform proposal as being a loss in welfare. They may consider that they would lose the prospect on a post-retirement real income which enables them to maintain the pre-retirement standard of living during old-age. The literature points out that government finance also may be used for collective risk-bearing, including intergenerational risk-sharing. A comparison is made between a funded defined-benefit scheme and government finance with respect to collective risk-sharing. The question is raised of how the government budget can be used to reproduce the unique risk-sharing features of a collective defined-benefit scheme. It is aimed to organize a risk-sharing arrangement between the government budget and pension savings which are hold by workers on an individual base (defined-contribution plan). This arrangement should provide retirement income insurance comparable with a defined-benefit plan.

The *objective of the study* is twofold.
First of all, the study aims to develop a theoretical framework for analysing the welfare effects of arrangements which offer retirement-income insurance based on intergenerational risk-sharing. Two arrangements will be studied more specifically: firstly, funded defined-benefit plans within which funding risks are borne by the plan sponsors, i.e. active workers and employers/ shareholders, and, secondly, risk-sharing between the government budget and pension savings, where risk is borne by (young and old) taxpayers. The objective of the analysis of this arrangement is to investigate whether the unique welfare-enhancing properties of funded defined-benefit plans can be reproduced (Part I).
The second aim of the study is to use concepts derived from the theoretical framework in Part I to evaluate the current supplementary pension scheme in operation and to assess welfare implications of proposals for reform (Part II).

The economics of pensions comprises a broad field of research themes. (Compare Bodie 1990, Breyer 1994, Felderer 1993, Hurd 1990 for surveys on topics in research). A study on pensions is therefore necessarily subjected to *restrictions*. The analysis in this thesis is primarily interested in welfare

aspects of retirement income insurance offered by the supplementary scheme. These welfare aspects can be listed into three main categories[1]: - availability of insurance, - income redistribution and - economic efficiency. The treatment of insurance aspects of pension schemes is rather limited in the economic literature. A main conclusion from this study, however, is that the utility of being insured for standard-of-living risk is substantial. Insurance offered by the supplementary scheme appears therefore of utmost relevance in the current debate on reform of the supplementary scheme. However, insurance aspects are not dealt with so far in studies on the effects of reform of the Dutch pension scheme[2]. This thesis is aimed at emphasizing the importance of the welfare aspects of retirement income insurance.
Income redistribution effects between the participants of defined-benefit plans are also dealt with intensively. These (ex post) transfers occur as a consequence of the insurance offered. The analysis is resticted to transfers between generations. In general, no attention is paid to transfers due to individual differences in career pattern, probability of dying and gender. These kinds of transfer imply also intragenerational redistribution[3].
The impact of labour mobility on the future sustainabality of defined-benefit plans is discussed in chapters 2 and 3. Other topics concerning economic efficiency remain more or less out of the scope of this study; the supplementary pension scheme may be of influence on individual behaviour, such as the impact of pension fund savings on saving behaviour (Feldstein 1978) and on labour supply, due to early retirement and more preference for leisure (Woittiez et al. 1994). Efficiency effects may also occur because of

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1 This list is to the analogy of evaluation of a social security scheme based on redistributive taxation (Varian 1980, Lindbeck 1994).

2 Huyser & van Loo (1986), Bolhuis & Vossers (1986, 1990) and WRR present calculations on the evolution of contribution rates of the public scheme and the supplementary scheme for status quo and reform options. Using a microsimulation model with a representative sample of individual socio-economic life histories, Nelissen (1994) and Nelissen & Verbon (1993) provide projections on the redistributive impact of public and supplementary pension schemes within and between generations for status quo and reform options. A main objective of Breunesse's (1995) blueprint for a new pension scheme is improving economic efficiency; as to the supplementary scheme, a defined-contribution plan is proposed in order to establish pension income insurance on the principles 'deferred wage' and 'actuarial fairness on an individual basis'. Broer et al. (1993) develop a theoretical model of the Dutch pension scheme to explore the impact of several reform options on intergenerational income redistribution and efficiency effects related to labour supply.

3 Expositions on these kinds of income transfers can be found in Petersen ed. (1990), den Hertog & Kraamwinkel (1991), the '*Pensioennota*' of the 'Ministerie van Sociale Zaken en Werkgelegenheid' (1991), Breunesse (1995).

(government) regulation in the field of defined-benefit plans, which might lead to a lack of competition in the market for pension provisions[4].
Furthermore, the framework of analysis developed in this study is not suited to take up the question as to the optimal mix of retirement income provisions. Such a mix will consist of some combination of public pensions, supplementary pensions and individual retirement income provisions on a voluntary basis. The study also will not deal fundamentally with the issue as to the optimal range of risk-sharing within a defined-benefit plan (however see section 2.3.1). This range can vary from risk-sharing between workers employed at one firm towards risk-sharing in one nation-wide defined-benefit plan. Usually the assumption is made that there is one nation-wide defined-benefit plan.

The list below presents an overview of the issues which are dealt with:

Part I *Supplementary pensions, welfare and risk-sharing*:

- the need for intervention into retirement-income provisions and the welfare aspects of intergenerational risk-sharing organized either as a public pension scheme or as a supplementary pension scheme (Chapter 2);

- a formal analysis of the welfare effects of a funded defined-benefit plan based on intergenerational risk-sharing; a nationwide pension fund is considered for the cases of a closed economy with mandatory participation and for a small open economy with international labour mobility (Chapter 3);

- the use of government finance to replicate the main advantages of a funded defined-benefit plan (insurance for standard-of-living risk and intergenerational risk-sharing) and the advantages of defined-contribution plans (such as individual freedom of choice) (Chapter 4);

- the impact of the tax method with respect to pension savings on the tax rate level, on volatility in government tax revenues and on the significance of risk-sharing within the economy (Chapter 5).

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[4] Compare Bakker & van Dam (1995) for a survey and critical discussion of themes concerning regulation and competition.

Part II *Supplementary pensions in the Netherlands and evaluation of reform proposals*:

- a characterization of the funding method and the presence of funding risks in the organization of the final-pay plan structure in the Netherlands (Chapter 6);

- aging, the assumed need for reform of the supplementary scheme and the welfare trade-off between the reform-induced loss in retirement insurance and the reform-induced gain in life-time income (Chapter 7).

1.2 Outline of the study

Chapter 2 examines the literature on the welfare-enhancing properties of pension schemes with mandatory participation and forced intergenerational transfers. Primarily the question dealt with is that of why there is a need for intervention with retirement income provisions, either as a public pension scheme or as a firm-sponsored supplementary pension scheme which can be structured as a defined-benefit plan or as a defined-contribution plan. From the normative approach, there are at least three categories of argument to justify government intervention with respect to retirement income provisions: paternalism, income redistribution and market failure. However, far less attention is paid to the raison d'être of supplementary pension schemes. This chapter aims to show that arguments which justify a public pension scheme are of relevance too for supplementary schemes. Public and supplementary pension schemes are discussed primarily on the private market failure to provide for prefered retirement income certainty. This is qualified as preference for so-called standard-of-living insurance. This type of insurance can be organized by a defined-benefit plan with wage-related benefits. It is argued that this plan implies intergenerational risk-sharing. An intergenerational insurance contract is exposed to the risk that the contract may not be optimal ex post for future generations. This issue is discussed intensively.

Chapter 3 presents a formal analysis of the welfare aspects of funded defined-benefit plans which offer retirement-income insurance based on intergenerational contracts. The setting of the standard two-period overlapping generation model with no bequests (Diamond 1965) is used. A defined benefit plan inevitably implies income transfers ex post between

insured workers and the sponsors involved in the bearing of the funding risk. Every generation of workers born has the freedom to set up a defined-benefit scheme and to decide on the nature of risk-bearing. Three cases will be studied. Two of these can be characterised as extreme cases: only intergenerational risk-sharing and only intragenerational risk-shifting. The third case is a mixture of these two extremes. Within the confines of the model used in the chapter, it will be shown that the representative individual prefers intergenerational risk-sharing when he has a relatively high degree of risk-aversion, while he will opt for intragenerational risk-shifting in the case of a relatively low risk-aversion. The preference of the representative individual reflects the weighted average preferences of high and low risk-averters. The relative size of these groups and the magnitude of their degree of risk-aversion are decisive for the allocation of total old-age savings of a generation to the pension fund and the market portfolio.
These results are derived for a closed economy in which the young generation is obliged to participate into intergenerational risk-sharing. The analysis will also be extended to the case of a small open economy with international labour mobility. The relevant situation to study is when a defined-benefit plan in operation runs a shortage ex post. The participation into the plan may then be unattractive for the young generation, because they must balance the fund. Mobile labour can avoid this income loss simply by migration or by working at firms which offer to their employees a defined-contribution plan. This will imply that the risk of underfunding is shifted to the elderly themselves. As it will be set out, the young generation still may prefer to participate in a plan with a shortage because it will not lose the retirement income insurance offered by this plan. The necessary condition for the support of the young generation is that the disutility associated to the (maximum) income loss is outweighed by the gain in utility of being insured.

Chapter 4 introduces government finance into the analysis. The aim is to show that government finance can be used to construct an arrangement for collective risk-bearing with respect to old-age savings, including intergenerational risk-sharing. The government is able to enforce collective risk-bearing because of its taxation power. Within a stylized framework, the first consideration is the welfare aspects of government bonds which offer an indexed position for growth in real standard of living. There is also a discussion on a plan of Bovenberg (1993). This plan also attempts to use the public budget to reduce risk-exposure of savings retained in a defined-contribution plan. The discussion then sets out how the concept of government index-bonds can be used in real life to replicate the insurance offered by a final-pay scheme with inflation-indexed benefits. It is proposed that the government should

issue so-called nominal-wage-index and price-index bonds. Wage-index bonds provide the prospect of the expected rate of interest on government bonds plus the deviation between actual and expected nominal wage growth during the term of the bond. Price-index bonds pay out the expected rate of interest on government bonds plus the deviation between actual and expected inflation rate (price-index bonds). The primary aim of the creation of these new bonds is to ensure that individual investors who are forced to participate in a defined-contribution plan are able to create a provision which replicates the unique retirement income insurance offered by a funded defined-benefit scheme. Individual investors are free to retain their retirement savings in these bonds. The distribution of wage-index bonds and price-index bonds combines the advantages of defined benefit plans such as the prospect of post-retirement real income insurance and collective risk-bearing, with the advantages of retirement provision on an individual basis, such as individual freedom to choose on optimal life-time consumption profile and to allocate retirement savings according to individual risk-return preferences. Finally, it is shown that, seen from an ex ante point of view, these bonds will imply a decline in the volatility of government finance. This will contribute to welfare because of the reduction in volatility of tax rates.

Chapter 5 deals with the relationship between the taxation of pension savings and government finance. Pension savings can be taxed according to either the prepayment method or the cash-flow method. The two methods have a different impact on government finance in the long run. After a demonstration of the characteristics of the two tax methods, an analytical treatment of the relationship between the taxation of pension savings, the level of tax rate and volatility in tax revenues is presented. It will be shown that the cash-flow tax method should be preferred to the prepayment method. The implementation of the cash-flow tax method implies, first of all, a lower tax rate level. Secondly, the cash-flow tax method leads to a broadening of the tax base, which may reduce tax rate volatility. If so, the tax method will contribute to (intergenerational) risk-sharing within the economy.

The central theme of chapter 3 is a theoretical analysis of the welfare-enhancing properties of a funded defined-benefit plan which offer retirement income insurance based on collective risk-bearing. *Chapter 6* is concerned with the question of how this arrangement (may) function in real life. The chapter presents a relatively simple setting with three generations. The essential institutional characteristics of the Dutch supplementary scheme can be represented within this setting. It enables us to gain a clear view on the

insurance offered, the nature of risk-bearing and the impact of fluctuations in insured risks on the deviation of the actual premium rate from its projected (actuarial) rate. The built-in presence of backloading which implies a pay-as-you-go element in the financing method is discussed. It will be concluded that the funding method of Dutch supplementary schemes *as such* is characterised by *actuarial fairness*. The funding method implies two-sidedness of income transfers ex ante between sponsors and the scheme. Furthermore it will be shown that aging will have a very modest impact on the supplementary premium rate, despite the presence of the pay-as-you-go element in the financing method.

Nevertheless, the supplementary scheme in the Netherlands will also be subject to the problem of aging, because of its integration with the public pension scheme. The institutional structure of this mixed system implies that the finance burden of aging associated with the public pension scheme is shifted partly to the supplementary scheme. Some are pleading for reform of the supplementary scheme in operation in order to moderate the increase in its premium burden and to reduce intergenerational income inequality. *Chapter 7* deals with the issue of whether there is a need to reform the supplementary scheme at all. A reform option aimed at reducing intergenerational transfers may lead to a change in the life-time income of the generations involved. In general, future generations will enjoy an improvement of life-time income compared with the no-reform scenario. However, a reform option also will imply a change in the composition of the portfolio of retirement provisions. The relative share of insured income provided by the pension scheme will decrease. As far as the representative individual compensates the decrease in pension income by increasing his individual retirement savings, then an increase in risk-exposure will be encountered. Two types of reform proposals will be analyzed. The first group maintain the basic structure of the final-pay scheme. The main conclusion as to these reform options is that continuation of the current set-up may be more preferable to future generations than reform. The crucial aspect is the trade-off between the reform-induced gain in utility which future generations attach to the increase in life-time income and the reform-induced decrease in utility because of the loss of retirement income insurance. The net-effect in utility terms depends on the degree of risk-aversion and the magnitude of the exposure to risk. The more risk-aversive the representative individual is and the higher the risk, the more likely it is he will prefer the status-quo above reform. A more radical option of reform is substitution of defined-benefit plan structure for defined-contribution plans. The result of analysis suggests that the introduction of defined-contribution plan always appears to be a welfare-deterioration.

This is primarily to be explained from the dominance of the loss in welfare because of the exclusion of retirement income insurance. It is also considered that the introduction of a defined-contribution plan is accompanied by the simultaneous issuance of wage-index bonds by the government, as proposed in chaper 4. The individual pension saver then is able to reproduce the insurance offered by a defined-benefit plan with wage-related benefits. The alternative 'defined-contribution plan plus index-bonds' can then be welfare-dominant compared with the other alternatives discussed.

1.3 Institutional aspects of the supplementary pension scheme in the Netherlands

As in most developed countries, the institutional structure of the pension system in the Netherlands is organized as a three-pillar structure. The first pillar comprises the public pension scheme on account of the General Old Age Law (AOW) offering a basic flat-rate pension income to all retirees. Financing is on a pay-as-you-go basis. The benefit is approximately equal to the legal minimum wage. The second pillar provides to former workers an additional income from the supplementary pension scheme. The third pillar comprises personal savings which individuals voluntarily undertake at their own expense. These savings are accumulated on a strictly individual basis. They are primarily retained as individual life insurance, home equity, bank accounts and participation in mutual funds. Individuals can use these provisions to create additions to the first two pillars according to individual needs and preferences.

The supplementary pension scheme in the Netherlands is mainly organized as a funded defined-benefit plan. The benefit entitlement is determined by years of service and a reference wage, which can be final-pay or the average wage over the years of service. The defined-benefit formula takes into account the retirement benefit of the public scheme. Generally, the plans are final-pay plans, promising to pay a gross benefit -including the AOW-benefit- equal to a maximum of 70% of the gross wage income last earned. The maximum benefit will be received when contributions to the scheme have been paid in full for a period of forty years. After retirement, benefits are mostly inflation-indexed or even wage-indexed. However, the indexation is conditional on the financial position of the fund and the contributors.

The Pensions and Savings Act (PSW) stipulates that pension promises made to employees within the supplementary pension scheme have to be funded. Furthermore, the assets for the defined benefits have to be held within a separate trust, usually organized as a pension fund. Two important kinds of pension fund can be distinguished, namely the industry pension fund (so-called 'bedrijfspensioenfonds') and the company pension fund (so-called 'ondernemingspensioenfonds'). An industry pension fund is organized for a branch of industry. By law it is stipulated that participation in an industry pension fund is mandatory for all firms operative in the branch. A company can only opt-out if it establishes a company pension fund which offer a better pension plan to its employees than the alternative of the industry fund.

Table 1.1: Key figures pension funds at the end of 1993

	Industry pension funds	Company pension funds	Pension funds for professions	ABP
Number of funds	81	967	11	1
Participants (x1000)	2.511	751	37	968
Fund wealth (billions of guilders)	136	119	12	174

Source: Verzekeringskamer

Table 1.2: Participants supplementary schemes in the Netherlands according to type of pension plan

Type pension plan	**1987*** number (x 1000)	%	**1994**** %
Participants excl. ABP			
Defined-benefit			
- final-pay ('eindloonstelsel')	1.532	72	77
- combination final-pay and average wage	113	5	2
- average wage ('middelloonstelsel')	327	15	13
- other ('vaste bedragen')	140	7	8
Defined contribution	14	1	0
Total	2.126	100	100
ABP			
- final-pay ('eindloonstelsel')	954	100	

Source: * Pensioenkamer (1989): '*Pensioenkaart van Nederland*', Den Haag
** Coopers & Lybrand (1994): '*Bezuinigingen op de AOW*', Den Haag

Whenever a supplementary scheme exists within a firm or branch of industry, the participation by the workers is as a rule mandatory.
Pension entitlements of the civil servants are held within the Civil Servants Pension Fund (i.e. 'Algemeen Burgerlijk Pensioenfonds', abbreviated as ABP). Furthermore, one can mention as type the pension fund for profession (the so-called 'beroepspensioenfonds'). As table 1.1 reports, at the end of 1993 there were 82 industry pension funds, 1014 company pension funds and 11 funds for

professions. Table 1.2 presents figures on the relative size of plans as measured by the number of participants. It is clear the final-pay plan is by far the most important type.
In the appendix to this chapter, some information is presented on pension systems in Europe.

1.4 Discussion on reform

This section pays attention to some issues in the debate on the reform of the Dutch pension system which are of relevance for the supplementary scheme.

(i) Aging

The need for reform of the current pension system in operation will stem firstly from the process of aging in the coming decades (compare the appendix to this chapter for evidence on main trends). In the case of the supplementary scheme, the process of aging may result in a steep increase in premiums and intergenerational income redistribution in favour of current generations participating in the labour force and in disfavour of the future generations.
Two reasons for this are usually put forward.
The first has to do with the foreseeable shifting of a part of the finance burden of the public scheme to the supplementary scheme in the coming decades. The purchasing power of the public benefit is aimed to be guaranteed by yearly indexation of the benefit to wages in industry. However, in the eighties the automatic-linking mechanism was inoperative for several years because of cuts in social security. In general, because of aging, it is to be expected that in the coming decades the indexation of the public pension will lag behind the growth in wages and welfare. The accumulated pension rights within the supplementary scheme provide the prospect of a total pension income which is related to some fraction of final-pay or average wage. Therefore a (relative) decrease in the public pension benefit implies that the portion of the pension income to be provided by the supplementary scheme necessarily increases.
A second reason why aging might lead to an increase in the supplementary premium rate has to do with the phenomenon of backloading. It is common practice in the determination of the actuarial contribution rate either to do as if there will be no wage increase in the future or, at best, to assume just a limited wage increase, based on the development of the average career of

the employee. This practice implies that the *actuarial* premium rate is set at a level which is too low. Because the plans are mainly final-pay indexed defined-benefit schemes, every wage and price increase will lead to shortages in the fund's wealth. Extra contributions (so-called backservice) in addition to the actuarial premium sum are therefore necessary. These backservice payments will be larger, the more 'grey' the labour force is, because the burden of the backservice will increase with the relative growth in accumulated pension claims vis-à-vis the wage sum, while relatively few years on average per worker remain to build up the additional pension claims. Therefore, the more 'grey' the labour force is, the more backservice payments there will be per worker and the more this will lead to a rise in *actual* premium rate. As the premium rate is age-independent ('doorsneepremie'), young workers will contribute more than they need to fund their own pension entitlements actuarially.
The rise in the actual premium rate is expected to occur from the year 2010 onwards when the relatively large cohorts born in the immediate post-war years ('baby-boom generation') is about to retire. The extra premiums will have to be financed predominantly by currently young cohorts born from the end of the fifties up until those born in this decade. If the pension scheme is not reformed, it can be foreseen that these young cohorts, in present-value terms, have to pay more supplementary premiums than they may expect to receive as supplementary pension income. Because of this foreseeable loss in life-time income, it appears that the current supplementary pension system fail to attract the participation of currently young and future cohorts. They may aim a reform of the scheme in order to lessen the intergenerational income redistribution. One main result of this study however is that continuation of the current structure may be more preferable to future generations than reform. The disutility associated with the reform-induced loss of retirement income insurance may outweigh the increase in utility because of the gain in life-time income.

(ii) **Pension promise of defined-benefit plans** ('pensioentoezegging')

In 1991 the government presented the so-called 'Pensioennota'. One proposal refers to the replacement of the dominant final-pay system ('eindloonstelsel') with a system in which individual pension benefit is related to the average-earned wages during working life ('middelloonstelselsel'). A characteristic aspect of the final-pay scheme is that workers with a steep improvement in their career pattern at the end of their working life are entitled to a high final-pay related pension income while their average wage income and

therefore the average paid premium have been relatively low. The replacement of the final-pay plan by the average-wage plan would contribute to more equivalence between the paid-in premiums and the supplementary benefit one is entitled to. Furthermore, an average-wage related scheme would be more suitable for meeting current trends, such as less uniformity in career patterns, increasing labour mobility, more divergent life-styles and more flexible labour relations.
However in the public debate after the publication of the 'Pensioennota', it became clear that the representatives of the sponsors of the supplementary scheme, namely employers' organisations, labour unions and pension fund representatives, were not inclined to abolish the final-pay system (Wolff 1991). Furthermore, a recent study (Coopers & Lybrand 1994) reveals that the workers participating in supplementary scheme predominantly prefer to maintain the final-pay plan structure of the supplementary scheme. Far less value was attached to the average-wage plan, whereas a defined-contribution plan was not preferred at all. Also, employers support a final-pay plan, however, in a less pronounced way than their employees. Moreover, employers have an explicit aim to restrict the open-end character of the existing plans.

(iii) **Substitution of defined-benefit plans for defined-contribution plans**

A recent theme in the discussion on reform is to substitute - partly - the defined-benefit plan structure for so-called defined-contribution plans (CEC 1991, Bovenberg 1993, Nelissen 1994, Breunesse 1995). In a defined-contribution plan, each employee has an individual account into which the employer and the employee involved make periodical contributions until retirement. The benefits are related to the total contributions on behalf of the individual during his years of service and the accumulated earnings on the investment of these contributions, where investments will reflect individual preferences concerning the trade-off between expected return and risk-exposure. Furthermore, individual workers are more able to design the structure of retirement income provisions according to individual preferences, thus avoiding the paternalism of defined-benefit plans. The defined-contribution plan is well appropriate to meet the current trends towards less uniformity in career patterns, increasing labour mobility, more divergent life-styles and more flexible labour relations.
One main disadvantage of a defined-contribution plan, however, is the exclusion of collective risk-sharing. Risks have to be borne by the individual

himself. As previously stated, employees' support for defined-contribution plans is not large.

(iv) **Tax-policy issues**

The fiscal treatment of pension savings is similar to that found in most industrialized countries. Pension savings including investment income are tax-exempt while pension income is taxed. This implies deferment of taxes on wages and interest income in pre-retirement income.
Fiscal treatment has become a part of the reform debate because of the question of whether pension funds are excessive overfunded. The combination of high rates of return on investment and moderate wage growth during the eighties and nineties has lead to large reserves in the funds. Because of the fiscal treatment, these excess reserves are partly due to deferred taxes. The government aimed to tax away a part of these excess reserves. This aim has been an element of the law known as the 'Brede Herwaardering' (Petersen 1992). The proposal concerning the taxation of fund reserves has been withdrawn because of opposition from the pension funds. The funds claimed that they need the excess reserve for periods which are less favourable for funding. The debate has made clear the strong relationship between government finance and pension savings. This relationship is discussed more in detail in chapter 5.

APPENDIX

A.1.1 Some evidence on pension systems in Europe

Below some information on pension systems in Europe is presented.
Table A.1.1 gives a brief overview of pension systems in 12 member states of the European Community. The table reflects the state of the art in 1992. All countries offer a basic provision financed on a pay-as-you-go basis.
Denmark, Ireland and the UK show the same structure as the Netherlands. These countries also provide as the first pillar a nation-wide basic provision. This provision supplies a lump-sum benefit which is usually indexed in some way. In the UK an additional average-pay benefit is provided. Because the first pillar in these countries is of limited magnitude, the second pillar is in general fairly extensive. This pillar in these countries usually has a defined-benefit structure. In Denmark however dominates the defined-contribution plan.

Table A.1.1: Overview pension schemes in the European Community 1992

		First Pillar			Second Pillar		
Country	Retire-ment age (M/F)	Type of benefit[a]	Financing method	Aspired pension level	Type of benefit[a]	Financing method	Aspired pension level
NET	65	LS	PAYG	-	FS	Fund	70
UK	65/60	LS/AS	PAYG	50	FS	Fund	
IRE	66	LS	PAYG	-	AS	Fund	65
DEN	67	LS	PAYG	-	AS/DC	Fund	80
GER	65	AS	PAYG	50	AS	Book reserve	
FRA	60	AS	PAYG	±70[b]			
BEL	65/60	AS	PAYG	60			
ITA	65	AS	PAYG	70			
SPA	65	AS	PAYG	100			
POR	65/62	AS	PAYG	80			
LUX	65	LS/AS	PAYG	70			
GRE	65/60	FS	PAYG	100			

[a]) LS = lump sum; AS = linked to average salary; FS = linked to final salary, DC = defined-contribution

[b]) including integrated supplementary pension schemes

Source: Besseling P.J. & R.F. Zeeuw (1993): '*The Financing of Pensions in Europe: Challenges and Opportunities*', Research Memorandum no. 111, CPB, Den Haag.

Belgium, Greece, Italy, Portugal, Luxembourg and Spain have an extensive nation-wide first pillar offering average-pay linked defined-benefits at a substantial level. As a consequence, usually no supplementary pension scheme exists (or it is very small of magnitude). In Germany the first pillar is linked to average pay. The financing method for the second pillar is generally on a funded basis. The popular means of funding however is the book-reserve method. The pension reserves are part of the liabilities of the sponsor company. The reserves however are re-insured. France is a special case because of the provision of supplementary pensions on a pay-as-you-go basis.

Table A.1.2 provides information on pension-fund assets per country in 1992. For Europe these assets are concentrated in a limited number of countries, reflecting the

institutional structure of their pension systems. Funds in the UK alone accounted for almost 60% of total pension fund assets. The share of the Dutch funds is almost 22% of total assets in Europe. Second-pillar pension wealth in Germany is equal to about 9%. The other member states contribute by less than 10%. The ranking is different when pension fund assets are classified as % of GDP; the Netherlands and the UK dominate the scene. As the information in table A.1.1 already has suggested, the importance of funded schemes for Denmark and Ireland is also relatively large.

Table A.1.2: Pension-fund assets in the European Community 1992

	Pension fund assets		
	ECU bn	% of total	% of GDP
UK	530.7	59.0	65.9
NET	196.1	21.8	79.0
GER	83.0	9.2	5.6
FRA	34.0	3.8	3.3
DEN	19.5	2.2	17.7
IRE	13.2	1.5	35.1
ITA	9.5	1.0	1.0
SPA	6.3	<1.0	3.1
Remaining 4	7.6	-	-
EUR(12)	899.8	100	16.6

Source: Mortensen (1992)

A.1.2 Some evidence on aging

The tables below present some information on aging.
Aging stems from two processes: the fall in the fertility rate and the increase in life expectancy. Table A.1.3 reports total fertility rate (= the number of children born on average to a 'typical' female during her life time). A fertility rate of 2.1 implies (ceteris paribus) zero population growth. The rate drops below this threshold from the first half of the seventies on. The WRR and the CBS project a continuation of the low fertility rates in the coming decades. This would imply, first of all, a decline in the growth rate of the population in the medium term. In the long run, the low birth rate will even lead to a continual shrinking population. The process of aging is amplified by the increase in life expectancy at birth. Males and females born in 1990 may expect a life span of 74.0 years respectively 80.3 years. This is a substantial increase in comparison

with males and females born in the fifties. For 1950 the figures are 70.5 and 72.8 respectively. Given the retirement age of 65, expected life-time during old age increase with 3.5 resp. 7.5 years for males and females. Expressed for the old-age life span of those born in 1950, the increase is 64% for male retirees and as much as 96% for female retirees.

Table A.1.3:Total fertility rate (= the number of children born on average to a 'typical' female during her life time) and life expectancy at birth for males and females in the Netherlands

	TFR	Life expectancy at birth	
		M	F
1950	3.1	70.5	72.8
1955	3.0	71.0	74.2
1960	3.1	71.5	75.3
1965	3.0	71.2	76.2
1970	2.6	70.7	76.5
1975	1.7	71.5	77.8
1980	1.6	72.5	79.5
1985	1.5	73.1	79.7
1990	1.6	74.0	80.3
2010	1.8	<76.0	x
2040	1.8	<76.0	x

Source: WRR (1993)

Table A.1.4: Fertility rate, population shares and dependency rate (steady state values)

Fertility rate	Population growth	Population shares			Dependency rate
		0-15	15-65	65+	65+/(15-65)
2.5	0.8	39	38	23	0.61
2.1	0.0	30	40	30	0.75
1.5	-1.2	20	36	44	1.22

Source: Sturm (1991)

Moreover, the low birth rate will also have implications for the demographic structure. The lower birth rate will imply an increase in the share of the elderly to the total population.
Table A.1.4 shows how powerful the impact of the fertility rate is on the population's age structure. The table presents the shares of different population age groups for alternative fertility rates. All else equal, a decline in the fertility rate from 2.5 to 1.5 will lead to a doubling of the old age population share (over 65) and the share of the young below 15 approximately will be halved. This would suggest that the working population as share remains almost unaffected. Defining the dependency rate as the number of persons of 65+ in relation to potential workers (15-65), then a fall in fertility rate from 2.5 to 1.5 will mean that the dependency rate is doubled.

The WRR study 'Ouderen voor Ouderen: Demografische ontwikkelingen beleid', (1993), the CPB-studies 'Nederland in drievoud' (1992) and 'Scanning the Future' (1991) and a report of the World Bank (1994) provide much relevant and detailed information on demographics, aging and the impact on the economy. Reference can also be made to Razin & Sadka (1995) for a broad survey on themes in theory with respect to the interaction of population and economics.

PART I

SUPPLEMENTARY PENSIONS: INTERGENERATIONAL RISK-SHARING AND WELFARE

2 Supplementary pension schemes as employee retirement income insurance

2.1 Introduction

This chapter raises the question of why supplementary pension schemes with mandatory participation exist at all. A supplementary plan is usually neatly integrated with the public pension scheme. Therefore, an analysis of the raison d'être of supplementary pension schemes also calls for a treatment of public pensions.
Several arguments which insist on intervention with the provision of retirement income will be reviewed (section 2.2). Literature on the subject has provided intense discussion on the rationales for public schemes. An important contribution to the literature has been Diamond (1977), who has derived, within the tradition of normative welfare economics, a framework for the analysis of public schemes. According to the normative approach, there are at least three categories of arguments which justify government intervention with respect to retirement-income provisions: paternalism, income redistribution and market failure. The argument of paternalism may also explain the interference of the employer with the old-age income provisions of his employees. As part of the labour contract, an employer may offer to organize a pension saving scheme for his employees. Such a scheme can be structured as a defined-benefit plan or as a defined-contribution plan. The argument of market failure is related to the incompleteness of the insurance market to provide retirement real income insurance. The literature in the field points out that this kind of insurance can be based on intergenerational risk-sharing. The private market is not able to organize this. Non-market arrangements are therefore necessary to organize intergenerational risk-sharing. It can be set up through a public pension scheme, financed on a pay-as-you-go base. This is well-known from the literature. A main purpose of this chapter is to show that a defined-benefit

plan also implies retirement income insurance based on intergenerational risk-sharing. Hence, the argument of overcoming failure of the insurance market, which justifies the existence of a public scheme, is also of relevance to motivate a defined-benefit plan.
Section 2.3 evaluates defined-benefit plan and defined-contribution plan as the two prototypes of a supplementary scheme. The emphasis is revolved primarily around the private market failure to offer retirement income insurance. The plans are discussed with respect to the issues: return, risk and (group) insurance. These issues demonstrate how, in many respects, the two plans can be seen as opposites.
Literature within the field of pension economics is extensive. Therefore, the review has been selective. For a more comprehensive treatment of rationales of public schemes and supplementary schemes, reference can be made to Blinder (1988), Bodie (1990), Breyer (1994), Holzmann (1992), Kuné (1987), Petrie & Sturm (1990), Thompson (1983, 1988), Verbon (1988), World Bank (1994).

2.2 Rationales for intervention

2.2.1 Paternalism

Paternalistic rationales for intervention refer to the ability of (young) individuals to make choices between consumption during their economically-active period and during their old age. One can distinguish two kinds of argument: pure paternalism and self-control paternalism.

Pure paternalism

Many individuals will not save enough if left to their own devices, even if actuarially fair retirement provisions are available. One must not rely on the unrealistic characterisation of individual decision-making as irrational in order to explain undersaving. It is sufficient to assume that the process of decision-making is based on 'bounded rationality': intentionally rational behaviour and aims, subjected however to individuals' limited ability to process information. Firstly, undersaving may relate to cognitive dissonance: psychological findings point out that individuals may underestimate the probability of unpleasant events occurring to them, like inability to work in the future. Secondly, undersaving can stem from myopia, i.e. individuals tend to attach undue importance to short-term benefits at the expense of

issues which are relevant in the longer term. Thirdly, retirement-planning involves actuarial and financial economics, which go beyond the capacities of many savers.
The above arguments may justify intervention in retirement income. However, this does assume that government, firms and representatives of workers have a better understanding of what is in their interests than the individuals themselves. The possibility of failures in the decision-making by government, fund managers and so on, can never be ruled out. Moreover, in order to be successful, participation in any arrangement has to be mandatory. It has then to be recognised that the intervention to correct the poor decisions of some can impose costs on others who have made saving decisions adequately and in accordance with their preferences.

Self-control paternalism

The theory of the life-cycle hypothesis assumes that individuals choose the optimal consumption plan and execute the plan with the necessary discipline. In real life, individuals are aware of their shortcomings concerning self-control at the moment of which they have to take the decision to delay consumption of disposable income. Therefore, they might find it useful to lock themselves into long-term pure capital-reserve 'forced-savings' programmes. Self-control paternalism may therefore explain individual retirement savings within life-insurance programmes as well as the broad support for compulsory participation in public and private pension schemes (Thaler & Shefrin 1981).

2.2.2 Income redistribution

Clearly, public pension schemes on a pay-as-you-go basis have as their fundamental goal the redistribution of income. This redistribution can be between generations (intergenerational) as well as within generations (intragenerational).

With respect to intergenerational redistribution, the active young workers care for the elderly so that they can enjoy a decent standard of living without having to work or to rely on gifts from relatives or from charity. The introduction of an intergenerational transfer system makes all cohorts better off. The social-security system permits the older workers and retirees to increase their consumption. Therefore, they directly experience an increase in utility. The cohorts of the younger workers may also encounter an increase

in utility, because they feel themselves better off due to the rise in well-being of the elderly (interpersonal utility) and because of the prospect of also obtaining public pensions in the future. However, in their youth the elderly were also fully capable of working and saving for a retirement-income provision for their old age. Why then, does the government play such an important role in providing old-age pensions to every retiree, irrespective of whether or not those involved have worked and paid taxes? Blinder (1988) has looked for explanations for the creation of present public pension schemes from a historical perspective. He finds that social security has been created or extended whenever an economy has had to experience the effects of an adverse event such as war or a depression, or when the economy has experienced high growth level or anticipates future growth. In the US, the social-security system stems from the Great Depression. The cohorts of older workers and retirees were hard hit by the Depression and they had no time or opportunities to restore the associated large losses in lifetime income. The argument of 'just an accident of history' firstly explains why a public scheme such as in the US has been started and secondly, also why it is unfunded: the taxes levied could be used immediately to make payments to the elderly from that moment onwards. In the Netherlands, social security was started up on a large scale during the fifties. A mixture of experiences with widespread poverty during the thirties, the 'Keynesian revolution' in economics and the dominance of social-democratic ideas explain the introduction of social security. Of course, in reality the creation of a public scheme stems from a complex set of factors. However, society's aversion to intergenerational inequality is certainly one of these factors as the USA and the Netherlands show. For a more detailed treatment of the historical background of public schemes, compare Verbon (1988).

Within the Dutch public scheme, income redistribution is also *intra*generational in nature. Benefits are equal for everyone, but the premium which one has to pay during youth increases according to income up to a maximum. Therefore, the low-income categories benefit more from the public scheme than higher-income categories. This redistribution from high to low wage income calls for mandatory participation because, otherwise, the rich and high-earners would simply opt out. Also, the 'free rider' argument can explain mandatory participation: if participation is voluntary, some people will not participate during their younger years. They anticipate that there will be some income support during their old age because others will not let them go hungry.

2.2.3 Failure of the insurance market

Individuals who are looking for opportunities to insure themselves against the undesirable consequences of life-time risk and economic risks concerning retirement income are confronted with a market system which is far from complete in covering all possibilities in all future periods. The incompleteness of the capital market might prevent the individual from constructing the portfolio of retirement-income provisions which is optimal, given his preferences concerning expected return and risk and given available resources during life-time.
In this section, three such failures resulting from incompleteness will be examined: the absence of an annuity market in which life-time risk can be insured on actuarially fair terms (2.2.3.1), the absence of futures markets in which wage-path risk can be insured and in which generations can trade factor share uncertainty (2.2.3.2), and the absence of safe *real* investment opportunities (2.2.3.3). Because of the incompleteness of the insurance market, individuals are exposed to standard-of-living risk with respect to their pension wealth. Subsequently the manner in which intergenerational risk-sharing may overcome failures in the private insurance market will be set out (2.2.3.4). This is illustrated for the public scheme with some examples discussed in the relevant literature (2.2.3.5).

2.2.3.1 Annuities and life-time risk

Life-time uncertainty need not be a problem for the individual when the private insurance market is functioning well. If this is so, workers can simply use their retirement savings for the purchase of annuities from private insurance companies, where the relationship between premiums and annuities paid is actuarially fair and based on the probability distribution of the life span of the individual's age cohort.
In the literature, it has been suggested that adverse selection problems may prevent the development of an insurance market (Diamond 1977). Individuals with a higher than average life expectancy will have a great need for this kind of insurance. If people have better information about their life expectancies than life-insurance companies, then the insurance companies will find that their customers have greater longevity than the reference population as a whole. Feldstein (1985), Eckstein, Eichenbaum & Peled (1983, 1985) and Karni & Zilcha (1989) amongst others show that when the private annuities market is plagued by adverse selection, intervention set up as a social-security programme with fair annuities and mandatory

participation may improve social welfare. Individuals are forced to contribute in a pre-specified way to the programme when young, and are paid off during their old age at an actuarially fair rate of return which incorporates the individual survival probabilities and the market rate of return. This argument provides a rationale only for a fully-funded insurance programme. This is in contrast to the almost universal use of pay-as-you-go financing of public pensions.
The Dutch life-insurance market is well-developped. Competition is in general large. The insurance companies provide a broad spectrum of products of life-time insurance, ranging from the traditional life-annuities with as pay-out nominal fixed-amounts to the new unit-linked insurance products within which life-time risk is insured but the investment risk on premiums paid-in are borne by the insurant himself (Ponds et al. 1992). There are countries like the United States, in which the private annuities market is not so well developed. Apart from the adverse selection problem, there are other explanations for small transactions on private annuities markets.
A simple explanation (Abel 1988) is that people have a strong bequest motive and thus, even if annuities were offered on an actuarially-fair basis, individuals might not be willing to purchase them.
Kotlikoff & Spivak (1981) have put forward the idea that, if the market for annuities is severely hampered by adverse selection problems and transaction costs, family risk-sharing arrangements will be preferred to transactions in the private annuities market. The young benefit if the elderly die early and lose if they live longer than average. This intergenerational risk-sharing within the family does not necessarily reflect altruistic feelings but simply reflects the behaviour of selfish family members. The authors calculate that inter-family risk-pooling with respect to the risk of death may account for a substantial reduction in retirement wealth supplied on the private annuities market.

2.2.3.2 Wage-path risk

The future income of an individual is for a large part out of his control. The future wage-path is determined partly by economy-wide secular developments such as a labour-augmenting technical process which is decisive for the long-term trend in wage growth rate and partly by one's own career, which determines the deviations of the individual wage path from the trend. In real life, there is no market available in which uncertainty with respect to the individual wage path can be insured. Like life-time uncertainty, such a market will be plagued by adverse selection problems

because individuals who expect to be comparatively less productive will demonstrate a high demand for this kind of insurance.

2.2.3.3 Inflation risk and the lack of indexed assets

Future retirees are interested in the purchasing power of their retirement savings and they will therefore look primarily for protection against inflation risk. Table 2.1 presents evidence on nominal and real returns realized on stocks, bonds and real property for the Netherlands. As future retirees are interested in the real value of their old-age savings, the most relevant columns are those presenting the real returns. Stocks do have a high real rate of return, however they are also very risky. The performance of investments in bonds is characterized by a low real rate of return and relatively low risk in comparison with stocks. The standard deviations of the real returns are almost equal to the standard deviations of the nominal returns. This suggests that there is no strong correlation between nominal rates of return and the inflation rate.

Table 2.1: Mean and standard deviation of total rate of return on an annual basis on stocks, bonds and real property in the Netherlands, 1947-1988

	Nominal		Real	
	Mean	St. dev	Mean	St. dev
Stocks	10.8	21.0	5.7	21.7
Bonds (long-term)	5.5	6.7	0.6	8.0
Real property	8	10to15	3	10to15

Source: Frijns & Goslings (1989)

Table 2.2 presents evidence on the inflation rates and the nominal and real interest rates for the Netherlands. The figures indicate that the real rate of interest and the inflation rate are both characterized by strong fluctuations. Inflation rate and the real returns both appear to be non-stationary. Therefore, diversification of the individual portfolio and hedging strategies might result, at best, in a partial reduction of inflation risk and uncertainty with respect to the real returns. Also, there is no mutual fund or mix of mutual funds available which offer a safe real rate of return.

Life-insurance companies offer only *nominal annuities*. With this kind of insurance, an individual only substitutes life-time risk for inflation risk. Indexed annuities could provide insurance against both risks. Independence (negative correlation) of individual risks is an important precondition for any insurance market. A very serious problem for the private provision of inflation indexation is that (unanticipated) inflation affects all those insured simultaneously. There are hardly any assets available which life-insurance companies can use to construct a good long-term hedge against inflation risk on its liabilities. So, by offering inflation indexation, an insurer would expose himself to a risk which is too large. Therefore, the private market for annuities fails, because it does not offer annuities which are indexed for inflation.

Table 2.2: Inflation and interest rate in the Netherlands 1947-1992

Period	Inflation	Nominal interest rate	Real interest rate (ex post)
1947-1951	6.6	3.5	-3.2
1952-1956	2.1	3.7	1.6
1957-1961	2.4	4.5	2.2
1962-1966	4.7	5.4	0.7
1967-1971	5.9	7.2	1.4
1972-1976	8.9	8.5	-0.4
1977-1981	5.6	9.5	4.0
1982-1986	2.3	7.6	5.2
1987-1989	1.8	6.3	5.5
1990-1992	2.9	8.7	5.8
1993-1994	2.7	6.7	4.0

Source: Frijns (1990), CPB

The lack of real annuities in the private market as such can be alleviated by *inflation-indexed bonds* issued by the government. The periodic rate of return of an inflation-indexed bond consists of a real fixed-base rate of return and a variable part related to some price index.
Inflation-indexed bonds can overcome the private market failure to offer an investment outlet with certainty with respect to the *real* investment outcome. Moreover, the availability of inflation-indexed bonds creates opportunities for financial intermediation. The life-insurance sector could provide indexed annuities if indexed bonds become available, making the capital market less incomplete for the individual investor.

The government is an ideal institution for issuing inflation-indexed bonds. The government itself has indexed assets in the form of tax revenues levied on the nominal wage and rental income. So issuing inflation-indexed bonds would provide less of a mismatch between revenues and expenditures of the government related to outstanding debt. Moreover, the issuance of indexed bonds by the government might help to control inflation because it eliminates a main incentive for the government to inflate the economy. With indexed debt, the government is no longer able to reduce the value of outstanding liabilities by allowing inflation to increase or to endure. Inflation will produce an immediate increase in the burden on outstanding debt. In general however, governments are reluctant to issue inflation-indexed bonds[1]. A serious objection levelled against inflation-index bonds is that protecting bondholders from inflation might reduce the pressure to maintain price stability. If part of the pain of inflation is removed, then the demand of the public for inflation control by monetary authorities will weaken, and inflation will worsen. Another explanation for the lack of indexed government bonds in many countries can be that, at the moment at which the issuance has to take place, the prevailing real market rate of return, which has to be the real rate for the bond during the whole term, is either too high for the government or too low for the investor (compare the reluctance of the Dutch government to issue index bonds during the late eighties because of, as is argued, the high level of the real rate, as seen from a historical perspective). Moreover, the issuing of indexed bonds is sometimes interpreted as a capitulation to inflation. This argument is derived from the observation that indexed bonds have been issued by governments of countries (UK, Israel) with a reputation for high inflation rates. Since the issuance of index bonds from the beginning of the eighties onwards, however, the inflation rate in the UK has actually declined substantially. Extensive discussion on the pros and contras of indexed bonds can be found in Dornbusch & Simonsen (1983), Fischer (1986), Munnel & Grolnic (1986). For a discussion on the issue in the case of the Netherlands, see Bomhoff (1983) and Custers (1990). Goslings (1994) provides a discussion on the positive characteristics of indexed bonds for pension savings.

With respect to the theme of the study, it is of relevance to note that inflation-indexed government bonds with a fixed real return will only protect against the uncertainty of inflation. They provide no insurance against the *risk of real increases in the standard of living*. Hence, if a pension-saver's sense

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[1] Fischer (1986b) discusses some reasons for the non-issuance of indexed bonds by the corporate sector for the USA.

of well-being depends not only on the absolute level of his consumption but also on the level of those around him, then the risk in utility terms of inflation-indexed bonds can be considerable, especially because of the long accumulation period of retirement provision. Merton (1983) proposes issuing so-called consumption-indexed linked government bonds, which would provide protection against both inflation risk and risk concerning the real change in the standard of living. The periodic increment of these bonds is the growth rate in aggregate consumption per capita. The savings held in these bonds keep pace with the average consumption level.
Chapter 4 will provide further consideration of this issue.

2.2.3.4 Standard-of-living risk, retirement income insurance and intergenerational risk-sharing

The unpredictability of the future wage path in combination with the uncertainty with respect to the real rate of return provides difficulties for spreading life-time resources according to the preferred life-time consumption profile. During the retirement period, one can ultimately determine whether the wealth accumulated during working period reflects undersaving or oversaving. With respect to their income during retirement, individuals therefore are exposed to *standard-of-living risk*. This risk is defined as the uncertainty with respect to the realization of the preferred standard-of-living during retirement. It might be that a retiree will not have enough income (wealth) to maintain a standard of living comparable with standard in the preretirement period. It might also be that the retiree experiences his actual standard of living as relatively low compared with the standard of the younger generations due to high wage income growth.

The welfare-enhancing property of the availability of retirement income insurance can be well illustrated by a quotation from Samuelson in which he refers to his younger years, during which he wanted to make provisions for retirement:

> "...two of the three features that I wanted in a retirement provision were just not available.
> [1] Not knowing just when I should die, I wanted an *annuity for life*. This, my friendly Prudential agent had long been glad to sell me. (...)
> [2] Not knowing what the future price level would do, I wanted a *real* annuity. This was just not available (...)
> [3] Noticing that the average real level of consumption was rising in the modern mixed economies, and realising that my unhappiness increases when I see myself moving down the scale of real income and consumption relative to the people of all ages

> I live with, my final unreasonable demand was for an annuity that would leave me for life at the same *percentile* level of the working age population's real living as I had become accustomed to.
> There was no way I could get these three wishes."
> (Samuelson 1983, p. 279)"

Several decades later, Samuelson's second and third wish still cannot be realized in the private insurance market.

