Generation Lucky?

Evaluating per cohort net lifetime pension benefits of participants to a Dutch second pillar pension fund

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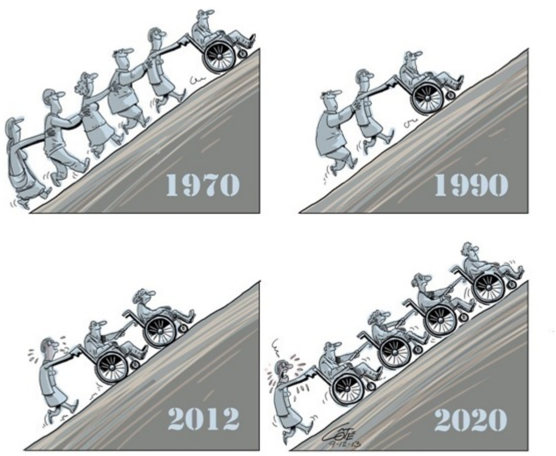

Abstract

1957-2097: Analysis of lifetime net pension benefits of participating age cohorts (1932-1988) to ABP pension fund. ABP's pension scheme does not yield actuarial fair results, as it transfers from young (1963-1988) to old (1932-1962). The largest beneficiaries (Generations Lucky) are age cohort 1947 through 1949, Generations Unlucky are age cohorts 1978 and 1987. Lifetime net pension benefits range between – 3.7 bln euro and 5.3 bln euro (in terms of 2014 euros). This study shows that adjusting pension benefits is a potent instrument, and should not be regarded as a last resort.

Key words: intergenerational risk sharing, actuarial fairness, lifetime net pension benefits.

– *It's not fair* –
Henk Krol (2012)
(& Calimero)

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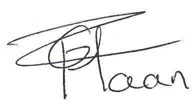
Preface and acknowledgements

I consider a lack of understanding retirement economics to be one of the major gaps in general knowledge. As Steenbeek (2014) puts it: “commonly, people consider thinking about their pension to be even more annoying than visiting the dentist.” This is a pity, as ignoring the fact that one is also responsible for what is approximately the last quarter of one’s life runs counter to the survival instinct deemed so characteristic of mankind.

To be true, before I started working on this thesis I did not know all that much about pensions either, apart from being vaguely aware of the name ABP from the news. Having finished my study, I now find my former ignorance quite incomprehensible, since as far as pension benefits are concerned there is no bliss in ignorance. In his book *De pensioenmythe* from 2011, Martin Pikaart painted a gloomy picture of the current position of the Dutch pension system. Pikaart opened my eyes to the issues afflicting our pension system and got me more interested in the economics of retirement which are often so hard to grasp.

I would like to thank APG Heerlen and *Rijckheyt*, the Heerlen city archives, for their hospitality and help in tracing all of ABP’s annual statements. Furthermore, I am grateful to the staff of AFEP at the Dutch Ministry of Finance – especially to Suzanne Kok and Mathijs Gerritsen – for helping me to progress in these studies during my time as an intern there. I must thank my roommates Max and Wouter for extending a helping hand when my model got too complicated for my own computer to handle, and Wessel for our many brainstorm sessions on investments by a pension fund and the yields thereon. I am especially beholden to my family and Marieke for their patience and support, both of which were in abundance. And finally, I would like to express my gratitude to Bas Jacobs for his devotion to this thesis and for structuring my thoughts. You have been a marvellous coach.

I would like to express my sincere hope that this study will contribute to the vast and exciting literature on the Dutch second-pillar pension provision. Next to this, I strive to contribute to what I consider to be one of the most necessary policy debates in the Netherlands. It may be true that not everything in life can be fair, but let us make sure that the provision of pension benefits will always be so. There is merit to the slogan of ABP’s pension administrator: “Tomorrow is today”, so let us start thinking about tomorrow, today.



F.G. Haan
Rotterdam, January 2016

Non-technical summary

Saving for your pension is a heavily debated subject in the Netherlands. “Young” blame “old” from having overly generous pension arrangements, whereas old claim that their pension benefits are in accordance to the pension fund’s returns on investment gathered when they were saving for their retirement. This study discusses the question: “who benefits from being a participant in ABP’s pension scheme, and to what extent”. To this ends the cash flows to and from ABP (from the perspective of a participant) are compared. How much is reimbursed to a participant in terms of pension benefits for each euro contributed to the fund? And, is this ratio equivalent for participants belonging to different age cohorts? These ratios per age cohort are called per cohort lifetime net pension benefits: the balance of the money paid to the fund (contributions) and the money received back from the fund (benefits) all written in real values (i.e. in euros of 2014, to be able to compare purchasing power). A positive lifetime net pension benefit means that for each euro contributed to the fund, a participant gets a higher pension benefit in return; so this participant’s purchasing power will increase as a result of the fund. The opposite holds as well: a participant with a negative lifetime net pension benefit loses purchasing power as a result of its participation to the fund. An actuarially fair result is reached when a participant’s reimbursement (i.e. its pension benefit) has the same real value as its contribution, this is equivalent to a zero lifetime net pension benefit.

Figure 1 shows per cohort lifetime net pension benefits (in terms of billions of 2014 euros) for all age cohorts (1932 through 1988), if current pension policy is unaltered until the fund’s termination (the “baseline scenario”, depicted by the black line in Figure 1). The lifetime net pension benefits are not equivalent over the age cohorts: age cohorts 1947-1949 rank at the top, age cohorts 1978-1980 and 1987 rank at the bottom. Figure 1 shows that most generations have positive lifetime net pension benefits: for each euro they contributed to the fund, they receive back more than a euro in terms of pension benefits. This is not sustainable: the pension fund distributes a larger sum of pension benefits than it receives in contributions and investing these contributions on the financial market. ABP is running a deficit and will have accumulated a deficit of 87.3 billion euro when it is terminated (after the passing away of the last person born in 1988).

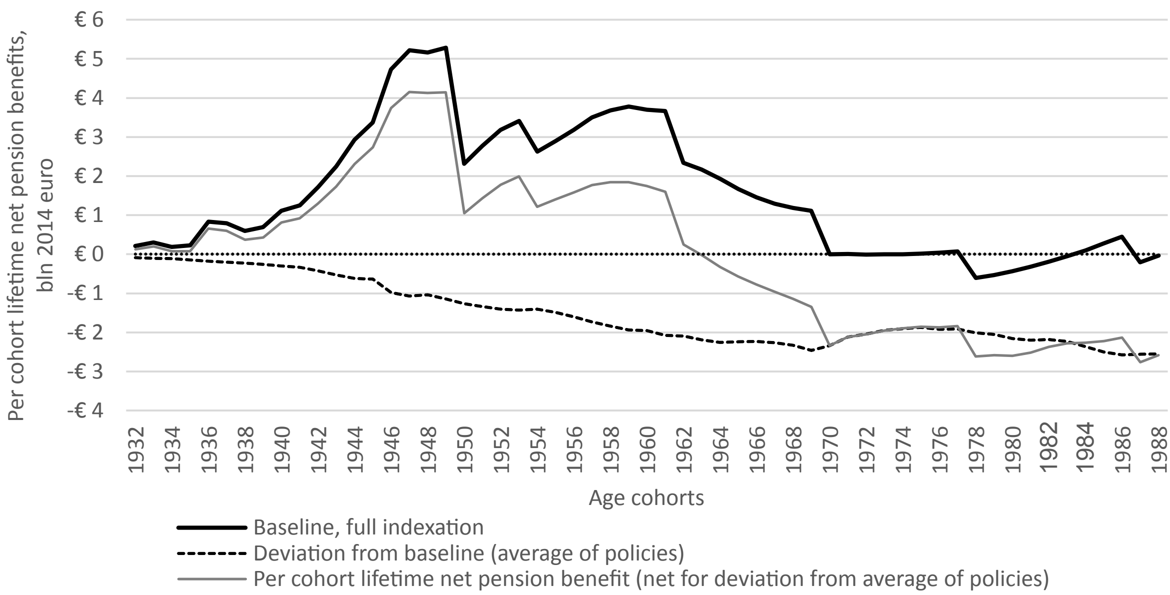


Figure 1: Baseline and average deviation caused by pension policy and average per cohort lifetime net pension benefit after pension policy changes has been enforced, full indexation regime, in billions of 2014 euro.