Economic literature points to collective risk-bearing as a way of overcoming the private-market failure to provide for *retirement income insurance.* In particular the literature makes a case for intergenerational risk-sharing, often with the involvement of government finance (Gordon & Varian 1988, Merton 1983, Stiglitz 1983, Fischer 1986, Gale 1990, Enders & Lapan 1982 1993, Richter 1993).

Usually, intergenerational risk-sharing is analyzed in the face of uncertainty as to the *factor rewards*: wages and rental income. Long-term wage risk and rental-income risk are not diversifiable within a cohort because these risks effect individuals of the same age simultaneously. This observation may provide scope for welfare improvement through risk-pooling between generations. In a long-term perspective, wage income and rental income as shares of total income are negatively correlated. Because workers' income is mainly from wages, and retirees' income is mainly from rental income, intuition suggests that both the young and old generations can benefit from intergenerational risk-sharing with respect to factor reward uncertainty. The negative correlation between factor rewards lends itself well to the construction of a hedge contract between the old and young. This kind of insurance implies a system of redistributive transfers between workers and individuals holding pension savings. The income redistribution ex post will be from high rental income to low wage income, and vice versa.
Risk-sharing between factor rewards is only possible for shocks for which wage income and rental income are negatively correlated. Intergenerational risk-sharing concerning *shocks* for which *wages and rental income are positively correlated,* requires a contract with a term long enough to transfer resources from periods with a high income level to periods with a low income level.
Intergenerational risk-sharing may also be of relevance in the face of uncertainty with respect to the *future wage path.* Wage-path risk creates uncertainty as to the future level of income and future standard of living. When the future wage path contains a random component, then lucky generations with high wage growth are able to support less lucky generations. A system of retirement income insurance with wage-related

benefits, covering succeeding generations of workers, may be a welfare-improvement ex ante to the generations involved.

The reason for the lack of a private market arrangement providing intergenerational income risk-sharing is straightforward: current and future generations are not both alive prior to the outcome of the income risks. The current young are not able to precommit future young workers to a hedge, although on an ex ante basis both generations can benefit. Whenever the current young generation of workers wants to commit itself to an insurance contract, the other party to the hedge has not yet been born. By the time the next young generation of workers comes to the labour market and can commit to the intergenerational contract, the outcome ex post of the contract will be known. The support of the future young generations is contingent on the outcome of the contract ex post. They will not accept voluntarily a contract that will lead to a loss in welfare for them (Gordon & Varian 1988).
There are two ways to solve this problem concerning the participation of the future generations.
The commitment of future generations can be enforced by the requirement of *mandatory participation*. The justification of mandatory participation may be based on a metaphor used by Rawls (1971) to evaluate the redistribution effects of social security. He considers decision-making on social security is taking place 'in an original position', in which unborn individuals are supposed to be ignorant of their future positions. Before the '*veil of ignorance*', all individuals are alike. After 'passing through the veil', individuals will differ depending on the state in which they are born. In the original position, before the riskiness of each person has been revealed, all persons would be equally insurable. This metaphor can be used to implement an insurance scheme based on income redistribution ex post from lucky individuals to less lucky individuals, in which partipation is mandatory. From an ex ante point of view, the insurance offered will be a welfare-enhancement to the individuals involved.
As it will be set out in the next chapter, intergenerational risk-sharing contracts can also be based on *voluntary participation* by future generations, even when they would lose life-time income ex post. Prerequisite is that such a *self-enforcing* contract must be ex post optimal, i.e. time-consistent, in all future states of nature. Rational young workers will voluntary participate into the contract when the gain in utility of being insured against retirement income risks exceeds the loss in utility associated to the income loss. Hence, current generations can lock future generations into the contract by taking care that - for all possible states of nature in the future - the outcome of the contract is always a welfare-improvement ex post for future generations

compared with the option of no participation in the insurance contract. When this is not the case, then the future young generations can always use their political power (voting) and/or economic power (international labour mobility) to withhold their support to the contract. Hence, in order to secure the voluntary participation of the next generation, it might be that the reach of the risk-sharing has to be restricted compared with a contract based on mandatory participation. So, the requirement that a contract with voluntary participation must be optimal ex post, can lead to a contract which is welfare suboptimal relative to a contract based on a binding commitment (cf. Kotlikoff, Persson & Svensson 1988).

A complete evaluation of retirement income insurance based on intergenerational risk-sharing should imply trading off various kind of *effects on welfare*. This concerns firstly, - the effect of *insurance gain* due to the reduction in variance of retirement income, secondly, - the effect of *income redistribution ex post* on life-time income of the generations involved, and thirdly, - effects related to *economic efficiency*, such as distortions on labour supply and the capital investment process, and changes in saving behaviour. A loss in wage income due to high contribution rates (ex post) in general will have a downward impact on domestic labour supply, due to more preference for leisure (for example early retirement) and strengthening of labour migration. Additional wage claims in order to compensate for the high premium burden may drive out domestic firms to abroad. Welfare costs also might occur when the high contribution rates of defined-benefit plans lead to a re-allocation of the domestic labour force in favour of firms without defined-benefit plans, provided that the new allocation of the labour force implies a lower productivity level compared with a non-distorted allocation. These kinds of efficiency costs will be compensated by individual welfare gains related to more optimal saving behaviour: the saving decision may be altered, because the prospect on a riskfree retirement income reduces the need for precautionary pension savings.
The analysis in this study pays primarily attention to the trade-off between the insurance effect and the income redistribution effect. Impact of (international) labour mobility on the sustainability of defined-benefit plans is discussed in section 2.3.1 of this chapter as well as in section 3.6 of chapter 3. Other efficiency effects related to disincentives to labour supply and effects on saving behaviour are not dealt with. With respect to the latter, it is assumed that the availability of retirement income insurance has no impact on the decision how much to save. This partial analysis may be justified by the observation that the welfare aspects of the availability of retirement income insurance based on funding and intergenerational risk-

sharing is a neglected theme in the literature. Analyses on the welfare aspects of a *funded* defined-benefit scheme based on *inter*generational sharing of income risks are not known to the author[2]. The purpose of the next chapter 3 is to provide a contribution to this subject.
Economic literature does provide several examples of studies on the welfare improvement of *inter*generational risk-sharing through a *public* pension scheme on a pay-as-you-go basis. Some of them are set out below in section 2.2.3.5.

2.2.3.5 Public pensions and intergenerational risk-sharing

Merton (1987) points to the role of a public scheme to improve diversification of life-time income recources. He examines a model in which income shares accruing to capital and labour are stochastically determined due to fluctuations in productivity. Because human capital is non-tradable, economic inefficiencies arise in this economy since, early in their life, individuals are forced to hold too much of their wealth in human capital in relation to financial capital, i.e. retirement wealth, while on retirement all capital is only available as financial capital. These portfolio imbalances preclude welfare-improving sharing of factor-share risk. Merton shows that a public pension scheme which pays the retirees a share of current-wage income and taxes the young accordingly provides diversification of income risk across factor shares and increases welfare by improving the efficiency of risk-bearing in the economy. The contribution of Boadway et al. (1992) is interesting because of the distinction between closed and open economies. It appears that the welfare improvement of intergenerational risk-sharing via a public scheme is larger for a closed economy than for an open economy. An open economy is in a better position to deal with domestic productivity shocks because of its ability to borrow from and lend to the rest of the world.
Green (1977), Smith (1982) and Brandts & de Bartolome (1992) motivate intergenerational transfers through a pay-as-you-go public scheme as a type of insurance against *demographic uncertainty*. An increase in the size of the

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[2] For contributions on the welfare aspects of social security based on *intra*generational redistributive income taxation within which individuals face *income risk*, compare Varian (1980), Eaton & Rosen (1980), Easley et al. (1985, 1993). Social security may be a welfare-improvement indeed, depending on the trade-off between the gain of being insured, the effects of income redistribution and distortions on labour supply related to the tax rate.
Also one can find in the literature theoretical analyses on the welfare aspects of a *funded* social security program based on *intra*generational sharing of *life-time risk*. Compare for example Karni & Zilcha (1989), Feldstein (1985), Eckstein et al. (1983, 1985).

working population would decrease the capital-to-labour ratio in the economy, decreasing wages, whereas it would increase the return on capital, and the opposite outcome would result if the working population has decreased. Because their incomes are negatively correlated, a social insurance contract between the future retirees (= current workers) and as yet unborn workers would be beneficial, seen from an ex ante point of view. Risk concerning the rate of population growth can result in the bad luck of being born into an unusually large cohort or of being retired when the then active cohort is unusually small, because these large cohorts are confronted with relatively low wages as well as a relatively low rate of return on their savings. For a two-period model, Smith (1982) analyzes the realistic case of a fixed benefit for retirees, where the costs are divided equally among the members of the young generation. The tax levy is contingent upon the size of the preceding generation. Such a social contract would be beneficial to cohorts which are relatively large. In general, the fixed benefit system has the effect of creating net transfers in life-time income from lucky (small) generations to unlucky (large) generations. When welfare is described by a utility function with a sufficiently high degree of risk-aversion, the increase in the welfare of the poorest generations exceeds the loss in welfare of the rich.

Enders & Lapan (1982, 1993) evaluate the welfare-enhancing effects of intergenerational risk-sharing via the public scheme against the distortion in the labour supply because of the increase in the tax rate. For a constant relative risk-aversion utility function, it turns out that a tax rate can always be found such that the beneficial effects of risk-sharing are more dominant than the detrimental effects of the distorted labour/leisure choice.

In a stochastic two-period overlapping generations model with risk-averse individuals, Siandra (1994) demonstrates that a public pension scheme based on pay-as-you-go financing may be optimal even in a dynamically efficient world. The reason is that the insurance value of public pensions may outweigh the life-time income loss due to intergenerational transfers. A negative correlation between labour earnings and returns form savings is assumed. The degree of risk-aversion is decisive for the outcome of the trade-off between the insurance effect and the income effect. This analysis takes also into account the distorting effects of the pay-as-you-go transfers on the capital-labour ratio and labour supply.

The preceding sub-section has pointed out that intergenerational contracts must be *self-enforcing of nature*. Sjoblom (1985) discusses explicitly the long-term stability of public pension schemes. A public pension scheme is a program under which income is transferred from the young to the old. Young

generations are not bound by law to continue the system established by their predecessors. They can use their political power (voting majority) to reject a pension program which they do not want. What mechanism enforces that the future young will support a public pension scheme whenever it is established? The future generations have an incentive to support because they perceive themselves as future beneficiares. The temporal separation of costs and benefits creates a kind of temporal credibility problem: the benefits that future voters will chose to transfer to future retirees will depend in some way on the taxes that these future retirees themselves were willing to collect when they were young.

2.3 Supplementary pension scheme

This section deals with the strengths and weaknesses of the two prototypes for supplementary pension schemes which firms can offer to their employees: defined-benefit plans and defined-contribution plans. The evaluation reflects the basic observations of the literature, compare for example Bodie (1990), Bodie, Marcus & Merton (1988) and Besseling & Zeeuw (1993). The emphasis here is on aspects which are related to the private market failure to offer retirement income insurance. The plans are discussed with respect to the issues: return, risk and (group) insurance. These issues demonstrate how, in many respects, the two plans can be seen as opposites.

2.3.1 Defined-benefit plan

Return

The primary objective of funded defined-benefit schemes is to offer former workers a supplementary pension in addition to the basic public pension such that total pension income enables them to have a standard of living comparable to that enjoyed during the working years. The total pension benefit is related in some way to the wage level in the pre-retirement period. Normally, this is achieved by relating the benefit at the start of the retirement period to either final-pay or to average wage. Moreover, during retirement there is usually some kind of *indexation*. In the Netherlands and the United Kingdom, the benefits are often inflation-proven or even welfare-proven, so maintenance of the pre-retirement standard of living during the period of retirement is guaranteed. When workers participate in the overall fund risk and pay a proportional share of

the contribution, then protection offered to current retirees against inflation implies that the active workers have to bear the inflation risk on the defined-benefits. However, the indexation is not unconditional, but contingent on the financial situation of the fund and therefore also on that of the plan's sponsors (Frijns & Petersen 1992, Lutjens 1989).
In countries such as the US, mobile employees and retirees are exposed directly to inflation risk, since their defined benefits are fixed in nominal terms. As to the reasons why pension funds do not offer protection against inflation risk whereas they do for other risks, such as the risk of longevity, the literature points out, among others things: - the elderly have enough inflation protection through public pensions, owner-occupied homes and other assets (Feldstein 1983); and - the firm sponsoring the plan cannot hedge inflation risk through an appropriate investment strategy, and is therefore reluctant to promise inflation-adjusted pensions (Summers 1983).

Risk

Workers covered by a defined-benefit plan are no longer subject to life-time risk. Pension benefits are paid out for as long as the pensioner lives, so there is insurance against life-time risk. Group insurance through a funded defined-benefit plan with mandatory participation clearly avoids the adverse-selection problem; private information on survival probabilities will be of no use. Moreover, diversification of longevity risk for a large pool of workers in any one firm or branch of industry will be as efficient as a private life-insurance company, or even more efficient because supplementary schemes are not hampered by the problem of adverse selection.
As a rule, the paid-in premium in a fully-funded final-pay plan is related to the present value of the future benefits, where the discount factor ideally is equal to the difference between the market return on assets and the growth rate of wages (compare chapter 6). Usually, an attempt is made to achieve *actuarial fairness*[3]. Actuarial fairness is achieved when each participant can expect an ex ante one-to-one relationship between the present value of contributions paid and the present value of the benefits to be received on retirement[4] (after allowing for mortality risk). Simply because the future is

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[3] The concept of actuarial fairness (equity) is seldom defined in the literature. An exception is Besseling & Zeeuw (1993). Compare also Goslings (1994) for a discussion on this term.

[4] The payment of contributions into the scheme in operation by employer and/or workers is usually seen as a component of the total compensation for labour supplied during working life. The 'Stichting van de Arbeid' (1969) expresses this by using the

uncertain, actuarial fairness for the individual worker can only be promised ex ante, and not guaranteed ex post. The actual rate of return on investment and the wage inflation will diverge from their expected values, resulting in alternating periods of overfunding and underfunding of the fund. Any structural imbalance between assets and liabilities of the fund has to be neutralized. Two aspects are relevant: (1) the flexibility of the contribution rate and, (2) accountability for the deficit in the fund's financial position and the problem of optimality ex post. These two aspects are discussed below.

(1) Funding risks and contribution rate

With respect to the *contribution rate*, at one extreme one can distinguish full flexibility in the contribution rate, so any imbalance in the funding of the pension promises will have a direct impact on the income of the sponsors, i.e. the firm's profit (shareholders value) and the disposable wage of the workers. The opposite case is stability in the contribution rate, implying alternate periods of overfunding and underfunding. During periods with high rates of return and low wage inflation, fund reserves can be built up which can be used for periods in which the growth in pension liabilities exceeds the expansion of pension assets.

Zalm (1990) points to the existence of a so-called '*pension fund paradox*'. This paradox states that, during periods of economic prosperity, pension funds experience a bad performance, while they do well during periods of economic recession. ("Als het goed gaat met de economie, gaat het slecht met pensioenfondsen. Als het slecht gaat met de economie, gaat het goed met pensioenfondsen".) This supposed relationship is derived by Zalm from the post-war development of the Dutch economy. The fifties and sixties have witnessed high economic growth. These years were not favourable for the funding of pension plans, because the capital market rate of return was relatively low (decisive for the growth of pension fund wealth) while the growth rate of wages was high (decisive for the increase in pension fund liabilities). From the mid-seventies onwards, the situation has been reversed: a high capital-market rate of return and a moderated wage growth. These two periods have been reflected in the funding position of pension plans: a trend towards underfunding and a trend towards overfunding respectively. According to Zalm, the pension fund paradox offers the possibility of reducing the impact of the macroeconomic fluctuations on the

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slogan: 'Pension costs are labour costs'. This implies that pension costs and labour costs constitute a whole and that the supplementary pension income should be considered as *deferred wages*. (Compare also Lutjens 1989, Bulow 1982, Gustman et al. 1991, Ippolito 1987)

variability in net wages. Zalm makes a case for a rather flexible premium-rate policy. A boom will lead to high wage growth, which may cause underfunding. Economic conditions are then favourable for raising the premium rate. A recession will imply low wage growth so overfunding may be the result. If so, there is leeway for a temporary premium rate reduction and the staggering of the net wage is less than that of the gross wage. For a discussion on this issue, compare also Ponds (1992).
The pension fund paradox is based on the principle of opposite results for the rate of return on capital and wage income growth. This principle will also be employed in chapter 3.

(2) *Intergenerational risk-sharing and the problem of optimality ex post*
With respect to the *financial position of the fund,* which of the sponsors should bear the funding risks? Should it be the current young workers, paying either a higher or lower actual premium than the premium they need to pay for actuarially fair benefits? Or should it be the shareholders of the firm(s) participating in the plan, who have to absorb any divergence between the value of the pension assets and the pension liabilities? The insurance offered by a funded pension scheme with defined benefits therefore may imply income transfers: between different generations of workers and/or between workers and shareholders. In the Netherlands, one can find a rich diversity with respect to this issue, because the sponsors are free in making rules on who should bear the risks of defined-benefit plans.
There are plans in which the statutes prescribe that the sponsoring firm is solely responsible for funding shortages. However, the firm will also be the first to benefit from reductions in contributions. Funding risks due to fluctuations in rate of return and wage inflation are therefore borne by the employer(s)/shareholders. This opens the way for making the funding dependent on the firm's payment capacities. Friedman B.M. (1983), Feldstein & Morck (1983), Bulow, Morck & Summers (1987) provide, for the USA, studies on the relationship between the funding of the pension saving scheme (overfunding, underfunding) and the value of the sponsoring firm for its shareholders.
In other plans, it is prescribed that employees pay a proportionate share of the contributions, so the active workers and the firm/shareholders jointly share the risks associated with pension promises made to current and future retirees. This implies risk-sharing within an intergenerational setting. The current young workers bear (a part of) the investment risk on pension savings which are held for the payment of benefits to current retirees.

Rules indeed can be formulated concerning the formal bearing of the funding risk. However, the *actual enforcement* of these contracts will depend primarily on the economic power of the sponsors. With respect to the issue of risk-bearing, this power is related directly to their mobility. In general, one can state that the more mobile the sponsors are, the greater the incentive for the sponsors is to withdraw themselves from actual risk-bearing when the outcome ex post is disadvantagous to them.
Firms/shareholders may in the first instance participate in the risk-taking. In the long run however, domestic wages have to be competitive with wage costs abroad. Firms will therefore shift the additional labour costs related to funding shortages to the workers via reduced wages, so that total labour costs remain unchanged. Due to their mobility, firms are always able to shift the funding risks to the less mobile workers.
In turn, young workers are more mobile than the older part of the labour force and the retirees. Hence, the young workers are also able to withdraw themselves from risk-bearing.
A pension fund covers usually a group of workers of a large company or of a branch of industry.
Of relevance is first of all mobility of labour between branches of industry because of differences in contribution rates. A reason for these differences can be that the plans differ in the size of the accumulated pension claims of the retirees and the elderly workers in relation to the number of workers. It is common practice for Dutch pension funds with respect to their funding policy either to do as if there will be no wage increase in the future or at best to assume just a limited wage increase, based on the development of the average career of the employee. This practice implies that the accumulated premium reserve is too low in relation to future claims. Because the plans are mainly final-pay plans with inflation-proven benefits, every wage and price increase will lead to shortages in the fund wealth. Additional contributions are necessary therefore. As the contribution is age-independent, young workers will contribute more than they need actuarially for their own pension entitlements. In general, when a funding shortage occurs in a plan, then the additional premium per worker to balance the plan is larger the more 'grey' the group of participants is (cf. also chapter 6). Future young generations may be inclined to arbitrage between 'grey' and 'green' pension plans, creating the problem of adverse selection. Arbitrage on the contribution rate for the supplementary scheme might lead to a situation in which 'grey' pension funds, i.e. which have a relatively large number of retirees and older workers, will be less attractive for young participants. The young and therefore still mobile workers may prefer to work in branches of industry with on average a younger group of workers and a smaller number of retirees.

A second kind of labour mobility is from (traditional) branches of industry with a defined-benefit plan to (new) branches of industry which offer to their employees a defined-contribution plan. A main characteristic of a defined-contribution plan is that risk-bearing is on an individual base. Intergenerational risk-sharing and income transfers are absent (see section 2.3.2).
Finally, a third kind of labour mobility is migration to (neighbour) countries in which the pension schemes imply less or even no income redistribution between generations.
The worst-case scenario of a defined-benefit plan is that a position of structural underfunding is realized, whereas no sponsors are present anymore to supplement the shortage of the fund. This scenario implies that the acquired rights on defined-benefits by the retirees and older workers can not be expired. Usually, indexation of benefits is conditional on the financial position of the fund. So, a funding crisis of a plan can be resolved by an incomplete indexation of benefits or even no indexation at all.
Therefore the current young individuals, especially those who are working in old-fashioned branches of industry, have to fear for the indexation of their future pension claims where they are entitled to, because the future young individuals might not be willing to participate in some or even none of the currently existing defined-benefit plans.

How can be dealt with the problems relating to labour mobility[5]?

With respect to domestic labour mobility from 'grey' to 'green' branches of industry, a solution can be the formation of a *nation-wide pension fund.* This fund then must replace the current structure of industry pension funds and company pension funds. The fund wealth of the individual pension funds is transferred to the new nation-wide pension fund. At the same time, workers' and retirees' pension rights, which are built up in the individual pension funds, are transfered to the new fund. This nation-wide fund provides a standard supplementary pension arrangement with wage-related benefits to

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[5] At present, labour mobility is not large. In general, wages (human capital) of individual workers are linked to education and years of experience. A new job in another branch of industry may look beneficial from the point of view of avoiding high premium costs for the supplementary plan. However, the new job may result in lower gross wage rate. The net-effect on take-home pay can be negative. Furthermore, international labour mobility is still rather low, due to family links, differences in language, cultural background and the like. Moreover, the population structure of neighbour countries will age as well, so these countries also have to cope with rising contribution rates of their pension schemes in the future.

all participants. This reform concerning the institutional structure of the pension fund industry will only provide an effective answer to domestic labour mobility between branches of industry with defined-benefit plans which differ at their premium costs. A nation-wide pension fund is in no way a suited answer to the possible drain of labour to firms which offer their employees a defined-contribution plan or to the threats stemming from international labour mobility. These two kinds of labour mobility still may require a serious consideration of reform proposals of the current scheme. Reform can be needed in order to make the system less unfair for the future younger generation and so avoiding that the intergenerational contract may break down at some moment in the future.
However, as it will turn out in the chapters 3 and 7, one must be careful with taking conclusions concerning the need for reform. It might be that the gain in welfare of being insured for standard-of-living risk due to the participation into a final-pay plan is large enough to outweigh the deterioration in welfare associated to income losses in order to absorb future shortages in the funding of the plan.

Disadvantages of defined-benefit plans

There are other serious disadvantages associated to defined-benefit plans. These disadvantages are related to the aspects of group insurance and mandatory participation.
A collective scheme has to offer uniform insurance and therefore it is suited ideally to homogeneous groups of individuals with identical needs and preferences. However, uniform insurance and compulsory participation may conflict with the current trend towards more individualistic lifestyles and diversity in career patterns.
Moreover, there is no one-to-one relationship between the contribution paid and the pension income a worker will receive later on. The contributors may therefore seen the premium paid as a kind of tax, being a part of the wedge between gross-wage earnings and take-home pay. This might lead to a distortion in the labour market because of the disincentive involved on the part of the labour supply. Older workers have even the option to stop working altogether due to the availability of early retirement arrangements.
Defined-benefit plans may score less with respect to the portability of pension rights. If portability is limited, then labour mobility will be reduced. Recently, however, a large number of Dutch pension funds have set up a transfer system of surrender value ('systeem van waardeoverdracht'). If a worker finds a new job, this arrangement implies that the pension fund or

the insurer of the old employer transfers the value of the accumulated pension rights to the implementing body of the supplementary scheme of the new employee.
Income redistribution can never be the primary goal of a funded supplementary scheme. However, the insurance is offered to the group of workers as a whole. This inevitably implies income redistribution ex post, as the scheme benefits some generations and disadvantages others. Furthermore, for the schemes operative in the Netherlands there may also be income redistribution within a generation, which is not meant by the plan. Two reasons for this are given here. A characteristic aspect of the dominant final-pay plan is that workers with a steep improvement in their career pattern are entitled to a high final-pay related pension, which is relatively large compared with their average wage and the premiums paid on average. Secondly, vesting rules specifying the number of years an employee must work are usually disadvantageous or at best have a neutral effect for mobile workers and part-time workers, so in some way there will be redistribution of income and wealth within the fund in favour of those with many years of service with no interruption in their career or with no change of employer. More specifically, the income redistribution will be disadvantageous to women because they often retreat temporarily or definitively from the labour market in order to care for children (den Hertog & Kraamwinkel 1991).

2.3.2 Defined-contribution plan

Return
Within a defined-contribution plan, each employee has an individual account into which the employer and the employee make regular contributions. On retirement, the employee can dispose of the accumulated value of the funds in his account. Wealth is equal to the sum of contributions and the actual investment returns. The firm has no obligation beyond making the periodic contributions. No group insurance is available.

Risk
Investment risks have to be borne by the individual employee himself. This can be seen as a favourable feature as well as a shortcoming. It is a favourable feature because the employee is free to choose how to invest his account and so allowing for a risk-return strategy suited to individual preferences. It is a shortcoming because the individual is fully subjected to the bad luck of unexpectedly high inflation or productivity shocks which

are not compensated for in the return on investment of the stock of retirement wealth. Although the individuals are able to reduce investment risk to a certain degree by buying individual life-insurance contracts on a nominal basis, they are in no way able to exclude risk concerning their actual standard-of-living position during retirement in the same way as a defined-benefit scheme.

Individual provision

The contributions are usually specified as a predetermined fraction of salary, but individuals are free to make additional contributions. There is a close and transparent relationship between the contribution paid from wage income and the pension wealth the person will receive later on. Due to the nature of the plan, problems with respect to actuarial fairness and portability of claims are excluded. Life insurance products can be used to tailor income during retirement according to individual preferences and needs. However, operation costs of individual insurance tend to be high because of administrative costs and profit increments. For the Netherlands, 'de Verzekeringskamer' (Bakker & van Dam 1995) reports that operation costs amount to an average of around 21% of the premium paid for individual provisions, around 5% for group insurance and below 1% for the state pension. The employer can reduce operation costs by bargaining for a group life-insurance arrangement. However, this will involve some requirements concerning compulsory participation of the individuals in the group arrangement, therefore introducing some distortionary elements.

Table 2.3: Operation costs of pension funds and life-insurance companies (ABP not included)

	in % of premiums		in % of balance	
	1989	1993	1989	1993
Industry pension funds	6.3	5.8	0.2	0.2
Company pension funds	5.5	4.4	0.1	0.1
Life insurance companies	17.1	13.3	1.6	1.2
- collective	-	7.2	-	-
- individual	-	21.1	-	-

Source: Bakker & van Dam (1995)

2.4 Evaluation

Paternalistic motives including self-control paternalism may underlie the implementation of a supplementary scheme. Such a scheme can be organized as a defined-benefit plan or as a defined-contribution plan.
Supplementary pensions in the Netherlands are mainly structured as defined-benefit plans. This chapter has analyzed defined-benefit plans as a form of employee retirement insurance aimed at overcoming the *failure of private insurance market* to provide retirement income insurance. Because of this failure, individual pension savers are exposed to *standard-of-living risk.* This risk is defined as the possibility that the retiree will not have enough income (wealth) to maintain a standard of living after retirement comparable with the standard enjoyed during the pre-retirement years and/or comparable to the standard of living of those around him.
This risk itself stems from uncertainties involved in the provision of retirement wealth:
(1) *life-time risk*: the uncertainty as to the life-span implies the possibility that the retiree will outlive the amount saved for the provision of retirement income.
(2) *investment risk*: the uncertainty as to the rate of return on retirement wealth implies the possibility that the amount saved for retirement will be inadequate because the assets in which wealth is invested perform poorly, either in relation to inflation, eroding the purchasing power of the retirement savings, or in relation to the real rate of return which has been expected.
(3) *wage-path risk*: the uncertainty as to the future wage-path implies the possibility that pension savings from wages are insufficient to realize a preferred allocation of life-time income to life-time consumption.

The literature in the field points out that retirement income insurance can be based on intergenerational risk-sharing. The private market is not able to organize this. Non-market arrangements appear therefore necessary to organize intergenerational risk-sharing. Such an arrangement can be structured through a public pension scheme, financed on a pay-as-you-go base. This is well-known from the literature. A main purpose of this chapter has been to show that a defined-benefit plan with wage-related benefits, also implies retirement income insurance based on intergenerational risk-sharing.

The main advantage of a *defined-benefit plan* is the insurance offered relating to post-retirement real income, which enables the participants to maintain the pre-retirement standard of living during their old age. A retired worker

will receive a pension benefit which is related in some way to the wage earned. If the reference wage is final wage, this kind of saving represents a link between the standard of living before and after retirement. It may be that employees prefer an average-wage plan in which the retirement benefit is related to (inflation-adjusted) career-average earnings in order to eliminate excessive dependence on the wage realised in the final years of employment.
Defined-benefit plans are cost effective compared with retirement insurance on an individual basis.
The insurance can be provided due to risk-bearing by younger generations. Rules of the plan may prescribe that shareholders of the sponsoring firm(s) also participate in the bearing of the funding risks of the plan. In the long run however, domestic wages have to be competitive with wage costs abroad. Firms will therefore shift the additional labour costs related to funding shortages to the workers via reduced wages, so that total labour costs remain unchanged. Due to their mobility, firms are always able to shift the funding risks to the less mobile workers. A severe weakness of insurance based on intergenerational risk-sharing is that the plan may be sub-optimal ex post for future generations. Mandatory participation of the employees therefore is required, creating labour market distortions. The uniformity of the insurance offered can also be seen as a serious disadvantage because of the increasing heterogenity in lifestyles, diverging career patterns and differences in preferences concerning insurance. A very unpleasant feature of the final-pay plan is that it redistributes from employees with an average-career or below average to employees with a steep career.

A *defined-contribution plan* is almost the opposite of a defined-benefit plan. Strengths of a contribution plan are labour-market neutrality and freedom of individual choice in life-time consumption profile and risk-return investment strategy. A very disadvantageous feature is the lack of certainty with respect to the ultimate real pension wealth. Workers participating in a defined-contribution plan therefore have to face uncertainty as to maintenance of standard of living after retirement. Life-insurance products can be of only limited use because these products only offer certainty in nominal terms. Moreover, individual insurance is burdened with high operating costs. Chapter 4 discusses two plans (a plan of Bovenberg and a plan of the author) which both use government finance to support the individual worker in reducing individual exposure to risk with respect to pension savings.

3 Funded defined-benefit plans as intergenerational contracts

3.1 Introduction

The aim of this chapter is to present a formal analysis of the welfare-enhancing properties of a funded defined-benefit plan in which the insurance offered is based on collective risk-bearing,

In a world of full information and perfect markets (including a market for standard-of-living risk insurance), there is no rationale for a funded defined-benefit plan. Any increase in retirement savings within these collective plans will be offset by a decrease in individual retirement savings. There is perfect substitution between pension fund saving and individual old-age savings, the sum of the total retirement savings remaining unchanged (Feldstein 1978). The rational individual is indifferent to who does the saving, caring only about the income which can be consumed during old age.

However, as discussed in the preceding chapter, one main raison d'être of pension schemes in reality is to offer post-retirement real income insurance whenever the private (insurance) market is not able to deliver the insurance preferred. Literature within this field has provided much discussion on the rationale for a public scheme which is financed on a pay-as-you-go basis. This rationale has often been said to rely on its ability to establish (or to improve) intergenerational risk-sharing (Smith 1982, Merton 1987, Boadway et al. 1992 amongst others). In comparison, much less consideration has been given to the issue of intergenerational risk-sharing by means of a firm-sponsored funded defined-benefit plan. Funding risks are usually said to fall within the responsibility of the employer. This is typical for the literature oriented to the supplementary scheme in the USA (Bodie 1990). In the case of the Netherlands, however, funding risks can also be borne by active workers. Hence, two extremes in the collective bearing of funding risks

concerning existing pension rights can be distinguished analytically. Funding risks are to be borne completely by (1) active workers, so one can refer to intergenerational risk-sharing, or (2) the shareholders of the sponsor firms. These two situations will be explored for a closed economy. The chapter also considers the viability of an intergenerational risk-sharing arrangement for a small open economy with international labour mobility.

The set-up of the chapter is as follows. Section 3.2 presents the Diamond's standard 2-period overlapping generations model. This model is modified for uncertainty with respect to the factor shares wage income and rental income. The uncertainty stems from demographic risk. Section 3.3 deals with the preferences of risk-averse individuals concerning the return-risk characteristics of their retirement income provisions. Sections 3.4 and 3.5 set out a formal analysis of the improvement in welfare following the introduction of a funded defined-benefit plan based on collective risk-bearing. A distinction is made to intergenerational risk-sharing between workers and retirees, and intragenerational risk-redistribution between high and low risk-aversive individuals. Section 3.6 treats the issue of whether the main conclusions concerning intergenerational risk-sharing are also valid for a small open economy with international labour mobility.

3.2 Basic model

A convenient model within which to analyze the effects of retirement income provisions is the well-known 2-period overlapping generations model (Diamond 1965). It is widely used for analyses on the aggregate implications of life-cycle savings by individuals. The capital stock and total income originate from the savings of individuals who save in their younger years to finance their consumption during retirement. The model lends itself well to issues on the optimality of retirement savings and the organization of retirement provisions.

Each generation lives for two periods. A generation works only in the first period of life, earning a real wage income which is partly consumed and partly saved to finance its second-period retirement consumption. It is assumed that precautionary savings and bequests are absent. Hence savings are only meant for retirement purposes. The savings of the young generation in period t generate the capital stock that is used to produce output in period t+1 in combination with the labour supplied by the young generation of period t+1. The size of generation t is L_t, which is the number of individuals

born at time t and working in period t. Labour force grows in t at the rate n_t so that:

$$L_t = (1+n_t)L_{t-1} \tag{2.1}$$

The economy is described by the standard competitive one-sector model. Firms act competitively and use the constant returns technology $Y_t = F(K_t, L_t)$. Output per worker y_t $(=Y_t/L_t)$ is given by the production function $f(k_t)$, where k_t is the capital-labour ratio (K_t / L_t) and the production function is assumed to satisfy the following conditions f'>0, f''< 0.

$$y_t=f(k_t) \qquad f'(k_t) > 0 \ , \ f''(k_t) < 0 \tag{2.2}$$

Competition in the markets for capital and labour guarantees that each factor is paid its marginal product. Hence:

$$r_t^m = f'(k_t) \tag{2.3}$$

$$w_t = f(k_t) - r_t^m k_t \tag{2.4}$$

where w_t and r_t^m are the wage rate and the market return on capital respectively in period t.

The model of Diamond is modified by introducing uncertain future income shares. Any source of uncertainty for which the wage income and rental income are correlated negatively and which is exogenous to the model can be used. Usually, welfare aspects of intergenerational risk-sharing are examined within models in which uncertainty stems from shocks or fluctuations over time in productivity or fertility. Here it is assumed that changes in the population growth rate will cause changes in the ratio of the working population in relation to the capital invested by the retired. It is straightforward that a change in the ratio of capital stock to labour will influence the income distribution, where wages (workers' income) and rental income (retirees' income) are negatively correlated to each other.
Demographic uncertainty is introduced into the model by allowing the number of workers per retiree to be a random variable. We simplify the model by considering only two states of nature. Increasing the number of states or introducing a probability distribution for population growth (e.g. a

normal distribution) will make the analysis more complex without adding anything to the basic argument of the chapter.
It is assumed that L_{t+1}/L_t can take only two values: either $(1+n^a_{t+1})$ or $(1+n^b_{t+1})$, both with a probability of 1/2, so:

$$n_{t+1} = \begin{cases} n^a_{t+1} \text{ with probability of } 1/2 \\ \\ n^b_{t+1} \text{ with probability of } 1/2 \end{cases} \tag{2.5}$$

The return on capital and the wage rate in period t+1, r^m_{t+1} resp. w_{t+1}, are determined when the value of n_{t+1} is known. It is assumed that $n^a_{t+1} < n^b_{t+1}$. Hence $k^a_{t+1} > k^b_{t+1}$, $w^a_{t+1} > w^b_{t+1}$ and $r^a_{t+1} < r^b_{t+1}$. Let $E[r^m_{t+1}]$ represent the expected market rate of return in the next period and $E[w_{t+1}]$ the expected wage income in the next period, so:

$$\begin{aligned} E[r^m_{t+1}] &= \frac{r^a_{t+1} + r^b_{t+1}}{2} \\ \\ E[w_{t+1}] &= \frac{w^a_{t+1} + w^b_{t+1}}{2} \end{aligned} \tag{2.6}$$

The representative individual of the generation maximizes as utility function:

$$\max U(c_1, c_2) = u(c_1) + E[u(c_2)] \qquad u'(.) > 0 \quad , \quad u''(.) < 0$$

subject to

$$c_{1t} + s_t w_t = w_t$$

$$E[c_{2t}] = (1 + E[r^m_{t+1}])s_t w_t$$

where $s_t w_t$ are the savings of generation t for consumption in period t+1, c_{1t} represents consumption in the first period of generation t, and $E[c_{2t}]$ represents expected level of consumption in the second period of generation t.
Plausible behaviour with respect to risk would suggest that, the more uncertain the future rate of return on savings is, the more consumers will save. Three factors then are relevant for the the saving rate s_t: the wage income, the expected market rate of return $E[r^m_{t+1}]$ and its uncertainty as measured by its variance $\sigma^2_{r_{t+1}}$. Hence:

$$s_t w_t = s(w_t, E[r^m_{t+1}], \sigma^2_{r_{t+1}}) = w_t - c_{1t} \tag{2.8}$$

An increase in uncertainty has the effect of making that consumers derive utility from being more prudent, thus deferring more consumption. In the context of the chapter, this means that, the larger the spread of possible outcomes of population growth around its mean is, the higher s_t will be. However, it is very difficult to solve for optimal consumption in the presence of prudent behaviour (Compare Blanchard & Fischer 1989 chapter 6). Moreover, when the proposed insurance offered by a funded scheme is introduced (section 3.4), such behaviour of prudence can have feedback effects on the decision variables themselves: the insurance offered would lead to a decrease in preferred total retirement savings of individuals and therefore to a lower capital stock and in turn (in a closed economy) to a higher market rate of return in the next period. Taking this effect into account would complicate the analysis of the chapter, without adding much to its basic argument. It is therefore assumed that the decision concerning the provision for retirement income is split up in two parts: first the amount of pension savings, and secondly the allocation of pension savings.
The individual first takes the decision with respect to the *amount* of pension saving from wages. Subsequently, the individual decides on the *allocation* of pension savings to available investment outlets. In this section, only one asset is available. This concerns the risky market portfolio with as yield $E[r^m_{t+1}]$. As denoted in expression (2.9), the expected level of second period consumption $E[c_{2t}]$ is first-period pension savings plus second-period expected return $(1+E[r^m_{t+1}])$. In the sections 3.4 to 3.6, the individual has the risk-free defined-benefit plan as additional investment outlet into which he can allocate his pension savings.

$$E[c_{2t}] = s_t w_t \ (1 + E[r^m_{t+1}]) \tag{2.9}$$

The savings of the young in period t, $s_t w_t L_t$, generates the capital stock in the next period K_{t+1}. Therefore, capital per worker in period t+1 is:

$$k_{t+1} = K_{t+1} / L_{t+1} = s_t w_t / (1 + n_{t+1}) \tag{2.10}$$

The set of equations (2.1)-(2.10) is a fully-specified system.

3.3 Risk-aversion

It is assumed that individuals are risk-averse with respect to their old-age wealth. They measure the expected utility of the uncertain old-age consumption level by looking at the mean and variance. The preferences of risk-averse individuals are represented by an exponential utility function which implies constant absolute risk aversion:

$$u(c_2) \quad = A - e^{-\alpha c_2} = A - \exp(-\alpha c_2) \qquad A>0 \ , \ \alpha >0 \tag{3.1}$$

This utility function is widely used because of its analytical convenience. Its first derivative is positive ($u'>0$), implying that utility is increasing with respect to consumption. The second derivative is negative ($u''<0$), implying risk-aversion. The (Arrow/Pratt) coefficient of absolute risk-aversion is measured by $-u''/u'$. For the utility function under discussion, $-u''/u'$ is equal to the constant α. Higher values of α imply greater risk-aversion. Above all, the constant absolute risk-aversion utility function has the very useful result that, if c_2 is normally distributed, the expected utility $E[u(c_2)]$ can be expressed in terms of the expected value of the mean, $E[c_2]$, and variance of old-age consumption, $\sigma^2_{c_2}$, as follows (cf. Deaton & Muelbauer, 1980, pp. 401-404; Blanchard & Fischer, 1989, chapter 6):

$$E[u(c_2)] = A - \exp\left(-\alpha\left[E[c_2] - \tfrac{1}{2}\alpha\sigma^2_{c_2}\right]\right) \tag{3.2}$$

where :

$$E[c_2] = \frac{c_2^a + c_2^b}{2} \tag{3.3}$$

$$\sigma_{c_2}^2 = \frac{\left(c_2^a - E[c_2]\right)^2 + \left(c_2^b - E[c_2]\right)^2}{2} \tag{3.4}$$

Differentiating (3.2) with respect to $E[c_2]$ and σ_{c_2}, and holding $E[u(c_2)]$ constant, gives the slope of the indifference curve with constant expected utility:

$$\frac{dE[c_2]}{d\sigma_{c_2}} = -\frac{\partial E[u(c_2)]/\partial \sigma_{c_2}}{\partial E[u(c_2)]/\partial E[c_2]} = \alpha\sigma_{c_2} \tag{3.5}$$

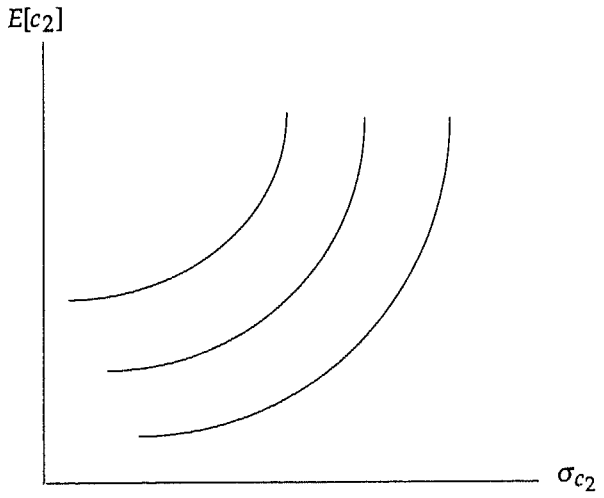

Figure 3.1: Indifference curves

The derivation of (3.5) to σ_{c_2} is equal to α and is therefore positive. Hence, in a $\left(E[c_2], \sigma_{c_2}\right)$ graph, the indifference curves display the shapes illustrated in figure 3.1. Each curve consists of a family of $\left(E[c_2], \sigma_{c_2}\right)$ points where expected utility is constant.

3.4 Defined-benefits and intergenerational risk-sharing

In this section, the mean-variance calculus is used to construct an intergenerational insurance contract which is organized as a pension scheme with defined benefits and full funding. The contract is a welfare-improvement for future retirees in the next period as well as for the workers born in that period. This intergenerational insurance contract can be characterised as a *Pareto-improvement*. Each generation is expected to be better off, given the information available at the time of enactment of the contract.

Wage income and rental income as shares of total income are negatively correlated. Because workers' income is mainly from wages and retirees' income is mainly from rental income, intuition suggests that both the young and old generations can benefit from intergenerational risk-sharing with respect to income uncertainty. The current young generation is not able to precommit future young workers to a hedge. By the time the next young generation of workers come to the labour market and can commit itself to the contract, it will know the outcome ex post of such a contract. This can be characterized as a failure of the private-insurance market. Chapter 2 has dealt with two positions concerning this problem.
First, the *voluntary commitment* of the next generation can be ensured by checking that the contract is optimal ex post, i.e. time-consistent, in all possible states of nature. This issue is dealt with in section (3.6) of this chapter.
Secondly, the commitment of future generations can be mandatory of nature. *Mandatory participation* can be motivated by making use of Rawls' justification of a social contract, which is providing insurance based on redistribution ex post from lucky to less lucky individuals. This section (3.4) and the next (3.5) employ a variant of Rawls' principle. This variant runs as follows.
Let us assume that the current workers set up a pension fund which operates economy-wide. During their young years, workers allocate their old-age savings in accordance with preferences, partly as individual investment in the market portfolio which yields the market rate of return, and partly as a premium paid into the pension-fund scheme in exchange for a certain defined benefit to be received during their old age. The defined benefit is composed of the premium paid plus a predetermined fixed rate of return. The current workers are the owners of capital in the next period. During their old age, they own directly (via the market portfolio) or indirectly (via the pension

fund) the capital stock. So, they themselves or their representatives (plant and fund managers) are involved in the negotiations on the labour contract for the workers in the next period. Retirees in the next period are therefore able to force future workers to guarantee the solvency of the pension scheme in operation, so that the defined benefits for future retirees can always be paid out.
Hence, when the current young generation takes the decision to save partly via a pension fund with defined benefits as payouts, the impact on the welfare of the future young generation has to be considered as well.
It is assumed that the young generation in period t structures the pension plan in such a way that, from an ex ante point of view, the insurance contract is *actuarially fair* to the next young generation. As will be set out further on in this section, this is guaranteed when the two conditions (4.1) and (4.2) are fulfilled:

$$E[\omega_{t+1}] = E[w_{t+1}], \tag{4.1}$$

$$\sigma_{\omega_{t+1}} \leq \sigma_{w_{t+1}} \tag{4.2}$$

Equation (4.1) states that the expected disposable income of the representative worker of the next generation of workers subject to the insurance contract $E[\omega_{t+1}]$ has to be similar to the expected wage income of the representative worker in the absence of an intergenerational contract $E[w_{t+1}]$ According to equation (4.2), the risk of disposable income $E[\omega_{t+1}]$ has to be less or at least equal to the risk of the expected wage income $E[w_{t+1}]$, where risk is measured by the standard deviation.

The only variable which is not yet known is the rate of return which is promised on the savings held within the fund. This rate of return is called the *actuarial rate of return* and it will be abbreviated as R_{t+1}
This actuarial rate of return can be determined with the help of condition (4.1). The term h_t is defined as the fraction of old-age savings in the pension fund preferred by generation t, where $0<h_t<1$. In this way, expected old-age wealth in the next period for the current young with a fraction h_t invested in the fund, can be expressed as follows:

$$\begin{aligned} E[c_{2t}^{h}] &= h_t s_t w_t (1+R_{t+1}) + (1-h_t)\, s_t w_t (1+E[r_{t+1}^{m}]) \\ &= h_t\, c_{2t}^{db} + (1-h_t)\, E[c_{2t}^{m}] \end{aligned} \tag{4.3}$$

where $E[c_{2t}^h]$ is the expected level of retirement consumption, which consists of a fraction h_t of c_{2t}^{db}, this is the certain defined benefit outcome of old-age savings within the fund, and of a fraction $(1\text{-}h_t)$ of $E[c_{2t}^m]$, this is the expected outcome of old age savings invested in the risky market portfolio[1].

The magnitude of R_{t+1} can be determined with the help of equation (4.1) which states that the expected income with and without a contract for the future young has to be similar on an ex ante basis: $E[\omega_{t+1}] = E[w_{t+1}]$, so:

$$\frac{[w_{t+1}^a + h_t(r_{t+1}^a - R_{t+1})k_{t+1}^a] + [w_{t+1}^b + h_t(r_{t+1}^b - R_{t+1})k_{t+1}^b]}{2} = \frac{[w_{t+1}^a + w_{t+1}^b]}{2} \qquad (4.4)$$

where $k_{t+1}^i = s_t w_t L_t / L_{t+1}^i$, $i = a,b$. From (4.4) the following expression for the actuarial rate of return can be derived:

$$R_{t+1} = \frac{r_{t+1}^a k_{t+1}^a + r_{t+1}^b k_{t+1}^b}{k_{t+1}^a + k_{t+1}^b} \qquad (4.5)$$

Note that the magnitude of R_{t+1} is less than $E[r_{t+1}^m]$:[2]

$$R_{t+1} < E[r_{t+1}^m] \qquad (4.6)$$

This can be explained by the fact that the contract is required to be actuarially fair ex ante for the *representative* worker of the next young generation. In case (*b*) a pension fund surplus will result. This surplus has to be divided among many workers. Per worker the surplus amounts to

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[1] As has been set out in section 2 of this chapter, it is assumed that a change in uncertainty with respect to c_2 will not influence the allocation of wage income to first-period consumption and old-age savings.

[2] This can easily be seen from the definitions applied. $E[r_{t+1}^m]$ is the arithmetic mean of r_{t+1}^a and r_{t+1}^b with as weights 1/2 resp. 1/2, while R_{t+1} is a weighted average of r_{t+1}^a and r_{t+1}^b where the lowest of the two rates of return will have the highest weight in R_{t+1}: $r_{t+1}^a < r_{t+1}^b$ corresponds with $k_{t+1}^a/(k_{t+1}^a + k_{t+1}^b) > k_{t+1}^b/(k_{t+1}^a + k_{t+1}^b)$.

$h_t[r^b_{t+1} - R_{t+1}]s_t w_t L_t / L^b_{t+1}$. In case (*a*) the pension fund experiences a shortage which has to be met by a small group of workers. Per worker this shortage is equal to $h_t[R_{t+1} - r^a_{t+1}]s_t w_t L_t / L^a_{t+1}$. If R_{t+1} would have been set at a level equal to $E[r^m_{t+1}]$, then (in absolute terms) the shortage per worker born in case (*a*) would be larger than the surplus per worker in case (*b*). This implies that the contract would not be actuarially fair ex ante for the representative worker of the next generation: $E[\omega_{t+1}] < E[w_{t+1}]$.

Therefore, the actuarial rate of return R_{t+1} must be lower than $E[r^m_{t+1}]$ in order to guarantee that the contract is actuarially fair to the future young representative. If the magnitude of R_{t+1} is determined according to equation (4.5), no bias ex ante in the income of the next young generation will occur.

$\sigma^2_{c_2|h}$ is denoted as the variance of a portfolio consisting of a fraction h_t of investments in the fund and of a fraction $(1\text{-}h_t)$ of investments in the risky market portfolio with a variance $\sigma^2_{c_2|m}$. The magnitude of $\sigma^2_{c_2|h}$ is equal to[3]:

$$\sigma^2_{c_{2t}|h} = (1-h_t)^2 \sigma^2_{c_{2t}|m} \tag{4.7}$$

The value of h_t can now be solved. The solution runs as follows. Rewriting (3.2) with the help of (4.3) and (4.7) gives:

$$E[u(c_{2t|h})] = A - \exp\left(-\alpha\left[h_t c^{db}_{2t} + (1-h_t)E[c^m_{2t}] - \tfrac{1}{2}\alpha(1-h_t)^2\sigma^2_{c_{2t}|m}\right]\right) \tag{4.8}$$

Maximizing $E[u(c_{2t|h})]$ with respect to h_t and rearranging the terms produces as solution for h_t:

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[3] The variance $\sigma^2_{c_2|h}$ of such a portfolio H is equal to:

$$\text{var}(H) = h^2\ \text{var}(c^{db}_2) + (1-h)^2\ \text{var}(E(c^m_2)) + 2h(1-h)\ \text{cov}(c^{db}_2, E[c^m_2])$$

$$\sigma^2_{c_2|h} = 0 + (1-h)^2\sigma^2_{c_2|m} + 0$$

Note that an increase in h implies a reduction in risk-exposure.

$$h_t = 1 - \frac{E[c_{2t}^m] - c_{2t}^{db}}{\alpha \sigma^2_{c_{2t}|m}} \tag{4.9}$$

This result is in accordance with economic intuition. The value of h_t will increase, the larger α is, i.e. the larger is the degree of risk-aversion. The value of h_t will also be higher, the lower the trade-off between expected return $E[c_{2t}^m]$ and risk $\sigma^2_{c_{2t}|m}$ is, and the higher the value of the defined benefit c_{2t}^{db} is[4].
Intergenerational risk-sharing will only take place if $0<h_t\leq 1$. This condition is fulfilled when:

$$0 \leq \frac{E[c_{2t}^m] - c_{2t}^{db}}{\alpha \sigma^2_{c_{2t}|m}} < 1 \tag{4.10}$$

The next section discusses collective risk-bearing in a defined-benefit plan when $h_t < 0$.

Knowing the mean and risk of the portfolio with as assets the risk-free investment in the pension fund and the risky investment in the market portfolio allows us to construct figure 3.2. The line XM consists of different combinations of the two opportunities available for holding retirement savings, i.e. pension-fund investments and the market portfolio. At point M, total retirement savings consist of a full investment in the market portfolio: $h_t = 0$; at point X, retirement savings are held completely within the fund: $h_t = 1$. The term h_t will increase as one moves from M to X.

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[4] Expression (4.9) can be rewritten in terms of mean and variance of the market rate of return and the riskfree return. Rearrange $h_t = 1 - \frac{E[c_{2t}^m] - c_{2t}^{db}}{\alpha \sigma^2_{c_{2t}|m}}$ as:

$$h_t = 1 - \frac{s_t w_t \left([1 + E[r_{t+1}^m]] - [1 + R_{t+1}] \right)}{\alpha (s_t w_t)^2 \left[\left((1 + r_{t+1}^a) - (1 + E[r_{t+1}^m]) \right)^2 + \left((1 + r_{t+1}^b) - (1 + E[r_{t+1}^m]) \right)^2 \right] / 2}, \text{ so}$$

$$h_t = 1 - \frac{E[r_{t+1}^m] - R_{t+1}}{\alpha (s_t w_t) \sigma_r^2}.$$

The expression for the line XM is given in (4.3') and is obtained by rewriting (4.3) with the help of (4.7).

$$E[c_{2t}^h] = c_{2t}^{db} + \frac{\sigma_{c_{2t}|h}}{\sigma_{c_{2t}|m}}\left(E[c_{2t}^m] - c_{2t}^{db}\right) \tag{4.3'}$$

The slope of the line XM is :

$$\frac{dE[c_{2t}^h]}{d\sigma_{c_{2t}|h}} = \frac{E[c_{2t}^m] - c_{2t}^{db}}{\sigma_{c_{2t}|m}} \tag{4.11}$$

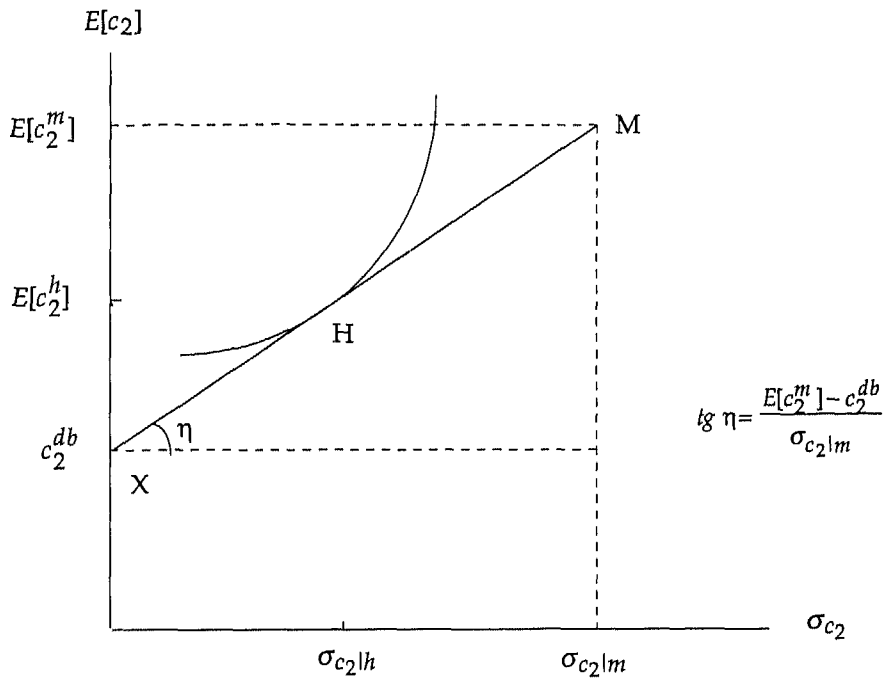

Figure 3.2: Optimum portfolio and trade-off expected return and risk in the case of intergenerational risk-sharing

Equation (4.11) describes the *actual* trade-off between expected return and risk. The *preferred* trade-off between $E[c_{2t}]$ and σ_{c_2} is described by the expression for the slope of the indifference curves in equation (3.5). By equating the expressions (4.11) and (3.5), one can also calculate the preferred

fraction h_t in the pension fund[5]. The introduction of the defined-benefit plan enables the representative individual to move along the line XM from the original position at point M, where all old-age savings are held in the market portfolio to reach point H.

The Pareto-improvement of the insurance contract for the workers in the next period t+1 can also be shown graphically. Obviously workers prefer, ex ante, a higher wage income to a lower wage income and less risk to more risk with respect to their income. This is reflected in figure 3.3 by the indifference curves $E(U_1)$ and $E(U_2)$, where $E(U_2)>E(U_1)$.

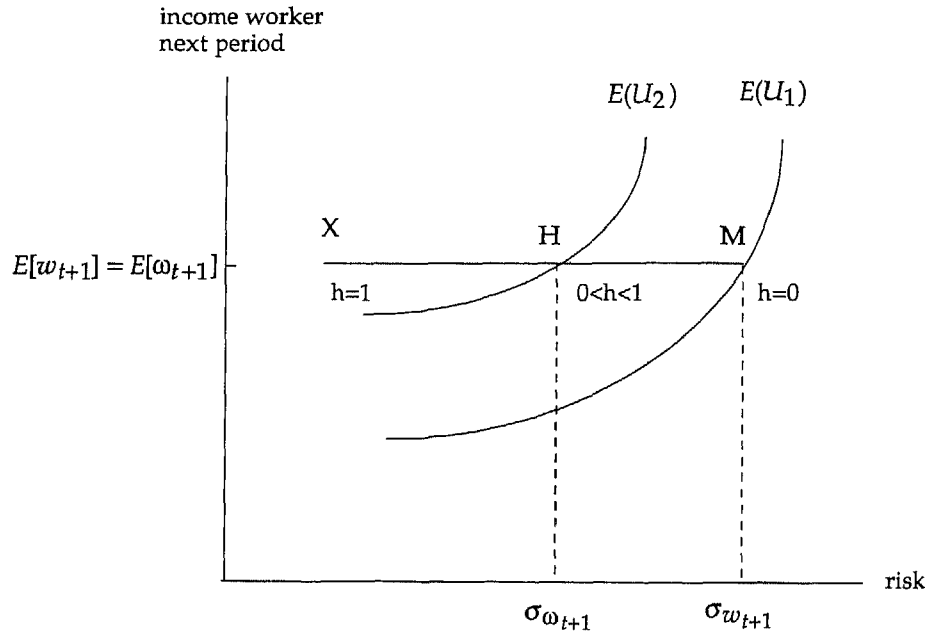

Figure 3.3: Expected outcome / risk characteristics of the income of the workers next period without (h=0) and with (0<h<1) a funded defined-benefit plan based on intergenerational risk-sharing

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[5]Equating produces: $\alpha\sigma_{c_{2t}|h} = \frac{E[c_{2t}^{m}] - c_{2t}^{db}}{\sigma_{c_{2t}|m}}$. Because $\sigma_{c_{2t}|h} = (1-h_t)\sigma_{c_{2t}|m}$ (compare (4.7)) one can derive the same result for the value h_t as in equation (4.8).

The intergenerational insurance contract has no impact on the expected outcome of the income of the representative worker born in the next period $E(\omega_{t+1}) = E(w_{t+1})$. The risk with respect to its income will be reduced however, whereas the reduction in risk will be greater, the larger is h_t.

This can be shown if the variance of ω_{t+1} is compared with w_{t+1}:

$$\sigma^2_{\omega_{t+1}} = \frac{\left[\omega^a_{t+1} - E(w_{t+1})\right]^2 + \left[\omega^b_{t+1} - E(w_{t+1})\right]^2}{2}$$

$$= \frac{\left[w^a_{t+1} + h_t(r^a_{t+1} - R_{t+1})k^a_{t+1} - E(w_{t+1})\right]^2 + \left[w^b_{t+1} + h_t(r^b_{t+1} - R_{t+1})k^b_{t+1} - E(w_{t+1})\right]^2}{2}$$

respectively (4.12)

$$\sigma^2_{w_{t+1}} = \frac{\left[w^a_{t+1} - E(w_{t+1})\right]^2 + \left[w^b_{t+1} - E(w_{t+1})\right]^2}{2}$$

Because the wage rate and the rate of return are negatively correlated, it can be seen that $\sigma^2_{\omega_{t+1}} < \sigma^2_{w_{t+1}}$, and that the reduction in risk will increase as h_t increases.

However, this conclusion should be drawn with some caution. The size of either a shortage or a surplus in the fund can be so great that the implied transfer between the worker's income and the fund will actually lead to an increase in the volatility of workers' income instead of a decrease, i.e. that $\sigma^2_{\omega_{t+1}} > \sigma^2_{w_{t+1}}$. If the transfer is very large, it could be the case that the risk concerning workers' income actually increases in comparison with the situation in which no pension fund exists. This will occur when $\omega^a_{t+1} < w^b_{t+1}$ or $\omega^b_{t+1} > w^a_{t+1}$. With the help of (4.12), one can derive from the requirement that $\sigma^2_{\omega_{t+1}} \leq \sigma^2_{w_{t+1}}$ the condition for the maximum value of h, indicated as $h^{\max}$. In order to guarantee that $\sigma^2_{\omega_{t+1}} \leq \sigma^2_{w_{t+1}}$, the preferred value of h_t may not be larger than $h^{\max}$:

$$h_t \leq h^{\max} = \frac{w^a_{t+1} - w^b_{t+1}}{\left(R_{t+1} - r^a_{t+1}\right)k^a_{t+1}} = \frac{w^a_{t+1} - w^b_{t+1}}{\left(r^b_{t+1} - R_{t+1}\right)k^b_{t+1}} \tag{4.13}$$

If condition (4.13) is not fulfilled[6], the preferred portfolio H can not be realized. The representative individual has to decrease the value of h_t from its preferred level to $h^{\max}$. This implies a change in the composition of the portfolio: the relative share of the savings in the pension fund has to be lowered in favour of the relative share of investment in the market portfolio.

The welfare improvement offered by the pension fund is not specific for the case of stochastic population growth. The result can be generalized for any source of uncertainty which has an impact on tomorrow's capital-labour intensity and, in addition, on tomorrow's wages and rate of return. Therefore, in any case where k_{t+1} is stochastic and the degree of risk-aversion is sufficiently high, the proposed intergenerational risk-sharing in accordance with the conditions of the intergenerational contract stated, will be a Pareto-improvement for the generations involved.

This section has analyzed the welfare aspects of a funded defined-benefit plan organized as an intergenerational insurance contract with mandatory participation, and in which the insurance offered is based on inter-generational risk-sharing. One may conclude from this section that the plan is a welfare improvement for the generations involved. The rule has been applied that an intergenerational insurance contract with mandatory participation can only be organized if the contract is actuarially fair to the next generation. The application of this rule yields a solution for the actuarial rate of return to be offered as the certain rate of return on premiums paid. This risk-free actuarial rate of return falls below the risky market rate of return: $R_{t+1} < E[r^m_{t+1}]$. The degree of risk-aversion of the representative individual is decisive for the allocation of retirement savings to the pension fund and the market portfolio.

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[6] Making use of a Cobb-Douglas production function $y=k^{\beta}$, the outcome of $h^{\max}$ has been calculated for different combinations of the capital income share β and spread of the growth rate of cohort size, i.e. n^a and n^b. Plausible as well as extreme values for n^a, n^b and β have been used. No combination could be found for n^a, n^b and β which yields a result for $h^{\max}$ greater than 1.

3.5 Intergenerational risk-sharing and/or intragenerational risk-redistribution

As previously stated, the funding risks of a defined-benefit plan can also be borne by the shareholders of the sponsoring firm(s). The aim of this section is to formulate the concept of risk-bearing by shareholders within the framework developed in the preceding section. The analysis is carried out within a 2-period overlapping generation model. Bequests and precautionary savings are absent, so total wealth (capital stock) consists only of retirement savings. Hence, within this framework retired workers are the only shareholders in the economy. To the extent that there is risk-bearing by shareholders, the implication is that one group of retirees participates in the bearing of the funding risks associated with the defined benefits intended for retirees of the same age-cohort. This risk-redistribution within a generation therefore implies that individual workers differ as to the degree of risk-aversion they demonstrate with respect to investment risk on old-age savings. Within the context of the 2-period overlapping generation model, one can refer to *intragenerational risk-redistribution* ranging from high to low risk-averse individuals.

The analysis in the preceding section was applied to the representative individual. In order to implement the idea of intra-generational risk-redistribution, let us assume that the representative individual represents two groups of workers. These two groups are equal with respect to all relevant aspects, however they differ in the degree of risk-aversion concerning investment risk applying to retirement savings. A generation consists of a fraction λ_1 of highly risk-averse individuals with a risk-aversion variable equal to α_1. The fraction of low risk-averse individuals is λ_2 with a risk-aversion variable equal to α_2. Hence, the risk-aversion of the representative individual α can be described as the weighted average of the risk-aversion of the two groups of individuals, where $\alpha_1 > \alpha > \alpha_2$:

$$\lambda_1 + \lambda_2 = 1 \tag{5.1}$$

$$\alpha_1 > \alpha_2 \tag{5.2}$$

$$\alpha = \lambda_1\alpha_1 + \lambda_2\alpha_2 \tag{5.3}$$

The term h_{1t} is defined as the fraction of retirement savings the highly risk-averse individuals prefer to hold in the pension fund. The complement (1-h_{1t}) is the preferred fraction in the market portfolio. In the previous section,

a procedure for determining the size of the preferred allocation to the pension fund h_t of the representative worker has been set out. The same procedure can be applied to determine the size of h_{1t}. Expression (4.8) is thus rewritten by substituting α for α_1 and h_t for h_{1t}:

$$E[u(c_{2t}|h_{1t})] = A - \exp\left(-\alpha_1\left[h_{1t}c_{2t}^{db} + (1-h_{1t})E[c_{2t}^{m}] - \tfrac{1}{2}\alpha_1(1-h_{1t})^2\sigma^2_{c_{2t}|m}\right]\right) \qquad (5.5)$$

Maximizing $E[u(c_{2t}|h_{1t})]$ with respect to h_{1t} produces the solution for h_{1t}:

$$h_{1t} = 1 - \frac{E[c_{2t}^{m}] - c_{2t}^{db}}{\alpha_1\,\sigma^2_{c_{2t}|m}} \qquad (5.6)$$

which can be rewritten as (compare equation 4.9):

$$h_{1t} = 1 - \frac{\alpha(1-h_t)}{\alpha_1} \qquad (5.6')$$

The same procedure can be applied to solve for h_{2t} which gives:

$$h_{2t} = 1 - \frac{E[c_{2t}^{m}] - c_{2t}^{db}}{\alpha_2\,\sigma^2_{c_{2t}|m}} = 1 - \frac{\alpha(1-h_t)}{\alpha_2} \qquad (5.7)$$

The preferred allocation of the representative worker of his old-age savings to the pension fund h_t can be written as the weighted average of h_{1t} and h_{2t}:

$$h_t = \frac{\lambda_1\alpha_1}{\alpha}h_{1t} + \frac{\lambda_2\alpha_2}{\alpha}h_{2t} \qquad (5.8)$$

where the weights reflect the relative proportion of the high and low risk-averters in the risk-aversion of the representative individual, which equals α.

What can be said about the range of h_t, h_{1t} and h_{2t}?
Inspection of equation (4.9) reveals that h_t may be positive as well as negative. If $h_t > 0$, the representative individual prefers to allocate a part of his old-age savings into the pension fund. However, when $h_t < 0$ there is *on average* no preference for retaining old-age savings in the pension fund. However, this is *on average*. High risk-averters may still prefer to save via

the pension fund. The necessary condition is that α_1 is sufficiently high to guarantee that $h_{1t}>0$. Furthermore, it is known that $h_{2t} < h_t < h_{1t}$ because $\alpha_2 < \alpha < \alpha_1$. Finally, the size of h_{2t} can be either positive or negative.

The above enables us to distinguish four cases with respect to the nature of collective risk-bearing within a defined-benefit scheme:

(i) intergenerational only
(ii) intergenerational and intragenerational
(iii) intragenerational only
(iv) neither intergenerational nor intragenerational

Each case is illustrated by a diagram, displayed in figure 3.4. Points H_1 and H_2 reflect the preferred portfolios of high and low risk-averse individuals, whereas point H represents the portfolio of the representative worker and Point M is the market portfolio.
Expected old-age wealth and the associated risk for a high risk-averter and a low risk averter respectively are reflected in the expressions below[7]:

$$\begin{aligned} E[c_{2t}^{h_j}] &= s_t w_t\Big(h_{jt}(1+R_{t+1})+(1-h_{jt})(1+E[r_{t+1}^m])\Big) \\ &= h_{jt}c_2^{db}+(1-h_{jt})E[c_2^m] \end{aligned} \tag{5.9}$$

$$\sigma_{c_{2t}|h_j} = (1-h_{jt})\sigma_{c_{2t}|m} \tag{5.10}$$

where $j = 1, 2$

The four cases/diagrams are based on the same conditions and variables with one exception. This concerns the degree of risk-aversion displayed by the individuals. The four cases/diagrams are ranked according to decreasing degrees of risk-aversion. So the magnitude of α_1 is the greatest in case (i)

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[7]The coordinates of points H, H_1 and H_2 depend on the size of h, h_{1t} and h_{2t} respectively. These variables can be solved by equating the preferred trade-offs between return and risk to the actual trade-off. This produces (compare footnote 4):

$$\alpha(1-h_t)\sigma_{c_{2t}|m} = \alpha_1(1-h_{1t})\sigma_{c_{2t}|m} = \alpha_2(1-h_{2t})\sigma_{c_{2t}|m} = \frac{E[c_{2t}^m]-c_{2t}^{db}}{\sigma_{c_{2t}|m}}.$$

and the smallest in case (iv). The same applies for α_2, and, consequently, also for α. Hence, the four cases also differ in the ranking of h_1, h_2 and h.[8]

(i) $0 < h_{2t} < h_t < h_{1t} < 1$:

Intergenerational risk-sharing only

When h_{2t} is positive, all individuals invest in a portfolio consisting partly of old-age savings held in the pension fund and partly of the market portfolio. h_{2t} is smaller than h_{1t}. This reflects the low risk-averse individual's preference for saving a smaller fraction in the pension fund and for a larger fraction in the risky market portfolio, as compared to the high risk-averters. Point H_2 is therefore characterized by a higher expected return, but also by more risk-exposure than point H_1. This case is shown in diagram 3.4.i.

(ii) $h_{2t} < 0 < h_t < h_{1t} < 1$:

Mixture of intergenerational risk-sharing and intra-generational risk redistribution:

When h_{2t} is negative, low risk-averse individuals prefer to take more risk than the market risk with respect to their investments in order to obtain the prospect of a higher expected rate of return than the market portfolio. Point H_2 is now located to the right of point M. This is realized when the low risk-averters can participate into the bearing of the funding risk associated with the defined benefits of the high risk-averse individuals within their generation, i.e. intragenerational risk sharing.

How do the *institutional characteristics* may look like of the construction of intra-generational risk-redistribution? Many stories can be told.

Here it is assumed that the (representative) firm issues two kind of shares. Normal shares give prospect of the regular firm result, which is equal to the market rate of return $E[r^m_{t+1}]$. These shares are bought by high risk-averters and by the pension fund. The other category of shares also offers the prospect of the market rate of return. However it also supplies an additional return because of participation in bearing the funding risks of the pension fund sponsored by the firm. These shares are bought only by low-risk averse individuals.

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[8] Expressed formally as: $\alpha_1^i > \alpha_1^{ii} > \alpha_1^{iii} > \alpha_1^{iv}$ $\quad h_1^i > h_1^{ii} > h_1^{iii} > h_1^{iv}$

$\alpha_2^i > \alpha_2^{ii} > \alpha_2^{iii} > \alpha_2^{iv}$ and $h_2^i > h_2^{ii} > h_2^{iii} > h_2^{iv}$

$\alpha^i > \alpha^{ii} > \alpha^{iii} > \alpha^{iv}$ $\quad h^i > h^{ii} > h^{iii} > h^{iv}$

After payment of the defined pensions to the high risk-averse retirees, the balance of the end-value of the pension fund's assets and its liabilities is equal to $h_{1t}\lambda_1 s_t w_t L_t[(1+r^m_{t+1})-(1+R_{t+1})]$. This result (either a surplus or a shortage) is for account of active workers (intergenerational risk-sharing) at an amount of $h_t s_t w_t L_t(r^m_{t+1}-R_{t+1})$, and for the low risk-averse retirees, who have bought the special shares (intragenerational risk-shifting), for an amount of $-h_{2t}\lambda_2 s_t w_t L_t(r^m_{t+1}-R_{t+1})$. The actual extent of retirement wealth for the low risk-averse retiree is determined by the investment result on the special shares. The return on these shares consists of two components: the actual market rate of return plus the result of risk-sharing within the pension fund. The retirement wealth for a low risk-averter is equal to $c^{h_2}_{2t} = sw_t(1+r^m_{t+1})-h_2(r^m_{t+1}-R_{t+1})$.

The expected value of $c^{h_2}_{2t}$ exceeds the expected value of an investment in the market portfolio: $E[c^{h_2}_{2t}] > E[c^m_{2t}] = sw_t(1+E[r^m_{t+1}])$ because the expected result of participation in the risk-bearing in the pension fund is positive: $-h_{2t}(E[r^m_{t+1}]-R_{t+1})>0$.

(iii) $h_{2t} < h_t < 0 < h_{1t} < 1$:

Intragenerational risk-redistribution only

The degree of risk-aversion is, on average, so low that the value of h_t becomes negative. On average, the generation prefers a portfolio with more risk-exposure than the market portfolio in order to obtain the prospect of a higher rate of return than the capital market of return. Hence, point H is now also located to the right of point M. The high risk-averters still allocate a proportion of their old-age savings into the pension fund. The bearing of the associated funding risk is on a completely intra-generational basis. There is no intergenerational risk-sharing[9].

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[9]Case (iii) may raise the question of how it is possible for the collective risk-bearing in this case to be completely based on intragenerational risk-shifting, while the conditions of the defined-benefit plan are grounded on the conditions of the intergenerational insurance contract set out in the preceding section. More specifically, one may wonder why the offered rate of return in the defined-benefit scheme is still equal to R_{t+1}. Why not higher or lower? The rate offered can not be *lower* than R_{t+1}; high risk-averters can always go to firms which offer them the opportunity to participate in a plan in which funding risk is borne by the next young generation. The high risk-averters will not be prepared to supply their labour to firms which offer an actuarial rate below R_{t+1}. In addition, it is impossible to envisage that the actuarial rate of return being set *above* the value of R_{t+1}. Clearly, the high risk-

(iv) $h_{2t} < h_t < h_{1t} < 0$:

No preference for a defined-benefit plan based on the conditions of intergenerational risk-sharing:

Now even low risk-averters are not interested in saving via the pension fund. Their degree of risk-aversion is also too low in comparison to the actual trade-off offered by the pension fund. Diagram 3.4.iv corresponding to this case shows that at point M the trade-off *preferred* by the high and the low risk-averter (i.e. slope of the indifference curve at point M) is, in both cases, greater than the *actual* trade-off offered by the pension fund.

In reality, the retirement-income insurance offered by defined-benefit plans is based on collective risk-bearing by active workers and/or shareholders. Within the stylized world of the 2-period overlapping generation framework with no bequests and precautionary savings, the concept of risk-bearing by shareholders implies intragenerational risk-redistribution from high risk-averse to low risk-averse individuals. This risk-redistribution contributes to the welfare of both types of individuals. The relative shares of the high and low risk-averters within a generation (λ_1 and λ_2) and the degree of risk-aversion of these two groups (α_1 and α_2) are decisive for the relative size of collective risk-bearing by active workers (intergenerational risk-sharing) and shareholders (intragenerational risk-shifting).

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averters would benefit from this. However, this would be detrimental to the low risk-averters and there is no reason at all why low risk-averters will offer this higher rate of return.

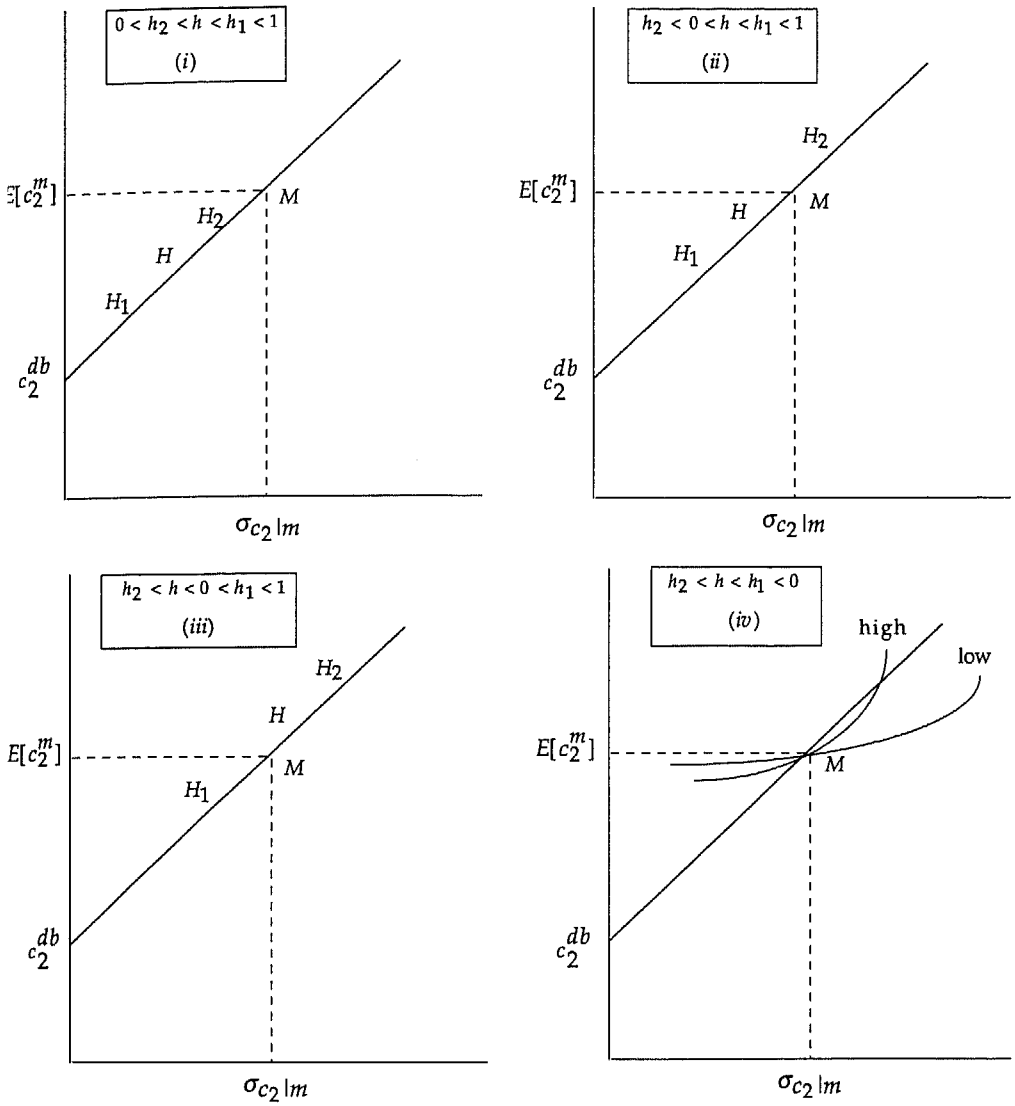

Figure 3.4: Portfolios preferred by the representative worker (H), high risk-averse individuals (H_1) and low risk-averse individuals (H_2) for different degrees of risk-aversion

3.6 Intergenerational insurance contracts and labour mobility: the problem of sub-optimality ex post

3.6.1 Introduction

The analysis up to now is built on quite restrictive assumptions. A closed economy is assumed. The next young generation is obliged to participate in a defined-benefit plan in operation. These restrictive assumptions has enabled us to highlight the welfare-enhancing nature of retirement income insurance based on intergenerational risk-sharing. The insurance offered implies income transfers *ex post* between the plan and the young generation. The young generation is favoured when the fund runs a surplus. However, it must balance a plan shortage due to a bad investment result. This income loss can not be avoided because participation has been assumed to be mandatory of nature.

The framework used differs from real life at some crucial aspects. Amongst others, this concerns firstly that the economy is open of nature, secondly, firms may organise the pension plan for their employees as a defined-contribution plan, and, thirdly, labour is mobile. These aspects are of utmost relevance when a defined-benefit plan based on intergenerational risk-sharing runs a shortage ex post. The participation into such a plan may then be unattractive for the young generation, because it must balance the fund. As has been set out in chapter 2, mobile labour can avoid this income loss simply by migration or by working at firms which offer to their employees a defined-contribution plan. Hence, a mobile young generation may shift the risk of underfunding to the elderly themselves.
However, these alternatives to a defined-benefit plan offer no insurance. An employee with a defined-contribution plan is fully exposed to investment risk. Furthermore, retirement income insurance may not be present in other countries. Therefore, despite the loss in life-time income ex post, the young generation may still prefer sharing the riskfree domestic defined-benefit plan. It is the argument of this section that participation still is *optimal ex post* for the young generation when the *gain in utility* of being insured for investment risk with respect to pension savings does outweigh the *disutility* of the loss in income, due to the covering of a deficit in the funding of the plan.
This section raises the question of which the critical aspects are concerning the voluntary participation of young individuals in a defined-benifit plan which runs a shortage ex post. The analysis is carried out for an open economy in which a nationwide defined-benefit plan is operating.

Subsequently, the section discusses in 3.6.3 the issue how to deal with the problem when it can be foreseen that the plan is not optimal ex post for all future states of nature.

3.6.2 No mandatory participation

The situation of the domestic economy as a small open economy is considered. The domestic economy and foreign economies are similar in all aspects with one exception. Retirement income insurance is absent in foreign economies, whereas in the domestic economy a nationwide defined-benefit plan is operative based on intergenerational risk-sharing. This plan is only accessible to workers born in the domestic economy. These workers however are not obliged to participate. When they would prefer not to participate, they can either ask their domestic employee for a defined-contribution plan or they can simply migrate[10]. Consequently, both of these alternatives imply that they have to allocate their pension savings then completely in the only asset available to them: the risky world-marketportfolio. Hence, they are no longer insured against investment risk. It is also assumed that domestic born workers are equal in all relevant aspects.
International capital mobility guarantees that worldwide the same capital market rate of return is prevailing, so the domestic capital-labour ratio equals the world capital-labour ratio, and the domestic wage equals the world wage. Capital and labour are paid according to their marginal product: $r=f'[k]$ and $w=f[k]-rf'[k]$. The domestic size of the labour force born in the domestic economy each period is equal to either L^a or L^b, where $L^a<L^b$. There is no correlation between the size of the new-born domestic workers and new-born workers abroad. This assumption rules out any relationship between the size of the domestic-born workers and factor rewards[11].
It is assumed that for all periods ahead, world market capital intensity can take each period two values: k^x and k^y, both with a probability of a half, where $k^x>k^y$ and $E[k]=(k^x+k^y)/2$. The corresponding values for the capital market rate of return are r^x and r^y, where $r^x<r^y$ and $E[r]=(r^x+r^y)/2$. The wage is of the magnitude of either w^x or w^y, where $w^x>w^y$ and $E[w]=(w^x+w^y)/2$. Due to international capital mobility, the size of the domestic labour force

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[10] Chapter 2 has also discussed labour mobility between domestic defined-benefit plans. This is not dealt with here. The same factors which are decisive for the choice between participation or no participation into the nationwide pension fund will also be present in the analysis of labour mobility between domestic defined-benefit plans.

[11] The implications when a positive correlation would be present, are discussed in footnote 14.

has no influence on the domestic wage and the domestic rate of return on capital. Therefore, there are four possible states of nature in any period, consisting of the combinations of a low or a high world market capital-labour ratio next period, and a small or a large new-born generation in the domestic economy next period.

Let us assume the young generation in period t aims to set up a defined-benefit plan based on intergenerational risk-sharing. To the analogy of the closed economy, this plan based must fullfil the requirement that it is actuarially fair for the next generation. This is guaranteed when the actuarial rate of return R_{t+1} is set at a level which ensures that condition (4.1) is satisfied, i.e. when $E[w_{t+1}] = E[\omega_{t+1}]$. Rewriting expression (4.4) for the open economy delivers:

$$E[w_{t+1}] = E[\omega_{t+1}] \quad \Rightarrow \tag{6.1}$$

$$\left[w^x + w^y\right]/2 = \left[\left(w^x + \frac{(r^x - R_{t+1})W_t}{L^a}\right) + \left(w^x + \frac{(r^x - R_{t+1})W_t}{L^b}\right) + \left(w^y + \frac{(r^y - R_{t+1})W_t}{L^a}\right) + \left(w^y + \frac{(r^y - R_{t+1})W_t}{L^b}\right)\right]/4$$

The variable W_t stands for the pension savings allocated to the defined-benefit plan by generation t.

After some re-arrangement of (6.1), it turns out that the actuarial rate of return is equal to the expected rate of return on the world-marketportfolio: $R_{t+1} = E[r]$. The latter is the same for each period ahead. Hence, when a defined-benefit plan is operative, then the actuarial rate of return is for each period in the future equal to E[r]:

$$R_{t+k+1} = R = E[r] \quad \text{where k} = 0,1,2.. \tag{6.2}$$

The solution R = E[r] for all period ahead implies that the preferred fraction of retirement savings in the pension fund h by all young generations is equal to 1 (cf. expression 4.9):

$$h_{t+k} = h = 1 \quad \text{where k} = 0,1,2... \tag{6.3}$$

Generation t aims to exclude the possibility that the next young generation t+1 is not willing to participate in the contract. Generation t has therefore to verify that *for all possible states of nature* of period t+1, participation into the plan is *optimal ex post* for generation t+1. This generation t+1 in turn has to investigate that the plan is optimal ex post for generation t+2, because generation t+2 has to bear the funding risks related to the pension savings of generation t+1. In turn, generation t+2 will only accept the plan when it has certainty concerning the participation of generation t+3, and so on. Hence, the support of generation t+1 is depending on the support of the generation born in t+2, t+3, ... and so on.

Therefore, for all future periods ahead, generation t must examine that the defined-benefit plan is optimal ex post for the generations involved. Generation t is able to perform this examination because all relevant information is available to this generation. It has been assumed that for all periods ahead, the factor rewards can take on two values, depending on whether case x or case y is actual. Furthermore, the result has been derived that - whenever a defined-benefit plan is operative - the actuarial rate of return R for all periods ahead is equal to $E[r]$. Given the result $R=E[r]$, it is also known that - whenever a defined-benefit plan is operative - all generations will prefer a complete allocation of their pension savings into the plan: $h=1$. Preferences of generations are assumed to be invariant in time. All generations prefer to maximize expected utility of life-time consumption according to expression (2.7). Let the term $U^{db}(c_1,c_2)$ represents expected utility of life-time consumption per individual when a defined-benefit plan is operative. The term $U^{no}(c_1,c_2)$ stands for expected utility when no defined-benefit plan is in force. Domestic workers are offered a defined-contribution plan. Consequently, pension savings are allocated completely into the risky world-marketportfolio.

The generations t+1, t+2, ... and so on, prefer to participate in the defined-benefit plan when for each of them the condition below is met:

$$U^{db}(c_1,c_2) > U^{no}(c_1,c_2) \tag{6.4}$$

Using the framework of the sections 3.3 and 3.4, and after some re-arranging, expression (6.4) can be rewritten as (cf. the appendix):

$$\underbrace{\frac{\left[R-r^{j}\right]W_{t+k}}{L^{i}}}_{\text{effect on income young generation of period t+k+1 due to the result of pension fund in this period}} < \frac{\alpha(sw^{j})^{2}\sigma_{r}^{2}/2}{(1-s)+s(1+R)} \qquad (6.5)$$

where $k=0,1,2,3..,\ i = a, b$ *and* $j = x, y$

in which σ_r^2 reflects the risk concerning the rate of return of investments in the risky world-marketportfolio and W_{t+k} stands for the pension savings allocated into the plan by the retirees of period t+k+1. The other variables are known.

The left-hand side of the expression (6.5) denotes the impact on the income per member of the young generation due to the result of the pension plan if the young generation would participate. The expression says the following. If the change in income due to the pension fund result falls below the value of the term on the right-hand side, then the young generation will prefer to participate in the defined-benefit plan above one of the two alternative options, i.e. migration or a defined-contribution plan[12].

Note that the right-hand side of (6.5) is always positive.

The left-hand side of (6.5) can be positive as well as negative depending on the actual investment result r^j.
The left-hand side is *negative* when there is a surplus in the fund. This occurs in case x when $r^j = r^x$. The actual rate of return exceeds its expected value: $r^x > E[r] = R$, so the plan runs a surplus. The young generation will experience an income increase. The *income improvement per worker* depends on the size of the young generation: $\left[r^x - R\right]W_{t+k}/L^a$ or $\left[r^x - R\right]W_{t+k}/L^b$.

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[12] It is also possible to derive an expression for a *closed* economy. In principle, one will find the same critical determinants as in expression (6.5). However, the solution found is complicated and hard to interpret. Main reason is that the size of pension savings differs for the options open to the workers. When they would prefer to participate, they save a fraction s of the disposable income ω. The option of no participation implies that they save a fraction s of the wage income w. These differences in amount of savings are reflected next period in different values of the capital-labour ratio. Therefore, the expected rate of return and its risk will also differ for the two alternatives: participation or no participation. All these differences would be present in the solution of a condition for a closed economy alike the one in equation (6.5).

The left-hand side is *positive* when $r^j = r^y$. The pension plan experiences a shortage, because $r^y < E[r] = R$. The *income loss per worker*, in order to cover the plan's deficit, is equal to $\left[R - r^y\right] W_{t+k} / L^i$. The young generation is only willing to accept this income loss when the *gain in utility* of being insured for investment risk with respect to pension savings does outweigh the *disutility* of the loss in income. This is the case as long as the condition in expression (6.5) is met. The size of the right-hand side of the expression is critically dependend on the degree of risk-aversion α, the actuarial rate of return R (which is equal to the expected rate of return $E[r]$), the investment risk σ_r^2, the preferred pension saving rate[13] s, and finally the wage-income w^j of the young generation. Note that the impact of these factors is in accordance with which one would expect intuitively. Examination of the right-hand size shows that violation of (6.5) is the less likely the higher the degree of risk-aversion, the higher the investment risk, the lower the expected rate of return on the market portfolio and the higher the prefered size of pension savings. Note furthermore that a funding shortage due to a low rate of return is accompanied by a high wage rate, reflecting that the contract is based on intergenerational sharing of income risk[14].

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[13] It is assumed in this section that the saving rate s is constant, irrespective of the size of workers' income and irrespective of the riskiness of the investment strategy.

[14] The analysis in this section has presupposed *no* relationship between the size of the domestic-born workers and labour force abroad. What would be the implications for the analysis if for example [1] the situation of a very large open economy is considered, or [2] if the assumption is made that there is a positive correlationship between the domestic labour force and the labour force abroad? [1] and [2] both imply an increase in probability that the domestic labour force is relatively small, i.e. L^a, or large, i.e. L^b, when the world labour force is small respectively large. The stronger the relationship in labour force size, the more likely it is that a funding shortage of the defined-benefit plan will occur - because of relative labour scarcity on the worldmarket, so that $r<R$ - when the domestic labour force is also small. In turn, it is more probable that a funding surplus will result - because of relative labour abundance on the worldmarket, so that $r>R$ - when the domestic labour force is also large. Hence, the probability that a small domestic generation will be confronted with a fund's shortage is larger than the probability that there is a surplus in the fund. On expectation therefore, a small generation has to meet a fund shortage. Moreover, this expected shortage is relatively large per member because of the small size of the generation. On the other hand, it is more probable that a large domestic generation will meet a fund surplus than a fund shortage. The expected surplus per worker of the large generation is relatively small.
In a similar manner as for the closed economy (compare equations (4.4) to (4.6) and the surrounding text, more specifically pages 58-59), it can be argued that when R is set at a level equal to $E[r]$, then on expectation the shortage per worker born in case (a) would be larger than the surplus per worker born in case (b). On expectation, there would result a negative bias in disposable income of the domestic *representative* worker next period. This chapter has employed the requirement that an intergenerational

When generation t detects that in at least one of the future periods, there is one state of nature in which condition (6.5) fails, the participation of generation t+1 to the plan is not guaranteed. Generation t then must either allocate all his savings to the risky world-marketportfolio or it can set up the defined-benefit plan which provide prospect on the riskfree return R but the pay-out of this return is not guaranteed, because the plan can be sub-optimal ex post for the generation t+1.

Summarizing this section, intergenerational risk-sharing without mandatory participation is hampered by the problem of being sub-optimal ex post. The voluntary support of the young generation may indeed be doubtful when the plan runs a shortage ex post, because this shortage must be absorbed by the then living young generation. Nevertheless, the young generation may still prefer to participate in a plan with a shortage because it will not lose the retirement income insurance offered by this plan. The necessary condition for the support of this young generation is that the disutility associated to the (maximum) income loss is outweighed by the gain in utility of being insured. Hence, a main conclusion from this sub-section is that a generation which is aiming to allocate pension savings to a defined-benefit plan, with insurance based on intergenerational risk-sharing, is able to *lock in* the support of the succeeding generations. This generation has to take care that for the succeeding generations the option of participation into the defined-benefit plan is a welfare-improvement ex post for all possible states of nature.

3.6.3 Dealing with the problem of sub-optimality ex post of contracts based on intergenerational risk-sharing

Intergenerational risk-sharing has been identified as welfare-enhancing ex ante for the generations involved. This kind of risk-sharing can be structured according to a defined-benefit plan. The previous sub-section has paid attention to a severe weakness of a defined-benefit plan. Labour is mobile, so creating the problem that members of a young generation can withhold their support to a defined-benefit in operation whenever the outcome ex post is sub-optimal to them.

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contract has to be actuarially fair ex ante to the next generation(s). Therefore, if either [1] or [2] are supposed, the actuarial rate of return R has to be set below the expected market rate of return $E[r]$. Hence, the same set of arguments used in the case of the closed economy to justify that $R < E[r]$, would apply also for an open economy.

Two positions concerning this problem can be distinguished:
(*i*) *Problem of sub-optimality ex post is absent:*
The requirement of the condition (6.5) can be expected to be met in all states of nature for all periods ahead. The degree of risk-aversion and the exposure to investment risk are large enough to guarantee that future generations always will prefer to participate in the riskfree pension plan in operation, irrespective whether the plan actually runs either a surplus or a shortage.
(*ii*) *Problem of sub-optimality ex post is present*
When it can be foreseen that condition (6.5) will be violated in at least one state of nature in one of the periods ahead, there is no full guarantee that generation t+1 will cooperate with the plan in all states of nature. Generation t may then consider two options:
(*a*) Generation t can restrict the size of pension savings allocated to the defined-benefit plan, i.e. a lowering of h. The aim of this restriction is to restrict the size of a shortage whenever it occurs.
(*b*) Generation t may set up an alternative institution to organize intergenerational risk-sharing in the field of retirement income insurance. This is the subject of the next chapter in which the use of government finance is examined on the aspect of risk-sharing between government budget and pension savings.

However, even if position (*i*) would be relevant, then the problem that the defined-benefit plan can become sub-optimal ex post may still be present in a potential manner. It is always possible that a parameter of the contract, which has been treated as exogenous, is changing unexpectedly. Chapter 7 is dealing with a non-expected increase in the benefit rate of the defined-benefit plans currently in operation in the Netherlands. This will take place from the year 2010 onwards. This increase has not been foreseen at the moment of implementation of the plans. Funding shortages in the supplementary scheme will occur. These future shortages imply that the future young generations will be confronted with an income loss due to these shortages in the fund. While the problem of sub-optimality ex post of the scheme may be absent at the present moment, this need not be the case in the future. The foreseeable income loss for the future generations could imply that this problem will become manifest in the coming decades. Hence, current workers have to fear for the pay-out of their pensions in the future where they are entitled to, because the future young individuals might not be willing to participate in the existing plans. It may be in the interest of the current active generations to accept a reform of the current scheme in order to make the system less unfair for the future younger generation and so to avoid that the intergenerational contract may break down at some moment in the

future. In chapter 7, the question will be raised of whether there is a need for reform of the scheme currently in operation. In general, reform implies indeed that young generations will face an improvement in their life-time income. However, reform will also imply that there is a decline of the size of retirement income insurance available to them. Hence, the evaluation of proposals of reform must be based on the trade-off between the loss in utility due to the loss in retirement income insurance and the gain in utility related to the improvement in life-time income. Some options are examined in chapter 7: - no reform at all, - reform in order to restrict the (maximum) income loss for the future young generations (i.e. a lower h), - or to abandon the defined-benefit plan altogether by introducing a defined-contribution plan.