However, the fund cannot be in deficit at termination as this means that it lacks the capacity to distribute pension benefits during the last years of its existence (i.e. to the youngest generations). Therefore, it is imperative that the fund takes action to solve the deficit before it is terminated. The fund has four instruments at its disposal to do this. First, it can require larger contribution payments from its participants. This leaves the costs of settling the fund's deficit for those who are not retired yet, as retirees do not pay contribution payments anymore. Second, the fund can decrease the pension right accrued for each euro contributed to the fund. This again leaves the adjustment costs to be borne by the non-retirees. Third, the fund can chose to (temporarily) stop to increase pension rights and benefits with the price level (a process known as indexation). This measure affects all generations, as retirees receive their not-indexed pension benefits presently, whereas non-retirees will receive those in the future. Failing to index pension rights and benefits to price inflation thus negatively affects the purchasing power of current and future pension benefits. Finally, the fund can choose to slash current and future pension benefits. This has a direct effect on current retirees, as their benefits are lowered overnight. This measure is generally regarded as a last resort, as retirees cannot cushion blows to their pension benefits as they do not earn labour income anymore.

The deviation (the interrupted black line in Figure 1) from the baseline (uninterrupted black line) shows the average costs born per age cohort from changes to pension policy. The line is decreasing in the cohort's birth year. This means that, on average, the costs borne per cohort for solving the fund's deficit, are getting higher as the participants are getting younger. The policy adjusted per cohort lifetime net pension benefits (depicted by the grey line in Figure 1), show the lifetime net pension benefit each generation has after the policy changes have been effectuated. The total value of these benefits is zero, which means that the fund has no residual deficit (or surplus) at termination. However, Figure 1 also shows that the lifetime net pension benefits differ per cohort. All cohorts born between 1932 and 1962 have positive net pension benefits, which means that they are net beneficiaries of the fund. All cohorts born between 1963 and 1988 are net contributors, as their net pension benefits are negative. The pension fund can also use the pension instruments (contribution rate, right accrual rate, pension benefit disbursement and indexation regime) combined. Each policy measure affects different generations in another way. An actuarial fair result is yielded when all generation's lifetime net pension benefits are equal to zero. In that scenario each participant gets exactly their contribution back in terms of pension benefits indexed for price inflation, which should result in pension benefits equal to seventy per cent of the average labour income this individual had during his or her career. Figure 2 shows the two policy measures which yield the most actuarially fair results possible for ABP:

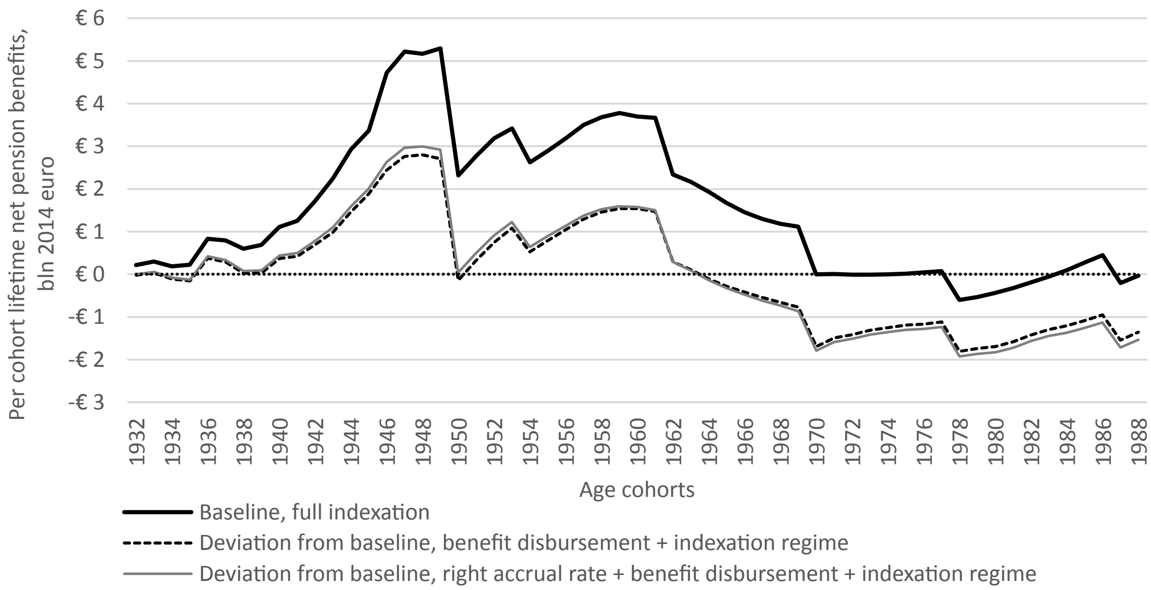


Figure 2: Baseline and adjusted per cohort lifetime net pension benefits for top 2 most preferred policy combinations, full indexation regime, in billions of 2014 euro.

Figure 2 shows that a joint adjustment of benefit disbursements (a one-off cut of 13.3 per cent, effectuated in 2014) and the indexation regime (a one-off increase of 0.3 per cent) is preferable from an actuarial fairness point of view. A roughly similar result yields from adding an adjustment of the pension right accrual (a one-off reduction of 3.3 per cent, effectuated in 2014) to the equation. This reduces the cut to pension benefits (to a reduction of 11.6 per cent), and increases the indexation regime parameter (with 0.4 per cent).

Figure 2 shows that per cohort lifetime net pension benefits can be cut in two parts: positive for age cohorts 1932-1962 (who are net beneficiaries even after the policy change) and negative for age cohorts 1963-1988 (who become net contributors after the policy change). This result shows that the oldest generations remain net beneficiaries of the pension scheme, even when their pension benefits are cut by over 10 per cent overnight. Put differently: slashing pension benefits leaves senior age cohorts worse off compared to the baseline scenario. Their pension benefits however, are still in excess to their contributions to the fund. A conclusion of this is that taboos on adjusting pension benefits are unfounded.

This research shows that the question "who benefits from being a participant in ABP's pension scheme, and to what extent" can be answered. ABP's pension scheme does not yield actuarial fair results, as it transfers money from young (1963-1988) to old (1932-1962) for a wide range of policy options. The largest beneficiaries (*Generations Lucky*) are age cohort 1947 through 1949, whose lifetime net pension benefits range between 2.8 and 5.3 bln euro. The largest contributors (*Generations Unlucky*) are age cohorts 1978 and 1987, whose lifetime net pension benefits range between -1.8 and -3.7 bln euro.

1 Introduction

Luck always seems like it belongs to someone else – David Levien

The Dutch pension system has been subject of discussion for the past decades. As advances in future life expectancies were already foreseen at the establishment of the old age benefits system (in 1947, to be made permanent in 1957), it was evident that the system would have to be revised in the future. These concerns never have fully faded away, and policy changes effectuated since 1957 (e.g. switch from a final wage to an average wage system and raising the retirement age) show that policymakers already have done some work to bolster the sustainability of the system.

After the onset of the financial crisis in 2008, following on the collapse of Lehman Brothers and fuelled by the deadly embrace between system banks and European governments, a sense of reformism came into Dutch politics. It was acknowledged that the time of procrastinating (politically unpopular) pension reforms was over. In 2014, the Dutch government, pension funds and social partners agreed to raise the retirement age and link it to life expectancy figures to aid the sustainability of the pension system (Staatsblad, 2015).

Changes to pension policy causes asymmetries between different age cohorts. If the legal retirement age is increased, this results in a different time division over labour and retirement (i.e. leisure) for all individuals who yet have to retire. Current retirees are unaffected, as policy changes are not enforced retroactively. Even when improvements in longevity of the next generation over the former ones are taken into account the result might be that the young work longer, and are retired shorter, than their parents. This may lead to concerns over the fairness of the pension scheme.