3.7 Evaluation

Collective pension-fund schemes with defined benefits can be a welfare improvement for insured workers when the private market is plagued by a market failure to provide for the preferred retirement income insurance. An important aspect of defined-benefit plans is the question of who bears the investment risk and the other risks related to the fund. Within many plans, risks are shared by employers/shareholders and active workers. Within the setting of the standard two period overlapping generation model with no bequests (Diamond 1965), the welfare improvement of defined-benefit plans has been examined. A defined-benefit plan inevitably implies income transfers ex post between insured workers and the sponsors involved in the bearing of the funding risk. Every generation of new-born workers has the freedom to set up a defined-benefit scheme and to decide on the nature of risk-bearing. Three cases have been discussed. Two of them can be characterized as extreme cases: only intergenerational risk-sharing and only intra-generational risk-shifting. The third case is a mixture of these two extremes. Within the confines of the model used in the chapter, it has been shown that the representative individual will prefer intergenerational risk-sharing ($h>0$) when this individual has a relatively high degree of risk-aversion, while he will opt for intragenerational risk-shifting ($h<0$) when he has a relatively low risk-aversion. The preference of the representative individual reflects the weighted-average preferences of high and low risk-averters.

The above-mentioned results have been derived for a closed economy in which the young generation is obliged to participate into intergenerational risk-sharing. The analysis has been extended to the case of a small open

economy with international labour mobility. The relevant situation to study is when a defined-benefit plan in operation runs a shortage ex post. The participation into the plan may then be unattractive for the young generation, because it must balance the fund. Mobile labour can avoid this income loss simply by migration or by working at firms which offer to their employees a defined-contribution plan. This implies that the risk of underfunding is shifted to the elderly themselves. Nevertheless, the young generation still may prefer to participate in a plan with a shortage because it will not lose the retirement income insurance offered by this plan. The necessary condition for the support of the young generation is that the disutility associated to the (maximum) income loss is outweighed by the gain in utility of being insured.

APPENDIX

The derivation of expression (6.5) is presented.

Making use of expression (4.8), expression (6.4) is rewritten as (A1):

$$A_1 - \exp\left(-\alpha c_1^{db}\right) + A_2 - \exp\left(-\alpha\left[E[c_2^{db}] - \frac{1}{2}\alpha\sigma^2_{c_{2|h}}\right]\right) > A_1 - \exp\left(-\alpha c_1^{no}\right) + A_2 - \exp\left(-\alpha\left[E[c_2^{no}] - \frac{1}{2}\alpha\sigma^2_{c_{2|m}}\right]\right) \tag{A1}$$

From (A1) results (A2):

$$c_1^{db} + E[c_2^{db}] - \frac{1}{2}\alpha\sigma^2_{c_{2|h}} > c_1^{no} + E[c_2^{no}] - \frac{1}{2}\alpha\sigma^2_{c_{2|m}} \tag{A2}$$

It is assumed that the saving rate s is constant, irrespective of the size of the workers' income and irrespective of the investment strategy.

With respect to the size of factor rewards in any period, either case x or case y is relevant. For reason of efficiency in notation, w^j and r^j are used, where j=x,y. Similarly, a domestic born generation can be of the size of L^i, where i=a,b.

Consider a young generation born in period t+k+1, where k=0,1,2,3...

When *no defined-benefit plan is operative,* first-period income for the young generation is equal to the prevailing wage in period t+k+1, i.e w^j. This wage is distributed to first-period and second-period consumption as follows: $c_1^{no} = (1-s)w^j$ and $E[c_2^{no}] = sw^j(1+E[r])$ respectively. The risk on retirement wealth $\frac{1}{2}\alpha\sigma^2_{c_{2|m}}$ can be expressed via $\frac{1}{2}\alpha(sw^j)^2[(1+r)-(1+E[r])]^2$ as $\frac{1}{2}\alpha(sw^j)^2\sigma_r^2$.

When *a defined-benefit plan is existent* in period t+k and the young generation of period t+k would participate in the plan, then first-period income of a member of the next young generation t+k+1, when this generation also would prefer to participate in the plan, is equal to ω_{t+k+1}, where $\omega_{t+k+1} = w^j + \frac{[r^j - R]W_{t+k}}{L^i}$, i.e. disposable income of generation t+k+1 depends on the wage rate prevailing in period t+k+1 plus the income effect due to the pension fund result. This income is allocated to first-period consumption $c_1^{db} = (1-s)\omega_{t+k+1}$ and pension savings $s\omega_{t+k+1}$. All pension savings are held in the defined-benefit plan: h=1, so second-period consumption is equal to $c_2^{db} = s\omega_{t+k+1}(1+R)$. This investment is riskfree: $\frac{1}{2}\alpha\sigma^2_{c_{2|h}} = 0$.

Putting all these information into (A2), expression (A3) can be acquired from (A2):

$$\omega_{t+k+1} > \left[\frac{(1-s)w^j + sw^j(1+E[r]) - \alpha(sw^j)^2\sigma_r^2/2}{(1-s)+s(1+R)}\right] \qquad \text{(A3)}$$

Recognizing that $\omega_{t+k+1} = w^j + [r^j - R]W_{t+k}/L^i$ and $R = E[r]$, (A3) finally can be rewritten with some re-arrangement as (A4), which is expression (6.5) of this chapter.

$$\frac{\left[R - r^j\right]W_{t+k}}{L^i} < \frac{\alpha(sw^j)^2\sigma_r^2/2}{(1-s)+s(1+R)} \qquad \text{(A4)}$$

4 Defined-contribution plans and risk-sharing via the government budget

4.1 Introduction

In the Netherlands, a discussion is going on to change the current structure of the supplementary scheme. A case is being made to substitute final-pay plans for defined-contribution plans (CEC 1991, Bovenberg 1993, Breunesse 1995). This reform should accommodate the trend towards more diversity among individuals. However, as a recent study by Coopers & Lybrand (1994) points out, the majority of Dutch employees prefer to maintain the final-pay plan. Apparently, the insurance offered by the final-pay plan is a reflection of the preferences of the participating workers. If so, the workers might evaluate the proposed reform as a loss in welfare. They lose the prospect of a post-retirement real income, which enables them to maintain the pre-retirement standard of living during old-age. The insurance offered is based on collective risk-bearing, including intergenerational risk-sharing. This kind of insurance is not available in the private (insurance) market.

This chapter introduces government finance into the framework which has been developed so far. As seen in chapter 2, government finance can also be used for risk-bearing on a collective basis due to its taxation power. One way to organize collective risk-bearing with the help of the public budget is the distribution of index bonds. Governments are ideal institutions to issue index bonds. They have indexed assets in the form of tax revenues from income. The issuing of index bonds will therefore create a matched position between tax receipts and the part of government spending which is related to indexed government debt. Chapter 2 also indicated that the regular index bonds usually protect the investor only against the uncertainties of inflation. They offer no protection against the risk of real increases in the standard of living. This chapter aims to overcome this shortcoming with respect to regular index

bonds. It is proposed to substitute regular government bonds for so-called nominal-wage-index bonds and price-index bonds.
Nominal-wage-index bonds offer the prospect of the expected rate of interest on government bonds plus the deviation between actual and expected nominal wage growth during the term of the bond. Price-index bonds pay out the expected rate of interest on government bonds plus the deviation between actual and expected inflation rate (price-index bonds). The difference between nominal wage growth and the inflation rate is interpreted as a measure for the growth in the real standard of living.
An explicit aim of the issuance of these bonds is to offer those participating in a defined-contribution plan an investment outlet for their pension savings which allows them to get prospect of creating the same kind of retirement-income insurance provided by a wage-related defined-benefit plan with indexed benefits. More generally, the distribution of nominal-wage-index bonds and price-index bonds enables the individual pension saver to combine the advantages of defined-benefit plans, such as collective risk-bearing and the prospect of maintaining the pre-retirement standard of living during old-age, with the advantages of a retirement provision on an individual basis, such as individual freedom to choose the optimal life-time consumption profile and to allocate retirement savings according to individual risk-return preferences.

The structure of the chapter is as follows. Within a stylized framework, first of all the welfare aspects of government bonds which offer an indexed position for growth in real standard of living are dealt with. A plan of Bovenberg (1993) is also discussed. This plan also aims to use the public budget for reducing risk-exposure on savings held in a defined-contribution plan. Then the chapter proceeds to set out how the individual investor can use nominal-wage-index and price-index bonds to replicate the insurance offered by a final-pay plan with inflation-indexed benefits. Finally, the discussion turns to the impact of these bonds on the volatility of government finance.

In the interests of readability, the notation used in this chapter, and also in the chapters 6 and 7, concerning the expected value of a variable deviates from the previous chapter. The expected value of variables is indicated by an asterix. For example, the expected rate of return is denoted as r^*, whereas the previous chapter uses the expression $E[r]$.

4.2 Plan Bovenberg, index bonds and standard-of-living risk

Bovenberg (1993) discusses the sharing of interest rate risk between government debt and pension savings. The financial position of the government and that of pension savers is negatively correlated with respect to interest rate risk. The government as debtor is favoured by a low rate of (real) interest on outstanding government bonds, whereas the pension saver as investor is favoured by a high rate of (real) interest. Bovenberg argues that the two parties are natural partners for achieving a hedge with respect to interest rate risk. He elaborates a detailed plan to realize this idea. An essential element of the plan is that the government participates in the investment risks of pension savings. When the actual rate of real return is high and exceeds some maximum value, the government must levy an extra tax on the investment income from pension savings. These extra tax revenues compensate the government for the high interest rate burden on outstanding debt. The government has to subsidize pension savers when the actual rate of real interest is low and falls below some minimum value. The interest burden on outstanding debt is low, so the government is able to subsidize.

The proposed hedge between the two parties indeed implies favourable effects. As a consequence of the proposed hedge, the volatility of the burden on outstanding government debt is reduced. This will contribute to less volatility in government taxation, so that current and future tax payers will benefit. Note that the expected interest burden on outstanding debt undergoes no change. Pension savers experience a reduction in their exposure to investment risk, whereas the expected return on their investments remains unchanged.

Bovenberg states furthermore, that the joint implementation of a defined-contribution plan and his plan for interest rate risk-sharing makes it possible to combine the advantages of a defined-contribution plan (individual freedom of choice) with the collective bearing of investment risks on pension savings, whereas a main disadvantage of defined-contribution plan is overcome, i.e. individual exposure to investment risk. He evaluates this combined availability as a suitable alternative to the final-pay plan currently in force. However, Bovenberg's proposal only provides a hedge against real interest rate risk. His plan does not succeed in copying the unique feature of a final-pay plan, that of offering insurance against standard of living risk. Here, it is proposed that the government should distribute index-like bonds with an investment return structure such that the individual investor can replicate the income insurance offered by a final-pay plan. In the following part of this section, some welfare aspects of these kinds of bonds within a

stylized framework are spelled out. The next section deals with the issue of how this may be organized in reality.
Table 4.1 displays four alternative investment opportunities for a worker who is looking for an appropriate outlet for his pension savings. Alternative 1 reflects the return-risk characteristics of an investment in the market portfolio. Alternative 2 is related to an investment in regular government bonds. Plan Bovenberg is presented as alternative 3. Finally, alternative 4 represents the return-risk characteristics of the proposed so-called real standard-of-living index bonds.

Table 4.1: return as net of growth in standard-of-living (r-μ) and associated risk of four investment alternatives

		Surplus return over growth real standard of living	Risk
1	Market portfolio	$\frac{1+r^m}{1+\mu}$	$\sigma_{\frac{1+r^m}{1+\mu}}$
2	Regular government bonds	$\frac{1+r^g}{1+\mu}$	$\sigma_{\frac{1+r^g}{1+\mu}}$
3	Plan Bovenberg	$\frac{1+r^{g*}}{1+\mu}$	$\sigma_{\frac{1+r^{g*}}{1+\mu}}$
4	Real standard-of-living-index government bonds	$\frac{1+r^{g*}}{1+\mu^*}$	0

All variables are defined in real terms. Variables denoted by * express the expected outcome. The absence of * reflects the actual outcomes.

r^m = real rate of return on market portfolio
r^g = real rate on interest on government bonds
μ = real growth rate of standard of living

With respect to real standard-of-living risk, the representative worker is risk-averse. He/she evaluates the investment alternatives in two respects: (a) the expected real rate of return r in excess of the expected growth rate in real standard of living μ; and (b) risk as measured by the standard deviation of the surplus of the growth in rate of return over the growth in standard of living.
For the moment, the question of which variable can be used to measure the real growth in standard of living is left unanswered. In the next section, the difference between nominal wage growth and the inflation rate as a measure is employed.

Regular government bonds (alternative 2) yield a fixed nominal rate of return. However, the real rate of return is uncertain because of inflation risk. Investors assume that an investment in government bonds is not subject to insolvency risk because of the taxation power of government. Hence, investors are willing to accept a yield on government bond which is lower than the expected rate of return on the market portfolio: $r^{g*} < r^{m*}$. It is plausible to assume that $\sigma_{rg} < \sigma_{rm}$. This implies that $\sigma_{\frac{1+r^g}{1+\mu}} < \sigma_{\frac{1+r^m}{1+\mu}}$.

Alternative 3 is intented to represent the *plan Bovenberg* within the framework of discussion. It is assumed that the expected real rate of interest r^{g*} functions as the contractual rate of return of the hedge between the government (debt) and pension savings. The two parties agree that the government may tax away any surplus of the actual rate of return on investment above r^{g*}. The government must subsidize pension savings when the rate of return on pension savings falls below r^{g*}, where the subsidize is equal to the difference. Hence, pension savings held in the hedge contract yield a fixed real rate of return of r^{g*}, so that risk with respect to the rate of return is absent: $\sigma_{1+r^{g*}} = 0$. However, the investor will not evaluate this alternative as risk-free because he/she is still subject to standard-of-living risk. The risk relevant to this alternative is therefore: $\sigma_{\frac{1+r^{g*}}{1+\mu}} > 0$.

Alternative 4 is related to so-called *real standard-of-living index bonds* distributed by the government. It is assumed that the government issues bonds which offer as a fixed base rate of return the expected surplus of the real rate of interest on government bonds over the expected growth rate of the

real standard of living: $\frac{1+r^{g^*}}{1+\mu^*}$. This base rate of return is supplemented during the term of the bond by the actual growth rate of the real standard of living μ, so that total actual rate of return is equal to $\frac{1+r^{g^*}}{1+\mu^*}(1+\mu)$. The worker evaluates this alternative firstly with respect to the surplus of the total rate of return over the actual growth in standard of living. Because of the pay-off structure of the bond, the investor knows with certainty that this outcome is equal to the given base rate of return $\frac{1+r^{g^*}}{1+\mu^*}$. Hence, this alternative is free from standard-of-living risk: $\sigma_{\frac{1+r^{g^*}}{1+\mu^*}} = 0$.

In figure 4.1, the curve connecting the points 1 and 2 is the efficient set in the absence of the two plans. This efficient set represents the locus of all combinations of the market portfolio and regular government bonds for which the expected return is the highest for risk given. An examination of the figure reveals that, with respect to return and risk, the introduction of standard-of-living index bonds as well as the plan Bovenberg both are a welfare improvement with respect to the original efficient set. Portfolios consisting of the market portfolio and one of these two alternatives dominate all portfolios which lie on the original efficient set[1]. A risk-averse investor will select as an optimal portfolio one that lies on the line which connects the points 1 and 4, i.e. a portfolio consisting of a fraction of the standard-of-living index bonds and the market portfolio. The degree of risk-aversion of the individual worker will be decisive for the composition of the optimal portfolio. The more risk-averse the individual is, the higher the fraction of index bonds in his portfolio, and thus the lower the return, but also the smaller the risk-exposure. The issuance of the index bonds dominates the plan Bovenberg. If standard-of-living index bonds would not be available, then combinations of the market portfolio and the plan Bovenberg is welfare

[1] It is assumed that the correlation between r^m and r^g is high enough to guarantee that the original efficient set of portfolios consisting of the market portfolio and the regular government bonds remains below the line connecting points 1 and 3. This line reflects the efficient set of combinations of market portfolio and investments in the plan Bovenberg. This efficient set is a straight line because the rate of return on investments in the plan Bovenberg is fixed. Hence, the covariance in returns is zero, so that risk-reduction as a result of diversification will not occur (compare footnote 3 in chapter 3). This also applies to the set consisting of the index bonds and the market portfolio.

dominant with respect to the original efficient set consisting of market portfolio and regular government bonds.

Summarizing this section, two alternative plans have been evaluated, i.e. the plan Bovenberg and real standard-of-living index bonds. The evaluation is related to their merits of making use of the government budget to provide an investment opportunity which is suited of meeting the preferences of an individual worker who is risk-averse with respect to real standard-of-living risk and who is looking for an appropriate investment outlet. It is concluded that the plan Bovenberg and the proposal concerning standard-of-living index bonds are both successful in supporting the individual worker in realizing a more preferable structuring of his portfolio of retirement provisions. Given the preference of the individual workers for standard-of-living insurance however, real standard-of-living index bonds are dominant to the plan Bovenberg with respect to reduction in risk-exposure.

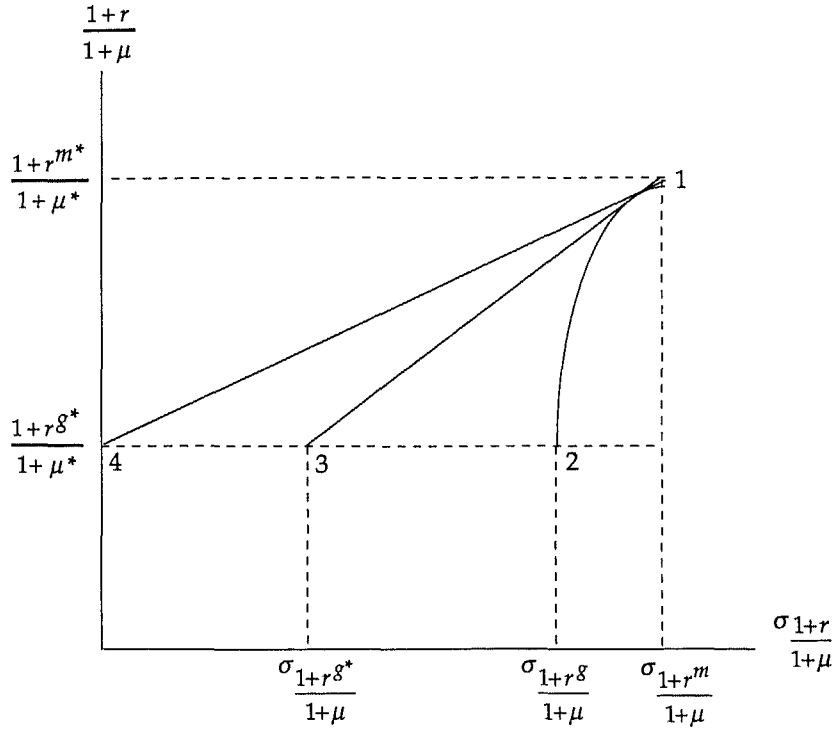

Figure 4.1 : Return as net of growth in standard of living (r-μ) and associated risk of the four investment alternatives

4.3 Government index bonds

The preceding section has considered the welfare aspects of so-called real standard-of-living index bonds. This section aims to show how this idea can be implemented into economic reality.

4.3.1 Characteristics of index bonds

It is proposed that the government should issue two kind of index bonds: the so-called nominal-wage-index bonds and the so-called price-index bonds. The term of these bonds is one period, as in the case of regular bonds.

The government pays out on outstanding *nominal-wage-index bonds* next period a rate of return equal to r^{w}_{t+1}. This rate is determined by the base rate of return I^{w} and the actual growth rate of the nominal wage next period m_{t+1} as follows:

$$\left(1+r^{w}_{t+1}\right)=\left(1+I^{w}\right)\left(1+m_{t+1}\right)=\left(\frac{1+r^{g*}}{1+m^{*}}\right)\left(1+m_{t+1}\right) \tag{4.1}$$

where the size of the base rate of return I^{w} is the expected rate of interest on regular government bonds r^{g*} discounted by the expected wage growth m^{*}.

As in the case of nominal-wage-index bonds, the actual rate of return on *price-index bonds* next period r^{π}_{t+1} is composed of the actual inflation rate π_{t+1} and the base rate of return I^{π}, where the latter is the expected rate of interest on regular government bonds r^{g*} discounted by the expected inflation rate π^{*}:

$$\left(1+r^{\pi}_{t+1}\right)=\left(1+I^{\pi}\right)\left(1+\pi_{t+1}\right)=\left(\frac{1+r^{g*}}{1+\pi^{*}}\right)\left(1+\pi_{t+1}\right) \tag{4.2}$$

4.3.2 Individual preferences

An individual worker who is participating in a defined-contribution plan is taken as point of departure. It is assumed he wishes to use the wage-index and price-index bonds to replicate the features of a firm-sponsored final-pay plan with indexed benefit. What then is the nature of the features of such a plan?

Let us assume that the life-cycle of each individual consists of three phases. During the first and second phases of a life-time, individuals are part of the workforce and, during their third phase, individuals are retired. Let w_t and w_{t+1} stand for the nominal wage rate in period t and period t+1, m^* for the projected growth rate of nominal wages, r^* for the projected rate of return, and π^* for projected inflation. The actual outcomes of π_t, m_t and r_t will differ from their projected values π^*, m^* and r^*. The assumption is that $uw_{t+1}(1+x^*)$ is the defined benefit offered by the final-pay plan to individuals belonging to the generation, which enters the workforce in period t, where u reflects the benefit rate.

The premium rate to be paid by individuals in generation t can be solved from the equalization of premiums paid by these individuals during their working life in periods t and t+1, including the projected investment result in t+1 and t+2 and the projected benefits that this generation will obtain in t+2. This gives[2]:

$$
\begin{aligned}
& pw_t(1+r^*)(1+r^*)+pw_{t+1}(1+r^*)=uw_{t+1}(1+\pi^*) \\
& \Rightarrow \\
& pw_t(1+r^*)(1+r^*)+pw_t(1+m^*)(1+r^*)=uw_t(1+m^*)(1+\pi^*) \\
& \Rightarrow \\
& p=\frac{u}{\left(\frac{1+r^*}{1+\pi^*}\right)\left(\frac{1+r^*}{1+m^*}+1\right)}
\end{aligned}
\qquad (4.3)
$$

Now that some core characteristics of the final-pay plan have been determined, consideration can again be given to our individual who is obliged to save for his old-age wealth through a defined contribution plan.

The individual participates in the workforce in periods t and t+1. He prefers to enjoy a retirement income during period t+2 equal to a fraction v of his pre-retirement standard-of-living, where the income targeted is indexed for

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[2] As shown in chapter 6, this premium rate is the same as the premium rate of a final-pay plan financed by the pure funding method of Indexed Benefit Obligations.

inflation The saving rate is equal to s. The size of s will be determined later on (equation 4.5).
The availability of the index bonds enables the individual to plan the following investment strategy. Savings from wage income in period t sw_t are used to purchase nominal-wage-index bonds giving an actual return of $\left(\frac{1+r^{g*}}{1+m^*}\right)(1+m_{t+1})$. The total proceeds of these bonds in period t+1 plus new savings from wage income in this period sw_{t+1} are invested during period t+2 in price-index bonds providing a return of $\left(\frac{1+r^{g*}}{1+\pi^*}\right)(1+\pi_{t+2})$.

The total proceeds of this strategy add up in period t+2 to:

$$\left[sw_t\left(\frac{1+r^{g*}}{1+m^*}\right)(1+m_{t+1})+sw_{t+1}\right]\left[\left(\frac{1+r^{g*}}{1+\pi^*}\right)(1+\pi_{t+2})\right]$$
$$\Rightarrow \qquad (4.4)$$
$$sw_t\left(\frac{1+r^{g*}}{1+m^*}+1\right)\left(\frac{1+r^{g*}}{1+\pi^*}\right)(1+m_{t+1})(1+\pi_{t+2})$$

Now the size of the saving rate s can also be determined. It can be solved from the equalization of projected proceeds in expression (4.4) and preferred projected retirement income, which is set equal to $vw_{t+1}[1+\pi_{t+2}]$.

So, from $sw_t\left(\frac{1+r^{g*}}{1+m^*}+1\right)\left(\frac{1+r^{g*}}{1+\pi^*}\right)(1+m_{t+1})(1+\pi_{t+2})=vw_{t+1}[1+\pi_{t+2}]$, the size of s can be solved which reads as:

$$s=\frac{v}{\left(\frac{1+r^{g*}}{1+m^*}+1\right)\left(\frac{1+r^{g*}}{1+\pi^*}\right)} \qquad (4.5)$$

Hence, planned savings has to be equal to the discounted value of preferred pension wealth which is a fraction v of final-pay. The discount factor used is a compilation of the base rates offered by the index-bonds, i.e. the projected surplus of expected government rate of interest over expected nominal wage growth rate respectively the expected inflation rate. Because the actual incremental of these bonds is the sum of the base rate plus actual wage growth or actual inflation rate respectively, the total actual proceeds of

these bonds will be sufficient to realize the aimed level of standard of living in retirement.
Comparing (4.3) and (4.5), it can be ascertained that the result of the investment strategy which uses the index bonds is indeed comparable to that of the income insurance offered by a final-pay plan with inflation-indexed benefits. However, there are two exceptions. Firstly, within a firm-sponsored plan funding risks are borne by the plan's sponsors, i.e. workers and/or shareholders. However, risks with respect to index bonds are borne by government finance / tax-payers. This issue will be discussed in more detail in the next section. A second difference is the magnitude of the expected rate of return on savings held in index bonds versus the expected return on premiums paid into a funded plan. The expected rate of return r^* in a funded plan depends on the investment policy of the fund's managers. They may aim for a high return with a risky policy. Alternatively, they may pursue a less risky policy with a low rate of return. The expected rate of return of an investment strategy in the case of savings held in index bonds is equal to the projected rate of interest on government bonds r^{g*}.
The availability of index bonds can also be used by individuals to imitate other kinds of insurance offered by supplementary schemes. For example, individuals may strive to obtain a final-pay related retirement income where the income during retirement is *welfare-indexed*. This implies an investment strategy within which only wage-indexed bonds are purchased. An *average-wage* related retirement income would imply the purchase of inflation-indexed bonds[3].

4.4 Government finance

The distribution of the index-like bonds implies collective risk-bearing with respect to the interest rate, wage growth rate and inflation rate. The actual burden on the outstanding index-bonds is a compilation of the expected rate of interest plus the deviation of the wage rate and the inflation rate from their expected values during the term, where the expected values are fixed at the start of the term of the index-bonds. Consequently, the issuance of the index bonds proposed has no impact on the expected burden on outstanding government debt, because the expected rate of interest on index bonds is equal

[3] Note that if index bonds would come available, these bonds would also be an attractive investment outlet for wealth accumulated in the funded defined-benefit plans. Fund managers have the opportunity to create a *perfect match* between the wealth invested in the bonds and the fund's liabilities.

to the projected rate on regular bonds r^{g*}. However as will be shown below, the spread of total burden around its expected value will be reduced whenever the actual rate of interest, the actual wage growth and the actual inflation rate are less than perfectly correlated. The exposition of this has been kept as simple as possible. It is assumed that government expenditures (net of payment of interest burden on outstanding debt) per capita g_{t+1} and government debt per capita d_{t+1} are both a constant fraction of national income per capita y_{t+1}:

$$\frac{g_{t+1}}{y_{t+1}} = \frac{g_t(1+\psi_t)}{y_t(1+\psi_t)} = \frac{g_t}{y_t} \quad ; \quad \frac{d_{t+1}}{y_{t+1}} = \frac{d_t(1+\psi_t)}{y_t(1+\psi_t)} = \frac{d_t}{y_t} \tag{4.6}$$

where ψ_t reflects the annual growth rate of national income per capita.
The government budget reads as:

$$\tau_{t+1}y_{t+1} + d_{t+1} = g_{t+1} + d_t\left(\gamma_{rg}(1+r^g_{t+1}) + \gamma_m\left(\frac{1+r^{g*}}{1+m^*}\right)(1+m_{t+1}) + \gamma_\pi\left(\frac{1+r^{g*}}{1+\pi^*}\right)(1+\pi_{t+1})\right) \tag{4.7}$$

The right-hand side of the equation reports total government expenditure, which consists of g_{t+1} plus the repayment of outstanding debt d_t including the 'interest burden'. The interest burden is determined by the burden related to the regular bonds for a fraction γ_{rg} and by the burden related to the nominal-wage index bonds and price-index bonds for the fractions γ_m and γ_π respectively, where $\gamma_{rg} + \gamma_m + \gamma_\pi = 1$.
The left-hand side indicates how these outlays are financed: by the revenues from taxation on national income and by the issuance of new debt d_{t+1}. Equation (4.7) can be rearranged as expression (4.8):

$$\tau_{t+1} = \frac{g_t}{y_t} + \frac{d_t}{y_t} \times \left[\frac{\overbrace{\gamma_{rg}(1+r^g_{t+1}) + \gamma_m\left(\frac{1+r^{g*}}{1+m^*}\right)(1+m_{t+1}) + \gamma_\pi\left(\frac{1+r^{g*}}{1+\pi^*}\right)(1+\pi_{t+1})}^{\text{'interest burden'}} - (1+\psi_t)}{(1+\psi_t)} \right] \tag{4.8}$$

Inspection of (4.8) reveals that the volatility in τ_{t+1} will be lower, (1) the lower the correlation is between the components of the 'interest burden' in the numerator, and (2) the higher the correlation between the numenator and the denominator of the fraction is.
Below the evidence for (1) and (2) is discussed.
As to the first point, table 4.2 given below is informative with respect to the potential capacity of index bonds reducing the volatility in the interest burden of government debt. During the period 1949-1992, the degree of correlation between the time series of $r\delta$ and m, and between the time series of $r\delta$ and π is far from perfect positive (=+1). This indeed suggests that the issuing of nominal-wage-index bonds and price-index bonds might imply a decrease in the variability in the total burden of outstanding debt.

Table 4.2: Correlation coefficients between the interest rate on government bonds $r\delta$, growth rate of nominal wages m, consumer prices π, and growth rate net of national income per capita ψ for the period 1949-1992 (author's own calculations)

Correlation matrix

	$r\delta$	m	π	ψ
$r\delta$	1			
m	- 0.01	1		
π	0.20	0.49	1	
ψ	0.11	0.78	0.63	1

Source data: Besseling (1993) Appendix 3.

As to the second point, the last row of table 4.2 reports for the Netherlands the degree of correlation between the time-serie of ψ and the time-series of $r\delta$, m and π for the period 1949-1992. If one is aiming to reduce tax rate volatility by reducing the mismatch between government expenditures and revenues, the evidence of this row clearly suggests that the issueing of wage-index and price-index government bonds will contribute to this objective. An increase in the inflation rate and/or the nominal wage income will usually be reflected in a corresponding increase in national income. The issue of index bonds will contribute to a reduction in the mismatch between government expenditure and tax revenues, and hence tax rate volatility will also be reduced.

4.5 Evaluation

In the Netherlands, a discussion is going on in support of modifying the present structure of the supplementary scheme. One is aiming to make a case of substituting the final-pay plans for defined-contribution plans. This reform should anticipate the trend towards more diversity among individuals. However, Dutch employees in majority prefer to maintain the final-pay plan. Apparently, the insurance offered by the final-pay plan is a reflection of the preferences of the participating workers. If this is the case, the workers might evaluate the proposed reform as being a loss in welfare. They may consider that they would lose the prospect of a post-retirement real income which enables them to maintain the pre-retirement standard of living during old-age.

The main conclusion of this chapter is that government finance can be utilized to replicate unique features of a funded defined-benefit plan. Within a stylized framework, firstly two alternative plans in this respect were discussed. These alternatives concern the plan Bovenberg, and index bonds aiming to provide insurance against real standard-of-living risk. The evaluation of the merits of the two alternatives was related to an individual worker who is assumed to be risk-averse with respect to real standard-of-living risk and who is looking for an appropriate investment outlet for pension savings held on an individual basis, for example in a defined contribution plan. It has been concluded that the plan Bovenberg and the proposal of standard-of-living index bonds both are successful in supporting the individual worker to realize a more preferable structuring of his portfolio of retirement provisions. Given the preference of individual workers for standard-of-living insurance, real standard-of-living index bonds are dominant to the plan Bovenberg with respect to a reduction in exposure to standard-of-living risk.

Subsequently, the implementation of the idea to use government index bonds to provide standard-of-living risk insurance was dealt with.
In this way, the issuance by the government of so-called nominal-wage-index bonds and inflation-index bonds was discussed. Wage-index bonds offer a base rate of return, equal to the projected surplus of the expected government rate of interest over the expected growth rate of nominal wages, plus the actual nominal wage growth rate during the term of the bonds. Similarly, price-index bonds provide as base rate the excess of expected government interest rate over the projected inflation rate plus actual inflation rate during the

term of the bonds. It has been shown that these bonds enable the individual investor to create the same kind of retirement income insurance made possible by wage-related defined-benefit plan with indexed benefits. His investment plan then runs as follows. First, the individual investor must asses the preferred level of pension wealth, for example a pension wealth which enables him to maintain his pre-retirement standard of living. Subsequently, in the period(s) during labour-time at which he is able to take care for retirement provisions, the individual calculates the present value of the (corresponding portions) of this pension wealth. The discount rate used is a compilation of the base rates offered by the index-bonds. The calculated size of the required pension savings is used to purchase index-bonds. Because the actual incremental of these bonds is the sum of the base rate plus actual wage growth or actual inflation rate respectively, the total actual proceeds of these bonds will be sufficient to realize the aimed level of standard of living in retirement.

In addition, the issuance of the proposed bonds will reduce the volatility in the public budget. The actual burden on the outstanding index-bonds is a compilation of the expected rate of interest plus the deviation of the actual wage rate and the actual inflation rate from their expected values during the term of the bonds, where the expected values are fixed at the start of the term of the index-bonds. Hence, the index bonds have no impact on the expected value of the burden of outstanding government debt. However its volatility is reduced. Firstly, the decline in volatility occurs because the actual rate of interest on government bonds, the actual wage growth and the actual inflation rate are correlated less than perfect. The decline in volatility of the interest burden also implies a decrease in variability in tax rates. Furthermore, tax rate volatility will be reduced because the issuance of index bonds will contribute to a reduction in the mismatch between government expenditures and tax revenues. Nominal-wage-index bonds and price-index bonds are therefore also a welfare-improvement for all tax-payers. These tax-payers differ as to income source (wages, rental income and pension benefits) and in age, both implying intergenerational risk-sharing.

The next chapter deals with another channel of risk-sharing between government finance and pension savings. This is related to the so-called cash-flow method of taxation of pension savings.

5 Tax treatment of pension savings and risk-sharing

5.1 Introduction

This chapter deals with the relationship between the taxation of pension savings and government finance. Pension savings can be taxed according to either the prepayment method or the cash-flow method. The two methods have a different impact on government finance in the long run. Firstly, these two taxation methods will be considered. Then the attention will be turned to an analytical treatment of the relationship between the taxation of pension savings, the tax-rate level and volatility in tax revenues. The aim of this chapter is to show that the cash-flow method is preferable to the prepayment method. The implementation of the cash-flow taxation method first of all implies a tax-rate level lower than the prepayment method. Secondly the cash-flow taxation method leads to a broadening of the tax base, which may reduce tax-rate volatility. If so, this contributes to (intergenerational) risk-sharing within the economy.

5.2 Tax treatment of pension savings

Two alternatives within the tax treatment of pension savings can be distinguished, namely the cash-flow tax system and the prepayment tax system (Bovenberg & Petersen 1991, Johnson 1991, Keuzenkamp & van der Ploeg 1993, Vermaat & van Dam 1991). According to the *cash-flow method* ('omkeerregel'), pension savings from wage income are not subject to taxation, whereas the pension benefit is taxed where the benefit equals initial savings plus rental increment. According to the *prepayment method* ('voorheffings-variant'), pension savings from wage-income are not tax-deductible but the

pension income during retirement is free from taxation. Taxation on old-age consumption is therefore 'prepaid' during the pre-retirement period.
In most countries including the Netherlands, the cash-flow method is operative (Johnson 1991).

The two taxation methods raise tax revenues at different points in time. The prepayment method collects taxes at the moment at which the individual earns his wage income. In the case of the cash-flow method, the government defers the moment at which taxation takes place. The cash-flow method implies that young individuals will save more compared with the prepayment method, because they have to meet future tax payments on their pension benefits, so that net pensions are in accordance with the preferred consumption level during old age. At the same time, the government has to enlarge its financial deficit to compensate for the tax-deference. The cash-flow method therefore leads to a higher stock of government debt. However, this extra debt will be repaid when the young generation retires and pays its deferred taxes. Therefore, the cash-flow method implies no shifting of the financing of government outlays from current generations to future generations. The creation of extra debt runs parallel to an increase in tax income to be claimed in the future.
Hence, one may conclude that the two tax methods are neutral for government finance. However, the methods differ in their impact on the tax-rate levels and volatility in tax revenues.
The rate of return on the portfolio of pension savings will usually exceed the rate of interest which the government has to pay on its debt. This implies that the cash-flow method will yield more discounted tax revenues than the prepayment method. Therefore, the average tax rate on life-time income is lower according to the cash-flow method in comparison to the prepayment method. The *tax revenue bonus* of the cash-flow method will be reduced, however, when pension savings are invested in government bonds[1].
Compared with the prepayment method, the cash-flow method implies a re-ordering of the tax base. The relative weight of the taxation of wage income

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[1] Under the cash-flow tax method, individuals can arbitrage across different tax rates during working life and during retirement. Intertemporal tax arbitrage can reduce the tax revenue bonus. Usually, tax rates for individuals during retirement are lower than in the pre-retirement period. By postponing consumption from wage income until retirement through pension savings, one is able to take advantage of the differences in tax rates. This argument becomes weaker, the less the effective tax rates do differ during the two periods of life. Intertemporal tax arbitrage on pension savings is impossible when an individual is subject to the prepayment tax method. This study will not deal with the effects of different tax rates levied during one's life-time.

is reduced in favour of an increase in the relative weight of rental income. This re-ordering of the tax base might contribute to a reduction in the volatility of government finance. Necessary (unfortunately not sufficient) condition for this is that changes in wages and in the rate of return on pension savings should be negatively correlated. This condition is met within the framework applied in this study, because wage income and rental income as factor shares are negatively correlated.

5.3 Tax rates and fiscal neutrality

This section presents an analytical treatment of the relationship between government expenditure, the taxation of pension savings, the tax-rate level and volatility in tax revenues.

The analytical framework is once again the two-period overlapping generation model. The situation of a small open economy is considered. This situation has already been set out in section 3.6. Because of international capital mobility, the domestic capital market rate of return and the domestic wage rate are equal to the world market rate of return and the world wage rate respectively. Wage income and rental income as factor shares are negatively correlated. A high wage income is accompanied by a low rate of return on capital, and vice versa.

Initially, the analysis will only extend to tax rates for the steady state, in which variables are equal to their expected values. The next section studies the issue of taxation for an economy subject to uncertainty.

The government may enter the economy in many ways. The analysis here will be kept as simple as possible. Government expenditure per worker is planned to be equal to the constant g. Therefore, total government expenditure during period t is expected to be equal to $gE[L_t]$. When the prepayment method is operative, outlays ought to be financed by taxation to be paid by the young generation. Financing these outlays by issuing government debt is not allowed for. In the case of the cash-flow method, government outlays is financed by the taxation of wages net of pension savings, the taxation of pension income plus the distribution of government debt. The government sets the tax rates in both tax methods at a level such that, on expectation, it is guaranteed that the two tax methods are intertemporally neutral for the government budget.

Prepayment method

If the prepayment method is operative, the tax rate on wage income τ^{pp} within this simple framework can be solved from the equalization of government expenditure and tax sum[2]:

$$g[L_t] = \tau^{pp} E[w_t L_t] \quad => \quad \tau^{pp} = g / E[w] \tag{5.1}$$

Cash-flow method

If the cash-flow method is operative, the sum of tax revenues from wages net of pension savings plus the discounted tax revenues from pension income must be equal to total government expenditure. The government budget can be read in (5.2), where τ^{cf} reflects the steady state value of the tax rate to be applied to the taxation of the wage income (net of pension savings) and the pension income:

$$\begin{aligned} &gE[L_t] + \tau^{cf} sE[w]L_{t-1}\Big(1 + E[r^g]\Big) = \\ &\quad \tau^{cf}(1-s)E[wL_t] + \tau^{cf} sE[w]L_{t-1}\Big(1 + \gamma E[r^g] + (1-\gamma)[E[r^m]\Big) + \tau^{cf} sE[wL_t] \end{aligned} \tag{5.2}$$

The left-hand side of the equation reports total government expenditure. For the steady state, expenditure consists of $gE[L_t]$ and the repayment of outstanding government debt including its interest burden. This debt stems from the previous period and is equal to the deferred taxes on pension savings of the current old generation $\tau^{cf} sE[w]L_{t-1}$.
The right-hand side shows how total expenditure is financed, firstly by tax revenues and secondly by the issue of new government debt equal to the deferred taxes of the current young generation $\tau^{cf} sE[wL_t]$. Tax revenues are raised by taxing wage income net of pension savings, which equals:

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[2]The size of the actual wage sum in each period depends on which of the four possible states of nature will realize. These states of nature are made up of the combination of the two possible outcomes for the wage rate (either w^x or w^y) and the two possible outcome for the labour force (either L^a or L^b). The equality $gE[L_t] = \tau^{pp} E[wL_t]$ can be rewritten as: $\Big[gL^a + gL^b\Big]/2 = \tau^{pp}\Big[w^x L^a + w^x L^b + w^y L^a + w^y L^b + \Big]/4$. Re-arrangement of this result produces: $g = \tau^{pp}[w^x + w^y]/2$. So $\tau^{pp} = g / E[w]$.

$\tau^{cf}(1-s)E[wL_t]$, and by taxing the pension income of the current elderly, which equals $\tau^{cf}sE[w]L_{t-1}\left(1+\gamma E[r^g]+(1-\gamma)[E[r^m]\right)$. Pension income is the sum of principal plus investment income where the latter is determined by the preferred allocation to government bonds for a fraction γ and to the market portfolio (1-γ).
For an open economy, γ can take any value between 0 and 1, because inhabitants can buy foreign bonds or invest in the world market portfolio, whereas foreigners can buy domestic bonds. Hence: $0 \leq \gamma \leq 1$.

After some rearranging of equation (5.2), one can find the result below as solution for the steady state value of the tax rate in the case of an open economy:

$$\tau^{cf} = \frac{g / E[w]}{1+s(1-\gamma)\left(E[r^m]-E[r^g]\right)/(1+E[n])} \tag{5.3}$$

where $(1+E[n])$ reflects the expected relative size of the young generation as compared to the retirees $E[L_t]/L_{t-1}$.
The expression $s(1-\gamma)\left(E[r^m]-E[r^g]\right)/(1+E[n])$ in the denominator is the expected size of the *tax-revenue bonus*. It is positive because $E[r^m] > E[r^g]$.

Comparison

With the help of (5.1) and (5.3), the following comparison of the tax rates in the two different methods is easily derived:

$$\left.\begin{array}{l} E[r^m] > E[r^g] \\ \gamma < 1 \end{array}\right\} \Rightarrow \tau^{cf} < \tau^{pp} \tag{5.4}$$

At the moment at which the government distributes (extra) government bonds due to tax-exemption, it acquires a tax claim on total pension wealth. The higher the gross investment result on pension savings is in comparison to the rate of interest on government debt, the higher the tax-revenue bonus is, and consequently the more the tax rate in the cash-flow method will fall below the tax rate applying to life-time income subject to the prepayment method. The gross investment result is determined by the preferred allocation of

savings to government bonds and to the market portfolio. The higher γ is, the smaller the bonus. Hence, the application of the cash-flow method yields a higher life-time income in net terms than the application of the prepayment method because $E[r^m] > E[r^g]$, given that $\gamma<1$.

5.4 Taxation methods and volatility in government finance

In the preceding discussion, tax rates were derived for the steady state. Now, uncertainty will be allowed for in factor rewards. Fluctuations in actual wage rate and actual capital market return around their expected values (steady-state values) will be transmitted into tax income volatility. As will be shown, one positive side effect of the cash-flow tax method is its potential to reduce the volatility in tax revenues.

It is assumed throughout this section that government spending per worker remains constant and that an adjustment in the actual tax-rate level should restore the balance in government finance.

Prepayment method

The *prepayment method* requires government finance to obey the general rule that total spending should be matched by tax revenues. Creation of government debt or government savings is not permitted. Hence, the government budget is balanced by an extra tax-claim when tax revenues fall short of expenditure or by a tax restitution when tax revenues exceed government spending. The actual balance of government finance in period t according to the prepayment method is listed below. Equation (5.5) results from rewriting (5.1) in actual terms and adding the expression $\Delta\tau_t^{pp}L_t$:

$$gL_t = \tau^{pp}w_tL_t + \Delta\tau_t^{pp}L_t \tag{5.5}$$

where $\Delta\tau_t^{pp}$ stands for the size of either the tax restitution per worker or the extra tax-claim on worker's income. Equation (5.5) can be rewritten as:

$$\Delta\tau_t^{pp} = g - \tau^{pp}w_t \tag{5.6}$$

The prepayment method only taxes the income of workers. Low before-tax income of the workers results in low taxes, so tax revenues fall short of government outlays and an extra tax-claim on wage income is needed: $\Delta\tau_t^{pp}>0$. Tax revenues exceed government outlays when taxes are high because of a high before-tax income, so there is room for a tax restitution: $\Delta\tau_t^{pp}<0$.

Cash-flow method

When the *cash-flow method* is operative, the rule ought to be modified because part of the taxing of wage income is deferred to the next period. It is assumed that the deficit which is allowed for is equal to the tax deferral. The required adjustment to the government budget can be realized by a modification in tax revenues or government spending. Taxable income according to the cash-flow method consists of two components: the tax-claim on workers' income and the tax-claim on pension income. The preferred allocation of pension wealth is decisive for the size of pension income.
Because of volatility in factor rewards, the *actual* development of government finance will differ from its steady-state expression in (5.2). Rewriting (5.2) in actual terms and adding the expression $\Delta\tau_t^{cf}L_t$ produces the actual development of government finance in period t:

$$\begin{aligned} &gL_t+\tau^{cf}sw_{t-1}L_{t-1}(1+r_t^g)= \\ &\quad \tau^{cf}(1-s)w_tL_t+\tau^{cf}\Big(1+\gamma r_t^g+(1-\gamma)r_t^m\Big)sw_{t-1}L_{t-1}+\tau^{cf}sw_tL_t+\Delta\tau_t^{cf}L_t \end{aligned} \tag{5.7}$$

$\Delta\tau_t^{cf}$ stands for the magnitude of the extra tax claim or tax restitution per worker. This is expressed per worker because this makes it possible to compare $\Delta\tau_t^{cf}$ with $\Delta\tau_t^{pp}$.
Analogous to (5.2), the left-hand side of the equation reports government outlays plus the repayment of outstanding government debt including the interest burden. The right-hand side gives tax proceeds from wage income (net of pension savings) and pension income. The expression $\tau^{cf}sw_tL_t$ reflects new government debt which is equal to the deferred tax payments by the current young.