A similar situation arises when a pension fund runs a deficit caused by downturns of the financial markets: which generation should pay for this deficit? Several options exist. First, raise pension contributions paid by the currently employed (the "active" generation), thereby affecting their current consumption possibilities. Second, to decrease pension right accrual of the currently active generation, thereby affecting their consumption possibilities when retired. Third, it could be considered whether it would be reasonable to slash pension benefits of the currently retired, who are the wealthiest age cohort (Statistics Netherlands, 2014a), or who might have been active when the deficit was accumulated if it was not discovered immediately. Meanwhile it would also have to be acknowledged that retirees are struck harder by an unexpected assessment than employees, as the former miss the opportunity the latter has: to smooth the due payment through additional labour earnings[1]. Taking this into account, as a fourth option wouldit perhaps be reasonable to ask future generations (who have yet to start working,

[1]Resulting from a longer working week, retiring later or exerting higher efforts at the job.

of may not even be born yet) to pitch in. The due payment would not be unexpected to them, and they could smooth it over the entire course of their career. But would it be reasonable to enforce this on future generations when these generations are not involved in the decision making process as they are not born yet?
The above gives insight in the vast amount of questions which arise when economic turmoil forces pension funds to take unpleasant, but necessary actions. Age cohorts differ from others as they live through different time spans. One could have good luck and never live to see an economic downturn, or life might be tougher and economic circumstances bleak. As an individual cannot choose when (or where) it is born, the author of this study considers the time which an individual lives through a question of luck rather than choice. The question this study aims to answer is whether or not age cohorts exist which had more luck than others, and as a result of this reap more fruits from their participation in a pension fund.
The remainder of this chapter will set the stage for a study on pensions concerning the intergenerational sharing of risk, fairness and luck. Section 1.1 discusses the three pension pillars of the Dutch pension system. In section 1.2 ABP pension fund (the fund under scrutiny in this study) will be introduced. Sections 1.3 and 1.4 explore risks associated with pension saving and risk sharing in pensions, respectively. Section 1.5 introduces uniform contributions and mandatory participation. Developments relevant to pension saving in the Netherlands are provided in section 1.6, which is followed by a discussed of the policy instruments the fund has in section 1.7. Section 1.8 sketches the ongoing policy debate in the domain of Dutch pension saving. Finally, the main aim, research question and hypotheses of this study will be introduced in section 1.9.

1.1 Pensions in the Netherlands

Pensions in the Netherlands consist, as is common in the developed world (World Bank, 1994), of retirement benefits generated in three different pillars: central, collectively decentral and individually decentral (Rooij *et al.*, 2007). Zvi Bodie (2002) states that saving for pension serves the goal of smoothing consumption over the lifetime. Put differently: income after retirement should be comparable to income before retirement (Steenbeek, 2014). The first Dutch pension pillar, the public old age provision (*AOW: Algemene Ouderdoms Wet*) established in 1957 (as the successor of the *Emergency law of Drees* of 1947), entitles all Dutch residents to a uniform level of retirement benefits, regardless of age, income or gender, which is provided by the government. The sole requirement for applying to this provision is that a person has reached the retirement age, and has been a Dutch resident from the age of 15 until the superannuation age. Years spend abroad are translated in a linear deduction to the AOW-benefits. The first pension pillar has a strong redistributive focus, and it is financed on a pay-as-you-go basis (current pension

benefits are paid out of current pension contribution).
From 1957 to the end of 2012 the retirement age in all Dutch pension pillars was harmonised and fixed at the age of 65 years old. From 2013 a divide is made between the legal retirement age, which is applicable to the first pillar and will be gradually increased towards 67 in 2023, after which it will grow along with life expectancy, and the legal retirement directing age, which is applicable to the second pillar. The latter is increased to 67 years of age in 2014 and will be pegged to life expectancy figures from that year onwards (Rijksoverheid, 2012). As the third pillar is on an individual basis (through a contract with an insurance company), the retirement age applicable is determined between the insurer and the insured.
The second pillar consists of pension benefits to which employees accrued entitlements during their years of employment. Beetsma and Chen (2013) teach us that three different kinds of second pillar pension funds exist: industry-wide pension funds, company pension funds and profession pension funds. Despite its modest size and population, the Netherlands has accumulated a vast second pension pillar (both in number of pension funds (nearly 800) and accumulated capital), which can mainly be attributed to mandatory participation for employees (Pikaart, 2011). To illustrate this point, the investments of ABP in 2013 on its own amount to 325 billion euro (ABP, 2014a), or roughly half of Dutch GDP. Accumulated pension wealth (1,017 bln euro; DNB, 2015) exceeds Dutch GDP (663 bln euro; ECB, 2015) by fifty per cent in 2013, and it is estimated to outgrow it more than twice at its peak value (Boender *et al.*, 2006). Dutch second pension pillar funds are generally funded. In a funded pension scheme age cohorts accumulate pension wealth which is used to pay for their pension benefits after retirement. So, whereas in the first pillar individuals pay premiums for the pension benefits of the current retirees, in the second pillar premiums paid by individuals are used for pension benefits when they are retired.
Within the second pillar, paid pension premiums are invested collectively and are untaxed as the pension benefits (rather than the pension premiums) are subject to income taxation. The second pillar as such does not serve a redistributive agenda, the contributions paid by all participants should earn actuarially fair[2] pension benefits. Whether this actually materialises if a pension fund runs a deficit is the main topic of research of this study.
The third pillar in the Netherlands offers individuals the opportunity to save for higher pension benefits, on an individual basis and under a mild fiscal regime. Typically, third pillar arrangements are offered by (life) insurers and large financial institutions.
In the next section the pension fund of focus, ABP, will be introduced.

[2]Actuarial fairness is reached when total pension benefits disbursed to an individual are equal to the total pension contributions this person paid and the returns on invested these. This however, does not give any inference about the purchasing power this individual has, as the returns on investment do not have to match price inflation over the time of pension accumulation and disbursement.

1.2 Stichting Pensioenfonds ABP

Stichting Pensioenfonds ABP (henceforth referred to as ABP pension fund) was established on June 19th 1922 by ratification of the Law on pensions by her majesty Queen Wilhelmina aboard the SS Batavier V amidst the Atlantic Ocean (Brinke *et al.*, 2007). The fund was erected under the name *Pensioenraad* (Pension council), which it held until 1966, after which it changed its name to *Algemeen Burgerlijk Pensioenfonds* (Public Civil Pension fund), to come to its current name after the privatisation of the fund on January 1st 1996 (Sluimers, 2007).

ABP is an industry-wide pension fund, representing Dutch civil servants and all employees in the educational sector. The fund does not control its own investments, as its pensions are provided by All Pensions Group (APG). Although the name may suggest otherwise, ABP has been a private company since 1996, which coincides with the year in which ABP started a policy of conditional indexation of accrued rights and pension benefits to price inflation. The coverage ratio, which is the ratio of assets and liabilities of the fund, is pivotal in the question whether or not to index. The coverage ratio detects deficiencies to the fund's financial reserves with the aim to adjust pension policy in time to ward off solvency issues. At the onset of 2004, the fund changed from a final wage systems (in which pension rights are updated on a yearly basis to match the trend in the wage level) to an average wage system (in Dutch pension lingo this is represented as a "middle wage system", in which already accrued rights are not adjusted to the current wage level, other than by conditional indexation). ABP has been struck hard since the commencement of the financial crisis mid-2008, which forced the fund to (fully) withhold indexing pension rights and benefits since 2009, leaving pension right accruals and benefits ultimo 2013 behind 13.64 per cent in terms of price inflation (ABP/Pensioenraad, 1958-2014[3]).

1.3 Risks associated with pension accrual and collective schemes

When an individual saves for its pension, it is exposed to various types of risk. Bonenkamp *et al.* (2014) define risks as "outcomes that deviate from earlier held expectations". A rudimentary divide can be made between risks on individual (micro) level and risks on aggregate (macro) level (Bonenkamp *et al.*, 2014). The former, in pension idiom known as idiosyncratic risk, refers to the risks an individual faces, such as getting disabled, becoming unemployed or deceasing (before retirement). The latter, in pension lingo known as macroeconomic risk, deals with circumstances which influence (part of) the aggregate of pension fund's participants.