Expression (5.7) can be rearranged as:

$$\Delta\tau_t^{cf} = g - \tau^{cf}\left(w_t + \underbrace{[(1-\gamma)(r_t^m - r_t^g)]sw_{t-1}/(1+n_t)}_{\text{tax-revenue bonus}}\right) \tag{5.8}$$

Comparing (5.8) with (5.6) demonstrates that the cash-flow method differs from the prepayment method in three respects.
(1) Firstly, two aspects are related to the tax-revenue bonus. The presence of the bonus will contribute to a reduction in the volatility of tax revenues, if two conditions are met: firstly, changes in wages and in the rate of return on pension savings are negatively correlated, and secondly, that the rate of return on pension savings exceeds the rate of interest on government debt. Both conditions are realistic of nature. Because of the negative relationship between factor rewards, a bad result from the taxation of wage income will be accompanied by a good result from the taxation of the tax-revenue bonus, and vice versa.
(2) Furthermore, it has already been set-out that the bonus leads to the result that the steady state values differ concerning the tax rate level for both methods: $\tau^{cf} < \tau^{pp}$. This implies that the two methods will also differ as to the degree in which an (equal) deviation of actual taxable income from its expected value, will lead to either a compensating extra tax claim or tax restitution. Because $\tau^{cf} < \tau^{pp}$, the multiplication of a deviation of actual taxable income from its expected value is smaller in the cash-flow method than in the prepayment method.

The appendix to this chapter presents a formal treatment of the capacity of the cash-flow method to reduce the volatility in tax revenues. As it appears from this treatment, at the one hand there is an increase in volatility under the cash-flow method because of the enlargement of the tax base with the bonus. On the other hand there is a reduction in volatility because of the negative correlation between the components of the tax base, i.e between the wage income and the bonus. If the latter effect dominates the former effect, then the volatility in government finance under the cash-flow method is lower than under the prepayment method.

5.5 Evaluation

The method of taxation applied to pension savings is of influence on the evolution of government finance. On the basis of the preceding discussion, the following statements can be made.

The choice between taxation according to either the prepayment method or the cash-flow method is influential to *the size of government debt*. The prepayment method as such does not change the debt, the cash-flow method however leads to (extra) government debt equal to the tax-deferral.

The preferred taxation method affects the *tax sum* to be levied and, consequently, the level of the *tax rate*. The cash-flow method implies that the government has to borrow in order to finance the tax-deferral applying to pension savings and that workers have to save more in order to pay for the tax on pension income. The rate of return on the portfolio of pension savings will usually exceed the rate of interest which the government has to pay on its debt. This implies the cash-flow method will result in more discounted tax revenues than the prepayment method. If so, the tax-rate level applying to the cash-flow method will fall below the level in the prepayment method. When pension savings are invested in government bonds, however this tax-revenue bonus will be reduced. The reduction is proportional to the fraction held in government bonds.

The *main conclusion* with respect to the general theme of the study is that implementation of the cash-flow method applying to pension savings implies an increase in intergenerational risk-sharing. The *chosen tax method* applying to pension savings effects the volatility of government finance. In the cash-flow method, the government has to borrow due to tax-exemption. However, the government also acquires a tax claim on total pension wealth next period. Compared with the prepayment method, the cash-flow method implies a re-ordering of the tax base, in which the relative weight of taxation of wage income is reduced in favour of an increase in the relative weight of rental income. This re-ordering of the tax base contributes to a reduction in the volatility of tax revenues if three conditions are met: firstly, that the rate of return on pension savings exceeds the rate of interest on government debt, secondly, that changes in wages and in the rate of return on pension savings are negatively correlated, and thirdly, that the increase in volatility in tax revenues associated to the enlargement of the tax base with the rental income is not too large.

APPENDIX

It has to be shown when the tax revenues under the cash-flow method are less volatile compared with the prepayment method. A comparison is made between the variance in tax revenues.

As before (compare section 3.6), a small open economy is considered. Depending on the state of nature prevailing in the world-market economy, the capital market rate of return r^m is equal to either r^x or r^y, whereas the wage rate w equals either w^x or w^y. Here, demographic risk concerning the domestic population is excluded. It is assumed that each domestic-born generation is of equal size, $n^a=n^b=E[n]=0$. Hence, there are only two possible states of nature. Taking a long term view, it is realistic to assume that the expected rate of return on pension savings $E[r^m]$ will exceed the expected rate of interest on government bonds $E[r^g]$. It is assumed here that $E[r^g] < E[r^m]$ for all states of nature. The tax-revenue bonus of the cash-flow method is then always positive (cf expression 5.8). Labour and capital are assumed to be paid according to their marginal product in the world market economy. There is a negative correlation between wages and capital market rate of return (compare section 3.6).

[1] Prepayment method

Tax base:

Expectation $= E[w]$

Variance $= \mathrm{var}(w)$

Tax revenues:

Expectation $= \tau^{pp} E[w]$

Variance $= \left(\tau^{pp}\right)^2 \mathrm{var}(w)$

[2] Cash-flow method

Tax base:

Expectation $= E[w] + E[bonus]$

Variance $= \mathrm{var}(w) + \mathrm{var}(bonus) + 2\mathrm{cov}(w,bonus)$

Tax revenues:

Expectations $= \tau^{cf}(E[w] + E[bonus])$

Variance $= \left(\tau^{cf}\right)^2 [\mathrm{var}(w) + \mathrm{var}(bonus) + 2\,\mathrm{cov}(w, bonus)]$

The relationship between the volatility in tax revenues under the cash-flow method and the prepayment method can be compared by means of the variance of tax revenues:

$$\left(\tau^{cf}\right)^2\left[\text{var}(w)+\text{var}(bonus)+2\,\text{cov}(w,bonus)\right] \begin{matrix}<\\=\\>\end{matrix} \left(\tau^{pp}\right)^2 \text{var}(w) \qquad \text{(A.1)}$$

The volatility in tax revenues under the cash-flow method can be smaller, however unfortunately also greater than under the prepayment method, depending on the size of the two tax rates, the size of var(*bonus*) and the size of the covariance. The expression can be made more insightful as follows.

It has been assumed that the tax rates in the two methods are set at a level which deliver the same expected tax revenues (cf. section 5.3): $\tau^{cf}(E[w]+E[bonus])=\tau^{pp}E[w]$. This gives $(E[w]+E[bonus])/E[w]=\tau^{pp}/\tau^{cf}$. So, expression (A.1) can be rearranged as:

$$\frac{\text{var}(w)+\text{var}(bonus)+2\,\text{cov}(w,bonus)}{(E[w]+E[bonus])^2} \begin{matrix}<\\=\\>\end{matrix} \frac{\text{var}(w)}{(E[w])^2} \qquad \text{(A.2)}$$

The volatility in tax-revenues under the cash-flow is smaller than under the prepayment method when the left-hand side is smaller than the right-hand side. The presence of a (higher) bonus will increase the numerator of the left-hand side of (A.2). The impact of a (higher) bonus on the denumerator is indeterminate because var(*bonus*) is positive but the term 2cov(*w,bonus*) is negative. A full specification of the terms involved is necessary to determine the net-effect and so to arrive at a more definite result.

PART II

SUPPLEMENTARY PENSIONS IN THE NETHERLANDS AND EVALUATION OF REFORM PROPOSALS

6 Funding methods and funding risks in final-pay plans

6.1 Introduction

The central theme of chapter 3 has been a theoretical analysis of the welfare-enhancing properties of a funded defined benefit plan which offers retirement income insurance based on intergenerational insurance contracts. This chapter is concerned with the question of how this arrangement (may) function in real life.

The supplementary pension scheme currently operating in the Netherlands is mainly organised as a funded defined-benefit scheme. The benefit structure is usually a final-pay plan with inflation-indexed benefits. This chapter presents a relatively simple setting with three generations. The essential institutional characteristics of the Dutch supplementary scheme can be represented within this setting. It enables one to sketch a clear picture of the offered insurance, the nature of risk-bearing and the impact of fluctuations in insured risks on the deviation of the actual premium rate from its projected (actuarial) size.
In general, the nature of risk-bearing and the presence of income transfers within a pension plan will depend on its funding policy. This issue is examined in section 6.2, where an analytical distinction is made between two extremes in the funding of defined-benefit schemes: the so-called *Accumulated Benefit Obligation* (ABO) concept versus the concept of the *Indexed Benefit Obligation* (IBO). The IBO-concept can be seen as an example of pure funding. Actuarial fairness is aimed at explicitly here. For each generation a premium sum is paid equal to the expected value of their pension benefits. The ABO-concept does not take into consideration future wage growth and

inflation. This concept therefore involves the presence of backloading elements within the funding. Nevertheless, it appears that actuarial fairness is also present in this concept.
Pension plans in the Netherlands are situated somewhere between these two extremes. With the help of an adjustment in the framework of the ABO-method, one is finally able to define the channels of income transfers for a scheme with characteristics of the Dutch pension scheme and to assess the quantitative significance of these transfers. The built-in presence of backloading which implies a pay-as-you-go element within the finance method is commented on. It will be concluded that the funding method of Dutch supplementary schemes *as such* is characterized by *actuarial fairness*. The funding method implies a mutuality of income transfer ex ante between sponsors and the scheme. As discussed in preceding chapters, these sponssors ultimately the active workers. Furthermore, it turns out that aging has a very modest impact on the supplementary premium rate, despite the presence of the pay-as-you-go element within the financing method.

6.2 Funding methods

It is useful to make an analytical distinction between two methods of actuarial funding of pension obligations: the method of Indexed Benefit Obligations and the method of Accumulated Benefit Obligations. These concepts are distinguished by Bodie (1990) and Frijns & Petersen (1992). As will be set out in the next section 6.3, the funding practice in the Netherlands can be seen as a hybrid construction of these two extremes.

A setting is employed in which, at any moment in time, three generations are alive: firstly, the generations of young adults (25-45); secondly, the middle-aged (45-65); and finally the retired generation (65-85). Therefore, the life-cycle of each generation consists of three phases. During the first and second phases, the generation is part of the labour force and during the third phase, each generation is retired and obtains a pension income from the pension scheme in operation. All workers are obliged to participate in the (nation-wide) plan.
It is assumed that the benefit structure is a final-pay defined-benefit scheme with indexation.
The size of the young generation born in period t is L_t, the middle-aged generation born in the previous period t-1 consists of L_{t-1} workers and the retired generation, born in period t-2, numbers L_{t-2} members.

$$L_t = L_{t-1}(1+n_t) = L_{t-2}(1+n_t)(1+n_{t-1}) \tag{6.1}$$

The analysis applies to a small open economy. The world market economy is decisive for the future size and volatility of core economic variables, such as the growth rate of nominal wages, the inflation rate and the capital market rate of return.

6.2.1 Indexed Benefit Obligations

According to the method of Indexed Benefit Obligations, abbreviated as IBO, the liabilities of the plans must be equal periodically to the present value of the future pension benefits, explicitly taking into account the projected increase in wages between now and retirement and also taking into account the projected size of the indexation of pensions during retirement. The size of IBO can be derived as follows[1].

Firstly, it is necessary to know the size of the *actuarial* contribution rate p^{ibo}. Let w_t and w_{t+1} stand for the nominal wage rate in period t and period t+1, m^* for the projected growth rate of nominal wages, r^* for the projected rate of return and x^* for the indexation factor where x^* could be the projected inflation π^* or the projected wage increase m^*. The actual outcomes of x_t, m_t and r_t will differ from their projected values x^*, m^* and r^*.

It is assumed that $uw_{t+1}(1+x^*)$ is the preferred pension income (final-pay defined benefit) of the generation entering the labour force in period t.
The expression of the contribution rate p^{ibo} in the IBO-method can now be solved from the equalisation of paid premiums by generation t, including the projected investment result in t+1 and in t+2, and including the projected benefits this generation will obtain in t+2[2]:

---

[1] An alternative for the IBO-method is the funding method of Projected Indexed Obligations. The liabilities of the pension scheme within this method are equal to the present value of future benefits. The method only takes into account future wage growth between now and retirement. There is no provision for indexation of the pension benefit after retirement.

[2] From the solution of p^{ibo}, the *actuarial rate of return* R^{ibo} can be derived which the IBO-method uses to determine the required premium rate:

$$\left(1+R^{ibo}\right)\left(2+R^{ibo}\right) = \left(\frac{1+r^*}{1+x^*}\right)\left(\frac{1+r^*}{1+m^*}+1\right)$$

Hence, taking into account of future wage growth and inflation, the actuarial rate of return within the IBO-method is a compilation of the anticipated rate of return on

$$
\begin{aligned}
& p^{ibo} w_t (1+r^*)(1+r^*) + p^{ibo} w_{t+1}(1+r^*) = u w_{t+1}(1+x^*) \\
& \Rightarrow \\
& p^{ibo} w_t (1+r^*)(1+r^*) + p^{ibo} w_t (1+m^*)(1+r^*) = u w_t (1+m^*)(1+x^*) \\
& \Rightarrow \\
& p^{ibo} = \frac{u}{\left(\frac{1+r^*}{1+x^*}\right)\left(\frac{1+r^*}{1+m^*}+1\right)}
\end{aligned}
\tag{6.2}
$$

Subject to the IBO-method, the premium reserve at the end of period t, i.e. IBO_t, must be equal to the expression below:

$$IBO_t = p^{ibo} w_t L_t + p^{ibo} w_t L_{t-1} + p^{ibo} w_{t-1} L_{t-1}(1+r^*) \tag{6.3}$$

The *actual* premium q_t^{ibo} will deviate periodically from the actuarial premium p^{ibo} because the actual outcomes of x_t, m_t and r_t usually differ each period from their projected values. The size of this actual premium rate can be derived formally as follows.

At the end of period t, the premium reserve which must be present in the fund should be equal to IBO_t. During the current period, the fund has to pay pension benefits to the generation born in t-2: $u w_{t-1} L_{t-2}(1+x_t)$, reflecting that the pension in period t is related to the final wage earned in period t-1 and that the benefit is subsequently indexed for the actual outcome of x in period t. The fund has two income sources. Firstly, there is the investment income in period t on the premium reserve present at the end of the previous period: $IBO_{t-1}(1+r_t)$. The second income flow is the actual contributions paid by the generations t and t-1 during period t: $q_t^{ibo}(w_t L_t + w_t L_{t-1})$. If there is no actuarial shortage or surplus in the fund at the end of period t, the actual premium rate q_t^{ibo} will be equal to its actuarial rate p^{ibo}. If this is not the case, q_t^{ibo} has to be fixed at a level which guarantees the presence of a premium reserve at the end of period t which is equal to IBO_t.

$$IBO_t = q_t^{ibo}(w_t L_t + w_t L_{t-1}) - u w_{t-1} L_{t-2}(1+x_t) + IBO_{t-1}(1+r_t) \tag{6.4}$$

---

investment r^*, discounted for expected nominal wage growth m^* and discounted for the expected indexation factor x^*. Compare footnote 14 of chapter 3 for a discussion on the impact of cohort-size of the future young generations on the actuarial rate of return.

Making use of (6.1) and (6.3), (6.4) can be rearranged as:

$$q_t^{ibo} w_t L_t \frac{2+n_t}{1+n_t} = p^{ibo} w_t L_t \frac{2+n_t}{1+n_t} + p^{ibo} w_{t-1} L_{t-1} (r^* - r_t) + \\ + w_{t-1} L_{t-2} \left[u(1+x_t) - p^{ibo} \frac{(2+r^*+m_{t-1})(1+r_t)}{1+m_{t-1}} \right] \tag{6.5}$$

With the help of (6.2), from (6.5) the expression of the actual premium rate can be derived:

$$q_t^{ibo} = p^{ibo} \left[1 + \underbrace{\frac{1}{(1+m_t)(2+n_t)}}_{\text{multiplier}} \times \right.$$

$$\left. \times \left[\underbrace{(r^* - r_t) + \frac{\frac{(1+x_t)}{(1+x^*)} \frac{(2+r^*+m^*)(1+r^*)}{(1+m^*)} - \frac{(2+r^*+m_{t-1})(1+r_t)}{(1+m_{t-1})}}{(1+n_{t-1})}}_{\substack{\text{balance actuarial rate and actual rate of return on premium sum} \\ \text{for pensions of generation t-1 resp. generation t-2}}} \right] \right] \tag{6.6}$$

Several remarks can be made with respect to the expression for the actual contribution rate withinin the IBO financing method.

(1) The first point to note is the *possibility of the deviation* of q_t^{ibo} from p^{ibo}. It is only when the actual outcomes of the economic variables m_t, r_t and x_t differ from their expected values m^*, r^* and x^*, that the actual premium rate q_t^{ibo} in period t will deviate from its actuarial level p^{ibo}. Demographic variables as such do not have influence on the occurrence of imbalances. In the stylized world of the IBO-concept, four causes in which there are differences between expectations of and the realization in economic variables can be distinguished.

a) the difference between the anticipated and actual level of the pension benefit at the beginnig of period t due to a difference between expected and actual final-pay wage level: $uw_{t-2}(1+m^*)$ versus $uw_{t-1} = uw_{t-2}(1+m_{t-1})$;

b) the difference between the expected and realized indexation of the pension benefit, $(1+x^*)$ resp. $(1+x_t)$;
c) the difference between expected and realized rate of return on the investment of the part of the premium reserve which is collected for the payment of pensions in period t, r^* and r_t respectively. The rate of return in period t-1 is not of relevance because any difference between r_{t-1} and r^* would have already been neutralized at the end of period t-1;
d) besides the current pension benefits (a, b, c), the fund can operate a surplus or shortage of the premium reserve intended for the pensions of the current middle-aged generation t-1. The reserve in period t is expected to increase with r^*, but the actual rate r_t may be higher or lower.

(2) The second point to note concerns the *direction of the deviation* of q_t^{ibo} from p^{ibo}. Depending on the values of m_t, r_t and x_t, the actual premium may be higher or lower then the actuarial premium. Hence, income transfers within the IBO funding method are characterized by *two-sisdedness ex ante.*

(3) Thirdly, the *size of the deviation* of q_t^{ibo} from p^{ibo} will be influenced by the size of the wage sum $w_t L_t(2+n_t)/(1+n_t)$. The reason for this is that any imbalance between actual and actuarial premium reserve must be neutralized by the premium sum which the active generations have to pay. Therefore, the larger the wage sum is, the smaller the necessary change in contribution rate has to be. The growth in wage sum is determined by the growth in population (labour force) and the wage increase. This is reflected in (6.6) by the presence of $1/((1+m_t)(2+n_t))$ in the expression. This can be seen as a multiplier which is of influence on the impact on q_t^{ibo} of any difference between expectations and realizations. The smaller m_t and n_t, the larger the 'risk-bearing' multiplier and, therefore, the larger the impact of fund's budget on the actual contribution rate.

6.2.2 Accumulated Benefit Obligations

Subject to the ABO-method, the liabilities of the plan must equalize the obligations of all employees covered by the plan, without accounting for future increases in benefits because of wage growth and indexation promises. Future obligations are discounted at the market rate of return. This method involves additional contributions later on. Any wage and price increase in the future will lead to shortages in the fund wealth, therefore requiring backservice payments to restore fund shortages. The size of the ABO represents the extent of the plan sponsors' liability in the event of the termination of the plan.

As in the previous case, firstly the size of the actuarial contribution rate p^{abo} is determined. Let uw_t stand for the preferred pension income in the third phase of the life cycle of the generation entering the labour market in period t. Wage growth and inflation are ignored. The actuarial contribution rate p^{abo} within the ABO-method can now be determined[3]:

$$\begin{aligned} & p^{abo} w_t (1+r^*)(1+r^*) + p^{abo} w_t (1+r^*) = uw_t \\ & \Rightarrow \\ & p^{abo} = \frac{u}{(1+r^*)(2+r^*)} \end{aligned} \tag{6.7}$$

The premium reserve which must be present in the fund at the end of period t, i.e. ABO_t, must be equal to:

$$ABO_t = p^{abo}(w_t L_t + w_t L_{t-1}) + p^{abo} w_{t-1}(1+m_t) L_{t-1}(1+r^*) \tag{6.8}$$

The expression $p^{abo}(w_t L_t + w_t L_{t-1})$ reflects total premiums paid in period t by the young generation t and the middle-aged generation t-1. $p^{abo} w_{t-1} L_{t-1}$ stands for the premium sum which generation t-1 has already paid in the previous period. Irrespective of the actual rate of return which is earned on the latter, at the end of period t this part of the reserve present in the fund must be a fraction $(1+r^*)$ larger. Moreover, because the wage level has increased in period t by the growth rate m_t, the fund experiences a shortage

[3]As far as one can speak of an actuarial rate of return in this method, then this actuarial rate has to be seen as equal to r^*.

in its funding of the pensions of the middle-aged equal to an amount of $m_t p^{abo} w_{t-1} L_{t-1}(1+r^*)$. This shortage must be compensated by *backloading*.
The actual premium q_t^{abo} is set at a level such that it is guaranteed that at the end of period t, the premium reserve is equal to ABO_t:

$$ABO_t = q_t^{abo}(w_t L_t + w_t L_{t-1}) - uw_{t-1} L_{t-2}(1+x_t) + ABO_{t-1}(1+r_t) \qquad (6.9)$$

where $uw_{t-1} L_{t-2}(1+x_t)$ represents the pensions paid out to the retired generation t-2.
$q_t^{abo}(w_t L_t + w_t L_{t-1})$ stands for the actual premium sum paid in period t.

Making use of (6.1) and (6.8), (6.9) can be rearranged as:

$$\begin{aligned} q_t^{abo} w_t L_t \frac{2+n_t}{1+n_t} = p^{abo} w_t L_t \frac{2+n_t}{1+n_t} + p^{abo} w_{t-1} L_{t-1}\left[(1+m_t)(1+r^*) - (1+r^*)\right] + \\ + w_{t-1} L_{t-2}\left[u(1+x_t) - p^{abo}(1+r^*)(2+r_t)\right] \end{aligned} \qquad (6.10)$$

With the help of (6.7), from (6.10) an expression for q_t^{abo} can be derived:

$$q_t^{abo} = p^{abo}\left[1 + \underbrace{\frac{1}{(1+m_t)(2+n_t)}}_{\text{multiplier}} \times \right.$$

$$\left. \times \left[\underbrace{m_t(1+r^*)}_{\substack{\text{backservice burden} \\ \text{on premium reserve} \\ \text{gen. t-1 due to } m_t}} + \underbrace{(r^* - r_t) + \frac{(2+r^*)(r^* - r_t)}{(1+n_{t-1})}}_{\substack{\text{balance actuarial and actual rate} \\ \text{of return on premium reserve for} \\ \text{gen. t-1 resp. t-2}}} + \underbrace{\frac{(2+r^*)(1+r^*)x_t}{(1+n_{t-1})}}_{\substack{\text{indexation burden in t} \\ \text{on pensions gen. t-2} \\ \text{due to } x_t}} \right] \right] \qquad (6.11)$$

Analogous to the exposition of the IBO-method, the discussion now turns to the possibility, the direction and the size of deviations of the actual contribution rate q_t^{abo} from its actuarial rate p^{abo}.

(1) The *possibility of the deviation* of q_t^{abo} from p^{abo} is very likely.
Any increase in wages leads to back-service payments and, in addition, any indexation of pensions will require an additional contribution. The deviation can either be enlarged or contracted by the investment result on the premium reserve inherited from the previous period.

(2) With respect to the *direction of a deviation,* the expected value of q_t^{abo} will be larger than p^{abo} due to the back-service and the indexation burden.
The *backservice burden* is caused by the pension liabilities of the current middle-aged generation. The actual present wealth which is related to their acquired rights in the previous period t-1 is equal to $p^{abo}w_{t-1}L_{t-1}(1+r_t)$. However in period t, the value of this actuarial premium reserve must be equal to $p^{abo}w_{t-1}L_{t-1}(1+m_t)(1+r^*)$ because in the current period, wages have increased by a growth rate equal to m_t whereas the discounting of future benefits has taken place with the factor r^*. The difference between the actuarial premium reserve and the actual present reserve can be split up into two parts: firstly, the backservice burden related to wage growht and missed investment income: $m_t p^{abo}w_{t-1}L_{t-1}(1+r^*)$; and secondly, the result on the investment of the laid-in premiums in t-1: $p^{abo}w_{t-1}L_{t-1}(r^*-r_t)$..
With respect to the pensions paid out in the current period, additional wealth is needed, firstly to compensate for the shortage in the fund's wealth due to the *indexation burden* $x_t u w_{t-1}L_{t-2}(1+r^*)(2+r^*)$ and, secondly, because of a possible difference in actuarial and actual result on the investment of the premium reserve.
Note that if r_t would be very large while the values of m_t and π_t are around or below their projected values, it might be the case that q_t^{abo} will fall below p^{abo}.

(3) The multiplier $1/(1+m_t)(2+n_t)$ is of importance for the *size of the deviation.*

6.3 The supplementary pension scheme in the Netherlands

6.3.1 Backloading and actuarial fairness

Most final-pay plans in the Netherlands have funding methods which are located somewhere between the two extremes IBO-method and ABO-method. It is common practice in the determination of the contribution rate to either assume that there will be no wage increase in the future or, at best, to assume only limited wage increase based on the development of the average career of the employee (Hilbrand 1990). Because the plans are mainly final-pay defined-benefit schemes, every wage increase will lead to shortages in the fund's wealth. Moreover, the creation of shortages will be enlarged because pensions paid to retirees are usually indexed for inflation or even for real wage increase. As will be demonstrated, these shortages need not necessarily be absorbed by extra payment obligations. Future obligations taken at their present value, are discounted at an actuarial rate of return of only 4%, the so-called 'rekenrente'[4]. Since the sixties, the actual rate of return has been much higher than 4%. The resulting surplus in investment income is used to fund the shortage in the pension scheme due to backservice and indexation obligations. As will be shown from calculations based on realistic projections for economic variables, however, the surplus in investment income falls short of the fund's shortage. Additional premium contributions are therefore necessary. This implies that the actual supplementary premium rate must be increased in order to balance the fund. If no change in the structure of the scheme occurs and all economic variables are equal to their projected values, all generations of workers are obliged to pay this high supplementary premium rate. Hence, the funding method used in the Dutch supplementary scheme may be characterized as *actuarial fair*, i.e. the participants can expect equality ex ante between the present value of paid premiums and the present value of benefits to be received at retirement.

However, projections of the future costs of the supplementary pension scheme indicate a steep increase in pension outlays and in contributions to be paid by future workers. Furthermore, it can be foreseen that income transfers in the future will be one-sided only: from the future sponsors to the future retirees. The increase in contributions is often attributed to the process of aging. Two reasons for this are usually put forward.

The first is the shifting of a part of the finance burden of the public scheme to the supplementary scheme. This will be reflected in an increase in the finance burden of the supplementary scheme and, hence, into a rise in the

[4]For a discussion on function and the size of the 'rekenrente', compare Vermaat 1988.

actual contribution rate of the supplementary scheme. The discussion to this issue will return as the central theme in chapter 7.
A second reason why aging might lead to an increase in the supplementary premium rate has to do with the phenomenon of backloading. As has been said, it is common practice in the determination of the actuarial contribution rate to either act as if there will be no wage increase in the future or, at best, to assume only a limited wage increase based on the development of the average career of the employee. This practice implies that the actuarial rate of return is set at a level which is too low. Because the plans are mainly final-pay plans with inflation-indexed benefits, every wage and price increase will lead to shortages in the fund's wealth. Extra contributions in addition to the actuarial premium sum are therefore necessary. The 'greyer' the labour force is, the larger these backservice payments per worker will be. This is so because the burden of the backservice will increase with the relative growth in accumulated pension claims vis-à-vis the wage sum while on average less years per worker remain to build up reserves for the additional pension claims. Therefore, the older the labour force is, the more backservice payments there will be and the more this will lead to a rise in the actual contribution rate. The premium rate is age-independent ('doorsneepremie'). Consequently, young workers will contribute more than they need actuarially for their own pension entitlements. The calculations in this section indeed suggest that the aging of the labour force leads to an increase in backservice payments per worker. However, the quantitative impact of the demographic factor on the actual contribution rate is very modest compared with the impact of fluctuations in the other determinants: growth of wages, inflation rate and the rate of return on investment.

6.3.2 Calculations

The derived expressions relating to the actual and actuarial contribution rate of the ABO-method can be applied. However, the variable r^* (the projected rate of return) must be substituted for R^n, which stands for the actuarial rate of return ('rekenrente') used in the Dutch supplementary plans.

In the exposition below, the superscript n denotes the Netherlands. Hence, the actual and actuarial contribution rate are denoted as q^n and p^n respectively. It is assumed that the benefits are inflation-indexed only.

Table 6.1 reports projections of demographic developments, the nominal growth in wages, the inflation rate and the capital market rate of return on an annual basis as well as for a period of 20-years. These projections were taken from a recent CPB-study on the Dutch economy in the long run (CPB 1992). The fall in the growth rate of the labour force from 1% in period t-1 to 0.5% in period t reflects the anticipated decline in the fertility rate. In line with the practice within the Dutch scheme, the actuarial rate of return R^n ('rekenrente') is fixed at the level of 4%.
A problem arises with respect to the determination of the size of the supplementary premium rate u^n due to the difficulty in encompassing the policy of the government in the future relating to the benefit level of the public scheme. As set out previously, the (expected) disappearance of the automatic linking of the public pension to wage growth will have far-reaching effects on the size of u^n. For the time being, this problem[5] is bypassed by not assigning a value to u^n. Hence the table presented below concerns the quantitative relationship: q^n / u^n.

Table 6.1: Projections of parameters and premium rates

	in % a year	periodically (20 years)
Projections of parameter values:		
Actuarial rate of return	4%	$1+R^n = 2.1911$
Actual rate of return	7.5%	$1+r_t = 4.2478$
Growth rate of nominal wage	6%	$1+m_t = 3.2071$
Inflation rate	4%	$1+\pi_t = 2.1911$
Growth rate of labour force in t-1	1%	$1+n_{t-1} = 1.2202$
Growth rate of labour force in t	0.5%	$1+n_t = 1.1049$
Premium rates given the projections on parameter values:		
Actuarial premium rate/benefit rate		$p^n / u^n = 0.1430$
Actual premium rate/benefit rate		$q^n / u^n = 0.2325$

[5]This issue will be dealt with as central theme in chapter 7.

The actual contribution rate exceeds the actual rate of return by almost 9%-point in terms of u^n: 23.25% versus 14.30%. This is the case because the investment result is too low compared to the necessary increase in the financial means of the scheme. The actual rate of return is 7.5% annually, whereas the annual growth rate of nominal wages is 6%. Hence, not the assumed 4% ('rekenrente'), but only 1.5% (7.5%-6%) is available for the actuarial growth in pension wealth relating to the pension claims of the middle-aged. Furthermore, inflation is 4%, but only 3.5% (7.5%-4%) is available to pay for the indexation of pension benefits. Consequently, the fund experiences periodically a shortage which will be passed on to the plan's sponsors who must pay additional supplementary contributions.
In table 6.2, the results for q^n / u^n are presented for divergent outcomes with respect to the growth in the labour force, wages, investment income and finally inflation. The third of the five rows is the projected outcome. For each column, only the variable in question deviates from its assumed value in the basic variant. The other variables remain at their projected values.

Table 6.2: Impact on the size of q^n / u^n when the growth rate of the labour force, the rate of return, the growth rate of wages or the inflation rate deviate from their projections

(1) growth rate labour force		(2) growth rate nominal wages		(3) rate of return investment		(4) inflation rate	
year	q^n / u^n	year	q^n / u^n	year	q^n / u^n	year	q^n / u^n
-1.5%	0.2514	4%	0.2060	5.5%	0.3344	2%	0.1469
-0.5	0.2420	5	0.2202	6.5	0.2880	3	0.1858
0.5	0.2325	6	0.2325	7.5	0.2325	4	0.2325
1.5	0.2233	7	0.2427	8.5	0.1664	5	0.2887
2.5	0.2144	8	0.2510	9.5	0.0875	6	0.3559

Variations in the determining factors have a different impact on the actual contribution rate q^n expressed in terms of u^n.
The first column reports the impact of variations in the growth rate of the labour force on q^n / u^n, all other things being equal. As can be read in expression (6.11), the growth rate of the labour force is of importance for the size of the multiplier. An annual decline in the cohort-size of the growth rate of -1.5% over a period of 20 years will lead to a contraction in total labour force. Backservice payments must be met by fewer workers, so the actual contribution rate will rise compared to the basic variant. However the dramatic fall in cohort size (after 20 years the new cohort is only a 0.739 fraction of the middle-aged generation) involves only a rather modest increase in the actual contribution rate. Expressed in terms of q^n / u^n, this is a shift from 23.25% to 25.14%. A relatively high rate of growth in young workers of +2.5% results in a decrease in q^n/u^n to only 21.44%. Hence, a dramatically large difference of 4%-point in the growth rate of the labour force will result in only a 3.7%-point difference in the ratio q^n / u^n.
These calculations suggest that the impact of aging on the actual contribution rate via the backservice multiplier will be rather modest.

The second column shows the impact of divergent growth rates of nominal wages on the magnitude of q^n / u^n, all other things being equal. In comparison to the rate of return on investment (third column) and the inflation rate (fourth column), the effect of variations in the growth rate of wages is rather limited. This can be explained by the joint movement in wage growth and the necessary growth in the premium reserve. When wages go up, underfunding of the plan may result, implying backservice payments. If this is so, the additional contributions can be passed on to a wage sum which has also increased. Hence, the rise in the contribution rate because of backservice obligations is mitigated in this case. When wages grow slowly, the actuarial increase in the premium reserve is moderate in nature. In the case of overfunding, the plan will cause a decrease in the actual contribution rate. If intergenerational risk-sharing is present, the workers are compensated in this situation for a low wage income. One may conclude that the funding practice of the Dutch supplementary scheme mitigate the impact of swings in *gross* wages on the disposable income of workers.

As the third and fourth columns show, fluctuations in the rate of return and the inflation rate have a very sizeable impact on q^n/u^n, more specifically when this is compared to the quite restricted effects of variations in wage growth. A low actual rate of return is mirrored by a high actual contribution rate because of the resulting funding shortage, and vice versa. High inflation

rates entail large backservice payments and consequently a large increase in contribution rates. When inflation is low and the other relevant variables are equal to their basic variant level, the fund will realise a surplus which will be reflected in a fall in the contribution rate below its actuarial level.

The analysis above is not comprehensive in nature. It can only give an initial and rough impression of the effects of variations in the determining factors on the outcome of the actual contribution rate. However, the results in table 6.2 are not contradicted by large-scale calculations which are based on models constructed to assess future developments in the Dutch economy in a fully-specified macroeconomic setting, such as in the studies of Bikker (1992), Bolhuis & Vossers (1986, 1990), Huijser (1990) and WRR (1993). These models are appropriate for describing other effects of changes in the determining factors for the contribution rate. For example, a lower or higher growth rate of the labour force will have its effects on the labour market and, therefore, on the growth rate of wages and inflation and, in turn, on the contribution rate. In the partial analysis presented here, a rise in the inflation rate only effects the indexation burden of pensions. However, if wages are indexed for inflation, the growth rate of wages is, in some way, correlated with the inflation rate, so that a relatively high or low indexation burden can also be passed on to a relatively high or low nominal wage sum.

6.4 Evaluation

Chapter 3 analyzed the welfare aspects of a funded defined-benefit plan based on collective risk-bearing. This chapter has been concerned with the question of how such a plan may function in reality. More specifically, the supplementary pension scheme currently operating in the Netherlands has been the theme of discussion. This scheme is mainly organized as a funded defined-benefit scheme. The benefit structure is usually a final-pay plan with inflation-indexed benefits. The chapter has presented a relatively simple setting with three generations. The essential institutional characteristics of the Dutch supplementary scheme can be represented within this setting. Primarily, the funding method of the scheme and the impact of fluctuations in insured risks on the actual premium rate have been the central focus.

With respect to the funding method, it is typical practice with respect to the determination of the contribution rate to either assume that there will be no wage inflation in the future or, at best, to assume simply a limited

wage increase, based on the development of the average career of employees. Obligations are discounted using an actuarial rate of return of only 4%, the so-called 'rekenrente'. The actual rate of return is usually much higher than 4%. The resulting surplus in investment income is used to fund the shortage in the pension scheme due to backservice and indexation obligations because of wage and price inflation. As the surplus in investment income falls short of the fund's shortage, additional premium contributions are necessary. This implies that the actual supplementary premium rate must be raised in order to balance the fund. If no changes in the institutional structure of the scheme will take place, on expecation all generations will have to pay the same high actual premium rate. From an ex ante point of view, for all generations one may anticipate the same relationship between premiums paid and benefits to be received. The scheme can be qualified as being actuarially fair to its participants, despite the phenomenon of backloading, which introduces a pay-as-you-go element into the financing method.

Risk-bearing is related to demographic risk and three economic risks: inflation rate risk, rate of return risk and wage growth risk.

The demographic factor displays a restricted influence, despite the phenomenon of backloading. The calculations carried out suggest that the foreseeable aging of the labour force will indeed lead to an increase in the so-called backservice multiplier. However, the quantitative impact on the actual contribution rate is rather modest. It is concluded from this chapter that the process of aging in the coming decades *as such* will have little significance for the financing of supplementary pensions.

Fluctuations in the rate of return and the inflation rate have a very sizeable impact on the actual premium rate. The effect of fluctuations in the growth rate of wages is rather limited, which has been explained by the negative correlationship between wage growth and the funding position.

7 Aging, reform and welfare

7.1 Introduction

The previous chapter has studied the funding method of the Dutch supplementary pension. It has been argued that the funding method used *as such* implies actuarial fairness ex ante for the participants. Wage-path risk, investment risk and inflation risk can be diversified across overlapping cohorts of workers. Furthermore, it has turned out that the impact of the process of aging on the supplementary scheme as such will be quite modest. Aging indeed will lead to an increase in the size of the (backservice) multiplier. The latter is decisive for the degree to which the actual premium rate deviates from the actuarial premium rate in case of a shortage or surplus in the pension fund.

Because of the process of aging in the coming decades, the Dutch *public* pension scheme will be confronted with rising contribution rates and intergenerational income redistribution to the disadvantage of future generations. This is well-known and is well-documented in several analyses (Bikker 1992, Bolhuis & Vossers 1986 1990, Bovenberg et al. 1993, Broer et al. 1993, Huijser 1990, Nelissen & Verbon 1993, Nelissen 1994, WRR 1993). In order to maintain the support of future young generations, a change in the public scheme currently in operation may be necessary. At the present time, a public debate is in progress as to what set of measures would be preferable to control the future outlays of the public pension scheme. A lasting consensus has not been reached yet (mid-nineties). The outcome of this debate is however of great importance for the supplementary pension scheme because of its final-pay plan structure. It is very likely that an important element of change will be the incomplete indexation of the public benefit level for growth in wages. Because the Dutch pension system is an integrated system, comprising the public and the supplementary pension scheme, this will imply a partial shift in the finance burden of aging associated with the

public pension scheme to the supplementary scheme. One-sided income transfers via the supplementary scheme from future workers to current workers / future retirees will occur. The supplementary scheme is therefore no longer actuarially fair ex ante for future participants. They will have to pay more premiums than they will receive as benefits at retirement.

This chapter deals with the issue of whether there is also a need for reform of the supplementary scheme. A reform option aimed at reducing intergenerational transfers may lead to a change in the life-time income of the generations involved. In general, future generations will face an improvement in life-time income with regard to the non-reform scenario. However, the implementation of a reform option will also imply a change in the composition of the portfolio of retirement provisions. The relative share of insured income provided by the pension scheme will fall. To the extent that the representative individual compensates the fall in pension income by increasing his individual retirement savings, an increase in risk-exposure must be faced. The *main conclusion* of this chapter is that a continuation of the current structure may be more preferable to future generations than reform. A crucial issue is the trade-off between the gain in utility attached by future generations to the increase in life-time income and the fall in utility because of the loss of retirement income insurance. The net effect on utility depends on the degree of risk-aversion and the magnitude of the exposure to risk. The more risk-averse the representative individual is and the higher his exposure to standard-of-living risk, the more likely it is he will prefer maintaining the status-quo to reform.

The structure of the chapter is as follows. Section 7.2 discusses the need for reform of the supplementary scheme in more detail. In section 7.3, a simulation model is developed in which a pension system is represented with institutional characteristics of the Dutch pension scheme. The objective of the simulation is to study the effects of aging and the indexation policy of the public pension on the development of the future contribution rate of the supplementary scheme, the future backservice burden and the associated income transfers from (future) sponsors to retirees with existing pension rights.
Finally, the discussion turns to three proposals for the reform of the supplementary scheme: the introduction of the so-called AOW-independent franchise, incomplete indexation of the supplementary benefit rate, and the implementation of a defined-contribution plan. The latter reform option is also studied in combination with the simultaneous issuance of wage-index bonds and price-index bonds as proposed in chapter 4. The reform options

share the objective to make the supplementary pension scheme independent of the public scheme. The options are evaluated according to the trade-off in welfare terms between insurance and life-time income.

7.2 Reform and welfare

7.2.1 Backservice

The accumulated pension rights within the supplementary scheme organized as a final-pay plan provide the prospect of a total pension income which is related to a maximum of 70% of final-pay when the retiree has a full record of 40 years of pensionable service. The supplementary pension income is equal to the difference between the total pension income and a so-called franchise which is linked to the public benefit (aow). The purchasing power of the public benefit is aimed to be guaranteed by annual indexation of the benefit to wages in industry. During the eighties, the automatic-linking mechanism was inoperative for several years because of cuts in social security. It is to be expected that in the coming decades the indexation of the public pension will lag more and more behind the growth in wages and welfare (WRR 1993, Coopers & Lybrand 1994). The (relative) decrease in the public pension benefit also implies a (relative) decline of the franchise. Therefore, the portion of the pension income to be provided by the supplementary scheme necessarily goes up. For the supplementary scheme, this will involve additional funding and an increase in the supplementary premium rate because of the *increase* in backservice payments.
The backservice payments per worker intended to compensate for a fund shortage will be larger, the more 'grey' the labour force is. This is because, for a 'grey' labour force, the accumulated pension claims in the pension fund are relatively large vis-à-vis the wage sum, so any increase in the supplementary benefit rate will lead to a relatively large shortage in the fund[1].. Moreover, for a labour force which is on average old, relatively few years remain to build up the additional premium reserve. Therefore, the more 'grey' the labour force is, the more backservice payments per worker there will be and the more this will lead to a rise in the *actual* premium rate

As the premium rate is age-independent ('doorsneepremie'), young workers have to contribute more than they need actuarially for their own pension

[1] According to a study of Coopers & Lybrand (1994), a once-and-for-all decline in the public benefit to the wage rate of 1% would imply a rise in the premium burden of 14%, and a decline of 2% would lead to a rise in burden of 26%.

entitlements. This means that, in the coming decades, it is foreseeable that one-sided income transfers from future workers to future retirees / current workers will occur via the supplementary scheme.
Reform may therefore be necessary.

As has been seen in the preceding chapter, the scheme in operation already contains backservice payments, implying that the acual premium rate is in excess of the actuarial premium rate. However, it has been stated that if no changes are made to the institutional set-up of the scheme, all generations will have to pay this high actual premium rate because of the backservice payments included. As such, the scheme can be qualified as being actuarially fair to its participants, despite the phenomenon of backloading. However, the backservice burden implies that a pay-as-you-go element is introduced into the financing of the scheme. Hence, even if the current sponsors (workers and/or shareholders) were to prefer to abandon the final-pay plan altogether, contributions would still have to be paid to the scheme because of backservice payments which are related to the existing pension rights acquired by workers before the scheme had been terminated. These existing pension rights are protected by legal rules and can be seen as explicit contracts which have to be fulfilled. This issue will be dealt with further in section 7.5.

7.2.2 Trade-off between life-time income and insurance

It has been argued in chapter 3 that the structure of an intergenerational insurance contract has to be actuarially fair ex ante for all participating generations and should be at least welfare-neutral or even welfare-improving for generations not yet participating. This is realized by the requirement that the expected value of the possible intergenerational transfers involved in the contract is zero (chapter 3, expression 4.1) and that the risk-sharing of the contract should imply a reduction in the volatility of the life-time income of future generations (chapter 3, expression 4.2). However it is always possible that a parameter of the contract which has been viewed as exogenous at the moment at which the conditions of the insurance contract were formulated, changes unexpectedly during the term of the contract. In particular, a shock which has a negative impact on the expected life-time income of future young generations is of importance. Such a shock may imply that the contract no longer is a welfare-improvement to them. This chapter is dealing with the non-anticipated increase in the benefit rate of the supplementary plan currently in operation in the Netherlands. This will

take place from the year 2010 onwards. This increase has not been foreseen at the moment of implementation of the supplementary plan. Funding shortages in the supplementary scheme will occur, implying that the future young generations will be confronted with an income loss. It may be in the interest of the current active generations to accept a reform of the current scheme in order to make the system actuarially less unfair for the future younger generation and so to avoid that the intergenerational contract may break down at some moment in the future. However, it is not clear in advance whether a reform option concerning the current structure of the final-pay scheme, which aims to reduce the income redistribution and backservice burden, will indeed contribute to welfare in general for current and future participants. On the one hand, the reduction in income inequality between generations of workers may indeed lead to an increase in life-time income for future young generations. On the other hand, however, the proposals for reform currently circulating usually imply that the benefit level of the pension insurance is reduced. This will lead to a decrease in *insured* retirement income provided by the pension scheme. When the future generations compensate this decrease by saving more during labour time, they will be exposed to (more) standard-of-living risk with respect to retirement wealth. The loss in utility because of the decline in insurance may offset the improvement in utility due to the increase in life-time income.

7.3 Simulation

A simulation model is developed to study firstly, the impact of aging on contribution rates and intergenerational transfers, and secondly, to evaluate some proposals for reform of the supplementary scheme with respect to income redistribution and welfare. A stylized version of the Dutch pension scheme is employed[2]. The analysis is only partial in nature. Attention is paid exclusively to a shift in the population structure because of a once-and-for-all fall in the fertility rate. It is assumed in this chapter that the actuarial rate of return exactly matches the difference between the expected capital market rate of return and the expected growth rate of nominal

[2] In Dekkers (1994), a discussion can be found on simulation models of pension systems abroad (USA, Germany) and of the Dutch (supplemenatary) pension scheme (Bolhuis & Vossers 1986, 1990; Huiser & van Loo 1986, Nelissen 1993, 1994). In particular, the discussion is related to their use of modelling causes of intergenerational income redistribution through defined-benefit plans and assessing the size of these transfers.

wages. The model contains no interdependency between the pension scheme and the functioning of the labour market and the capital market. For a small open economy such as the Netherlands, it is sufficient to assume that gross-wage formation and the rate of interest are both determined by the world market. Furthermore, the labour-force participation rate and the retirement age both are assumed to be constant and there is no cross-border labour mobility.
Two scenarios are distinguished with respect to the indexation policy of the public pension: complete and incomplete indexation of the public benefit for growth in wages. The scenarios are evaluated on their impact on the income transfers within the supplementary scheme between sponsors and retirees.
The division of the income transfers to be paid by the sponsors is problematic because this will depend on the bargaining strength of the (representatives of the) sponsors during wage negotiations and within the board of the pension fund. A recent study (Coopers & Lybrand 1994) assumes that the future backservice burden will be divided amongst the sponsors in the proportions of 2/3 to be paid for by the shareholders and employers, and 1/3 to be paid for by workers. This division is based on what the pension's statutes formally state on this issue. However, as intensively discussed in preceding chapters, it is more plausible that future workers will bear a larger or even the whole part of the future backservice burden. Supplementary pension costs are labour costs. Firms will try to shift any severe and durable increase in supplementary pension costs to the gross wage sum, either directly, by an increase in the premium rate to be levied on gross wages, or indirectly, by lowering other compensation for labour supplied.
For the sake of simplicity and ease of calculation, it is assumed that workers will pay ultimately all backservice obligations. For a certain extent, this assumption may indeed overstress the role of intergenerational income transfers between workers. However, it is not an unusual issue in the literature on the subject (compare Broer et al. 1993, Nelissen & Verbon 1994).

7.3.1 Simulation model

This section sets out the characteristics of the simulation model.

Demographics
It is assumed that three generations are simultaneously involved in the pension system in operation, i.e. the young, the middle-aged and the retired generation. The relevant life-cycle of a generation consists of three phases, each lasting 20 years. During the first and second phases, the generation is

part of the labour force. Generations are retired in their third phase. Workers live without being exposed to the risk of death. Retirees do face a risk of death equal to $1-\lambda$, so their remaining life-time at the beginning of their final phase is expected to be λ*20 years (where $0<\lambda\leq 1$).
Let L_t, L_{t-1} and L_{t-2} stand for, respectively, the size of the young generation, the size of the middle-aged generation and the size of the retired generation, the latter at the beginning of their retirement period. The variable n_i indicates the growth rate of generation L_i in relation to the previous generation L_{i-1}. One can then state that:

$$L_t = (1+n_t)L_{t-1} = (1+n_t)(1+n_{t-1})L_{t-2} \tag{7.1}$$

The average size of the retired generation is $\lambda_t L_{t-2}$, and the average dependency ratio '*dep rat*' is therefore equal to $\lambda_t L_{t-2} / (L_t + L_{t-1})$, which can be rewritten as:

$$dep\ rat = \frac{\lambda_t}{(2+n_t)(1+n_{t-1})} \tag{7.2}$$

Pension scheme

The institutional structure of the pension scheme reflects the characteristics of the Dutch pension system. It is assumed that the total pension income of a retired worker at the start of retirement is a fraction u of final-pay and that during retirement the pension is wage-indexed. The pension benefit stems from two sources: the public scheme and the supplementary scheme.

Public pension scheme

The public pension scheme pays a flat-rate benefit to all retirees. The scheme is financed on a pay-as-you-go basis. In any one period, there is a net-net link between the public benefit level and the wage level. There are no other government outlays besides public pension spending. The net wage is therefore the gross wage w_t minus the premium burden for the public pension per worker $\tau_t w_t$, where τ_t reflects the contribution rate for the public scheme.
The public benefit is abbreviated as '*aow*'. The *aow* in period t (in net-terms) is equal to a constant fraction c of the net-wage $(1-\tau_t)w_t$, so that:

$$aow_t = c(1-\tau_t)w_t \tag{7.3}$$

Note that the net-net link implies a built-in brake. All other things being equal, an increase in the premium rate leads to a fall in the net wage and in turn to a fall in the aow.

The total premium burden is equal to total outlays for the public pension:

$$\tau_t w_t (L_t + L_{t-1}) = aow_t L_{t-2} \lambda_t \tag{7.4}$$

From (7.1), (7.3) and (7.4) one can derive an expression for the contribution rate of the public scheme:

$$\tau_t = \frac{c\lambda_t}{c\lambda_t + (2+n_t)(1+n_{t-1})} \tag{7.5}$$

The contribution rate of the public scheme depends on demographic factors in two respects:
- the life-time of the retired, where $d\tau/d\lambda > 0$
- the relative size of the two working generations, where $d\tau/dn < 0$

Supplementary pension scheme

Total pension benefit at the beginning of retirement in period t is a fraction u of final pay in period t-1. The benefit is wage indexed, so during retirement total pension benefit increases in line with the expected growth rate of the wage level m^* in period t. Total pension benefit is therefore on expectation equal to: $uw_{t-1}(1+m^*) = uw_t$.

The supplementary pension per retired worker is determined by the difference between the total pension promise and the public pension:

$$u_t^S w_t = uw_t - aow_t \tag{7.6}$$

Making use of the expression aow_t in equation (7.4), one can derive an expression for the size of the benefit rate in the case of the supplementary scheme u_t^S in period t:

$$u_t^S = u - c(1-\tau_t) \tag{7.7}$$

The supplementary scheme is based on funding. Two contribution rates are of relevance: the actuarial and the actual contribution rate.
The *actuarial* premium rate is equal to the discounted value of the pension entitlement promised. Premiums paid during labour time are equal to the present value of the supplementary benefits which the retired worker will obtain during his old-age. According to Dutch practice, fund managers take future obligations at their nominal value and discount them by the actuarial rate of return R. Fund managers also expect the current values of other relevant variables for the determination of the size of the actuarial premium rate to be maintained indefinitely in the future. Such variables are the size of the supplementary benefit rate u_t^s and the life expectancy λ_t.
The actuarial premium rate p_t^s can be solved from:

$$p_t^s w_t(1+R)(1+R) + p_t^s w_t(1+R) = u_t^s w_t \lambda_t \tag{7.8}$$

This produces the result:

$$p_t^s = \frac{u_t^s \lambda_t}{(2+R)(1+R)} \tag{7.9}$$

It is assumed that the actuarial rate of return R is set at a level which guarantees the condition stated in the equation below:

$$(1+r^*) = (1+R)\ (1+m^*) \tag{7.10}$$

where r^* stands for the expected capital market rate of return and m^* represents the expected nominal growth rate of wages.
It should be observed that this condition reflects the IBO-method of funding. Hence the phenomenon of built-in backloading is ruled out. The expected rate of return on the investment of the premium sum is $(1+r^*)$. This is used firstly for the backservice payment supplementing the shortage in the accumulated premium reserve because of the wage growth $(1+m^*)$. The remainder of the investment income is equal to the projected increase in the investment $(1+R)$. The motivation of the use of the IBO-method is primarily that it faciliates the calculations for the simulation as well as the interpretation of the simulation results. The 'price' of this simplification is that the consequences of the process of aging for the increase in contribution rate and the size of intergenerational income redistribution are underestimated.

The *actual* premium rate of the supplementary scheme q_t^s is equal to the actuarial premium rate plus or minus the income transfer between the pension fund and the workers necessary for balancing the fund. For the determination of q_t^s, the same procedure has been applied as in the previous chapter.

$$\underset{\text{premiumreserve at the end of period t}}{p_t^s w_t(L_t + L_{t-1}) + p_t^s w_{t-1}(1+r^*)L_{t-1}} = \underset{\text{actual premium sum paid}}{+ \; q_t^s w_t(L_t + L_{t-1})} - \underset{\text{pension benefits}}{u_t^s w_t L_{t-2}\lambda_t}$$

(7.11)

$$+ \; \underset{\text{premiumreserve at the end of period t - 1 plus investment income}}{p_{t-1}^s\left[w_{t-1}(L_{t-1} + L_{t-2}) + w_{t-2}L_{t-2}(1+r^*)\right](1+r^*)}$$

The premium reserve at the end of period t must be equal to the present value of the future obligations to the current generations of workers in period t. In the current period, the fund must pay pension benefits to the generation which entered the labour force in t-2. These obligations are equal to $\lambda_t u^s w_{t-1} L_{t-2}(1+m_t)$, where the benefit is related to the final wage earned in period t-1 and, during period t, this benefit is indexed for the growth rate of wages during period t.
The fund has two income sources. Firstly, there is the investment income in period t from the premium reserve present at the end of the previous period. The second income flow is the actual contributions paid by the generations t and t-1 during period t. When there is no actuarial shortage or surplus in the fund, the actual premium rate q_t^s will be equal to its actuarial rate p_t^s. If the fund does not realize an actuarial balance, the actual contribution rate will differ from its actuarial level. It will be fixed at a level which guarantees the presence of the required premium reserve at the end of period t.
From (7.11) and with the help of (7.9) and (7.10), one can derive an expression for the actual contribution rate of the supplementary scheme:

$$q_t^s = p_t^s + \left(p_t^s - p_{t-1}^s\right)\left(\frac{1+R}{2+n_{t-1}}\right) + \left(\frac{u_t^s\lambda_t - p_{t-1}^s(1+R)(2+R)}{(2+n_t)(1+n_{t-1})}\right) \qquad (7.12)$$

which can also be written with help of (7.9) as:

$$q_t^s = p_t^s + \left(p_t^s - p_{t-1}^s\right)\left(\frac{1+R}{2+n_{t-1}}\right) + \left(p_t^s - p_{t-1}^s\right)\left(\frac{(1+R)(2+R)}{(2+n_t)(1+n_{t-1})}\right) \qquad (7.12')$$

Note that the impact of demographics is restricted. The size of n_t only has impact on the magnitude of the deviation of q_t^s from p_t^s when p_t^s deviates from p_{t-1}^s. This will be the case when the level of u_t^s is higher or lower than its level in the previous period.

Total premium rate

The total premium rate to be actually paid, Θ, is the sum of the pubic pension premium rate and the supplementary premium rate:

$$\Theta_t = \tau_t + q_t^s \qquad (7.13)$$

Labour mobility

Chapter 2 has discussed the relationship between labour mobility and the sustainability of the defined-benefit plan based on intergenerational risk-sharing. The participation to the Dutch plan may not be optimal ex post for future generations due to sizeable backservice payments associated with the pension claims of the future retirees and older workers. This chapter does not consider the potential disruptive impact of future labour mobility. This is motivated as follows. Three kinds of labour mobility has been distinguished in chapter 2. First of all, this concerns domestic labour mobility between branches of industry because of differences in contribution rates levied by the representative pension funds. It is assumed here that when there is actually a threat that this kind of labour mobility may occur, then the government will intervene. The government will set up a nation-wide pension fund. All pension funds transfer their fund wealth to this new fund. The outstanding pension claims of the participants in these funds are also transferred to the new pension fund. The second kind of mobility is from branches of industry with a defined-benefit plan to firms which offer their employees a defined-contribution plan. The analysis in this chapter points out that participation to a defined-contribution plan will lead to a loss in welfare for future generations as compared with the currently operating defined-benefit plans.

The third kind of mobility is cross-border labour mobility. However, foreign economies also must face problems relating to aging of their population, such as increasing costs of their pension schemes. Furthermore, any comparative advantage of the economies abroad with respect to costs and insurance aspects related to pension schemes have to be compared with factors which can be seen as restrictive to international labour mobility, such as differences in languages and cultural background, family ties and so on. It is assumed that the impact of the restrictive factors on cross-border mobility outweighs the impact of international differences in costs and benefits of national pension schemes.

Impact of participation in a pension scheme on life-time income

Finally, a solution is provided for the impact on life-time income of the compulsory participation in the public and supplementary scheme.
For reasons of comparison, the components of life-time income of a generation are expressed in present value terms for the period in which workers entered the labour market. Wealth can be shifted forwards or backwards in time by appropriate transactions on the capital market. Therefore, the expected capital market rate of return r^* is used as the discount rate.

Let y_t stand for the life-time income of an individual belonging to a generation which enters the labour force in t.
If there were *no pension scheme at all,* the expected life-time income of an individual belonging to generation t would be equal to the present value of the wage income earned in the first and the second phases of the life cycle

$$y_t = w_t + w_{t+1}/(1+r^*) \tag{7.14}$$

The variable Δy_t is defined as the net-effect of participation in the pension scheme on the life-time income of an individual belonging to generation t. The size of the net-effect is simply the difference between the present value of pension income received and the present value of the premium sum actually paid:

$$\Delta y_t = u\lambda_{t+2}w_{t+2}/(1+r^*)^2 - \Theta_{t+1}w_{t+1}/(1+r^*) - \Theta_t w_t \tag{7.15}$$

Dividing (7.15) by (7.14), produces an expression for the relative increase or decrease in life time income of the individuals involved due to compulsory participation in the pension scheme. In doing this and making use of

$(1+r^*)=(1+m^*)(1+R)$, the following expression results for the *relative change in life time income*:

$$\frac{\Delta y_t}{y_t} = \frac{u\ \lambda_{t+2}/(1+R)^2 - \Theta_{t+1}/(1+R) - \Theta_t}{1+1/(1+R)} \tag{7.16}$$

This can be broken down into the relative change in life time income caused by firstly the public and secondly the supplementary scheme. The relative change in life-time income as a result of participation in the public scheme can be expressed as:

$$\frac{\Delta y_t^{\text{public}}}{y_t} = \frac{c(1-\tau_{t+2})\lambda_{t+2}/(1+R)^2 - \tau_{t+1}/(1+R) - \tau_t}{1+1/(1+R)} \tag{7.16'}$$

where $c(1-\tau_{t+2})/(1+R)^2$ is rewritten from $(aow_{t+2}/w_{t+2})/(1+r^*)^2$ (compare expression 7.3).
In the case of the supplementary scheme the result is:

$$\frac{\Delta y_t^{\text{sup}}}{y_t} = \frac{u_{t+2}^s \lambda_{t+2}/(1+R)^2 - q_{t+1}^s/(1+R) - q_t^s}{1+1/(1+R)} \tag{7.16''}$$

Objective representative worker

It is assumed that the representative worker entering the labour market in t aims to accumulate a retirement wealth z_{t+2} equal to *70%* of the wage level prevailing in period t+2:

$$z_{t+2} = 0.7 w_{t+2} \tag{7.17}$$

In order to exclude period-dependency in the simulation model, the present value of this target income $z_{t+2}/(1+r^*)^2$ is expressed as a fraction of life-time income y_t. This delivers:

$$\frac{z_{t+2}/(1+r^*)^2}{y_t} = \frac{0.7}{(1+R)(2+R)} = \bar{x} \tag{7.18}$$

Hence, the representative worker aims to accumulate a pension wealth in present value terms equal to a constant fraction of $\bar{x}$ of his life-time income. This target is achieved by way of a portfolio consisting firstly of claims on pensions from the public and the supplementary scheme, and secondly of individual savings. For the case when there is no pension scheme operative, the term $\bar{x}$ can be seen as the fraction of life-time income allocated to individual pension savings, i.e. $\bar{x} = [sw_t + sw_{t+1}/(1+r^*)]/y_t = s$ with s reflecting the individual pension saving rate.

The total benefit rate u reflects total pension claims expressed in life-time income terms. Hence individual retirement savings during life-time are equal to a fraction [0.7- u] of y_t.

The pension income is a fraction u of final pay. During retirement the pension benefit is wage-indexed. A generation which enters the labour market in period t will receive a pension equal to $uw_{t+1}(1+m_{t+2}) = uw_{t+2}$. The variable k is defined in this chapter as the fraction of retirement wealth which is provided by the pension scheme:

$$k = uw_{t+2}/0.7w_{t+2} = u/0.7 \tag{7.19}$$

Hence, $(1-k)$ is the fraction of the target retirement wealth which has to be achieved through individual savings. Therefore, $(1-k)$ equals $[0.7-u]/0.7$

Investment results on the individual savings are uncertain. So the individual will be exposed to standard-of-living risk, i.e. the risk that actual wealth may differ from the wealth targeted $\bar{x}$. Let us define σ_x^2 as the risk (variance) that the actual total result of individual retirement wealth will deviate from its target value $\bar{x}$. It is assumed that σ_x^2 is normally distributed. The portfolio of retirement income provisions is evaluated with respect to expected income and risk. The expected result of this portfolio is indicated as x_k^*. This is the weighted average of the present value of the riskfree pension of the pension scheme expressed in terms of y_t: $\frac{uw_{t+2}/(1+r^*)^2}{y_t}$ which can be rewritten as $k\bar{x}$, plus the present value of the expected outcome of individual savings expressed in terms of y_t: $\frac{(1-k)z_{t+2}^*/(1+r^*)^2}{y_t}$, which is denoted as $(1-k)\bar{x}^*$. Therefore,

$$x_k^* = k\bar{x} + (1-k)\bar{x}^* \tag{7.20}$$

The individual evaluates the portfolio according to the exponential utility function introduced in chapter 3. The expected utility of the portfolio x_k is equal to:

$$E[u(x_k)] = A - e^{-\alpha\left[x_k^* + \frac{\Delta y}{y} - \alpha(1-k)\sigma_x^2/2\right]} \tag{7.21}$$

where the variable α stands for the degree of risk-aversion and A is a constant.

When the pension scheme is actuarially fair ex ante to a generation, the expected value of $\Delta y/y$ is zero. A positive result of $\Delta y/y$ will increase generation's expected utility, whereas utility declines in the case of a negative outcome.

The term $\alpha(1-k)\sigma_x^2/2$ reflects the impact of risk-exposure on expected utility. Note that expected utility is lower, the larger the magnitude of risk σ_x^2, the higher the fraction of risky individual investments (1-k) and the higher the degree of risk-aversion α are.

7.3.2 Demographic shock

A once-and-for-all drop in the fertility rate is analyzed as shock. This will result firstly in a smaller cohort of children. The period following the fall in the fertility rate will be subjected to a smaller new generation of workers.

It is assumed that the fertility rate will decline in period t-1, so that the growth rate of the new generation entering the labour market in period t is smaller than the growth rate of the former new generation in period t-1: $n_t < n_{t-1}$. Furthermore, it is assumed that the rate will fall to a level which implies a shift from a growing population to a stationary population, $n_{t+1}=0$. This implies that the new generation in period t+1 and the succeeding generations are equal in size to that of the previous generation: $L_t=L_{t+1}=L_{t+2}\cdots$

Projections (WRR 1993, CPB 1993) indicate that from the year 2010 onwards, the dependency rate will increase to reach a peak around 2035 after which it will decline. Taking one period as a unit of 20 years, the analysis can be linked to reality as follows. Period t encloses the years between 2010 and 2030. Therefore, period t-1 consists of the years between 1990 and 2010, and period t+1 the years from 2030 to 2050.

period t-2 = 1970-1990	period t+1 = 2030-2050
period t-1 = 1990-2010	period t+2 = 2050-2070
period t = 2010-2030	and so on

The institutional structure of the scheme entails a total pension income of 70% of the gross wage for a full record of forty years of pensionable service, i.e. u = 0.7. In the initial steady state, the public benefit amounts to 40% of gross wage and supplementary pension to 30% of the gross wage, so that the start value of aow/w is 0.4 and the start value of u^s is equal to 0.3.
The premium rate for the public pension τ and the linking factor c for the initial steady state can be solved with the help of equation (7.5) and (7.3). This gives: τ = 6.05% and c = 0.4278. Only one economic variable has to be specified. This is the size of the actuarial rate R. It is set at an annual level of 2% (reflecting an assumed difference between the capital market of return and nominal growth rate of wages of 2%). Anticipated life-expectancy of the elderly equals 12 years, so λ_t is 0.6.
Table 7.1 summarizes the parameter values.

Table 7.1: Parameter values simulation

Parameter	Value	
Initial steady state		
$n_{t-1}=n_{t-2}=...$	+ 0.4859	(+0.02 annually)
u	0.7	
aow/w	0.4	
u^s	0.3	
c	0.4278	
R	0.4859	(+0.02 annually)
λ_t	0.6	
Demographic shock		
n_t	- 0.4859	(-0.02 annually)
$n_{t+1}=n_{t+2}=...$	0	(0.0 annually)

Besides the fall in the fertility rate in period t-1, no changes in (the mean and standard deviation of) any other variable are foreseen. Therefore, the generations alive in period t-1 are able to project the expected time paths of the relevant variables of the pension schemes during the adjustment process from the initial steady state to the new steady state.

7.4 Indexation of the public benefit and intergenerational transfers

The supplementary pension scheme *as such* is not subject to changes in the demographic structure. The ratio of retirees to workers is of importance when there is a fund shortage or a fund surplus because of differences between actual and expected results of economic variables.
However, the process of aging does have an impact on the supplementary scheme because it constitutes an integrated structure with the public scheme.
Two policy options will be considered with respect to the indexation of the public benefit for growth in wages: complete and incomplete indexation.
The appendix presents a more detailed comment on the characteristics of both the old and the new steady state and the adjustment process. At this point, a short comment will be provided on the impact of aging on the net-effect of participation in the supplementary scheme on life-time income, i.e. on $\Delta y^{sup}/y$.

Complete indexation
Aging leads to an increase in the public premium rate, which has a negative impact on the net-wage. Due to the net-net link between the level of the *aow* and the net-wage rate (compare expression 7.3), the ratio *aow/w* decreases. The Dutch pension system is an integrated system of the public and supplementary scheme. A relative decline in *aow/w* must be neutralized by an increase in the supplementary benefit rate u^s. This gives rise to backservice payments. Hence, one or more generations have to pay an actual supplementary premium q^s which is above the actuarial premium rate. This implies that, even in a scenario involving complete indexation of the public benefit, the supplementary pension scheme is affected by aging, due to its complementarity with the public scheme.
Section A.7.1 of the appendix presents a detailed treatment of this scenario.

Incomplete indexation
The policy of incomplete indexation is implemented by a reduction in the public benefit rate of 1% annually during period t-1 and period t. This policy is an extension of the indexation policy which the Dutch government actually pursued during the eighties and the first half of the nineties.
Incomplete indexation implies a fall in *aow/w* which is reflected in a decrease in the public premium rate. The supplementary benefit rate rises in order to compensate for the fall in *aow/w*. Hence, p^s must also increase. In addition, q^s rises firstly because of the increase in p^s and secondly because of the underfunding which results from the non-anticipated increase in u^s.

Nevertheless the net-effect on $\Delta y^{sup}/y$ is mitigated because the positive effect of u^s in fact outweighs the negative impact of the increase in q^s. This moderated impact is also reflected in figure 7.1, which presents the time paths of $\Delta y^{sup}/y$ for the complete and incomplete indexation variants. The time paths display more or less the same pattern.
Section A.7.2 of the appendix provides detailed comment on this scenario.

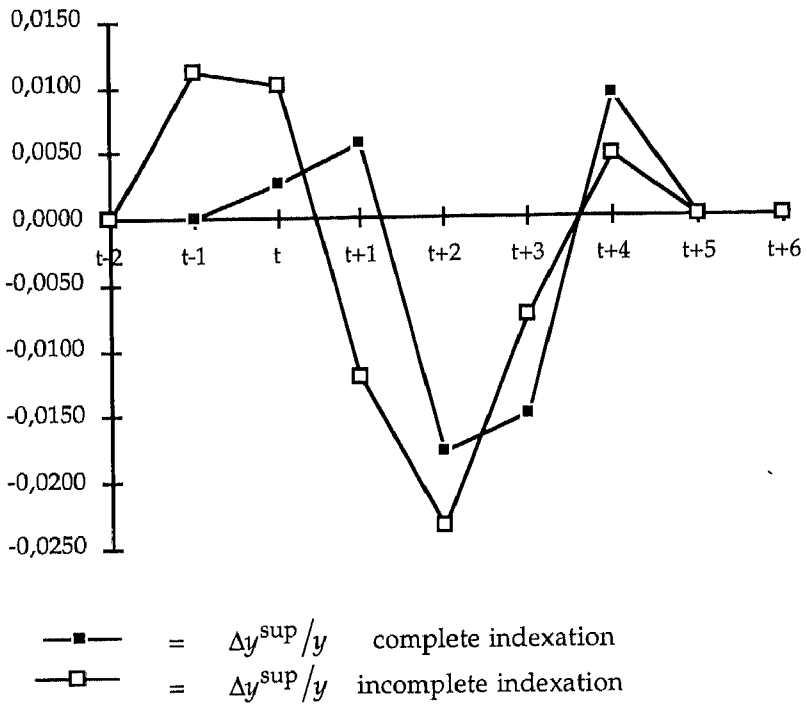

Figure 7.1: Time paths of $\Delta y^{sup}/y$ with complete and incomplete indexation variants for the public scheme

7.5 Reform proposals for the supplementary scheme

The current arrangement of the supplementary scheme will lead to a rise in the actual contribution rate and to intergenerational income redistribution. At present, several proposals are circulating in the discussion on the reform of the supplementary pension scheme. Three of these proposals[3] are worth examining here, as they will be capable of preventing an increase in the backservice burden caused by the relative decline in the *aow* with respect to the wage rate. Firstly, the essence of these reform proposals is presented. The first proposal concerns the introduction of an AOW-independent franchise (7.5.1), the second is the incomplete indexation of the supplementary benefit in a manner analogous to the case of the public benefit (7.5.2), and the third is the introduction of the defined-contribution plan (7.5.3). The discussion proceeds with the evaluation (7.6) of these proposals with respect to the welfare aspects of reducing the backservice burden, income redistribution and the welfare trade-off between changes in life-time income and insurance.

First of all, there is the question of whether it is possible to change supplementary pension rights at all? The relevant issue to be dealt with in this respect is which pension rights are susceptible for a change. The pension claims which one can distinguish are:
1. pension claims of current retirees;
2. pension claims of former but not yet retired workers;
3. pension claims of active workers;
4. new pension claims of active workers to be acquired in the future.

The *existing* pension rights (1, 2 and 3) with respect to the size of the pension income at the beginning of the retirement period have to be fulfilled (unless the individual employee agrees to the deterioration of his claims). The indexation of these pensions during retirement is conditional on the financial position of the pension fund. This may motivate the board of the pension fund to moderate the periodic indexation (for example an incomplete indexation for the wage rate or inflation rate). This can be one way of

[3] A frequently discussed proposal is also the substitution of the final-pay plan for an *average wage plan*. The total pension claim will then be based on average earned (indexed) wages. As a result, backloading requirements are reduced in comparison to a final-pay plan. The impact of the relative decrease in the public benefit on the backservice burden is, however, still present. Therefore, this variant will not be examined here.

shifting a part of the problem of financing the future backservice burden relating to the future retirees themselves.
Legal rules allow for pension statutes to be changed, so that *new* supplementary pension rights (4) can be built up within a new framework (Lutjens 1989, van Huizen & de Lange 1994).

7.5.1 AOW-independent franchise

At the point of introduction, the AOW-independent franchise is set at a level equal to that of the franchise in operation. After implementation, the new franchise must be indexed for the nominal growth rate of a reference wage rate, for example the average wage rate prevailing in the branch of industry or the firm which the pension fund represents. Hence, a relative decline of the *aow* compared with the (reference) wage rate has no further impact on the funding requirements of the new pension rights built up after the introduction of the AOW-independent franchise. In this way, actuarial fairness ex ante with respect to these new pension rights can be re-established.
Because of the legal rules concerning existing pension rights, the claims which have already been built-up before the introduction of the new franchise will remain valid. As a consequence, the retirees in the period of introduction receive a supplementary pension according to the old regime, whereas the middle-aged generation from this period now acquires two kinds of supplementary pension rights, i.e. those built up in the previous period under the old regime and those which will be acquired under the new regime. All pension claims of the young are accumulated under the new regime.
The introduction of an AOW-independent franchise implies that the norm of a total pension equal to 70% of final-pay can no longer be promised. If it is assumed that the new franchise is indexed for the growth in wages, as a consequence of this, the new supplementary benefit rate $\overline{u}^s$ remains constant and is equal to the actual supplementary benefit rate prevailing at the moment of introduction.
The expression below denotes the total pension of an individual worker who has entered the labour market in period t and has built up supplementary pension claims under the new regime during the periods t and t+1. The supplementary pension which this individual will receive at the start of his retirement period is an income equal to a constant fraction $\overline{u}^s$ of his final-pay. This benefit is indexed for the growth in wages during the

retirement period in t+2. The variable aow_{t+2} stands for the size of the public benefit in period t+2.

$$total\ pension_{t+2} = aow_{t+2} + \overline{u}^{s} w_{t+1}(1+m_{t+2}) \tag{7.22}$$

In order to obtain an expression for the actual benefit rate of total pension income, $total\ pension_{t+2}$ is rewritten as the expression $u_{t+2}w_{t+1}(1+m_{t+2})$, where u_{t+2} stands for the total benefit rate in relation to the final-pay actually prevailing. The expression (7.22) can be rearranged as (7.23). It is clear that the actual benefit rate for a retired generation in t+2 is equal to the sum of the fixed supplementary benefit rate and the size of the ratio of the public benefit aow to the wage rate during the period of retirement:

$$u_{t+2} = \frac{aow_{t+2}}{w_{t+2}} + \overline{u}^{s} \tag{7.23}$$

7.5.2 Incomplete indexation of the supplementary benefit rate

The foreseeable increase in the backservice burden can also be suppressed when, in the same way as incomplete indexation of the public benefit rate, the supplementary benefit rate does not follow the growth in the wage rate. Existing pension rights according to the extent of the supplementary pension scheme at the beginning of the retirement period must be honoured. The indexation of these pensions during retirement is conditional on the financial position of the pension fund. The non-anticipated drop in the ratio *aow/w* can be used as a motivation for moderating the periodic indexation. It is assumed that a 1% fall in the ratio of the *aow/w* will be followed by a 1% fall in the supplementary benefit rate u^{s}. Hence, the reform must be implemented in period t-1 and period t. This option makes it possible to shift a part of the backservice burden associated with the pensions of the retirees in period t-1 to these retirees themselves. This will contribute to more equality between generations.

7.5.3 Defined-contribution plan

It is assumed that the firm and the individual workers have decided that pension premiums should be paid into a defined-contribution plan. New pension rights within final-pay plans are no longer created. However, as in

the case of the other two options, backservice burden associated with existing pension rights is still present.
Let us assume that the pension fund is liquidated at the moment at which the defined-contribution plan is implemented. The generation retiring in the introduction period receives a supplementary pension according to the old regime. In the previous period, the middle-aged generation has acquired pension rights consisting of final-pay related supplementary pension income. This generation receives the present value of these claims. The size of these claims is based on the franchise prevailing in the period in which the defined-contribution plan is introduced. The proceeds are deposited by the middle-aged workers in their individual defined-contribution plans. A shortage in the balance of the pension fund due to the backservice burden is to be financed by the two working generations in the period of introduction[4].

7.6 Reform: life-time income, insurance and welfare

This section evaluates the proposals for reform presented in the previous section. The evaluation is based on three aspects:
- impact on supplementary premium rate;
- impact on intergenerational income redistribution;
- impact on expected utility.

It is assumed that the implementation of each proposal takes place in period t-1. This assumption reflects the idea that the reforms aim to anticipate the impact of aging.

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[4] The defined-contribution plan is introduced in period t-1. The premium rate to be paid by the workers in period t-1 can be solved from the expression below:

$$q^s_{t-1} w_{t-1}(L_{t-1} + L_{t-2}) = u^s_{t-1}\lambda_{t-1} w_{t-1} L_{t-3} + 0,5 * u^s_{t-1}\lambda_{t-1} w_{t-1} L_{t-2}$$
$$- p^s_{t-2}\left[(1+r^*)w_{t-3}L_{t-3} + w_{t-2}(L_{t-2} + L_{t-3})\right](1+r^*)$$

This expression is derived from equation (7.11). The last term on the right-hand side of equation (7.19) is the premium reserve which is actually present in the pension fund at the end of the period, while the first two terms reflect the pensions to be paid out to the retired generation and, respectively, the value of the claims acquired by the middle-aged generation. The above expression can be rewritten as:

$$q^s_{t-1} = [u^s_{t-1}\lambda_{t-1} - p^s_{t-2}(1+R)(2+R)]/((2+n_{t-1})(1+n_{t-2})) +$$
$$+ [0,5 * u^s_{t-1}\lambda_{t-1} - p^s_{t-2}(1+R)]/(2+n_{t-1})$$

This expression has been used in the calculations.

(1) *supplementary premium rate*

The control of the rise in q^S can be interpreted as a measure of the success of the proposal in preventing an increase in the *backservice burden*. Table 7.2 reports the time paths of the supplementary premium rate for four cases. The first is the case of incomplete indexation of the public benefit rate for the wage growth (compare the appendix). The other three cases are the latter case in combination with one of the three proposals for reform.
As table 7.2 reveals, the introduction of the new franchise in period t-1 and the incomplete indexation of the supplementary benefit rate are successful in achieving a moderation in the increase in the supplementary premium rate q^S.
The introduction of a defined-contribution plan leads to the complete disappearance of supplementary premiums. The presence of the backservice burden in period t-1 in this variant can be explained by the non-anticipated increase in u^S in t-1.
This outcome indeed may provide an incentive for implementing one of the reform options.

Table 7.2: Time paths of the actual supplementary premium rate ($=q^S$)

period	incomplete indexation public benefit	new franchise in t-1	incomplete indexation supplementary benefit	defined-contribution plan
t-2	0.0487	0.0487	0.0487	0.0487
t-1	0.0775	0.0775	0.0560	0.0177
t	0.0980	0.0685	0.0539	-
t+1	0.0884	0.0598	0.0656	-
t+2	0.0630	0.0598	0.0467	-
t+3	0.0707	0.0598	0.0525	-
t+4	0.0707	0.0598	0.0525	-
t+5	0.0707	0.0598	0.0525	-

(2) *Intergenerational income redistribution*

The second aspect of the evaluation concerns the change in intergenerational transfers via the supplementary scheme. This aspect has been chosen to have an idea of the success of the proposal in reducing income redistribution via the scheme in disadvantage of the future generations.
Table 7.3 reports on the time paths of the income transfers in each scenario. The net-income transfer of a generation with the pension fund is equal to zero if the present value of the actual supplementary premium sum paid is equal to the present value of the supplementary benefit actually received during retirement. This will occur in the steady state. The adjustment caused by the process of aging and indexation policy will lead to deviations between premiums paid by a generation and benefit received. These deviations imply intergenerational income redistribution via the supplementary scheme.

Table 7.3: Time paths of net-effect on life-time income of generations as a result of participation in supplementary scheme $(= \Delta y^{sup} / y)$

period	incomplete indexation public benefit	new franchise in t-1	incomplete indexation supplementary benefit	defined-contribution plan
t-2	0.0000	0.0000	0.0000	0.0000
t-1	0.0111	0.0111	0.0028	0.0111
t	0.0100	0.0048	0.0005	-0.0063
t+1	-0.0120	-0.0141	-0.0005	-0.0106
t+2	-0.0234	-0.0052	-0.0061	0.0000
t+3	-0.0074	0.0000	-0.0055	0.0000
t+4	0.0046	0.0000	0.0034	0.0000
t+5	0.0000	0.0000	0.0000	0.0000
standard deviation t-1 to t+4	0.0137	0.0086	0.0037	0.0067

The bottom section of the table denotes the standard deviation of the net-income transfers during period t-1 to period t+4. For the status-quo case, this time span covers the periods during which one or more of the generations has a net-income transfer with the pension fund which deviates from zero. The size of the standard deviation can be seen as a measure of intergenerational income redistribution. If actuarial fairness ex ante for all participating generations is aimed at, the smaller the standard deviation, the better. As the examination of this secton of the table reveals, the three reform options will lead to the moderation of income redistribution via the supplementary scheme.
As in the case of the controlled increase in q^s, this outcome may also provide an incentive to implement one of the reform options.

(3) *Expected utility: insurance and life-time income*

The third aspect is related to the change in expected utility. The target reduction in the backservice burden may be expected to lead to an increase in expected utility. However, there is also a loss in utility terms because the reform proposal will lower the risk-free fraction of insured retirement income, whereas - complementary to this - there will be an increase in the fraction of risky savings held on the capital market.
The expected utility has been set down in expression (7.21). The argument $\Delta y/y$ in this expression can be split up into $\Delta y^{\text{public}}/y$ and $\Delta y^{\text{sup}}/y$. The time path of $\Delta y^{\text{public}}/y$ is the same for all four cases under discussion. (Table A.7.2. column (9A) in the appendix reports the course of this time path.) Hence, $\Delta y^{\text{public}}/y$ is left out of the calculations because it has no influence on the ordering of the alternatives with respect to the time paths of the level of expected utility. After adjusting (7.21), expression (7.21') is obtained:

$$E[u(x_k)] = A - e^{-\alpha\left[x_k^* + \frac{\Delta y^{sup}}{y} - \alpha(1-k)\sigma_x^2/2\right]} \qquad (7.21')$$

Expression (7.21') says that the time-path of expected utility is determined by six parameters: [1] x_k^* ; [2] σ_x^2; [3] k; [4] $\Delta y^{sup}/y$; [5] α; and finally [6] A. The presentation now turns to assigning values to these parameters. Table 7.5 presents an overview of the parameter values.

[1] The expected value of the term x_k^* is equal to the objective of the investor with respect to retirement wealth, i.e. equal to the constant $\bar{x} = \frac{0.7}{(1+R)(2+R)}$ (compare expressions 7.18). The value of $\bar{x}$ turns out to be equal to 0.1895. This is calculated by plotting the relevant information of table 7.1 into expression (7.18).

[2] The value of σ_x^2 is postulated to be similar to the risk on the market portfolio. The latter is assumed to be equal to 0.025, implying a standard deviation of 0.158 (15.8%). This figure concerning market risk is more or less in correspondence with the evidence reported in table 2.1, chapter 2.

[3] The variable k has been defined as the fraction of retirement wealth which is provided by the pension scheme: $k = uw_{t+2}/0.7w_{t+2} = u/0.7$. The implementation of the reform options imply that k will decline with the decrease in the supplementary benefit rate. The time paths of k for the four different cases are presented in table 7.4 below.

Table 7.4: Time paths of k (=$u/0.7$)

period	incomplete indexation public benefit	new franchise in t-1	incomplete indexation supplementary benefit	defined-contribution plan
t-2	0.7/0.7	0.7/0.7	0.7/0.7	0.7/0.7
t-1	0.7/0.7	0.7/0.7	0.6489/0.7	0.7/0.7
t	0.7/0.7	0.6676/0.7	0.5881/0.7	0.3840/0.7
t+1	0.7/0.7	0.6144/0.7	0.5828/0.7	0.3423/0.7
t+2	0.7/0.7	0.6384/0.7	0.5875/0.7	0.3791/0.7
t+3	0.7/0.7	0.6384/0.7	0.5875/0.7	0.3791/0.7
t+4	0.7/0.7	0.6384/0.7	0.5875/0.7	0.3791/0.7
t+5	0.7/0.7	0.6384/0.7	0.5875/0.7	0.3791/0.7

[4] The time path of $\Delta y^{sup}/y$ for each of the four cases can be read from table 7.3 above.

[5] Consideration is given to three kinds of risk-aversion: low, moderate and high. The expression $h = 1-(E[r^m]-R)/\alpha sw\sigma_r^2$ which has been derived in chapter 3, footnote 4, is used in order to obtain values for α. The variable h stands for the preference of the representative individual for investment in the risk-free portfolio. For this chapter, the term sw has to be replaced by the term $\bar{x}$, i.e. the present value of the prefered pension wealth as fraction of life-time income. Standard theory in finance (cf. Copeland & Weston) usually assumes that $(E[r^m]-R)$ is about 0.05 (5%), reflecting the difference between the rate of return on the market portfolio and the risk-free return (compare also the evidence reported in table 2.1 in chapter 2). The term σ_r^2 is replaced by σ_x^2, compare [2]. When the information above is used, the following relationship between α and h is obtained: $h = 1-(E[r^m]-R)/\alpha\bar{x}\sigma_x^2 = 1-10.55/\alpha$. Below, some combinations between h and α implied by this relationship are listed.

h	0	0.33	0.5	0.75	0.83	0.9
α	10.55	15.82	21.10	42.20	63.30	105.50

The values of 15.8, 42.2 and 105.5 have been selected for α to represent respectively low, moderate and high risk-aversion.

[6] Finally, a value for the term A has to be chosen. The value of A only is decisive for the level of time-paths of expected utility. It has no impact on the relative ordering of the alternatives. Here, A is set at 0.25.

Table 7.5: Parameter values

α	=	15.8 (low risk-aversion)
	=	42.2 (moderate risk-aversion)
	=	105.5 (high risk-aversion)
σ_x^2	=	0.025
A	=	0.25
k	=	see table 7.4
$x_k^* = \bar{x}$	=	0.1895
$\Delta y^{sup}/y$	=	see table 7.3

In table 7.6, the results on expected utility are given for the case in which the degree of risk-aversion is moderate. This case is also reflected in figure 7.2. The figures 7.3 and 7.4 are related to high and low degrees of risk-aversion. Figure 7.5 reflects also expected utility paths for a moderate risk-aversion, but now savings retained within a defined-contribution plan are allocated into index bonds as proposed in chapter 4.

Table 7.6: Time paths of the expected utility of the retirement wealth portfolio (excl. public benefit) when the degree of risk-aversion is moderate ($\alpha = 42.2$)

period	incomplete indexation public benefit	new franchise in t-1	incomplete indexation supplementary benefit	defined-contribution plan (no index bonds)
t-2	0.2267	0.2267	0.2267	0.2267
t-1	0.2287	0.2287	0.2259	0.2287
t	0.2285	0.2268	0.2237	0.2177
t+1	0.2244	0.2213	0.2233	0.2075
t+2	0.2220	0.2240	0.2222	0.2117
t+3	0.2253	0.2250	0.2224	0.2117
t+4	0.2276	0.2250	0.2243	0.2117
t+5	0.2267	0.2250	0.2236	0.2117
t+6	0.2267	0.2250	0.2236	0.2117

Interpretation

As figure 7.2 reveals, the overriding feature of the case with a moderate degree of risk-aversion (α=42.2) is the fact that continuation of the current arrangement of the supplementary scheme is to be preferred to the implementation of one of the reform options. Status quo indeed will imply the largest increase in backservice burden and the most sizeable income

transfers in disfavour of future generations (compare table 7.2 and table 7.3 respectively). However the feeling of well-being involved in being insured for standard-of-living risk is so large that the loss in utility related to the fall in retirement income insurance is larger than the gain in utility related to a higher life-time income. The one exception to this, however, is the generation retiring in t+2 which will demonstrate a preference for a reform policy prescribing an AOW-independent franchise. Also the reform policy of incomplete indexation of the supplementary benefit rate yields a small improvement in expected utility, compared with the non-reform option.
Two figures have been selected to examine alternative values for the degree of risk-aversion α. Figure 7.3 shows what happens to expected utility when the representative individual is highly risk-averse (α = 105.5). The option of the introduction of a defined-contribution plan is not reflected in this figure 7.3. The disutility of not being insured is so great that the expected utility is far below the levels of expected utility in the other three cases[5]. This figure displays the same pattern for expected utility as figure 7.2 but, as one can expected, the preference of insurance is more pronounced. Moreover, all generations are now better off if there is no reform at all. Figure 7.4 is based on a low degree of risk-aversion (α=15.8). Therefore, the impact of the exposure to risk on expected utility is low. The impact $\Delta y^{sup}/y$ is dominating for the course of the time-paths of expected utility.

The implementation of a defined-contribution plan produces for the three cases discussed the worst result because, for this reform option, the drop of the insurance is the greatest. Main implication of this finding is that domestic workers have a preference for branches of industry and firms which organize a defined-benefit plan above firms which offer to their employees a defined-contribution plan. However it is important to note that this conclusion can only be written in *ex ante* terms. The question as to the optimality *ex post* of the final-pay plan requires a full specification of all future states of nature, alike the specification performed in section 3.6 of chapter 3. The time-consistency problem may still become manifest in the future because of the occurrence of a state of nature in which participation into a defined-benefit plan is sub-optimal ex post for future generations.
Chapter 4 has discussed the issuance of so-called wage-index bonds and price-index bonds by the government. These bonds can be used by individual

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[5] For reasons of completeness, the data concerning the time-path of the expected utility associated with the reform option of implementing a defined-contribution plan in period t-1 when risk-aversion is high, are presented here:

t-2	t-1	t	t+1	t+2	t+3	t+4	t+5
0.249918	0.249934	0.249467	0.247392	0.248150	0.248150	0.248150	0.248150

workers with defined-contribution plans to reproduce the same kind of insurance against standard-of-living risk as a final-pay plan. Consider that the implementation of defined-contribution plans in period t-1 indeed would be accompanied by the issue of wage-index and price-index government bonds. It is assumed that individual workers decide to allocate all their savings within defined-contribution plan into these index bonds. This will protect them of being exposed to standard-of-living risk. Consequently, changes in expected utility can only stem from the impact of income effects, i.e. $\Delta y^{sup}/y$. Figure 7.5 provides a comparison of the time-path of expected utility related to the reform option 'defined-contribution plan plus index bonds' with the time-paths related to the final-pay plan and the moderate reform proposals. Differences in time-paths between the former alternative and the non-reform option are caused solely by differences in income effects $\Delta y^{sup}/y$ for the generations involved. The occurrence of income effects within the defined-contribution plan is to be explained by the backservice obligations related to the outstanding pension claims in period t-1. This is the reason why the two generations which are part of the labour force in period t-1, retiring in period t and period t+1 respectively, experience a lower level of welfare in comparison with the generations which are born later, retiring from period t+2 onwards. As the figure 7.5 reveals, the reform option: 'defined-contribution plan plus index bonds' is *welfare-dominant* for the generations retiring in the periods t+1, t+2 and t+3. The non-reform case achieves an unfavourable result for the generations retiring in these periods, because these generations are part of the labour force in the periods t and t+1, in which the backservice burden within the defined-benefit plan is at its highest. Compare table 7.4 in which it can be read that q^s reaches its highest values during the periods t and t+1.