Distinct types of macroeconomic risks are associated with pension saving. The first type,

[3] This study uses data from the annual reports offered by ABP and its predecessors over the years 1957 through 2013. Partly (from 2008 onwards) available through abp.nl, the remainder was accessed and stored on photographs by the author at the venues of APG and the city archive of Heerlen. Photographic evidence of the latter will be provided by the author upon request.

demographic risk, has already been touched upon in the previous section. Demographic risk relates to the chance that fund participants might live longer than expected (longevity risk[4]) as a result of medical advances or rising incomes (which leave individuals with more money to spent on curative and preventative care). The composition of participants of the fund might also change (e.g. the dependency ratio chances, a development referred to as fertility risk). Longevity and fertility risks are both prevalent in the Netherlands, as greying and de-greening go hand in hand. Individuals also face the risk that their wages do not develop as they expect. This wage risk could lead to lower pension benefits, as a lower amount of pension contributions (due to the uniform contribution over lower than expected future labour earnings) leads to a lower amount of pension capital to invest and attract returns on.

Macroeconomic risks cannot be accommodated within a generation, as the risk impacts all participants of the generation symmetrically. Next to longevity and fertility risks, various other types of risks are associated with pension saving. For instance, productivity risks, which have to do with uncertainty about future wages. Or financial risks, which means that the returns on investment might be lower than expected as a result of an economic downturn. This would have an impact on the returns a pension fund can realise on investing the contributions of a certain age cohort, but this does not affect generations who are already retired or have not entered the fund yet. So, financial risks have an impact on pension accrual. Next to this, volatility in the prices of financial assets and the risk of inflation pose risks to pension saving.

Idiosyncratic risks can be amended (partly) by pooling participants (Ponds, 2003) as chances that a group of individuals is victim to these risks (disability, unemployment, decease, etc.) are much slimmer than they are on an individual basis. Macroeconomic risk can be amended by pooling age cohorts of participants to the pension fund. Empirics show that participation in a pension fund can result in an additional 30 per cent pension benefits when related to individual pension saving (Boender *et al.*, 2000), which is caused by several factors.

First, pension funds can better diversify their investment risks as their investment portfolios are larger than that of an individual investor. Second, pension funds have an informational advantage over individuals, because of financial illiteracy of the public and the size of the fund (Boender *et al.*, 2006; Els *et al.*, 2006). Financial illiteracy and irrational behaviour of the individual can have serious results, as each per cent loss of return due to these factors leads to a cumulative loss of 25 per cent of pension accrual over the lifetime (Bikker & De Dreu, 2006).

Third, individual participants are prone to behavioural fallacies (Els *et al.*, 2006). When participants are facing a choice concerning their pensions, commonly they admit they

[4]When an age cohorts lives on longer it receives pension benefits longer, thereby raising the liabilities of the pension fund.

possess little knowledge on the subject, and therefore choose the default option (Madrian & Shea, 2001; Bodie & Prast, 2012). A 2012 Dutch survey showed that nearly 70 per cent could be consider to be pension analphabetic, meaning that they were clueless concerning the size of their pension or if their accumulated pension would be enough to suffice after retirement (TNS-NIPO, 2012). Next to this, individuals are prone to myopic loss aversion (Benartzi & Thaler, 1999) which leads them blind sighted by the occurrence of low rates of return (losses) and overly focussed on the present. Finally, individuals are sensitive to framing (Kahneman & Tversky, 1984). All of these behavioural influences seem to be constant through social-economic groups, so they do not disappear along with higher wages or a larger educational attainment (Bodie & Prast, 2012). These behavioural fallacies can be (partly) resolved by collective pension saving through a pension fund, as investments are made by pension experts.

A final reason for collective pension saving is that pension funds have longer time horizons than individuals (the focus is beyond that of a single generation) and can therefore employ recovery policies which stretch over many years[5]. Intergenerational risk sharing will be discussed more extensively in the next section.

1.4 Risk sharing in pensions

Sharing the risks introduced in section 1.3 is beneficial to individuals, given that they are risk averse (Bonenkamp *et al.*, 2014), as pooling leads to lower expected effects per individual from adverse shocks (Beetsma *et al.*, 2011). In this case risk sharing is ex ante welfare enhancing (for the full population), but ex post this might not be the case (for individual participants). They sacrifice part of their pension benefits (or have to pay higher contributions) for the benefit of others. If economic circumstances grow grim, the sharing of risks in pension saving will result in moderate losses to all instead of high losses to some (Beetsma *et al.*, 2011).

Bonenkamp *et al.* (2014) give an excellent description of intergenerational risk sharing. They claim that young generations have relatively large amounts of human capital, but relatively little financial capital (when compared to old generations). Steenbeek (2014) defines human capital as the sum of all future wages. If risks are not shared intergenerationally, this leaves young participants vulnerable to wage risks (affecting the returns these young generations can get on their human capital). Young participants are not, however, heavily affected by inflation or financial market risk, as their financial capital holdings are limited. The older generation is prone to financial market risk, inflation and longevity risk, but is not overly vulnerable to wage risk. By sharing all these types of risks both the young and old generations can benefit, as "good" and "bad" risks will be traded off against each other, leaving only the residual risk (which due to the trade-off

[5]In practice this smoothing capacity is legally bounded to 10 years forward (Staatsblad, 2014).

will be of smaller size, and moreover will be shared over the full population, instead of just a generation). Participation risks should be diversified over as many age cohorts and time periods as possible, as this would smooth shocks as much as possible and affect each individual to the minimum extent possible (Bovenberg & Mehlkopf, 2014). Moreover, as Steenbeek (2014) claims, young individuals have a longer time horizon to cushion financial blows, so therefore it is optimal for old generations to share their financial risk with youngsters.

So, the most fundamental reason for sharing risks is that due to better time diversification individuals are enabled to consume equivalent amounts (relative to a situation in which risks are borne on an individual basis), but with lower uncertainty (Bonenkamp & Westerhout, 2011). The desirability of risk sharing thus rises with the rate of risk aversion, which is found to be remarkably high in the domain of pension saving (Kuné, 2006; Rooij *et al.*, 2007). Kuné (2006) adds that, due to risk aversion of participants, ex post risk sharing can even be welfare increasing, even when ex ante some participants lose from risk sharing[6].

Risk sharing in general, and intergenerational solidarity in particular, generates (substantial) subsidies between generations. Sharing of risks might have proverted (wanted), inverted (unintentional) or perverted (undesirable) effects (Kuné, 2006). Where some might potentially gain greatly from risk sharing, others might bear extensive burdens. Kuné (2006) argues that, even if a generation faces high costs associated with the sharing of risks, this does not directly imply that solidarity harms these generations. He argues that these costs might also be seen as a solidarity premium, which needs to be borne by part of the participants as a sacrifice for the good of the entire pension fund population. Two arguments are used: first, young participants will eventually get old too and have similar opportunities to benefit from risk sharing at that time (this argument assumes that the pension fund and mandatory participation both will be continued) and second, young generations reap the benefits of the pension infrastructure which is established by older generations. Moreover, young generations will receive (part of) their solidarity premium back through bequests. It could however be argued that both arguments are flawed, as the continuity of pension funds is not guaranteed and neither is the indexation of pension rights and benefits.

Boender *et al.* (2006) claim that due to informational issues (adverse selection and moral hazard) young generations are scarcely enabled to acquire liquidity taking their human capital as collateral. The financial markets deem it either impossible or too costly to

[6] High educated females on average live longer than low educated males. Bonenkamp (2007) finds significant pension accrual transfers from the latter to the former. It follows that low educated males ex ante lose from risk sharing if they enter a pension fund with many high educated females. Bonenkamp *et al.* (2014) argue that "risk sharing is based on the assumption that ex ante there is no transfer between the generations". Hassler and Lindbeck (1997) refer to this as "true risk sharing". As soon as ex ante transfers can be expected, risk sharing turns into redistribution.

find out if a young individual will have a high or low earnings capacity (as this is private information; Jacobs 2013), or to monitor whether the participants exerted effort after the extension of a possible loan. Liquidity issuers furthermore will not accept human capital as collateral for the sheer reason that retribution in the incidence of default is impossible; the issuer cannot force the borrower to provide labour as slavery is abolished (Jacobs, 2015). As shown above, by saving for pension collectively, possibilities are generated to trade risks between current and future generations. Since participation is mandatory informational problems will not arise. By capitalising on the human capital of young and future generations, old generations can share their financial risks, while offering a hedge against wage and productivity risks in return.