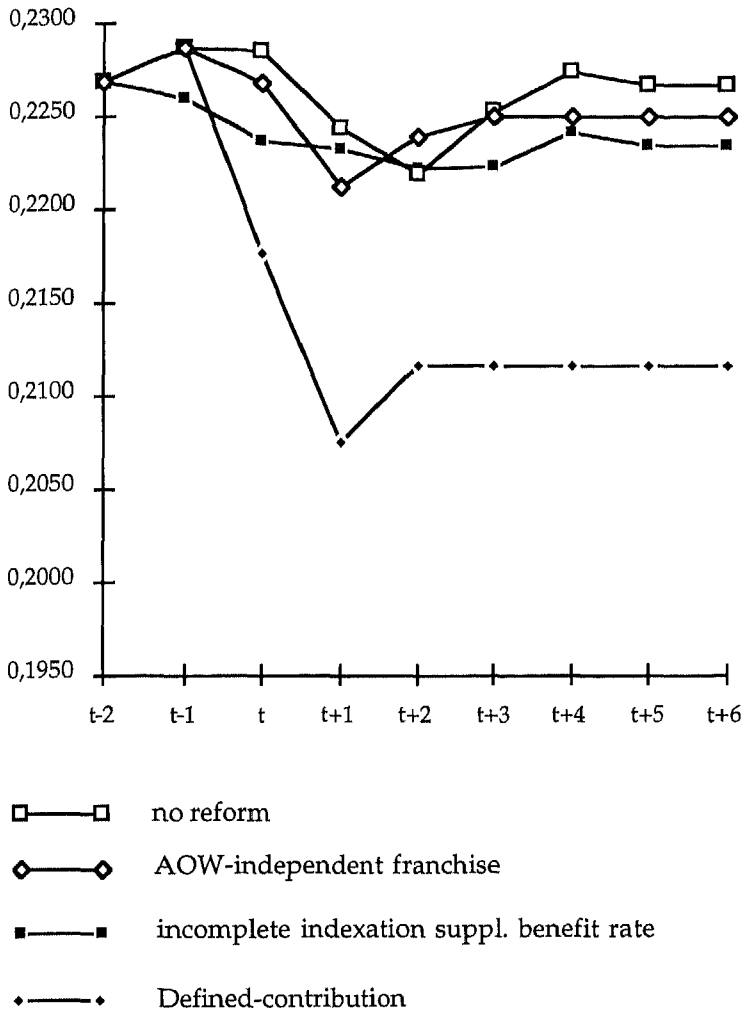

Figure 7.2: Expected utility when degree of risk-aversion is *moderate* (α=42.2)

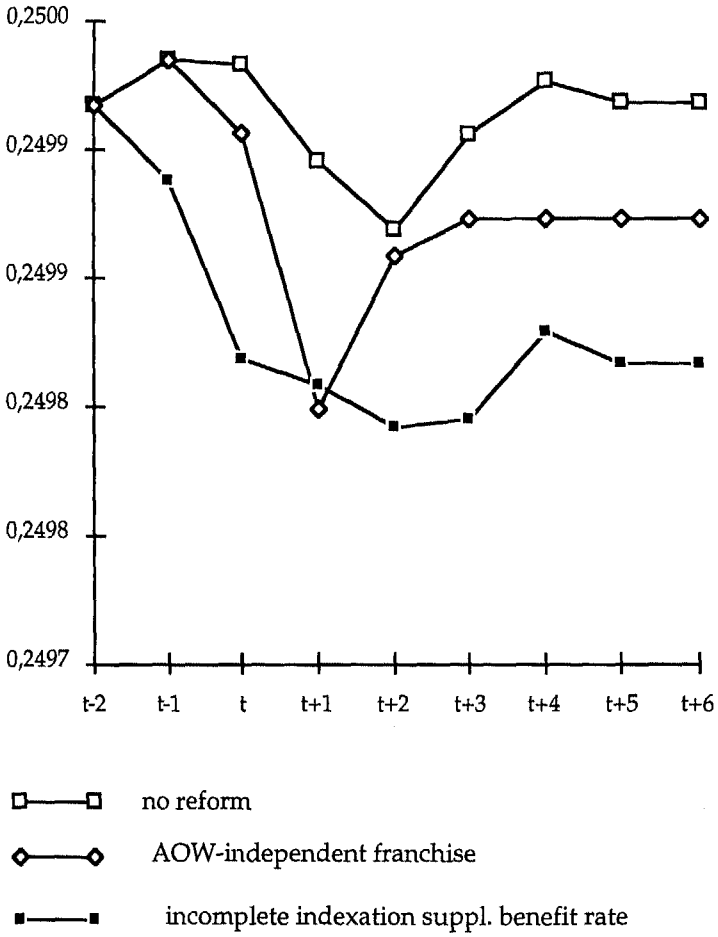

Figure 7.3: Expected utility when degree of risk-aversion is *high* (α=105.5)

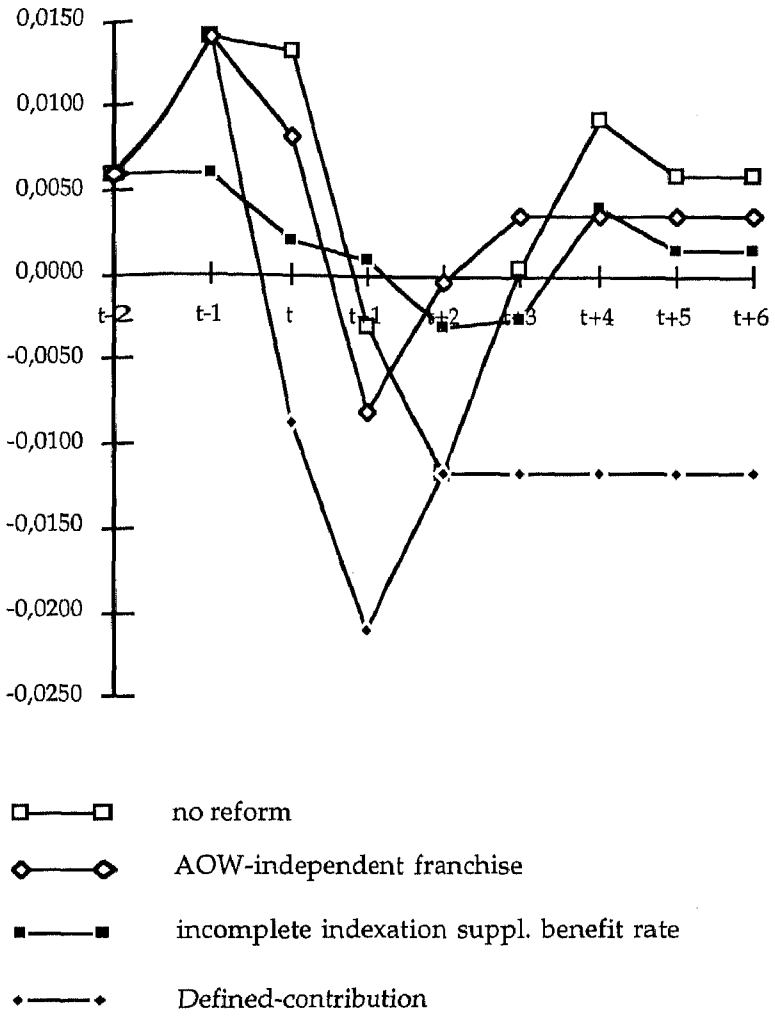

Figure 7.4: Expected utility when degree of risk-aversion is *low* (α=15.8)

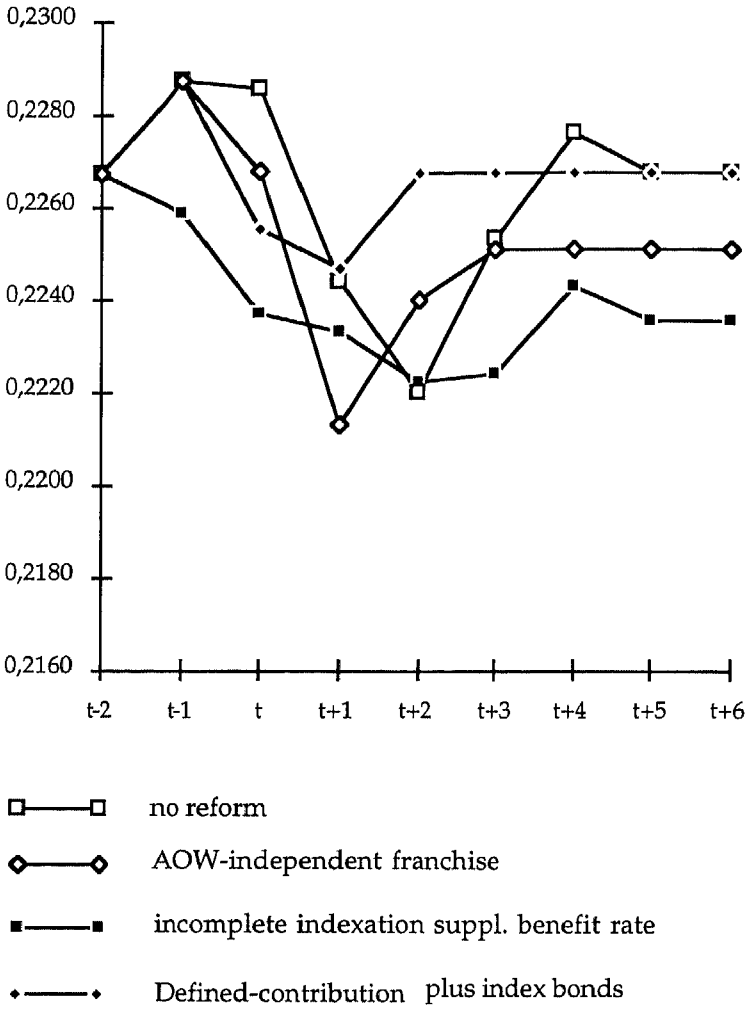

Figure 7.5: Expected utility when degree of risk-aversion is *moderate* (α=42.2) and all pension savings within defined-contribution plans are allocated to index bonds

7.7 Evaluation

The Dutch pension system is an integrated system, combining both the public and the supplementary scheme. It is foreseeable that the public benefit will fall in relation to the wage rate. This implies that the supplementary scheme must bear a larger part of the financing burden of the total pension outlays. This suggests an increase in the supplementary premium rate due to the non-anticipated increase in backservice payments. Moreover there will be intergenerational income redistribution in disfavour of future generations of workers.

This chapter has developed a simulation model in which a pension system with the institutional characteristics of the Dutch pension scheme is presented.

A primary aim of the simulation was to examine the effects on the supplementary scheme of aging and indexation policy concerning the public pension. More specifically, attention has been paid to the time paths of the future contribution rate, the future backservice burden and the associated income transfers from (future) sponsors to retirees with existing pension rights.

A second aim of the model has been to evaluate reform proposals with respect to the supplementary scheme as regards to welfare, where the latter is measured by the utility derived from the expected retirement wealth and the disutility of being exposed to standard-of-living risk. The representative individual aims to achieve a retirement wealth equal to 70% of final-pay, which is wage-indexed during retirement. The main conclusion from the evaluation of reform proposals is that continuation of the current set-up may be more preferable for future generations than reform. The reform options discussed are indeed successful in reducing the rise in the backservice burden and the degree of actuarial unfairness ex ante for future generations. However, the relative share of retirement income insurance in total retirement wealth is also reduced.

Two kinds of reform proposals have been analyzed as to their welfare aspects for future generations.

The first group maintains the basic structure of a defined-benefit scheme. Two options of this kind of reform have been considered: firstly, the introduction of the so-called AOW-independent franchise and secondly, the incomplete indexation of the supplementary benefit rate. These proposals have the objective to moderate the increase in premium burden and to reduce intergenerational income inequality. It has been concluded that the continuation of the current structure may be preferred more by future

generations than these reform proposals. A crucial aspect is the trade-off between the gain in utility attached by future generations to the increase in life-time income and the decrease in utility because of the loss of retirement income insurance. The net-effect in utility depends on the degree of risk-aversion and the magnitude of the exposure to risk. The more risk-averse the representative individual is and the higher the risk is, the more likely it is that he will prefer the status-quo to reform.

A more radical option of reform is substitution of the defined-benefit plan structure for defined-contribution plans. The introduction of defined-contribution plan is always a welfare-deterioration compared with the alternatives discussed. This is primarily to be explained from the dominance of the loss in welfare because of the exclusion of retirement income insurance. Hence, main implication of this finding is that domestic workers in the future also prefer to work in branches of industry and firms which organize a defined-benefit plan above firms which offer to their employees a defined-contribution plan. However, it is important to note that this conclusion can only be written in *ex ante* terms. The question as to the optimality *ex post* of the final-pay plan requires a full specification of all states of nature. It can not be ruled out that one can find one or more states of nature within which it is optimal for young workers to supply their labour to firms which offer to their employees no defined-benefit plan.

It has also been considered that the introduction of a defined-contribution plan is accompanied by the simultaneous issuance of wage-index bonds by the government, as proposed in chaper 4. The individual pension saver then is able to reproduce the insurance offered by a defined-benefit plan with wage-related benefits. The alternative 'defined-contribution plan plus index-bonds' appear to be *welfare-dominant* for future generations compared with the status-quo case and the two other reform alternatives discussed.

APPENDIX

A.7.1 Complete indexation of the public benefit

The table and figures in this section of the appendix present the results of the time paths for relevant variables when the public benefit level is completely indexed for growth in wages and no change in the supplementary scheme has taken place.

Figure A.7.1.a displays the course of the growth rate of a new generation entering the labour force. The once-and-for-all drop in the fertility rate in period t-1 leads to the situation of a growing population to a stationary population. Figures A.7.1.b to figure A.7.1.f show the impact of the demographic shock on the relevant variables during the adjustment process from the former steady state to the new steady state. This concerns respectively the dependency ratio (figure A.7.1.b), the contribution rate of the public scheme τ (figure A.7.1.c), the actual and the actuarial contribution rates of the supplementary rates, p^S respectively q^S (figure A.7.1.d) and the summing up of τ and q^S to the total contribution rate Θ (figure A.7.1.e), and finally, the impact of the demographic shock on the life-time income of the generations $\Delta y_{t-2}/y_{t-2}$ (figure A.7.1.f).

Here, a detailed comment is given on the characteristics of the old and the new steady state and the adjustment process for the scenario with complete indexation of the public benefit and no changes in the supplementary scheme. This comment is based on table A.7.1 and the figures A.7.1.a to A.7.1.f.

The adjustment process of the dependency rate stretches over three periods. The movement in the dependency rate is mirrored by the contribution rate of the public scheme τ. There is an increase from 6.50% in t-1 via 10.24% in period t, a peak of 19.98% in period t+1, after which there is a decline in t+2 to the new steady state value of 11.37%.

The behaviour of the actuarial and actual contribution rates of the supplementary scheme is as follows.

The change in the actuarial contribution rate stems in this 'complete indexation' scenario only from the net-net link between the public benefit and the wage level. An increase in the public contribution rate leads to a fall in the public benefit in relation to the wage level and, therefore, to an increase in the benefit rate of the supplementary scheme u_t^s. Figure A.7.1.d shows that the actuarial premium rate reflects the movement in the dependency rate in the same manner as the public premium rate τ.

In addition, the actual premium rate of the supplementary scheme largely mirrors the movement of the actuarial rate. However, the volatility is much greater. Any divergence in the balance of the fund will have an effect on the level of the actual rate.

In period t, the fund experiences a shortage because of the non-anticipated increase in the benefit rate of the supplementary scheme caused by the fall in public benefit. The pension fund must therefore be balanced by extra backservice payments. This explains the fact that in period t the actual premium rate exceeds the actuarial rate. During period t+1, the relative decline in the public pension is still ongoing and the ratio *aow/w* decreases further to its lowest value of 0.3423. Once again, the fund has a shortage to be absorbed by extra backloading, so that during this period the actual premium rate also exceeds the actuarial rate, reaching its maximum level equal to 8.74%. This is substantially higher than the old and new steady state values of the supplementary premium rate, which are equal to 4.87% respectively 5.21%. In period t+2, the actuarial rate p^S declines to its new steady state value. The actual rate is still changing in period t+2, because the accumulated premium reserve from the previous period t-1 is based on the high level of the actuarial rate prevailing in period t-1. The resulting surplus in the fund is used to lower the actual contribution rate.

Income redistribution

Obviously, the demographic shock will have a divergent impact on the life-time income of the generations which are involved in the adjustment process. Column (9) of table A.7.1 reports the total impact of participation in the two pension schemes on the life-time income of the generations (compare expression 7.16). Columns (9A) and (9B) split up this total impact into the effects caused by the public scheme and by the supplementary scheme respectively (compare the expressions 7.16' and 7.16'').

A distinction is made between the effects in the steady state and those during the adjustment process due to the transition from the old to the new steady state.

Steady state

A public or a supplementary pension scheme is *neutral with respect to life-time income* when its internal rate of return is equal to the capital market rate of return.

This is clear in the case of the supplementary scheme. The scheme is funded and the premiums paid into it are intended to be equal to the present value of the supplementary benefit. These premiums are invested in the capital market and earn the capital market rate of return r. This rate is also used as the discount factor.

From the Aaron-condition[#] it is wellknown that the internal rate of return of a pay-as-you-go (PAYG) scheme is equal to the sum of the population growth n and the income

[#] The rate of return which a generation will realize within a PAYG-scheme is determined by the benefits obtained during old age and the total premiums paid in the preretirement period. In a two-period/two-generation setting, this can be expressed as follows. Let generation L_t, born and working in period t, earn a total wage income of $w_t L_t$. This wage income is taxed to pay for the public pensions of the retired in period t. The retired generation is of a size $L_{t-1} = L_t/(1+n)$. Aaron (1966, 373) assumes that the retirees receive a pension which is related to the average wage

growth m. When $n+m$ falls below the capital market rate of return r, funding is more efficient than pay-as-you-go and vice versa. For $n+m=r$, the two financing methods yield the same internal rate of return.

Prior to the demographic shock, the growth rate of a new generation is equal to the actuarial rate of return: $n=R$. Making use of (7.10) this equality can be rewritten as $(1+n)(1+m)=(1+r)$ Hence, the existence of the public scheme in the old steady state is neutral with respect to the life-time income of the participants. Therefore, the generations retiring in period t-2, t-1 and t undergo no change in their life-time income because of their participation in the schemes. The fall in the fertility rate implies that $(1+n)(1+m)<(1+r)$. Now, participation in a pay-as-you-go financed public pension scheme is disadvantageous for life-time income. In the new steady state, obligatory participation in the public scheme has a negative impact on life-time income due to the inefficiency of the public scheme. As column (9A) of table A.7.1 shows, the loss in life-time income as a result of this obligatory participation in the public scheme amounts to 5.22% in terms of life-time income of a generation.

Adjustment process

The adjustment process associated with the transition from the old to the new steady state takes place between period t and period t+4.

Public scheme

Generations t and t+1 retiring in period t+2 and t+3 are the most severely disadvantaged. They enter the labour force in period t and period t+1. It is in period t+1 that the premium burden reaches its peak, primarily because of the very steep increase in the premium rate for the public scheme, which is related to the path of the dependency rate (compare column 9A and figure A.7.1.e). Generation t-1 retiring in t+1 is less unlucky because in its first working period in t-1, it has paid the still low public premium rate of the pre-shock regime. Also, the generations retiring from period t+3 on are better off because they enter the labour market after the dependency rate has fallen to its new steady state.

Supplementary scheme

Column (9B) reports the net-result of income transfers between a generation and the pension fund. No income transfers between a generation and the pension fund will occur in a steady state situation. The actuarial premium rate is set at a level which ensures equality between the present value of the premiums paid by a generation of workers and the present value of the supplementary pension benefit which this

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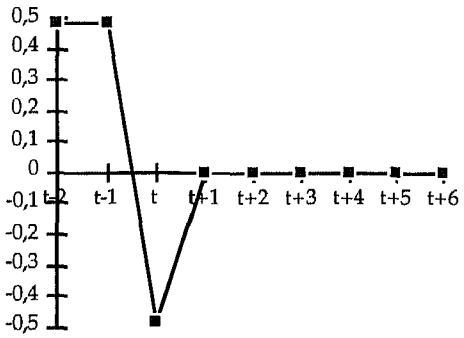
prevailing during their retirement. Let the public pension be a fraction u^o of the wage in that period. Generation t must pay a total premium of $u^o w_t L_{t-1}$. This generation obtains a total public pension of $u^o w_{t+1} L_t$. If wages grow by the rate m, the total return of this PAYG pension scheme is equal to: $u^o w_{t+1} L_t / u^o w_t L_{t-1} = (1+n)(1+m)$.

generation obtains. This equality is no longer guaranteed during the adjustment process. Column (9B) indicates that generation t-2, which retires in period t, obtains a positive net-result of its transfers with the pension fund equal to 0.26% of its life-time income. This can be explained by the non-anticipated increase in u^S during period t due to the fall in *aow/w* in period t. Hence, this generation receives a supplementary benefit which (in present value terms) is greater than the premiums paid during period t-1 and t-2. This exactly compensates the loss in life-time income which is related to the fall in *aow/w*. Generation t-1 retiring in t+1 also experiences an increase in net-income with the pension fund equal to 0.56%. This increase is now composed of two effects. Firstly, in this period there is also a gain in life-time income due to a non-anticipated increase in u^S. Secondly, generation t-1 experiences a loss in life-time income because of the increase in the actual supplementary premium rate. This second effect explains why the positive result of the supplementary scheme cannot compensate for the fall in life-time income associated with the public scheme.

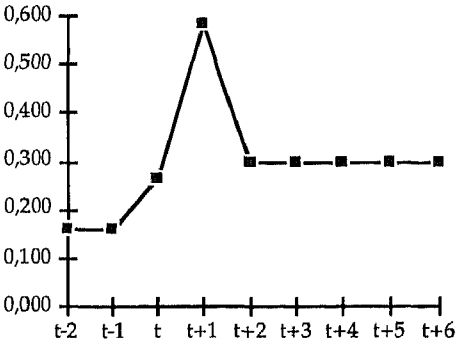
The two generations retiring in t+2 and t+3 have to pay such a huge actual premium rates during their working life that they are even in a loss position within the pension fund in terms of life-time income.

In period t+2 the dependency rate falls to its new steady state level. The public premium rate mirrors this fall so that the ratio *aow/w* increases. implying a decrease in the supplementary benefit rate. The pension fund finds itself in a position of overfunding because in the previous period the accumulated premium reserve was based on a supplementary benefit rate prevailing in that period which is higher than the benefit rate necessary for period t+2. From period t+2 onwards, the ratio *aow/w* undergoes no further change, and so the supplementary benefit rate is constant and, therefore, the pension fund will also be balanced.



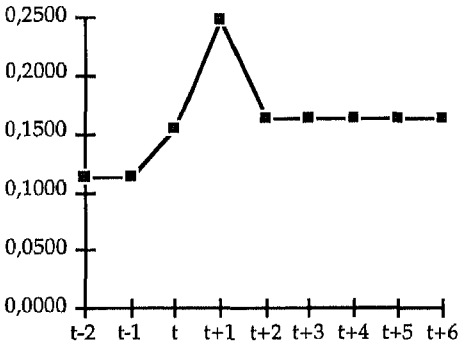
$= n_t$

Figure A.7.1.a



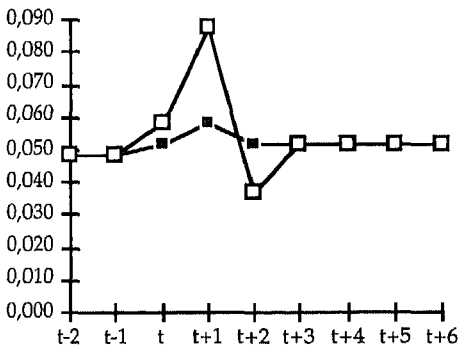
$= dep\ rat$

Figure A.7.1.b



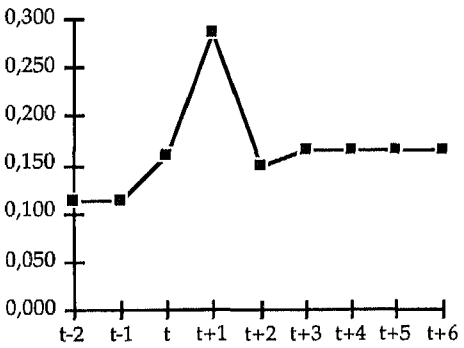
$= \tau_t$

Figure A.7.1.c



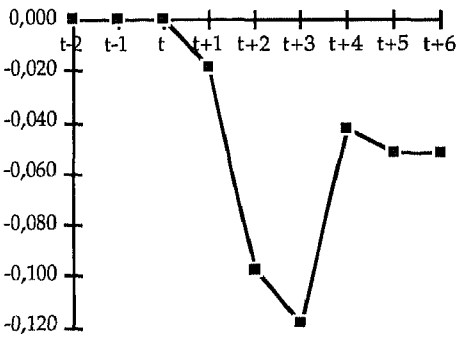
$= p_t^s$ $= q_t^s$

Figure A.7.1.d



$= \Theta_t$

Figure A.7.1.e



$= \frac{\Delta y_{t-2}}{y_{t-2}}$

Figure A.7.1.f

Table A.7.1: Time paths of relevant variables within the scenario for complete indexation of the public benefit

	1	2	3	4	5	6	7	8	9	9A	9B
period	n_t	*dep. rate*	*aow/w*	u^s	τ_t	p^s	q^s	$\Theta=\tau+q^s$	$\frac{\Delta y_{t-2}}{y_{t-2}}$	$\frac{\Delta y^{pub}_{t-2}}{y_{t-2}}$	$\frac{\Delta y^{sup}_{t-2}}{y_{t-2}}$
t-2	+ 0.49	0.162	0.4000	0.3000	0.0650	0.0487	0.0487	0.1432	0.0000	0.0000	0.0000
t-1	+ 0.49	0.162	0.4000	0.3000	0.0650	0.0487	0.0487	0.1432	0.0000	0.0000	0.0000
t	- 0.49	0.267	0.3840	0.3160	0.1024	0.0513	0.0582	0.1746	0.0000	-0.0026	+0.0026
t+1	0	0.584	0.3423	0.3577	0.1998	0.0581	0.0874	0.2288	-0.0188	-0.0244	+0.0056
t+2	0	0.300	0.3791	0.3209	0.1137	0.0521	0.0366	0.1720	-0.0978	-0.0700	-0.0178
t+3	0	0.300	0.3791	0.3209	0.1137	0.0521	0.0521	0.1799	-0.1185	-0.1036	-0.0149
t+4	0	0.300	0.3791	0.3209	0.1137	0.0521	0.0521	0.1799	-0.0429	-0.0522	+0.0093
t+5	0	0.300	0.3791	0.3209	0.1137	0.0521	0.0521	0.1799	-0.0522	-0.0522	0.0000
t+6	0	0.300	0.3791	0.3209	0.1137	0.0521	0.0521	0.1799	-0.0522	-0.0522	0.0000
t+7	0	0.300	0.3791	0.3209	0.1137	0.0521	0.0521	0.1799	-0.0522	-0.0522	0.0000

A.7.2 Incomplete indexation of the public benefit

The policy prescribing incomplete indexation of the public benefit for the growth rate of gross wage is structured by an annual decrease in the *linking factor c* of 1% over two periods. After a period of 40 years, the size of c will have fallen from the initial level of 0.4278 (compare table 7.1) to 0.2873 [$=0.4278/(1.01)^{40}$].

Premium burden

This policy option initiates a great deal of dynamics. All other things being equal, an annual cut of 1% for a period of 20 years should have to result in a fall in the public benefit rate, i.e. *aow/w* decreases in period t-1 from its initial value of 0.4 to a level of 0.3278 [$=0.4/(1.01)^{20}$]. However, the rate actually falls less far back to a level of 0.3317. This can be explained by the

Table A.7.2: Time paths of relevant variables within the scenario for incomplete indexation of the public benefit

	1	2	3	4	5	6	7	8	9	9A	9B
per iod	n_t	*dep. rate*	*aow/w*	u^S	τ_t	p^S	q^S	$\Theta = \tau + q^S$	$\frac{\Delta y_{t-2}}{y_{t-2}}$	$\frac{\Delta y^{pub}_{t-2}}{y_{t-2}}$	$\frac{\Delta y^{sup}_{t-2}}{y_{t-2}}$
t-2	+ 0.49	0.162	0.4000	0.3000	0.0650	0.0487	0.0487	0.1137	0.0000	0.0000	0.0000
t-1	+ 0.49	0.162	0.3317	0.3683	0.0539	0.0598	0.0775	0.1314	0.0000	-0.0111	+0.0111
t	- 0.49	0.267	0.2669	0.4331	0.0712	0.0704	0.0980	0.1691	-0.0071	-0.0029	+0.0100
t+1	0	0.584	0.2461	0.4539	0.1436	0.0737	0.0884	0.2320	-0.0329	-0.0209	-0.0120
t+2	0	0.300	0.2645	0.4355	0.0794	0.0707	0.0630	0.1423	-0.0807	-0.0573	-0.0234
t+3	0	0.300	0.2645	0.4355	0.0794	0.0707	0.0707	0.1501	-0.0822	-0.0748	-0.0074
t+4	0	0.300	0.2645	0.4355	0.0794	0.0707	0.0707	0.1501	-0.0318	-0.0364	+0.0046
t+5	0	0.300	0.2645	0.4355	0.0794	0.0707	0.0707	0.1501	-0.0364	-0.0364	0.0000
t+6	0	0.300	0.2645	0.4355	0.0794	0.0707	0.0707	0.1501	-0.0364	-0.0364	0.0000
t+7	0	0.300	0.2645	0.4355	0.0794	0.0707	0.0707	0.1501	-0.0364	-0.0364	0.0000

link between the *aow* and the net-wage $(1-\tau)w$. The cut in the *aow* initially leads to a decrease in the outlays for the public scheme. This implies a fall in the public premium rate τ, so net-wage will improve. Because of the link between the aow and the net-wage, the initial decline in the aow-level is partly compensated for.

Due to the integrated structure of the Dutch pension scheme, a policy of partial indexation will have no influence on the level of the total benefit rate u. However, the composition of u will change. The public benefit rate aow/w falls whereas the supplementary benefit rate u^S increases. Comparing the relevant columns in table A.7.3, the policy of cutting the public benefit implies a relative decline of the pay-as-you-go finance method, whereas there is a relative increase in the financing method of funding. In the long run, this policy will have a favourable impact on the total premium rate compared to the 'complete indexation' scenario. Indeed, table A.7.3 reports a negative value for $\Delta\Theta$ in the new steady state. Furthermore, the rise in the *actuarial* premium rate p^S is smaller than the fall in the public premium rate τ. During the process of adjustment, however, the increase in the *actual* premium rate q^S initially

exceeds the fall in public premium rate because of backservice payments intended to absorb the shortage in the fund which stems from the non-anticipated increase in the supplementary benefit rate. As can be read from table 7.3, the actual premium rate rises from an initial steady-state level of 4.87% to a peak of 9.8% in period t. This is more than a twofold increase. Subsequently, the premium rate declines to the new steady state level of 7.07%.

Income redistribution

A pay-as-you-go related scheme is Pareto optimal, so that it is inevitable that a (partial) conversion from the pay-as-you-go method to funding will be disadvantageous to one or more generations. This policy option has no influence on the total pension income of retirees because any fall in the public benefit will be compensated for by an increase in the supplementary benefit, leaving the total pension income unchanged[##]. Changes in total life-time income therefore only will arise when the actual premiums paid which are greater or less than the pension benefits received, both in present value terms. As examination of table A.7.3 shows, the burden of the (partial) conversion must be borne by the generations retiring in periods t and t+1. The generation retiring in period t experiences during its working years in period t-1 a rise in the total premium burden Θ vis-à-vis the 'complete indexation' variant. No other change in any of its life-time income components is foreseen. Therefore, life-time income for this generation will fall. The generation retiring in period t+1 must experience a rise in total premium also during period t. Its loss in life-time income is even larger compared with the loss of the preceding generation. All succeeding generations gain in terms of life-time income and enjoy the fruits of the extension of the funding element within the financing of the total pension income. For the generation retiring in period t+2, the gain in life-time income dominates because the fall in Θ in period t+1 more than adequately compensates the loss in life-time income related to the increase in Θ in period t.

[##] The case would be different for retirees with no prospect on supplementary pension at all. No compensation for the fall in the public benefit is available to them.

Table A.7.3: Time paths of relevant variables of Incomplete indexation scenario expressed as deviation from the time paths in complete indexation scenario.

period	$\Delta(now/w)$	Δu^S	$\Delta\tau_t$	Δp^S	Δq^S	$\Delta\Theta$	$\Delta\left(\frac{\Delta y_{t-2}}{y_{t-2}}\right)$
t-2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
t-1	-0.0683	+0.0683	-0.0111	+0.0111	+0.0288	+0.0177	0.0000
t	-0.1171	+0.1171	-0.0312	+0.0190	+0.0398	+0.0086	-0.0071
t+1	-0.0963	+0.0963	-0.0562	+0.0156	+0.0010	-0.0552	-0.0140
t+2	-0.1146	+0.1146	-0.0344	+0.0186	+0.0263	-0.0080	+0.0171
t+3	-0.1146	+0.1146	-0.0344	+0.0186	+0.0186	-0.0158	+0.0362
t+4	-0.1146	+0.1146	-0.0344	+0.0186	+0.0186	-0.0158	+0.0112
t+5	-0.1146	+0.1146	-0.0344	+0.0186	+0.0186	-0.0158	+0.0158
t+6	-0.1146	+0.1146	-0.0344	+0.0186	+0.0186	-0.0158	+0.0158
t+7	-0.1146	+0.1146	-0.0344	+0.0186	+0.0186	-0.0158	+0.0158

Epilogue part I & part II

The central focus in the analysis has been a representative individual worker who aims to realize his preferences with respect to his portfolio of retirement income provisions. It has been stated that the private (insurance) market fails to provide suitable forms of insurance against risks related to old age, such as the absence of insurance against wage-path risk and real investment risk (chapter 2). Individuals are therefore subject to standard-of-living risk with respect to their retirement wealth. This risk is defined as the possibility that the retiree will not have enough income (wealth) to maintain a standard of living after retirement comparable with the standard enjoyed during the pre-retirement years and/or comparable to the standard of living of those around him. Retirement income insurance could be based on risk-pooling between generations. First of all, intergenerational risk-sharing can be related to wage-path risk. This risk creates uncertainty to the future level of wage income and to the future standard of living. A system of retirement income insurance with wage-related benefits improves welfare. Such insurance will redistribute from lucky to less lucky generations. Risk-pooling between generations can also be related to factor income shares. The income of retirees is primarily rental income, whereas the workers' income is mainly from wages. In a long-term perspective, wage income and rental income as shares of total income are negatively correlated. This suggests that both young and old generations may benefit from intergenerational risk-sharing with respect to income uncertainty. Intergenerational insurance contracts can not be provided by the private market because the generations involved are not all alive or grown-up prior to the outcome of the income risks to be covered by these contracts. The support of the future young generations is contingent on the outcome of the contract ex post. These generations will not accept voluntarily a contract that leads to a loss in welfare to them.

Non-market arrangements appear therefore necessary in order to organize intergenerational risk-sharing with respect to retirement income insurance.

First of all, risk-pooling between generations can be structured through a public pension scheme financed on a pay-as-you-go base. This is well-known from the literature. Chapters 3 and 4 have analyzed three alternative forms of non-market arrangements. These arrangements are also able to provide retirement income insurance based on collective risk-sharing:
[1] The first arrangement concerns a supplementary pension scheme organized as a funded defined-benefit plan with wage-related benefits; funding risks with respect to the defined benefits of the retirees and the older workers are borne by the active workers.
[2] Two variants are based on risk-sharing between the government budget and pension savings. The government is able to be involved in risk-sharing because of its taxation power. Tax payers (young and old) ultimately bear the risks associated with the income guarantees offered by the government to pension savers.
[2a] The plan Bovenberg concerns the participation of the government in the investment risks relating to pension savings. The plan exploits the inverted relationship of the government as debtor and pension savers as investors with respect to interest rate risk.
[2b] It has been proposed in this thesis that the government should turn to the distribution of so-called nominal-wage-index and price-index bonds with a defined rate of return for the investors. To the analogy of the insurance offered by wage-related defined-benefit plans, these bonds provide protection against standard-of-living risk.

Dutch workers in majority are obliged to participate in the supplementary pension scheme which is offered to them by their employer. This scheme is mainly organised as a defined-benefit plan with wage-related benefits (final-pay or average wage). The financing method is primarily based on funding, but a pay-as-you-go element is present due to practice of built-in backloading. The funding method *as such* could be qualified as actuarially fair ex ante to its participants, i.e. the participating cohorts can expect equality ex ante between the present value of premiums paid and the present value of benefits to be received during retirement (chapter 6). A supplementary scheme can also be structured as a defined-contribution plan. In chapter 2 (section 2.3), the relative advantages and disadvantages of defined-benefit plans and defined-contribution plans have been discussed. The table below presents an overview of strengths and weaknesses of these two plans. The fourth column reports the outcome if an individual participating in a defined-contribution plan has allocated old-age savings to nominal-wage-index bonds and price-index bonds in order to replicate the retirement income insurance offered by a wage-related final-pay plan. Risks relating to the

(government) interest rate, the wage growth rate and the inflation rate are borne by the government budget, i.e. collectively by (young and old) tax payers. The combination of defined-contribution plan and these index bonds unify the advantages of defined-benefit plans, such as the prospect on maintenance of pre-retirement standard of living and collective risk-bearing, with the advantages of retirement provision on an individual basis, such as labour market neutrality, individual freedom to choose the optimal life-time consumption profile and to allocate retirement savings according to individual risk-return preferences. The third column outlines the features of Bovenberg's plan. The main disadvantage of this plan compared with the alternative with the index bonds is the lack of standard-of-living risk insurance.

Table E1: Strengths and weaknesses of the defined-benefit plan, the defined-contribution plan, the defined-contribution plan with plan Bovenberg, and the defined-contribution plan with savings held in nominal-wage-index or price-index government bonds

Features	Defined-benefit plan	Defined-contribution plan	Defined-contribution plan plus Bovenberg	Defined-contribution plan plus index bonds
Certainty maintenance pre-retirement standard-of-living	+	-	-	+
Collective risk-bearing:	+	-	+	+
- overlapp. generations workers	x			
- workers and shareholders	x			
- tax payers			x	x
Individual choice on:				
- risk-return investment strategy	-	+	+	+
- life-time consumption profile	-	+	+	+
Labour market neutrality	-	+	+	+

\+ = present
\- = not present
x = via

In the Netherlands, a discussion is going on in support of reforming the present structure of the supplementary scheme. The *process of aging* will lead to an increase in the financing burden of defined-benefit plans currently in operation. This implies that the costs of the scheme for future generations will increase. It may therefore be in the interest of the current active generations to accept a reform of the current scheme in order to make the system less unfair for the future young generations and so to avoid that the intergenerational contract may break down at some moment in the future. Furthermore, one is aiming to make a case of substituting the final-pay plans for defined-contribution plans. This reform should anticipate the trend towards *more diversity among individuals.*

Two kinds of reform proposals have been analyzed as to their welfare aspects for future generations.

The first group maintains the basic structure of a defined-benefit scheme. Two options of this kind of reform have been considered: firstly, the introduction of the so-called AOW-independent franchise and secondly, the incomplete indexation of the supplementary benefit rate. These proposals both have the objective to moderate the increase in premium burden and to reduce intergenerational income inequality. A main result from this study is that utility of being insured against standard-of-living risk may be substantial. Crucial is the trade-off between the reform-induced gain in utility attached by future generations to the increase in life-time income and the reform-induced fall in utility because of the loss of retirement income insurance. The net-effect in utility terms depends on the degree of risk-aversion and the magnitude of the exposure to standard-of-living risk. The more risk-averse the representative future individual is and the higher his exposure to standard-of-living risk is, the more likely it is he will prefer the option of *no reform* above moderate reform. However, it is important to note that this can only be written in *ex ante* terms. The question as to the optimality *ex post* of the final-pay plan requires a full specification of all future states of nature. It might be that one can find one or more states of nature within which opting out for future generations is welfare-optimal (compare section 3.6, chapter 3). As far as one conceives this as a realistic future scenario, then one may consider as a more radical reform option to substitute the defined-benefit plans in operation for defined-contribution plans. However the demand for standard-of-living risk insurance still will remain. This kind of insurance can not be provided by the private (insurance) market. This would plead for the introduction of alternative institutions to organize standard-of-living risk insurance. This thesis has examined the issuance of so-called wage-index and price-index government bonds. By a suited allocation of pension savings into these bonds, the individual worker with a

defined-contribution plan is able to reproduce the standard-of-living risk insurance offered by defined-benefit plans with wage-related benefits. The alternative 'defined-contribution plan plus index-bonds' appear to be *welfare-dominant* for future generations compared with the status-quo case and the two other reform alternatives discussed.

References

Aaron H.J. (1966): 'The social insurance paradox', in: *Canadian Journal of Economics and Political Science*, 32, pp. 371-374.

Abel A.B. (1988): 'Comments', in: Wachter S.M. (ed): '*Social Security and Private Pensions*', Massachusetts.

Bakker R.C.L. & R. van Dam (1995): '*Marktwerking en verplichtstelling in de pensioensector*', VK studies 4, Apeldoorn.

Barro R. (1979): 'On the Determination of Public Debt', in: *Journal of Political Economy*, vol. 87, pp. 940-71.

Besseling P.J. (1994): '*Pensions, Savings and the Labour Market in the Netherlands*', in: Papers and Proceedings 9401 OCfEB Rotterdam 1994.

Besseling P.J. & R.F. Zeeuw (1993): '*The financing of pensions in Europe: Challenges and opportunities*', CPB Research Memorandum no. 111, november 1993.

Bikker J.A. (1992); '*Lopende rekening en demografische onevenwichtigheid*', DNB Onderzoekrapport WO&E, nr. 9212, Amsterdam.

Blanchard O.H. & S. Fischer (1989): '*Lectures on Macroeconomics*', The MIT Press, Cambridge, Massachusetts.

Blinder A.S. (1988): 'Why is the Government in the Pension Business?', in: Wachter S.M. (ed): '*Social Security and Private Pensions*', Massachusetts.

Boadway R.W. & D.E. Wildasin (1989): 'A Median Voter Model of Social Security' in: *International Economic Review*, vol. 30, pp 307-327.

Boadway R.W., M. Marchand & P. Pestieau (1992): '*Pay-as-you-go social security in changing environment*', in: Böss D. & S. Cnossen (eds): 'Fiscal implications of an Aging Population', Springer Verlag, Berlin.

Bodie Z. (1980): 'An innovation for stable retirement income', in: *Journal of Portfolio Management*, 7, pp. 5-13.

Bodie Z. (1990): 'Pensions as Retirement Income Insurance', in: *Journal of Economic Literature*, 28, 28-49.

Bodie Z. (1990): 'The ABO, the PBO and Pension Investment Policy', in: *Financial Analysts Journal*, vol 46, pp 27-34.

Bodie Z. & J.B. Shoven eds. (1983): '*Financial Aspects of the United States Pension System*', University of Chicago Press, Chicago.

Bodie Z., A.J. Marcus & Merton R.C. (1988): '*Defined Benefit versus Defined Contribution Pension Plans: What Are the Real Trade-offs?*', in: Bodie Z., Shoven J.B. & Wise D.A.: '*Pensions in the U.S. Economy*', Chicago Press, Chicago.

Bodie Z., J.B. Shoven & D.A. Wise eds. (1983): '*Issues in Pension Economics*', University of Chicago Press, Chicago.

Bodie Z., J.B. Shoven & D.A. Wise eds. (1988): '*Pensions in the U.S. Economy*', Chicago Press, Chicago.

Bolhuis E. A. & W.J. Vossers (1986): '*Pensioenfondsen in Nederland: een modelanalyse*', Occasional Paper nr. 38, Centraal Planbureau Den Haag.

Bolhuis E. A. & W.J. Vossers (1990): 'Macropensioenmodel en beleid', in: Petersen C. (red): *Pensioenen: Uitkeringen, Financiering en Beleggінging*, Leiden

Bomhoff E.J. (1983): '*Indexatie van de staatsschuld*'. in: Rotterdamse Monetaire Studies, nr. 12.

Böss D. & S. Cnossen (eds): '*Fiscal implications of an Aging Population*', Springer Verlag, Berlin.

Bovenberg A.L. (1991): '*Overvloed en onbehagen. Over sparen en investeren in Nederland*', Oratie Tinbergen Instituut, Rotterdam.

Bovenberg A.L. (1992): 'Fiscus en vergrijzing: naar een ander fiscaal systeem?', in: *Weekblad voor Fiscaal Recht*, 24 decemeber 1992, pp. 1819-1829.

Bovenberg A.L. (1993): 'Een nieuwe fiscale behandeling van pensioenfondsen', in: *ESB*, 27-1-1993

Bovenberg A.L. & Petersen C. (1992): 'Public Debt and Pension Policy', *Fiscal Studies* vol. 13, pp. 1-14.

Bovenberg A.L., D.P. Broer & E.W.M.T. Westerhout (1993): 'Public Pensions and Declining Fertility in a Small Open Economy: An Intertemporal Equilibrium Approach', in: *Public Finance*, Vol. 148, 1993, pp. 43-59.

Brandts J. & C.A.M. de Bartolome (1992): 'Population uncertainty, social insurance, and actuarial bias', in: *Journal of Public Economics* 47, 361-380.

Breunesse E.A. (1995): '*Visie op Pensioenen in de 21e Eeuw*', Rijswijk.

Breyer F. (1989): 'On the intergenerational Pareto efficiency of pay-as-you-go financed pensions systems', in: *Journal of Institutional and Theoretical Economics*, 1989, vol. 145, pp. 643-657.

Breyer F. (1994): 'The political economy of intergenerational redistribution' in: *European Journal of Political Economy*, 10, pp. 61-84,

Breyer F. & M. Straub (1993): 'Welfare effects of unfunded pension systems when labor supply is endogenous', *Journal of Public Economics*, 1993, vol. 50, pp. 77-91.

Broer D.P., E.W.M.T. Westerhout & A.L. Bovenberg (1993): '*The tax treatment of pension savings in a small open economy*', Research Memorandum 9303, OCfEB, Rotterdam.

Browning E.K. (1975): 'Why the social insurance budget is too large in a democray', in: *Economic Inquiry* 13, pp. 378-387.

Buiter W. H. (1981): 'Time preferences and International Lending and Borrowing in an Overlapping-Generations Model', *Journal of Political Economy*, vol 89, no. 4, pp. 769-797.

Bulow J.I. (1982): 'What are Corporate Pension Liabilities?', in: *Quaterly Journal of Economics*, 97, pp. 435-52.

Bulow J.I., R. Morck & l. Summers (1987): 'How Does the Market Value Unfunded Pension Liabilities?', in : Bodie Z., J.B. Shoven & D.A. Wise eds. (1987): '*Issues in Pension Economics*', University of Chicago Press, Chicago.

Burbidge J.B. (1983): ' Social security and savings plans in overlapping-generations models' in: *Journal of Public Economics*, 21, pp 79-92.

Caballero R.J. (1991): 'Earnings uncertainty and aggregate wealth accumulation', in: *American Economic Review* , vol 81(4), pp. 859-871.

CEC (Centrale Economische Commissie) (1991): '*Advies Overschot op de Lopende Rekening en Pensioenbesparingen*', Den Haag, 1991.

Coopers & Lybrand (1994): '*Bezuinigingen op de AOW*', onderzoeksrapport Sectorgroep Pensioenfondsen, Den Haag.

Copeland T.E. & J.F. Weston (1989): *Financial Theory and Corporate Policy*, Addison-Wesley Publishing Company, 3rd edition.

CPB (1992): '*Nederland in drievoud*', 1992, Den Haag.

CPB (1992): '*Scanning the Future, A Long-term Scenario Study of the World Economy 1990-2015*', SDU Publishers, Den Haag

Custers J.J.L. (1990): 'Indexleningen geen panacee voor budgettaire problemen', *ESB*, 4-7-1990, pp. 613-616.

Cutler D.M., J.M. Poterba, L.M. Sheiner & L.H. Summers (1990): 'An aging society: opportunity or challenge?', in: *Brookings Papers Economic Activity*, 1, pp. 1-73.

Dalen van H.P. (1991): 'De prijs van de AOW', in: *ESB*, 11-12-1991.

Dalen van H.P. (1992): '*Economic Policy in a Demographically Divided World*', Springer Verlag, Berlin.

Dalen van H.P. & B.M.S. van Praag (1993): 'Public pensions, market power and intergenerational confidence', in: *Public Finance*, 48, pp. 16-28.

Davis E. (1991): 'The development of pension funds in the major industrial countries', paper prepared for the conference: 'Planning for Retirement in Europe', Centre for European Policy Studies, november 1991, Brussel.

Deaton A. & J. Meulbauer (1980): '*Economics and Consumer Behavior*', Cambridge University Press, Cambridge.

Dekkers G.J.M. (1994): '*Intergenerational Redistribution of Income through Additional Pension Schemes*', WORC Paper 94.02.011/2, Tilburg.

Diamond P. (1977): 'A Framework for Social Security Analysis', *Journal of Public Economics* 8, pp. 275-298.

Diamond P. A. (1965): 'National Debt in a Neoclassical Growth Model', *American Economic Review*, pp. 1126-1150.

Dornbusch R. & M. Simonsen eds. (1983): '*Inflation, Debt and Indexation*', MIT Press, Massachussets.

Easley D., N.M. Kiefer & U.M. Possen (1985): 'An Equilibrium Analysis of Optimal Unemployment Insurance and Taxation', in: *The Quaterly Journal of Economics* 100 Supplement, pp. 989-1010.

Easley D., N.M. Kiefer & U.M. Possen (1993): 'An Equilibrium Analysis of Fiscal Polic and Incomplete Markets', in: *International Economic Review* 4, pp. 935-952.

Eaton J. & H.S. Rosen (1980): 'Optimal Redistributive Taxation and Uncertainty', in: *The Quaterly Journal of Economics*, pp. 357-364.

Eckstein Z., M.S. Eichenbaum & D. Peled (1983): 'Uncertain lifetimes and the welfare enhancing properties of annuity markets and social security', in: *Journal of Public Economics*, 26, pp. 303-326.

Eckstein Z., M.S. Eichenbaum & D. Peled (1985): 'The distribution of wealth and welfare in the presence of incomplete annuity markets', in: *Quaterly Journal of Economics*, 100, pp. 789-807.

Enders W. & H.E. Lapan (1982): 'Social security, taxation and intergenerational risk-sharing', in: *International Economic Review*, 23, pp. 647-658.

Enders W. & H.E. Lapan (1993): 'A Model of First and Second-Best Social Security Programs' in '*Public Pension Economics*', Supplementum 7, *Journal of Economics*.

Felderer B. ed. (1993): 'New Issues in Public Pension Economics', in: *Public Pension Economics*', Supplementum 7, *Journal of Economics*.

Feldstein M.S. (1978): 'Do private pensions increases national savings?' in: *Journal of Public Economics* 7, pp. 277-293.

Feldstein M.S. (1983): '*Should private pensions be indexed?*', in: Bodie & Shoven ed. (1983), pp. 211-230.

Feldstein M.S. (1985): 'The optimal level of social security benefits', in: *Quaterly Journal of Economics*, 100, pp. 303-320.

Feldstein M.S. & R. Morck (1983): 'Pension Funding Decisions, Interest Rate Assumptations, and Share Prices', in: Bodie Z., J.B. Shoven & D.A. Wise eds. (1987): '*Issues in Pension Economics*', University of Chicago Press, Chicago.

Fischer S. (1986a): 'Welfare aspects of Government Issue of Indexed Bonds', in: Fischer S.: '*Indexing, Inflation and Economic Policy*', the MIT Press, Massachusetts.

Fischer S. (1986b): On the Non-existence of Privately Issued Index Bonds in the U.S. Capital Market', in Fischer S.: '*Indexing, Inflation and Economic Policy*', the MIT Press, Massachusetts.

Friedman B.M. (1983): 'Pension Funding, Pension Asset Allocation, and Corporate Finance: Evidence from Individual Company Account', in: Bodie Z., J.B. Shoven & D.A. Wise eds. (1987): '*Issues in Pension Economics*', University of Chicago Press, Chicago.

Frijns J.M.G. (1990): '*Economie en Pensioenen: Theorie*', in: Petersen C. ed. (1990)

Frijns J.M.G. & J.H.W. Goslings (1989): ' 'Matching' voor het pensioenbedrijf', *ESB* 6-9-1989, pp. 868-871.

Frijns J.M.G. & J.H.W. Goslings (1990): 'Matching in Nominale en Reële termen', in: Het Verzekeringsarchief, pp. 177-201.

Frijns J.M.G. & C. Petersen (1992): 'Financing, administration and portfolio management: How secure is the pension promise?', in: '*Private Pensions and Public Policy*', OECD Social Policy Studies no. 9, Paris.

Gale D. (1990): 'The Efficient Design of Public Debt', in: Allen F. & D. Gale: '*Financial Innovation and Risk Sharing*', The MIT Press, Massachusetts.

Gordon R.H. & Varian H. R. (1988): 'Intergenerational risk-sharing', in: *Journal of Public Economics* 14 pp. 1-29.

Goslings (1994): '*The structure of pension benefits and investment behaviour*'in: Papers and Proceedings 9401 OCfEB Rotterdam 1994.

Green J.R. (1977): '*Mitigating demographic risk through social insurance*', NBER Working Paper no. 215.

Gustman A.L. & O.S. Mitchell (1990): 'Pensions and Labor Market Activity: Behavior and Data Requirements', in: Bodie Z. & A.H. Munnell(eds): '*Sources, Uses, and Limitations of Data*', Pension Research Council, Pennsylvania.

Gustman A.L., O.S. Mitchell & T.L. Steinmeier (1993): '*The Role of Pensions in the Labor Market*', NBER Working Paper 4295, March 1993.

Hertog den J.A. & M. Kraamwinkel (1991): 'Pensioennadelen in het licht van de contracttheorie', in: *ESB* 11-9-1991, pp. 908-912.

Hilbrand M.W.J. (1990): 'De financiering van pensioenen, deel 2', in Petersen (red): *Pensioenen: Uitkeringen, Financiering en Beleggingen*, Leiden.

Holzmann R. (1992): 'The provision of complementary pensions: Objectives, forms and constraints', *International Social Security Review*, pp. 75-93.

Homburg S. (1990): 'The efficiency of unfunded pension schemes' in: *Journal of Institutional and Theoretical Economics*, 1990, vol. 146, pp. 640-647.

Homburg S. & W.F. Richter (1993): 'Harmonizing Public Debt and Public Pension Schemes in the European Community', in: *Journal of Economics*, Supplementum 7, pp. 51-64.

Huijser A.P. (1990): 'Capital Market Effects of the Ageing Population; The Dutch Pension System in the Long Run', in: *European Economic Review* 1990, pp. 987-1009.

Huijser A.P. & P.D. van Loo (1986): '*Vergrijzing, pensioenen en contractuele besparingen*', in: DNB Monetaire Monegrafieën Nr. 5, Amsterdam.

Huizen van Ph.H.J.G. & P.M.C. de Lange (1994): '*Pensioenverzekering*', 2e druk, Tjeenk Willink, Zwolle.

Hurd M.D. (1990): 'Research on the elderly: economic status, retirement, and consumption and saving', in: *Journal of Economic Literature*, xxviii, pp. 565-637.

Ippolito R.A. (1987): 'The Implicit Pension Contract: Developments and new Directions', in: *Journal of Human Resources*, 1987, pp. 441-464.

Jacobsen H., S.E.H. Jensen & S.O. Nielsen (1994): 'Population Ageing, Public Expenditures andSustainable Tax Policy', paper presented at the ESF-conference 'Economics of Ageing' 25-29 june 1994, Sitges Spain.

Jensen S.E.H. & S.B. Nielsen (1993): 'Ageing, Intergenerational Distribution and Public Pension Systems', in: *Public Finance* 48, 1993, pp. 29-42.

Johnson P. (1991): 'The taxation of occupational and private pensions in Europe: the theory and practice', paper prepared for the conference: 'Planning for Retirement in Europe', Centre for European Policy Studies, november 1991, Brussel.

Karni E. & I. Zilcha (1989): 'Aggregate and Distributional Effects of Fair Social Security', in: *Journal of Public Economics* 40, pp. 37-56.

Keuzenkamp H.A. & F. van der Ploeg (1993): 'Pensioen, belasting en staatsschuld', in: *Maandschrift Economie* 57, pp. 179-191.

Kotlikoff L.J. (1988): 'Intergenerational Transfers and Savings', in: *Journal of Economic Perspectives,* 1988, pp. 41-58.

Kotlikoff L.J. & A. Spivak (1981): 'The family as an incomplete annuities market', in: *Journal of Political Economy* 90, pp 372-391.

Kotlikoff L.J., T. Persson & L.E.O. Svensson (1988): 'Social Contracts as Assets: A Possible Solution to the Time-Consistency Problem', in: *American Economic Review* 78, pp. 662-677.

Kuné J.B. (1987): '*Pensioen en economie; enige financieel-economische aspecten van pensioenvoorzieningen*', Instituut voor Actuariaat en Econometrie, Amsterdam.

Lange de P.M.C. (1994): '*Pensioen regelen en verzekeren*', Kluwer, Deventer.

Lindbeck A. (1994): 'Uncertainty under the Welfare State: Policy-induced risk', Research Memorandum 9403 OCfEB Rotterdam.

Lutjens E. (1989): '*Pensioenvoorzieningen voor werknemers. Juridische beschouwingen over ouderdomspensioen*', Tjeenk Willink, Zwolle.

Marchand M. & P. Pestieau (1991): 'Public pensions; choices for the future', in: *European Economic Review,* 35, pp. 441-453.

McKenna C.J. (1986): '*The Economics of Uncertainty*', Wheatsheaf Books, Brighton.

Merton R.C. (1983): 'On Consumption Indexed Public Pension Plans', in: Z. Bodie & J. Shoven (eds.): '*Financial Aspects of the U.S. Pension System*', Chicago, 1983 . Reprinted as chapter 18 in: R.C. Merton: '*Continuous-Time Finance*', 1990, Prentice-Hall.

Merton R.C. (1987): 'On the Role of Social Security as a Means for Efficient Risk Sharing in an Economy Where Human Capital Is Not Tradeable', in: Bodie Z. & J.B. Shoven eds. (1987): '*Financial Aspects of the United States Pension System*', Chicago.

Ministerie van Sociale Zaken en Werkgelegenheid (1991): '*Pensioennota*', Den Haag.

Modigliani F. (1988): 'The role of intergenerational transfers and life cycle savings in the accumulation of wealth', in: *Journal of Economic Perspectives*, 1988, pp. 15-40.

Mortensen J. ed. (1992): '*The Future of Pensions in the European Community*', Centre for European Policy Studies, Brussels.

Munnel A.H. & J.B. Grolnic (1986): '*Should the US Government Issue Index Bonds?*', in: New England Economic Review, sept/oct., pp. 2-21.

Nelissen J.H.M. (1993): '*The redistributive impact of Social Security Systems on Lifetime Labour Income*', Dissertation Tilburg University, Reeks Sociale Zekerheidswetenschap rapporten no. 22, Tilburg.

Nelissen J.H.M. (1994): '*Towards a payable pension system: Costs and redistributive impact of the current Dutch pension system and three alternatives*', Tisser, Tilburg.

Nelissen J.H.M. & H.A.A. Verbon (1993): 'Ouderen voor jongeren', *ESB*, 8-9-1993, pp. 817-821.

Pensioenkamer (1989): '*Pensioenkaart van Nederland*', Den Haag.

Persson T. (1985): 'Deficits and intergenerational welfare in open economies', *Journal of International Economics* 19, pp. 67-84.

Petersen C. (1989): '*Economie&Pensioenen*', Stenfert Kroese, Leiden

Petersen C. ed (1990): '*Pensioenen: uitkeringen, financiering en beleggingen*', Stenfert Kroese, Leiden.

Petersen C. (1992): 'De vermogensoverschotheffing bij pensioenfondsen', in: ESB, 26-8-92, pp. 816-820.

Petrie M. & P. Sturm (1991): ' *Old Age Income Maintenance: Basic Problems and Alternative Responses*', OECD Working Papers no. 100.

Ponds E.H.M. (1991): 'Besparingen en pensioenregelingen in Nederland', in: *Maandschrift Economie* 55, pp. 283-295.

Ponds E.H.M. (1992): 'Pensioenbesparingen en stabiliteit', in: *Tijdschrift voor Politieke Ekonomie*, jaargang 14, pp. 47-63.

Ponds E.H.M. et al. (1992): '*Financiële markten en instellingen*', Open universiteit Heerlen.

Ponds E.H.M. (1993): 'Werkloosheidsverzekering op basis van kapitaaldekking', in: *ESB* 78, pp. 328-331.

Ponds E.H.M. (1993): 'Inkomensoverdrachten binnen het Nederlands pensioenbestel', in: *Tijdschrijft voor Bedrijfsadministratie*, 97, pp. 506-510.

Razin A. & Sadka E. (1995): '*Population Economics*', the MIT Press, Massachusetts.

Rawls J. (1971): '*A theory of justice*', Cambridge, Massachusetts.

Richter W.F. (1993): 'Intergenerational risk sharing and social security in an economy with land', in: *Public Pension Economics*', Supplementum 7, *Journal of Economics*.

Robison L.J. & P.J. Barry (1987): '*Competitive firm's response to risk*', New York.

Samuelson P.A. (1958): '*An extract consumption loan model of interest with or without the soical contrivance of money*', in: Journal of Political Economy, 66, pp. 467-482.

Samuelson P.A. (1975): 'Optimum social security in a life-cycle growth model', in: *International Economic Review*, 16, 539-544.

Samuelson P.A. (1983): '*Comment*' , in: Bodie Z. & J.B. Shoven eds. (1983): '*Financial Aspects of the United States Pension System*', University of Chicago Press, Chicago.

Siandra E. (1994): 'Social Security under Uncertainty and Dynamic Efficiency', mimeo, Cambridge England.

Sjoblom K. (1985): 'Voting for Social Security', in: *Public Choice*, vol. 45, pp. 221-240.

Smith A. (1982): 'Intergenerational transfers as social insurance', *Journal of Public Economics*, 19, 97-106.

Sinn H.W. (1989): '*Economic Decisions Under Uncertainty*', Physica-Verlag Heidelberg.

Stichting van de Arbeid (1969): '*Nota inzake het pensioenvraagstuk*', Commissie Sociale Verzekering.

Stiglitz J.E. (1983): 'On the Relevance or Irrelevance of Public Financial Policy: Indexation, Price Rigidities, and Optimal Monetary Policies ', in: Dornbusch R. & Simonsen M. H. (ed.): '*Inflation, Debt and Indexation*', MIT Press Cambridge.

Sturm P. (1991): '*Old-age income maintenance and ageing population - basic facts and problems*', paper presented at the conference 'Planning for Retirement in Europe' 28-29 november 1991, Centre for European Policy Studies, Brussels.

Summers L.H. (1983): 'Observations on the Indexation of Old Age Pensions', in: Bodie Z. & Shoven J.B. (eds.): '*Financial Aspects of the United States Pension System*', University of Chicago Press, Chicago.

Temminck Tuinstra A.J. (1991): 'Middelmatig beter dan goed', in: *ESB*, 17-7-1991.

Thaler R.H. & H.M. Shefrin (1981): 'An economic theory of self-control', in: *Journal of Political Economy*, vol. 89, pp. 392-405.

Thompson L.H. (1983): 'The social security reform debate', in: *Journal of Economic Literature*, xxi, pp. 1425-1467.

Thompson L.H. (1988): 'Altering the public/private mix of retirement incomes' in: Wachter S.M. (ed): '*Social Security and Private Pensions*', Massachusetts.

Varian H.R. (1980): 'Redistributive Taxation as Social Insurance', in: *Journal of Public Economics* 14, pp. 49-68.

Veall M.R. (1986): 'Public pensions as optimal social contracts', in: *Journal of Public Economics*, 31, pp 237-251.

Verbon H.A.A. (1988): '*The Evolution of Public Pension Schemes*' Berlin Heidelberg.

Verbon H.A.A. (1989): 'Conversion Policies for Public Pension Plans in a Small Open Economy', in: Gustafsson B.A. & N.A. Klevmarken (ed.): '*The Political Economy of Social Security*', Amsterdam.

Verbon H.A.A. (1990); 'Decision Making on Old-Age Transfers' in: R. van der Ploeg ed, '*Advanced Lectures in Quantitative Economics*', Academic Press, New York, pp. 169-210.

Verbon H.A.A. (1993): 'Public pensions. The role of public choice and expectations', in: *Journal of Population Economics*, 6, pp. 123-135.

Verbon H.A.A. & M.J.M Verhoeven (1991): 'Een slechte pensioennota', in *ESB*, 31-7-1991, pp. 780-781.

Verbon H.A.A. & M.J.M. Verhoeven (1992): 'Decision making on pension schemes under rational expectations', in: *Journal of Economics*, 56, pp. 71-97.

Vermaat A.J. (1988): '*Over de rekenrente*', lecture at 100th anniversary of "Actuarieel Genootschap".

Vermaat A.J. & R. van Dam (1991): 'Het belasten van pensioenmiddelen', *ESB*, pp. 545-549.

Verzekeringskamer (1995): '*Financiële gegevens pensioenfondsen 1993*' , Apeldoorn.

Wise D.A. (ed.) (1986): '*Pensions, labor and individual behavior*', University of Chicago Press, Chicago.

Woittiez I., M. Lindeboom & J. Theeuwes (1994): '*Labour Force Exit Routes of the Dutch Elderly: A Discrete Choice Model*' in: Papers and Proceedings 9401 OCfEB Rotterdam 1994

Wolff C.C.P. (1991): '*Pensioen onder druk; een economische analyse*', Stichting voor Ondernemingspensioenfondsen.

World Bank (1994): '*Averting the Old Age Crisis; Policies to Protect the Old and Promote Growth*', Oxford University Press.

WRR (Wetenschappelijke Raad voor Regeringsbeleid) (1993): '*Ouderen voor Ouderen; Demografische ontwikkelingen en beleid*', Den Haag.

Zalm G. (1990): 'Flexibele pensioenpremies en macro-economisch beleid', in: *ESB*, 5-12-1990.

Samenvatting
(Summary in Dutch)

1 Inleiding

In Nederland zijn de collectieve aanvullende pensioenvoorzieningen in hoofdzaak opgezet als een eindloonregeling met waardevaste of zelfs welvaartsvaste pensioenuitkeringen. Een dergelijke regeling biedt aan de deelnemende werknemers zekerheid ten aanzien van de levensstandaard na pensionering. Onder meer als gevolg van vergrijzing en de trend tot individualisering is de bestaande opzet ter discussie gekomen. Centraal thema van dit proefschrift is het analyseren van de welvaartsaspecten van een eindloonregeling voor de deelnemende werknemers. In het bijzonder wordt hierbij aandacht besteed aan de welvaartsaspecten die samenhangen met de geboden zekerheid ten aanzien van de levensstandaard na pensionering. Verzekeringsaspecten van pensioenen zijn een onderbelicht thema. Dit geldt zowel voor de theoretische literatuur als ook voor de beleidsdiscussies omtrent herziening van de bestaande pensioenregelingen. Deze studie wil een bijdrage leveren in de pensioendiscussie vanuit met name het verzekeringsaspect. Voordat de inhoud van het proefschrift wordt samengevat, zal eerst op kenmerken van het aanvullende pensioentraject in Nederland worden ingegaan als ook op de achtergronden van de hedendaagse discussie over de huidige opzet.

2 Het aanvullende pensioentraject in Nederland

2.1 Eindloonregeling

Het stelsel van pensioenvoorzieningen in Nederland kan worden getypeerd als een drie-lagen-stelsel.

1) De eerste laag is het *basispensioen van overheidswege* uit hoofde van de Algemene Ouderdomswet (AOW) en de Algemene Weduwen- en Wezenwet (AWW). Het basispensioen is in beginsel bestemd voor alle ingezetenen. De financiering is gebaseerd op het omslagstelsel, dat wil zeggen dat de uitkeringen in een bepaald jaar omgeslagen over degene die in dat jaar premieplichtig zijn.
2) De tweede laag bestaat uit *collectieve pensioenvoorzieningen voor werknemers*. Deze voorzieningen omvatten het geheel van regelingen binnen dienstverband bij bedrijven en overheden, die een *aanvullend* pensioeninkomen verschaffen op het basispensioen van overheidswege.
3) De derde laag bestaat uit oudedagsvoorzieningen die geheel op *individuele basis* worden gerealiseerd. Deze voorzieningen worden getroffen door hen die geen of onvoldoende pensioeninkomen kunnen opbouwen (vrije beroepen, ondernemers) of die naast hun aanvullende pensioenaanspraken een extra oudedagsvoorziening wensen.

Dit proefschrift handelt over de collectieve pensioenvoorzieningen voor werknemers, de tweede laag van het pensioenstelsel. Veelal zijn deze voorzieningen opgezet als een *pensioentoezeggingsysteem* ('defined-benefit plan'). In hoofdzaak gaat het hierbij om eindloonregelingen met waardevaste of welvaartsvaste pensioenuitkeringen: het toegezegde pensioen is uitgedrukt als percentage van het laatstgenoten loon en een ingegaan pensioen is geïndexeerd voor prijsstijging (waardevast) of loonstijging (welvaartsvast). Het aanvullend pensioeninkomen kan ook gerelateerd zijn aan het loon dat men gemiddeld tijdens de actieve periode heeft genoten. Een dergelijke regeling staat bekend als middelloonregeling. Aan eindloon- en middelloonregelingen ligt de gedachte ten grondslag dat de werknemer na pensionering over een inkomen kan beschikken dat vergelijkbaar is met het looninkomen tijdens de werkzame periode, zodat men in staat is om gedurende de oude dag de levensstandaard te continueren.
De financiering van aanvullende pensioenregelingen is gebaseerd op het kapitaaldekkingsstelsel: de premiebetalers sparen collectief voor het aanvullende pensioeninkomen, waarbij de afgedragen premies tijdens de actieve periode te samen met de gekweekte beleggingsinkomsten hierover een collectief vermogen vormen, dat - rekening houdend met sterftekansen en dergelijke - voldoende groot is om aan de deelnemers bij het bereiken van de pensioengerechtigde leeftijd de toegezegde pensioenuitkeringen te kunnen doen. Het opgebouwde vermogen is daarbij ondergebracht in pensioenfondsen of verzekeringsmaatschappijen. Collectieve pensioenregelingen kunnen zijn georganiseerd per bedrijfstak of per onderneming. De optimale vorm van kapitaaldekking is dat op ieder moment het evenredige deel van de pensioen-

toezegging is gefinancierd en dat de premiesom in een bepaalde periode gelijk is aan de contante waarde van nieuw verworven aanspraken gedurende die periode. Hier wordt meestal niet aan voldaan, vaak alleen al omdat op de lange termijn het beleggingsrendement en de loonstijging aan grote onzekerheden onderhevig zijn. Structurele verschillen tussen de opgebouwde premiereserve en de contante waarde van de verworven aanspraken zijn voor rekening van de premiebetalers en zullen leiden tot aanpassing in de verschuldigde premie. In de aanvullende pensioenregelingen bestaat er dan ook geen vast verband tussen de voor een individu of generatie ingelegde premies en de aanvullende pensioenuitkering dat uiteindelijk wordt verkregen. Hierdoor treden er tussen de deelnemende generaties inkomensoverdrachten op en kan gesproken worden van intergenerationele deling van risico's ten aanzien van onder meer looninflatie en beleggingsrendement.
Naast (intergenerationale) transfers als gevolg van fluctuaties in de economische kernvariabelen, treden er inkomensoverdrachten op doordat bij de vaststelling van de premie geen rekening wordt gehouden met verschillen tussen deelnemers naar met name niveau en ontwikkeling van het salaris, arbeidsverleden, sterftekans en gender. In veel pensioenregelingen wordt jaarlijks een zgn. doorsneepremiepercentage bepaald. Dit premiepercentage is gelijk voor alle deelnemers. Hierdoor betalen deelnemers waarvan de pensioenaanspraken minder dan gemiddeld toenemen mee aan de vermogensopbouw ten behoeve van de aanspraken van deelnemers die meer dan gemiddeld zijn toegenomen. De hantering van de doorsneepremie in een eindloonregeling leidt er toe dat degenen die laat in hun carrière een sterke verbetering van het salaris kunnen realiseren een hoog pensioen ontvangen in relatie tot de premies die zij hebben ingebracht. Bijgevolg dienen werknemers met een (minder dan) gemiddeld carrièreverloop een hogere premie te betalen dan op grond van hun pensioenaanspraken benodigd is. De deelnemers verschillen ook in (verwachte) levensduur, waardoor kort-levenden bijdragen aan de pensioenopbouw van lang-levenden. Herverdeling van vrouwen naar mannen kan optreden, omdat mannen gemiddeld genomen een steiler salarisverloop en een hoger inkomen kennen dan vrouwen. Maar er is ook herverdeling van mannen naar vrouwen doordat vrouwen gemiddeld genomen langer leven. Het netto-effect is dan ook op voorhand niet duidelijk.
Inkomensoverdrachten binnen pensioenregelingen als gevolg van verschillen tussen de individuele deelnemers wat betreft salarisontwikkeling, sterftekans, gender en dergelijke, komen in dit proefschrift in het algemeen niet aan de orde. De aandacht is primair gericht op inkomensoverdrachten als gevolg van intergenerationele financiering en risicodeling.

2.2 Hervorming

Uit recent onderzoek blijkt dat de deelnemers aan een eindloonregeling de opzet en geboden zekerheden in grote mate positief waarderen (Coopers & Lybrand 1994). Desondanks is de huidige opzet van collectieve pensioenregelingen in discussie, onder meer als gevolg van de vergrijzing van de (beroeps-) bevolking in de komende decennia en de trend tot toenemende individualisering.
De *vergrijzing* zal tot gevolg hebben dat naast de AOW ook via het aanvullende pensioentraject inkomensherverdeling zal optreden ten laste van de toekomstige generaties. Dit stelt de solidariteit tussen generaties op de proef. Momenteel (midden jaren negentig) zijn diverse hervormingsvoorstellen in discussie ter beperking van de inkomensherverdeling via het aanvullende pensioentraject. Een gemeenschappelijk element in deze voorstellen is dat de huidige generaties van werknemers een matiging van hun aanvullende pensioenaanspraken accepteren waardoor toekomstige generaties ontzien worden. In hoofdstuk 7 wordt nagegaan in hoeverre voor die toekomstige generaties ook daadwerkelijk positieve welvaartseffecten van deze hervormingsvoorstellen verwacht kunnen worden.
De *trend tot individualisering* krijgt onder meer zijn beslag in toenemende diversiteit in levensstijlen en loopbanen. Hierbij past het streven om werknemers meer verantwoordelijkheid en keuzevrijheid te geven bij de invulling van hun eigen oudedagsvoorziening. Momenteel is in discussie de collectieve pensioenverzekeringen - ten dele - te vervangen door een *premietoezeggingssysteem* ('defined-contribution plan'). In dit systeem, ook bekend als beschikbare premieregeling, wordt voor de individuele werknemer jaarlijks een vast percentage van het salaris als premiesom gestort op een individuele rekening. Het opgebouwde pensioen is uiteindelijk bepaald door de som van individuele premiestortingen plus de hiermee gekweekte beleggingsopbrengsten. Deze regeling is bij uitstek geschikt om werknemers hun aanvullend pensioen naar eigen wensen, inzichten en behoeften te laten invullen. Groot nadeel evenwel bij een premietoezeggingssysteem is dat de beleggingsrisico's geheel voor rekening komen van het individu zelf. In hoofdstuk 4 staat de vraag centraal in hoeverre de overheidsfinanciën gebruikt kunnen worden om aan individuele werknemers, die genoodzaakt zijn deel te nemen aan premietoezeggingssystemen, dezelfde inkomenszekerheden verschaft kunnen worden als die waarop men uitzicht heeft wanneer men kan participeren in een pensioentoezeggingssysteem.

3 Doelstelling

'Bezint eer ge hervormt'. Deze variant van een bekend gezegde lijkt een geschikt motto voor het proefschrift. Het proefschrift wil laten zien dat de bestaande opzet van het aanvullend pensioentraject met aan het eindloon (of het middelloon) gerelateerde pensioenuitkeringen, unieke welvaartsverhogende kenmerken heeft. Dit betreft ten eerste de geboden mogelijkheid tot intergenerationele deling van beleggingsrisico's en loonpadrisico, en ten tweede de geboden zekerheid ten aanzien van de levensstandaard tijdens de oude dag. Er zijn op de particuliere markt geen verzekeringscontracten beschikbaar waarmee op individuele basis risico's omtrent levensstandaard, looninflatie en beleggingen op soortgelijke wijze als bij een eindloonregeling kunnen worden afgedekt.
In deel I van het proefschrift wordt een theoretisch raamwerk ontwikkeld teneinde de welvaartsverhogende aspecten te analyseren van collectieve pensioenverzekeringen op basis van intergenerationele risicodeling. De inkomenszekerheden van collectieve pensioenverzekeringen zijn niet beschikbaar voor hen die individuele pensioenbesparingen aanhouden binnen een beschikbare premieregeling. In deel I wordt ook nagaan in hoeverre de overheidsfinanciën ingezet kunnen worden om de zekerheden van eind- (en middel)loonregelingen te reproduceren. Het basisidee is om beleggingsrisico's waarmee individuele pensioenbesparingen zijn behept, door de collectiviteit van (jonge en oude) belastingbetalers te laten dragen.
In deel II van het proefschrift wordt met behulp van de ontwikkelde concepten van deel I de huidige aanvullende pensioenregelingen in Nederland geëvalueerd. Vervolgens wordt een aantal hervormingstellingen gewaardeerd op hun implicaties voor de welvaart van de betrokken deelnemende individuen en generaties.

De doelstelling is als volgt naar onderwerpen per hoofdstuk uitgewerkt:

Deel I *Aanvullend pensioen, welvaart en risicodeling*
- het belang van interventies in de voorzieningen voor de oude dag, en de welvaartsaspecten van intergenerationele risicodeling in pensioenregelingen van overheidswege of binnen dienstverband in bedrijven of overheden (hoofdstuk 2);
- een formele analyse van de welvaartseffecten van een pensioentoezeggingssysteem gebaseerd op intergenerationele risicodeling; de situatie van een gesloten economie als ook van een open economie met internationale arbeidsmobiliteit worden beschouwd (hoofdstuk 3);

- de inzet van overheidsfinanciën teneinde de voordelen van een pensioentoezeggingssysteem (verzekering tegen levensstandaardrisico en intergenerationele risicodeling) en de voordelen van een premietoezeggingssysteem (individuele keuzevrijheid) te combineren (hoofdstuk 4);
- de invloed op de variabiliteit van de overheidsfinanciën van de twee verschillende methoden van fiscale behandeling van pensioenbesparingen: de voorheffingsvariant versus de omkeerregel (hoofdstuk 5).

Deel II *Aanvullende pensioenregelingen in Nederland en evaluatie van hervormingsvoorstellen*:
- een typering van financieringswijzen van de pensioentoezeggingssystemen en de mate van actuariële equivalentie (hoofdstuk 6);
- vergrijzing, de veronderstelde noodzaak tot hervorming en de afruil in welvaart tussen enerzijds het door de hervormingen geïnduceerde verlies in verzekerd aanvullend pensioeninkomen en anderzijds de geïnduceerde winst in levensduurinkomen (hoofdstuk 7).

4 Inhoud naar hoofdstukken

Hoofdstuk 2 bevat een bespreking van de relevante literatuur ten aanzien van de welvaartsaspecten van verschillende pensioensystemen. Aangegeven wordt dat de theoretische literatuur vooral aandacht heeft besteed aan het basispensioen van overheidswege met financiering op basis van het omslagstelsel. Een klassieke bijdrage is Diamond (1977), die vanuit de normatieve welvaartseconomie drie categorieën van argumenten onderscheidt, die een rechtvaardiging bieden voor overheidsbemoeienis met oudedagsvoorzieningen, te weten: het belang van *paternalisme,* dat gerelateerd is aan de bekwaamheid van individuen tot een gewenste spreiding van levensduurinkomen over levensduurconsumptie, gewenste *inkomensherverdeling* van jonge actieve generaties naar oude, inactieve generaties, en *marktfaling,* met name het in gebreke blijven van de particuliere verzekeringsmarkt in het aanbieden van gewenste verzekeringen tegen risico's die samenhangen met het oudedagsinkomen. Vergeleken met de aandacht voor het overheidspensioen, is de theoretische discussie in de economische literatuur naar de bestaansgronden en welvaartsaspecten van aanvullende pensioenregelingen voor werknemers tamelijk beperkt van aard. Er wordt uiteengezet dat argumenten die het overheidspensioen rechtvaardigen ook relevant kunnen zijn voor het rechtvaardigen van een pensioentoezeggingssysteem met (eind- of middel-) loongerelateerde pensioenuitkeringen. Een dergelijke pensioenregeling kan zekerheid bieden ten aanzien van de levensstandaard tijdens de oude dag. Levensstandaardrisico is

gedefinieerd als onzekerheid of het uiteindelijke pensioeninkomen voldoende groot is om de standaard waaraan men gewend is of die geprefereerd wordt, tijdens de oude dag ook te kunnen realiseren. De geboden zekerheid is mogelijk doordat risico's aangaande beleggingsrendement en de looninflatie collectief gedragen wordt door de deelnemende jonge en oude werknemers. Een pensioentoezeggingssysteem is dan ook te typeren als een intergenerationeel verzekeringscontract. Bij een dergelijk contract is vrijwillige deelname van toekomstige generaties onzeker. Als het pensioenfonds kampt met een onverwacht groot tekort als gevolg van een tegenvallend rendement of hoge looninflatie, dan dienen de actieven extra premie af te dragen teneinde dit tekort aan te vullen. Naar de mate waarin arbeid meer mobiel wordt, zullen met name jonge werknemers beter in staat zijn hoge inhaalpremies te ontlopen door werk te aanvaarden buiten bedrijfstakken en bedrijven waarvan het betreffende pensioenfonds een omvangrijke tekort kent. Drie vormen van arbeidsmobiliteit zijn in dit verband relevant: - arbeidsmobiliteit van 'grijze' naar 'jonge' bedrijfstakken; - arbeidsmobiliteit van bedrijfstakken en bedrijven met 'pensioentoezeggingssystemen' naar die met 'premietoezeggingssystemen'; en tenslotte - internationale arbeidsmobiliteit. Er wordt beargumenteerd dat de omvang van 'pensioenpremie-ontwijkende' arbeidsmobiliteit van toekomstige generaties af zal hangen van de afruil tussen enerzijds hun nutswinst die samenhangt met de door de pensioenregeling geboden verzekering tegen levensstandaardrisico, en anderzijds de daling in hun nut als gevolg van verlies van levensduurinkomen, doordat zij meer premies inleggen dan zij aan pensioenuitkeringen te zijner tijd zullen ontvangen.
Het alternatief voor een pensioentoezeggingssysteem is een premietoezeggingssysteem. Dit systeem is in feite een verplichte individuele pensioenspaarregeling voor de werknemer. De beleggingsrisico's dienen dan ook door de betrokken werknemer zelf gedragen te worden. Dit nadeel wordt gecompenseerd door de voordelen van individuele keuzevrijheid ten aanzien van de invulling van de oudedagsvoorziening.

In *hoofdstuk 3* wordt binnen een formeel kader de welvaartsaspecten geanalyseerd van een *pensioentoezeggingsysteem* met financiering op basis van kapitaaldekking en intergenerationele risicodeling. Hiertoe is gebruik gemaakt van het standaard 2-perioden overlappende generaties model (Diamond 1965). In het standaardmodel wordt onzekerheid ten aanzien van de inkomensaandelen looninkomen en kapitaalinkomen geïntroduceerd, waarbij deze onzekerheid voortkomt uit demografisch risico. Een pensioentoezeggingssysteem impliceert onvermijdelijk inkomenstransfers ex post tussen de verzekerden en de sponsors die het beleggingsrisico dragen. Elke nieuw geboren generatie kan zelf beslissen over het al dan niet opstarten van een pensioen-

toezeggingssysteem en welke partij het beleggingsrisico uiteindelijk draagt. Een generatie kan daarbij besluiten om het beleggingsrisico te delen met de volgende generatie. Het is ook mogelijk dat het beleggingsrisico wordt herverdeeld binnen een generatie, en wel van individuen met een hoge risico-aversie naar hen met een lage risico-aversie. Er kunnen dan ook drie situaties worden onderscheiden. Twee van deze drie zijn als extreem te typeren: of enkel intergenerationele deling van het beleggingsrisico of enkel intragenerationele verschuiving van het beleggingsrisico. Het derde geval is een combinatie van deze twee extremen. Er wordt aangetoond dat de mate van risico-aversie van het representatieve individu bepalend is voor de opzet van het pensioentoezeggingssysteem. Naarmate zijn risico-aversie hoger is, zal de voorkeur voor intergenerationele risicodeling toenemen.
De bevindingen van het hoofdstuk worden in eerste instantie afgeleid voor een gesloten economie waarbinnen één nationaal pensioenfonds opereert en waarbij - in het geval van intergenerationele risicodeling - de jonge generatie verplicht is deel te nemen. De analyse wordt vervolgens verbreed naar de situatie van een kleine open economie met internationale arbeidsmobiliteit. Een relevante situatie is dan die waarbij het nationale pensioenfonds een tekort kent in de vermogensvorming en er geregeld is dat de jonge generatie het 'funding' risico draagt (intergenerationele risicodeling). De jonge generatie dient derhalve dit vermogenstekort aan te vullen. De veronderstelling van internationale arbeidsmobiliteit impliceert dat de jonge generatie dit inkomensverlies kan vermijden door migratie. Bijgevolg dient het vermogenstekort door de oude generatie zelf opgevangen te worden, hetgeen een verlaging van zijn pensioenaanspraken betekent. Er wordt uiteengezet dat deelname aan het pensioenfonds met een vermogenstekort toch aantrekkelijk kan zijn voor de jonge generatie vanwege de geboden zekerheid ten aanzien van het oudedagsinkomen. De vrijwillige deelname van de jonge generatie blijkt afhankelijk te zijn van de afruil tussen de nutswinst van het verzekerd zijn en het verlies in nut als gevolg van het inkomensverlies voor het aanvullen van het fondstekort.

Een aanvullende pensioenregeling kan ook worden opgezet als een *premietoezeggingssysteem*. Belangrijk nadeel van dit systeem - vergeleken met een pensioentoezeggingssysteem met loongerelateerde uitkeringen - is dat de individuele werknemer zelf beleggingsrisico's dient te dragen en dat hij geen zekerheid heeft over zijn levensstandaard tijdens de oude dag. Centrale vraag van *hoofdstuk 4* nu is in hoeverre de overheidsfinanciën ingezet kunnen worden om te komen tot een reductie van het beleggingsrisico van de individuele pensioenbesparingen aangehouden binnen een premietoezeggingssystemen. Er wordt eerst een voorstel van Bovenberg (1993) besproken die het overheids-

budget ook wil aanwenden voor het collectiviseren van het beleggingsrisico op individueel aangehouden pensioenvermogen. Zijn idee heeft betrekking op het renterisico. Het biedt derhalve geen indekking tegen het levensstandaardrisico. In het proefschrift wordt voorgesteld dat de overheid overgaat tot de verkoop van speciale obligaties aan werknemers die sparen via een premietoezeggingssysteem. Deze individuele werknemers zijn vrij om hun pensioenspaargelden in deze obligaties aan te houden. De obligaties dienen deze werknemers in staat te stellen een rendement te realiseren dat vergelijkbaar is met het rendement dat verkregen zou zijn wanneer men had deel genomen aan een pensioentoezeggingssysteem met (eind- of middel-) loongerelateerde uitkeringen. Het hoofdstuk laat zien dat dit eenvoudig gerealiseerd kan worden wanneer de overheid overgaat tot het emitteren van zogenaamde loon-index obligaties en prijs-index obligaties. Het toegezegde rendement op een loon-index obligatie bestaat uit twee delen. Allereerst het basisrendement dat gelijk is aan het verschil tussen de verwachte rentevoet en de verwachte nominale loonstijging gedurende de looptijd van de obligatie. Dit basisrendement wordt aangevuld met de feitelijke nominale loonstijging gedurende de looptijd van de obligatie. Het rendement op een prijs-index obligatie is dan gelijk aan het verschil tussen de verwachte rentevoet en de verwachte inflatie, aangevuld met de feitelijke prijsstijging. In het hoofdstuk wordt aangetoond dat bij een juiste allocatie van de individuele pensioenbesparingen over deze twee soorten obligaties, een pensioeninkomen kan worden verkregen dat vergelijkbaar is met het inkomen dat men verkregen zou hebben als men had deelgenomen in een pensioentoezeggingssysteem met loongerelateerde pensioenuitkeringen. Dit gaat als volgt. De individuele werknemer bepaalt eerst zijn gewenste pensioeninkomen, dat bijvoorbeeld voldoende groot is om zijn levensstandaard aan het einde van zijn arbeidsperiode tijdens de oude dag te kunnen voortzetten. Vervolgens verdisconteert hij het benodigde vermogen terug naar momenten waarop hij in staat is een pensioenvoorziening te treffen. De discontovoet is bepaald door het basisrendement geboden door de index-obligaties. De aldus berekende contante waarde(n) bepalen nu voor welk bedrag index-obligaties dienen te worden aangeschaft. Doordat de aangroei van de obligaties de som is van het basisrendement plus de feitelijke loon- dan wel prijsstijging, zal de totale opbrengst van de obligatie gerelateerd zijn aan het gewenste niveau van levensstandaard. De overheid zelf heeft ook profijt van de uitgifte van deze obligaties. De vergoeding op reguliere overheidsobligaties is bepaald door de rentestand. De uitgifte van de loon-index en prijs-index obligaties leidt er toe dat de verwachte rentelast op uitstaande overheidschuld ongewijzigd blijft maar de volatiliteit van deze last zal afnemen. Minder variabiliteit van de overheidsuitgaven betekent dat ook de volatiliteit in de belastingtarieven

zal afnemen, en dit draagt bij aan de welvaart van (jonge en oude) belastingbetalers. Mocht het daadwerkelijk tot uitgifte van dit soort overheidsobligaties komen, dan worden de voordelen van een pensioentoezeggingssysteem, zoals levensstandaardverzekering en collectieve of intergenerationele risicodeling, gecombineerd met die van een premietoezeggingssysteem, zoals individuele keuzevrijheid.

Hoofdstuk 5 gaat in op de betekenis van de fiscale behandeling van pensioenbesparingen voor de overheidsfinanciën. Pensioenbesparingen kunnen worden belast volgens de omkeerregel: de pensioenpremies zijn aftrekbaar, terwijl de pensioenuitkeringen belast zijn, dan wel volgens de voorheffingsvariant: de pensioenpremies zijn niet aftrekbaar maar de pensioenuitkeringen zijn onbelast. De twee methoden werken verschillend in op de overheidsfinanciën. Dit wordt binnen een eenvoudig analytisch kader aangegeven. Aangetoond wordt dat de omkeerregel, die in Nederland wordt toegepast, te prefereren is boven de voorheffingsvariant. De omkeerregel leidt allereerst tot een lagere gemiddelde belastingtarief dan onder de voorheffingsvariant. De omkeerregel betekent ook een verbreding van de belastingbasis, waardoor de onzekerheid ten aanzien van de belastingontvangsten gereduceerd kan worden. De voorwaarden waaronder de reductie in variabiliteit in de belastingontvangsten optreedt, worden aangegeven.

In hoofdstuk 3 is een theoretische analyse gegeven van de welvaartsaspecten van een pensioentoezeggingssysteem, gebaseerd op intergenerationele risicodeling. *Hoofdstuk 6* houdt zich bezig met de vraag hoe een dergelijk systeem in de economische realiteit functioneert. Uitgegaan wordt van een formeel kader met drie overlappende generaties (jong volwassen, middelbare generatie en de gepensioneerde generatie). Binnen dit kader kunnen de essentiële kenmerken van een eindloonregeling met geïndexeerde uitkeringen worden weergegeven. Deze regeling is in Nederland veruit de dominante invulling van het aanvullende pensioentraject. In hoofdstuk 6 wordt met name aandacht besteed aan de financieringsmethode. De financiering in Nederland is in beginsel gebaseerd op kapitaaldekking, maar als gevolg van de ingebouwde backserviceverplichtingen wordt een omslagelement in de financiering binnengebracht. Er wordt uiteengezet dat de financieringsmethode ex ante actuarieel zuiver is voor de verschillende deelnemende cohorten. Actuarieel zuiver is omschreven als gelijkheid ex ante tussen de contante waarde van de (verwachte) premiestortingen enerzijds en de contante waarde van de (verwachte) pensioenuitkeringen anderzijds. Afwijkingen tussen de feitelijke pensioenpremie en de actuariële premie worden met name bepaald door de ex post fluctuaties in het beleggingsrendement en de inflatie-ontwikkeling. Schommelingen in

loongroei blijken daarentegen veel minder invloed te hebben op de pensioenpremie. Bij een grote nominale loonstijging is de back-service last hoog, maar de verschuldigde inhaalpremie kan verhaald worden op een met de looninflatie eveneens gegroeide loonsom. Als daarentegen sprake is van een gematigde loonontwikkeling zal de back-service last gering zijn en bijgevolg is de inhaalpremie ook klein. Verschillen in grootte van de verschillende generaties van deelnemende werknemers blijkt nauwelijks van invloed te zijn op de premiehoogte voor het aanvullende pensioen. Dit impliceert dat de vergrijzing van de (beroeps-)bevolking *als zodanig* een gering effect heeft op de kosten van de aanvullende pensioenen en de premie per gemiddelde werknemer. Desalniettemin zal het aanvullende pensioentraject te maken krijgen met stijgende premiedruk in de komende decennia als gevolg van vergrijzing. Dit komt omdat de aanvullende collectieve pensioenvoorziening een geïntegreerd systeem vormt met het overheidspensioen uit hoofde van de AOW. Het is waarschijnlijk dat in de komende decennia de AOW-uitkering de algemene loonstijging slechts ten dele zal volgen. Het deel van de toegezegde eindloongerelateerde pensioenuitkering dat voor rekening is voor het aanvullende pensioentraject wordt daardoor geleidelijk aan vergroot. Dit impliceert ook een hogere premie voor het aanvullend pensioen. Deze premiedrukstijging stelt de toekomstige intergenerationele solidariteit op de proef. Er circuleren verschillende hervormingsvoorstellen die de inkomensherverdeling via het aanvullende pensioentraject ten laste van de toekomstige jonge generaties willen inperken. In *hoofdstuk 7* worden de gevolgen van de relatieve terugval van de AOW-uitkering voor het aanvullende pensioentraject aan de hand van een gestyleerd simulatiemodel bestudeerd. Met name gaat daarbij de interesse uit naar de omvang van inkomenstransfers tussen de generaties en de effecten van deze transfers op het levensduurinkomen van de betrokken generaties. De hervormingsvoorstellen zullen in het algemeen er toe leiden dat de inkomensherverdeling ten laste van de toekomstige generaties vermindert. Het levensduurinkomen van deze generaties zal zich dan ook verbeteren, en daarmee hun welvaart ceteris paribus. Hervorming impliceert evenwel onvermijdelijk ook dat de pensioenverzekeringen in de toekomst minder royaal zullen zijn. Dit betekent een verlies aan welvaart.

Er wordt allereerst onderscheid gemaakt naar hervormingsvoorstellen die de structuur van het eindloonsysteem op zich handhaven, zoals de invoering van een AOW-onafhankelijke franchise en de onvolledige indexatie van ingegane pensioenen voor (loon-)inflatie. Deze voorstellen leiden tot een versobering van de regeling ten opzichte van de momenteel gangbare 70%-eindloonregeling. De toekomstige generaties hebben dan ook te kampen met een terugval in door de aanvullende pensioenregeling toegezegd verzekerd pensioeninko-

men. De betrokken individuen compenseren deze terugval in toegezegd verzekerd pensioeninkomen door voor eigen rekening extra te sparen. Dientengevolge neemt de blootstelling aan levensstandaardrisico ten aanzien van het oudedagsinkomen toe. Deze toename in blootstelling aan risico betekent verlies aan welvaart. De belangrijkste conclusie van dit hoofdstuk is dan ook dat voortzetting van de huidige opzet van het Nederlandse pensioensysteem voor toekomstige generaties te prefereren kan zijn boven welk hervormingsidee dan ook. Cruciaal in dit verband is de afruil tussen enerzijds de door een hervormingsvoorstel geïnduceerde welvaartwinst dat gerelateerd is aan een verbetering van het levensduurinkomen en anderzijds het door een hervormingsvoorstel geïnduceerde welvaartverlies als gevolg van de terugval in verzekerd pensioeninkomen. Het netto-effect voor het welvaartsniveau van toekomstige generaties blijkt af te hangen van ten eerste de mate van risicoaversie en ten tweede van de omvang van de blootstelling aan risico. Hoe meer risico-avers de representatieve werknemer is en hoe groter het risico is, hoe waarschijnlijker het is dat de toekomstige generaties handhaving van de bestaande pensioenregelingen zullen prefereren boven welk hervormingsvoorstel dan ook.
Een meer radicaal hervormingsvoorstel is de invoering van het premietoezeggingssysteem in de plaats van de gangbare eindloonregeling. De resultaten van de simulatie suggereren dat dit voorstel voor alle toekomstige generaties tot een verslechtering in welvaart zal leiden. Dit is te verklaren uit hoofde van het grote verlies aan welvaart als gevolg van het niet meer verzekerd zijn voor levensstandaardrisico. Dit welvaartsverlies wordt niet gecompenseerd door de welvaartswinst van een verbetering van hun levensduurinkomen door het verdwijnen van de voor hen nadelige inkomensherverdeling binnen de eindloonregeling. Er is ook bekeken wat de welvaartseffecten zijn wanneer de invoering van het premietoezeggingssysteem vergezeld wordt door de simultane uitgifte door de overheid van loon-index obligaties en prijs-index obligaties zoals voorgesteld in hoofdstuk 4. De individuele werknemer die pensioenspaargelden aanhoudt binnen een premietoezeggingssysteem is dan in de gelegenheid om met beleggingen in deze obligaties de inkomenszekerheid te reproduceren van een pensioentoezeggingssysteem met loongerelateerde uitkeringen. Dit alternatief blijkt voor toekomstige generaties welvaartdominant te zijn ten opzichte van de status-quo en de twee besproken hervormingsvoorstellen.

Nawoord

De oorsprong van dit proefschrift gaat terug naar de periode waarin ik verantwoordelijk was voor de ontwikkeling van de cursus 'Financiële Markten en Instellingen' van de Open universiteit. Toen is mijn interesse gewekt voor het onderwerp van risicodeling binnen pensioenfondsen. Meer specifiek: welke partij (actieve werknemers, werkgever, gepensioneerden, slapers) draagt uiteindelijk binnen pensioenfondsen het 'funding' risico? In de periode dat ik dit proefschrift schreef, is de belangstelling voor pensioenvraagstukken belangrijk toegenomen. Het publieke debat is nu met name gericht op de betaalbaarheid van de AOW in de toekomst. Vooralsnog is het aanvullende pensioentraject, het onderwerp van dit werk, minder prominent aanwezig in de discussie. Ik geef aan dat een analyse van de opzet van het aanvullende pensioen zou moeten berusten op een drietal aspecten: geboden zekerheden aan de deelnemers, herverdelingseffecten en economische efficiëntie. Zelf kom ik tot een positieve waardering van de thans gangbare eindloonregeling. De netto-welvaartseffecten lijken groter te zijn dan die van alternatieven. Dit is vooral gebaseerd op de vaststelling dat de unieke zekerheden die de eindloonregeling biedt aan de deelnemers, niet anderszins realiseerbaar zijn.

Op deze plaats wil ik mijn dank uitspreken aan degenen die belangrijk hebben bijgedragen aan de totstandkoming van dit proefschrift. Allereerst gaat mijn dank uit naar mijn promotor Harrie Verbon voor zijn bereidheid mij te begeleiden, zijn vertrouwen en vooral ook voor zijn coöperatieve en constructieve opstelling. Lans Bovenberg en Lex Meijdam hebben relevant en substantieel commentaar geleverd bij een eerdere versie. Ook de collega's van de Open universiteit wil ik danken voor de aan mij geboden tijd en faciliteiten voor onderzoek, als ook voor hun belangstelling voor en commentaar bij de resultaten. Vooral de samenwerking met Paul Verhaegen is voor mij vruchtbaar en leerzaam geweest. Gerard Popelier wil ik eveneens met name noemen omdat ik veel baat heb gehad bij zijn betrokkenheid tijdens de voortgang van het proefschrift. Daarnaast hebben, ieder op eigen wijze, verschillende oud-

studiegenoten en ook economen die bezig zijn met pensioenvraagstukken, mij bij het schrijven gestimuleerd en gecorrigeerd. De leden van de promotie-commissie: Lans Bovenberg, Jean Frijns, prof Th. van de Klundert, Lex Meijdam, Henk Peer en Paul Verhaegen, dank ik voor hun bereidheid om in de commissie zitting te nemen.
Susan Holdsworth heeft zorgvuldig mijn Engels gecorrigeerd. Naar ik hoop klinkt het wat minder Nederlands.

Heel graag noem ik hier ook Birgitta, voor haar voortdurende ondersteuning en meeleven en vooral ook voor haar begrip.

Eduard Ponds

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