Risk sharing between current and future generations is not possible through capital markets, as Hassler and Lindbeck (1997) point out that financial markets are unfit to establish a contract between current and future generations. The fact that current generations cannot trade risks with future generations on financial markets, renders these markets inefficient (Diamond, 1977; Gordon & Varian, 1988; Ball & Mankiw, 2001; Shiller, 1999). As future generations are not alive yet, setting up a financial contract of mutual consent is impossible, which makes the enforceability of such a contract troublesome. The future generation might decide to default on this intergenerational contract (which it did not set up or sign) as long as no judicial impediments to doing so exist. By making participation to a pension fund mandatory to all current and future generations, intergenerational risk sharing is enabled.

One could rightfully remark that macroeconomic risks could well be country-specific, as for instance life expectancies differ per country. This could give leeway to sharing risks internationally (Shiller, 1999). It must however be noted that the enforceability of such a practice seems weak (as countries cannot be forced to live up to their promises, and thus might therefore default on their obligations as soon as they would have to extend a subsidy ex post), and, even if this were not to occur, international risk sharing would not render intergenerational risk sharing obsolete as global risks might exist which can only be shared between generations (Bonenkamp *et al.*, 2014).

Mandatory participation and uniform contributions will be discussed in the next section.

1.5 Uniform contributions and mandatory participation

The pension system used in the second pillar in the Netherlands is characterised by fixed rates in pension right accrual and contribution rates. Pension funds are compelled to use a uniform contribution rate for all participants (Law on corporate pension funds or *Wet Bedrijfspensioenfonds* (*Bpf*)). The following reasons were used as foundations for the enactment of the law (Lutjens, 1999): one euro (at that time guilder) of pension accrual would cost a similar amount for young and old (thereby offering both equal chances on the labour market) and competition between branches would be eliminated (employers in different branches would face equivalent premium pressure, regardless of the ratio of young and old employees).

Uniform contributions do however cause younger generations to pay a higher contribution than would be actuarially fair, whereas for older generations the opposite holds (Boeijen *et al.*, 2006). Pension premiums paid by young generation will yield returns for a longer time than contributions paid by older generations, as the time span until retirement is longer for youngsters than for oldsters, which makes pension right accrual actuarial unfair (Lever *et al.*, 2013a). A pivoting point lays halfway an individual's career. From that moment the individual pays a contribution which is lower than the amount which would be actuarially fair (Boeijen *et al.*, 2006; Bonenkamp *et al.*, 2006). Boeijen *et al.* (2006) calculate that at the age of 46 an individual has paid a surplus amounting to seventy per cent of one year of labour earnings when compared to the actuarial fair contribution rate.

In a situation of ex ante risk sharing some generations optimally would opt out of the pension scheme. This is resolved by enforcing participation upon all employees. Mandatory participation was introduced in 1949 and has since been enforced by law (*Wet Bpf*, Article 8). Mandatory participation is only an indirect tool in the Netherlands. No employer is forced to offer its employees a pension scheme, nor is any participant obliged to save for his pension. But, if the employer offers its employee the possibility to opt in in a pension funds, it is compulsory for the employee to enter. According to Rooij *et al.* (2007), 77 per cent of Dutch employees is an advocate of mandatory participation. In 1996 a mere 9 per cent of all employees in the labour force did not accumulate any second pillar pensions (the so-called “white spots”) (Ministry of Social Affairs and Employment, 2002). This figure is confirmed by Bergamin *et al.* (2014).

Els *et al.* (2006) argue that mandatory participation is necessary as procrastination, inertia, self-control issues, limited financial knowledge and skills lead to an (insufficient) pension saving rate and low returns on investment.

Kuné (2006) states that risk-sharing can only be sustainable if participation in the pension fund is mandatory and on a non-discriminatory basis. Public acceptance of pension schemes hinges on the direction and size of redistribution effects (Börsch-Supan & Reil-Held, 2001), so gaining a comprehensive insight in these factors is of paramount importance.

The next section will discuss relevant developments in the Netherlands.

1.6 Relevant developments in the Netherlands

Since the introduction of the Dutch public pension provision AOW in 1957, the Dutch labour market characteristics and demographics have changed drastically.

A 65 year old male in 1960 could expect to live on an additional 14.53 years (16.09 years for females). In 2012 these life expectancies rose to 18.27 years for males and 21.24 years for females (Statistics Netherlands, 2013), increases of 25.74 and 32.01 per cent respectively. Figure 3 (after Smid *et al.*; 2014) shows observed and predicted life expectancies from 1990 until 2060 (Statistics Netherlands; 2014b):

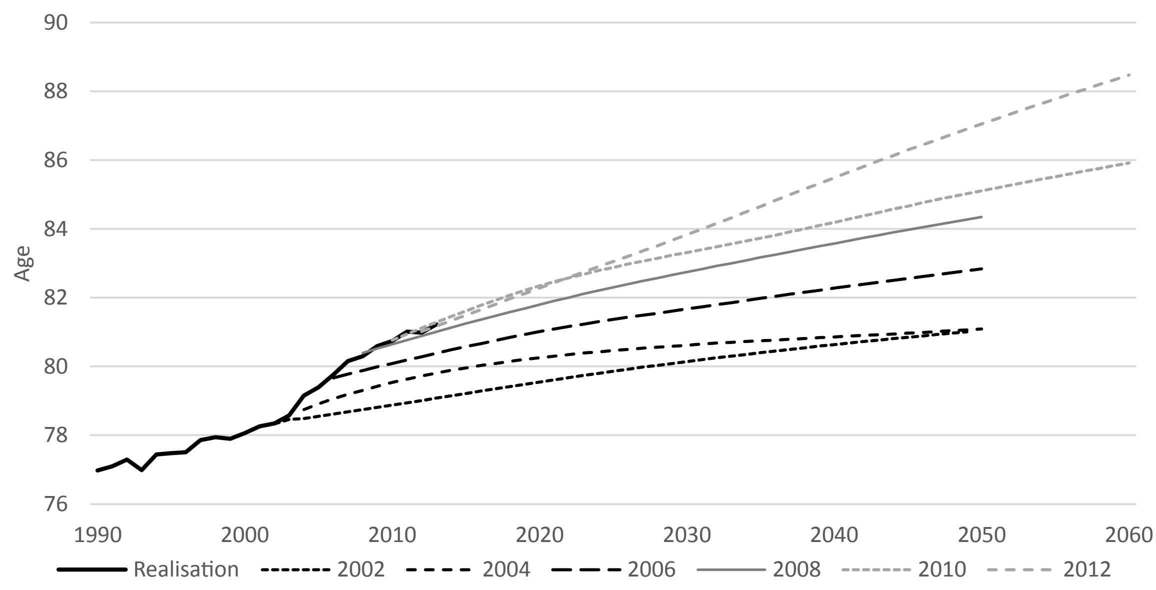


Figure 3: Actual and forecasted longevity, 1990-2060.
Source: Statistics Netherlands (2014b).

Stoeldraijer *et al.* (2012) expect life expectancy to increase further to 88 years of age (average for males and females). An average individual thus relies on old-age benefits for roughly a quarter of his or her life, which shows the significance of retirement schemes.

Fertility rates declined steadily over the last decades, from 3.10 children per woman in 1950, to 1.66 in 1975, to 1.72 in 2012 (Statistics Netherlands, 2014c). The results is a population which is both greying and de-greening. This has led to a situation in which the dependency ratio, which takes the ratio of retirees to the labour force, rose dramatically, from 16.8 per cent in 1960 to 29.0 per cent in 2014. This upward trend is expected to keep on increasing until 2040, after which it stabilises at an estimated 40 per cent (Smit *et al.*, 2014). Pikaart (2011) concludes from this the following: traditionally an individual worked one day a week for his retirement, if current arrangement are unaltered one can expect to work two days a week in the future for the old-age benefits of someone else. Moreover, pension benefits in the Netherlands (in both the first and the second pillar) have, implicitly but steadily, become more generous over time, as the time span over which these benefits were disbursed has increased along with increasing longevity (Bovenberg & Boon, 2010).

The manner in which pension rights are accrued (within ABP) has changed in 2004, from a final wage system to an average wage system. In a final wage system the pension accrual is "updated" annually, which boils down to the pension accrual being indexed to the growth of the participant's wage. This process is known as *back-service*. If an individual's wage is indexed to price inflation, the process of back-service effectively indexes pension right accrual to price inflation as well. With a final wage system the early years of employment got more valuable as time goes by, because of upward progress in the career profile and back-servicing (Bovenberg & Boon, 2010).

In an average wage systems early accrued pension rights are (if economic conditions permit this) indexed for inflation or centrally agreed wage rates (collective labour agreement wage), but not for the individual wage advances. Hence, there is no back-service in average wage systems. Bergamin *et al.* (2014) state that with an average wage system cuts on indexation lead not only to purchasing power losses for retirees, but also to lower pension rights (in real terms) for active participants. If a fund switches from a final wage to an average wage system halfway this drives a wedge between pension accrual of oldsters when related to that of youngsters. An increasing retirement age even further extends the time horizon for young employees towards retirement, making their future pension benefits worth less in terms of today's consumption (as the total sum has to be discounted over a larger amount of years).

Several other trends have emerged which make a revision of the Dutch pension scheme necessary. Labour mobility has increased and many employees switched from the traditional 40 (36) hour labour week to one with less or shorter working days (Bonenkamp *et al.*, 2014). Moreover, the amount of self-employed persons has risen tremendously, from 634 thousand in 2003 to roughly one million in 2014 (Statistics Netherlands, 2015). All these factors combined with the demographic changes leave pension funds to cope with rising liabilities and dwindling contributions as the number of retirees is rising at a faster pace than active participants. So, when economic turmoil struck in the 2000s, pension funds were forced to take on measures.

1.7 Pension instruments

When shocks occur which are likely to impact the solvency of the fund (in the future), pension funds have several instruments at their disposal. The fund can chose to raise pension contributions, lower indexation of rights and benefits, lower rights accrual or decrease benefit disbursements. Kuné (2006) states that rapid and adequate reactions on rate of return shocks will make smaller shock absorbers (solvency reserves) necessary.

However, if indexation targets are more ambitious, then larger reserves are required (as the yearly adjustments of pension rights will be larger in that case).
The first step to take when the coverage ratio (ratio of fund's assets to its liabilities) plunges is withholding indexation, which a fund is legally instructed to do when its coverage ratios are lower than 105 per cent. In a system of Defined Benefits (DB), participants have (as the name already gives away) certainty about the amount of pension benefits they receive. The catch with DB, however, is that the *nominal* rather than the *real* value of contribution is guaranteed. An individual thus always gets back the total amount of money it put in, but any certainty about future purchasing power is not given. If pensions are not indexed (or only partly so) for price inflation, the real value of pension benefits might well be exceeded by the real value of pension contribution paid in the past.
If this does not resolve the issue of insufficient coverage, a second step is to increase contribution rates. But, the efficacy of such policy is not guaranteed for two reasons. First, if participants know that this pension policy will be effectuated in the future (as they too observe the fund's coverage ratio), they might chose to leave the pension fund, either through switching funds (through seeking employment in another sector), migrating to another country or by dropping out of the labour force altogether. As the efficacy of the contribution policy will fall (fewer participants remain to pay higher contributions) the fund will have difficulties to get back to financial soundness. Second, the contribution device may be rendered powerless over time as the dependency ratio rises, too. This materialises if the liabilities of the fund rise faster than its assets, as benefits due to the retirees grow at a faster pace than the contribution fees to the fund. This also renders the contribution device impotent.
As a third option, the fund can lower pension right accrual. This affects all currently employed and future generations, which have not finalised their right accrual. A fourth step, generally consider as a last resort, is to slash pension benefits. This has an immediate effect on retirees (and in the future on current and future participants), who generally lack the capacity to cushion such blows as they are not employed any more. Slashing pension benefits is considered unfavourable, as it affects individuals who lack the opportunity to smooth the (unexpected) shock, which also is the group of participants who are most aware of their pension entitlements and are well represented by lobby groups and social partners.
Despite that, contribution rates are already historically high and due to the ageing of the Dutch population, the contribution instrument is no longer effective to accommodate disappointing returns on investment (Bergamin *et al.*, 2014). Hence, risks are shifted more and more to the participants (though indexation risks and the possibility of haircuts in right accrual or even benefit disbursements). Therefore Bonenkamp and Westerhout (2011) claim that slashing pension benefits should not be a last resort, but should be permitted in normal circumstances too. It is an effective means to prevent shifting burdens

to future generations, thereby making future generations more prone to seek exits of the pension fund.

All possible policy venues affect different age cohorts asymmetrically. Increasing contribution rates only impacts the age cohorts which are currently employed, or will be so in the future, while shielding the retirees' benefits. If the economy reverts back to its trend level, the increased contribution rate can be restored, so the average contribution rates over the generations evens out, but whether or not the economy will revert back to its initial stance is uncertain. Additional contribution requirements could also have a catching-up characteristic, which means that no pension rights are accrued over these contributions. This has a strong negative impact on the lifetime net pension benefits of an individual: it pays additional contribution, but will not receive additional pension benefits.

Lowering accrual rates has an asymmetric impact on both pre-retirement and post-retirement cohorts as accrued rights are annuitized to pension benefits at superannuation. Furthermore, adjusting the rate of right accrual impacts younger age cohorts more than older age cohorts (given that both are not retired yet), as the former will accrue pension rights at the lower rate for a longer time. Slashing benefits temporarily (i.e. reverting back to the original benefit level after a certain amount of time) leaves retirees and those on the brink of retirement lesser endowed and again distributes the burden of the financial turmoil of the fund uneven over generations.

To make pension funds more resilient to economic shocks several measures have been taken. Besides the aforementioned conditionality of indexations, the switch from final to average wage systems and the increase in the retirement age, the Dutch government has ceased to make early retirement fiscally appealing. At the beginning of 2006 the facilities for early retirement were phased out for all persons born after 1949, while contributions for this facility remained obligatory on a pay-as-you-go basis until the end of 2014 (Staatsblad, 2004). This means that all age cohorts born between 1950 and 1988[7] have, at least for some years, been liable to paying contribution used for a facility which they are not entitled to. Next to economic effects, changing the rules of the game results in social and psychological effects too. Montizaan *et al.* (2009) argue, on basis of a matched survey and administrative dataset conducted on male public sector employees, that health effects arose from this policy change. They find that the age cohort 1950 struggles with depression significantly more than the age cohort of 1949 (5.0 versus 3.5 percentage points, or an increase of 40 per cent) as a self-assessed ex ante result of changing the rule of the game midway. It must however be acknowledged that these results are prone to an upward bias for the 1950 age cohort, as the survey might be used as a tool to complain about the policy change. This does however not withstand the fact that the

[7] 1988 is the youngest age cohort considered in this study. It enters ABP pension fund in 2013 at the age of 25 years.

reform has an emotional impact. Montizaan *et al.* (2009) find behavioural changes too, as individuals indicate to plan on working more and consuming less (save more).
Based on recent developments it cannot come as a surprise that the second pension pillar in the Netherlands has been subjected to severe discussion. Amongst those most notable for their participation in this discussion have been CPB Netherlands Bureau for Economic Policy Analysis (henceforth referred to as CPB) and the Network for Studies on Pensions, Aging and Retirement of Tilburg University (Netspar), who have published a plethora of extremely insightful papers on the matter in Dutch context. Also notable are (youth departments of) political parties (YD, 2013) and Martin Pikaart (2011), who wrote a pitch-black analysis of what the current second pillar system utilised in the Netherlands would lead to, if policy changes are not enforced.
Pikaart (2013) is one of the few who has actually tried to quantify the effects (changes to policy concerning) the second pillar has on different generations. He shows that for age cohorts born in either 1946 or 1982 substantially different net profits materialise from the current system. When the payments for both the first and second pillar are equated, Pikaart (2013) finds substantial positive net profits for the older generation and negative net profits (about half in size of the older generation) for the young generation.

1.8 Policy debate

Intergenerational asymmetries stir emotional reactions in the policy debate. In discussions concerning retirement facilities scapegoating appears to be a default response. Youngsters blame oldsters from slicing a piece of the retirement pie which is disproportional to their contributions. Meanwhile, the oldsters claim that their investments yielded higher returns than currently possible, and that their returns are also not matched by expected future returns. To complicate this further, the number of stakeholders in this debate goes well beyond the actual participants of the fund. One could think of the fund's board and its structure: should participants be on the board of the fund? Moreover, the role which social partners and lobby groups of different age cohorts play in the policy arena should not be underestimated. All of this adds to the importance of this policy debate, making the political stakes high as advocating either young or old might result in votes lost from the other group. The author sees the emergence of the 50PLUS-party and part of the electoral success of the freedom party (PVV) as the fruits of lobbying by oldster advocacy groups. At the other side of the arena, youth departments of established parties (such as social democratic PvdA, liberal democratic D66 and liberal VVD) came with a ten-point action plan for a major overhaul of the pension system. One thing is crystal clear: all stakeholders want to be the ones benefiting from participation in the retirement facilities. But whether intergenerational asymmetries arise, and if so in whose favour these are is yet to be determined.

This study strives to shed some light on what has been a heavily debated issue in Dutch politics. Do the empirics side with the oldsters (like the 50PLUS-party) who claim that each euro of pension benefits disbursed to them is rightfully theirs, as they paid pension contribution with which they acquired an entitlement to these benefits? Or does the data point towards youngsters who claim that pension funds and oldsters alike have been living beyond their means by disbursing/collecting overly generous pension benefits, whilst leaving the young to bear the burden of financial recovery?

1.9 Aim of this research

Studies which aim to find quantitative results on welfare gains of intergenerational risk sharing are by no means superabundant (a point also stressed by Mehlkopf *et al.*, 2011 and Bonenkamp, 2007). Studies which have been conducted (Teulings & De Vries, 2006; Gollier, 2008; Draper & Westerhout, 2009; Bonenkamp & Westerhout, 2010; Mehlkopf, 2010, Cui *et al.*, 2011; Westerhout, 2011; WRR, 1991) find moderate to strong positive welfare results from collective and intergenerational solidary pension saving (compared to optimal individual pension saving), even though the welfare measure utilised differs. Most of these studies show that welfare effects differ per age cohort considered, and Gordon and Varian (1988) state that sharing risks with a higher number of generations is welfare improving.

Taking the above into consideration the literature seems to show that net profits of participation to a pension fund are asymmetrical. A chasm which to the best of the author's knowledge exists in the literature is found in research on the occurrence of asymmetrical per cohort lifetime net pension benefits. And, possibly even more engaging, the scope and causes of this asymmetry, and what this means for participants to a fund. Lever *et al.* (2012) claimed that a test for generation effects should be done on fund level rather than on aggregate level. This study aims to fill this void in the literature by considering real-life data of an existing pension fund with real participants instead of a theoretical fund with stylised agents.

This study is devoted to finding an answer to the following question:

What is the distribution of lifetime net pension benefits for the generations 1932 through 1988 in ABP pension fund?

To find the answer to this question cash flows of specific age cohorts to and from the pension fund are analysed. Do the participants get exactly their money's worth (is pension provision actuarially fair), or does one generation get too much at the expense of another?
This study will describe two analyses, both of which use the same methodology. This methodology will be extensively dealt with in chapter 3, but the essentials are as follows. A model is drafted based on retrospective data from 1957 up to 2014. From 2014 to 2023 the economy gradually moves towards an economic trend-neutral stance which is held from 2024 until fund termination. Using this model the amounts paid to and received from the pension fund by each individual age cohort will be computed in terms of 2014 euro, to ensure mutual comparability. For each generation the discounted balance of payments to and from the fund, the *per cohort lifetime net pension benefit*, is computed, taking account of the fund's return on investment (which is attributed on a yearly basis to each age cohort). The summation of these lifetime net pension benefits is the mirror image of the fund's reserve at termination: each euro gained back in pension benefits by the participants over the discounted contribution they laid in and the return thereon (i.e. the *excess* amount of money an individual receives from the fund) is a euro deficit to the fund. The reverse holds as well: each euro the participants lose to the fund, is a euro surplus to the fund.
The analyses conducted in this study are the following:

Analysis 1:
In the benchmark model the funding shortfall of ABP pension fund is calculated when current pension arrangements are continued without any change in pension policy.

Analysis 2:
The consequences for the intergenerational distribution are calculated of adjusting pension policies (indexation, contribution rates, right accrual rates, benefits) such that the intertemporal budget constraint of ABP holds.

Due to the fact that the fund is susceptible to shocks on the financial markets, as it invests in both domestic and foreign assets, one could argue that the incidence of a random financial shock impacts different age cohorts in an asymmetrical manner. The share of the financial burden to be dealt with by a specific generation is fully reliant on pension policy utilised and the occurrence of such a shock. It could well be that some age cohorts are fortunate enough to live through times with modest volatility, whereas others see financial markets jump up and down like a jigsaw.

Hypothesis 1:
Discrepancies exist between per cohort lifetime net pension benefits.

The underlying mechanism is such that financial shocks affect the yield of investments of the fund in an unexpected manner. This can both be aversely by a negative shock, or advantageously by a positive shock. As financial shocks occur stochastically, this leaves some cohorts more exposed to financial shocks than others. This is partially resolved by the ability of pension funds to smooth shocks over several years, but this does not eliminate asymmetries in chances to be confronted with financial shocks fully. The reason for this may be the timing of the shock. If an age cohort is deceased before the incidence of the shock, this age cohort will remain unaffected by it. The same holds for retired age cohorts, if the fund decides to smooth the shock forwards rather than backwards, by use of other policy instruments than slashing pension benefits. These age cohorts will remain unaffected by the shock as their pension benefits are not subject to any alterations in pension policy. Another reason for a generation to remain unaffected by a shock are legal bounds to the ability of the fund to smooth shocks forwards. Currently pension funds are bound to resolve deficits within ten years, thereby limiting the ability to smooth over the future generations to the next ten age cohorts. Younger age cohorts as a results will remain unaffected by the shock. This only holds if the legal framework remains unaltered, and in the (theoretical) case in which the fund succeeds to resolve its deficit timely.
As a result of this the distribution of the burden of financial shocks over the cohorts is partly asymmetrical. Moreover, as retrospective analysis shows that financial shocks are intergenerationally shared in a solely forward manner (younger generations share in the financial malaise of current generations, whereas the impact on older generations is negligible). So, intergenerational asymmetries are bound to occur by construction. This directly impacts that lifetime net pension benefits of some age cohorts to a higher (lesser) extent than others, leaving them relatively worse (better) off. Following on this, the second hypothesis is:

Hypothesis 2:
Per cohort lifetime net pension benefits of the oldest age cohorts exceed those of later born generations, as shocks to the fund's reserve are shared forward solely and the generosity of pension policy declines over the years.

The oldest generations are among those who take the most advantage of participating in the pension scheme. They have the opportunity to retire earlier, take advantage of better longevity than formerly expected by reaping (too) large pension benefits for a long period of time and they are largely shielded for intergenerational investment risk sharing as this is conducting in a solely forward manner.
In the next chapter the theoretical framework of this study will be reviewed.

2 Theoretical framework

This chapter outlines how the generational accounting model, as pioneered by Auerbach and Kotlikoff[8] (1991, 1994, 1998, 1999, 2002), provides a building block for this research. This study uses a methodology which is inspired by the generational accounting model, but differs on some points. The structure of this chapter is as follows: first, the zero-sum nature of the model will be introduced. Second, the main thoughts of the Auerbach and Kotlikoff methodology will be explored. The lessons learnt from this methodology will be used in the construction of the model used in this study, which will be dealt with in chapter 3. Finally, the similarities and contrasts of the model used in this study with the Auerbach and Kotlikoff model will be outlined.

2.1 Zero-sum games

Hoevenaar and Ponds (2008) state that the total accrued pension rights of all participant of a pension fund, must, by definition, equal the total wealth of the fund. Pensions in the second pillar have zero-sum characteristics (Lever & Bonenkamp, 2013b), as the total sum of pension contributions invested in the fund will be reimbursed at the pension fund's demise. The reimbursements might not be of equal net size over the generations if the fund performs worse than anticipated and thus faces a liquidity shortage. The fact that the pension fund faces a binding intertemporal budget constraint (Hoevenaar & Ponds, 2008) yields a situation in which some gain from participation in the fund and some lose, depending on the structure of the pension contract and the return on invest of the pension fund's investments.

Put differently: the pension fund must, by definition, be able to exactly balance its income (pension contributions received and the returns on investing those) and expenses (pension benefits paid and ancillary costs) at the end of its existence. So, the fund cannot pass on its shortfalls to future generations indefinitely; a no-Ponzi assumption is made and the pension fund is a zero-sum game (Bovenberg & Mehlkopf, 2014). Once a fund will cease it existence, a 'closure rule' will be applied to redistribute any residual wealth (be it surpluses or deficits) as the budget constraint must be strictly binding. This does, however, not imply that the accrued rights of individual participants to the pension fund are written in stone. Changes in pension policy have an impact on the claims individual participants have (their accrued rights). Shifts in pension fund policy follow a strict "one man's pain is another man's pleasure"-protocol, a practice Hoevenaar and Ponds (2008) see as a transfer of value. Taking a view of redistribution of resources between generations seems reasonable as well.

[8]This representation serves the sake of brevity, but certainly does not do right to the efforts of Jagadeesh Gokhale and Willi Leibfritz. Exact references are provided in chapter 8.

2.2 An introduction to Generational Accounting

Auerbach and Kotlikoff (1991, 1994, 1998, 1999, 2002) constructed a method to test if current government policy leads to a fair and equal redistribution of benefits and costs of government finances over different overlapping generations, including future (i.e. yet to be born) ones. Their method is of seminal importance as it offers a tool to gain insight in cash flows from the public (tax payers, or in the case of this study: pension fund participants) to a redistributor (the government or in this case: the pension fund). The central idea behind generational accounting is that money can never leave the system: each euro transferred from the public to the redistributor will end up in the pocket of one of the economic actors in this system. This can either be the same individual in the public, or another individual, or the redistributor itself (which keeps the euro in its reserves). Generational accounting thus assumes the system to be a zero-sum game: the losses of an actor are matched exactly by gains of another actor.
Another insight of generational accounting is to discount all cash flows to the same moment in time, to enable mutual comparability; generational accounts are written in net present value terms. If generational accounts of cash flows out off and into the pockets of the public are comparable among the different age cohorts which compose the public, this makes a ranking of these accounts feasible too. Put differently: generational accounts can be compared in size, thus making it possible to make inference about which age cohort has an account which is more beneficial than that of another. Concluding, generational accounting aids in analysing, comparing and ranking of net benefits of economic actors from a system in which they participate.
Auerbach and Kotlikoff (1991, 1994, 1998, 1999, 2002) impose a strictly binding intertemporal budget constraint on the redistributor, which in their works is the central government. This means that the summation of the government's current and future expenses must be smaller than or equal to its current reserves and all current and future income (all discounted to the same base year). Put differently: the redistributor must be able to pay off its debts (i.e. it cannot leave a negative reserve). So, the redistributor must have a sustainable budget, as defaulting on its debts is not possible. Concluding, generational accounting aids in analysing, comparing and ranking net benefits of economics actors and helps to gain insight in the sustainability in the redistributor's budget. As this study searches for the generation which reaped the most fruits from participation to a pension fund, generational accounting seems a natural way to go.

2.3 Generational accounting: similarities and differences

The main lesson taken from Auerbach and Kotlikoff (1991, 1994, 1998, 1999, 2002) is that all value gained by an age cohort (in excess of the nominal value of its contribution) must originate somewhere (either in excess yields on investment of the fund or in value losses by other age cohorts). The simile with generational accounting is as follows: the central planner is replaced by the pension fund, the tax payer paves for the pension fund participant, generations are still overlapping and the intertemporal budget constraint of the fund is as binding as the governmental one is in generational accounting. Likewise, all payments to and from a generation are discounted to a fixed moment in time (2014 in our case) and the accumulation thereof determines whether or not an age cohort is contributing more or less than it consumes out of the pension fund's reserve. The thought behind generational accounting is preserved: to use accounting measures to split a large cash flow (from the fund to its participants) into smaller bits (from the fund to the respective age cohorts).

Hoevenaar and Ponds (2008) point to two similarities between generational accounting for public finances and pension fund policy: both face intertemporal budget constraints and both have a limited number of policy instruments at their disposal (i.e. taxation, excises and subsidies versus the indexation regime, contribution rates and haircuts on right accrual or pension benefits).

The major difference with generational accounting is that the per cohort lifetime net pension benefits consider the full lifetime period, whereas Auerbach and Kotlikoff's generational accounts consider only the remainder of time. The per cohort lifetime net pension benefits thus are both retrospective and prospective, whereas the generational accounts are purely prospective. Where Auerbach and Kotlikoff are focussed on the expected future net benefits of government policy from a given moment in time (i.e. the net amount of money to be received from the government), this study rather focusses on the net benefits of participation to a pension fund over the full lifetime. The retrospective analysis, in which past cash flows between the participants and the fund are identified, enables this practice, and is an addition to the generational accounting method. The rationale behind this addition is the desire to rank generations on the basis of their lifetime net pension benefit, so inference can be made about the age cohorts who benefitted from the system most over their entire lifetime, instead of from a certain point in time onwards.

This results in differences in the intertemporal budget constraint of the redistributor. The summation of the present value of net income of the redistributor must equate the present value of its future expenses diminished by any wealth which the redistributor possessed *at the beginning of time or the start of its existence* (discounted to the base year), instead of the reserves *at the time of observation* (i.e. the base year).

A second difference with generational accounting is the fact that a finite time horizon is assumed in this study, as the pension fund closes to new participants in 2014 and gradually depletes afterwards. The methodology of Auerbach and Kotlikoff assumes an infinite time horizon in which the government runs its operations indefinitely. The rationale behind this alteration is the desire to limit the scope of this research, so intuitive claims can be posited.

Another difference with generational accounting and this study is that the pension fund (replacing the benevolent planner) has no redistributive agenda. The main goal of the pension fund is to be actuarially fair: provide all participants with a reimbursement on their contributions in the form of pension benefits which, when discounted, boils down to the nominal value of the contributions plus an equivalent yield to all generations. The fund thus makes no difference between individuals, and strives towards an equal treatment of each euro which an individual lays into the fund.

The next chapter comprises a detail description of the model used in this study.

3 Model

This study uses a methodology which is inspired by Auerbach and Kotlikoff's (1991, 1994, 1998, 1999, 2002) generational accounting model. As outlined in chapter 2, contrasting features of the model used in this study are the *finite* time horizon which is considered and the fact that per cohort net *lifetime* pension benefits are calculated rather than net proceeds of government policy *over the remainder of an individual's live.* To aid the structuring this study also draws from the CPB GAMMA model (Draper *et al.*, 2005; Draper & Amstrong, 2007), which lays the foundation for the technical description of the model utilised in this study, and CPB's greying studies (Van der Horst *et al.*, 2010). In this chapter the model will be gradually constructed and the assumptions used will be introduced. First, the means of discounting will be extensively dealt with. Second, the fund's intertemporal budget constraint will be introduced. Third, the age cohort's lifetime net pension benefits will be given in an intuitive representation. Fourth, the demographics of the pension fund's population will be outlined and the process of aggregation will be dealt with. Next, age cohort's income will be added, followed by the income which is applicable to retirement benefits accumulation. Seventh, pension right accrual and the fund's indexation will be introduced. Finally, pension benefits will be described and the termination of the fund is discussed.

3.1 Discounting and the discounting rate

As part of the analysis is forward looking, uncertainty arises as what lies ahead is unknown. The choice of discounting rate therefore is of paramount importance in the quest of generating successful lifetime net pension benefits. A higher rate of discounting depicts lower concern with the future and the interests of future generations (Kuné, 2006). Discounting occurs in the following manner:

$$\sum_{t=1957}^{t=2097} \frac{X_{i,t}}{\prod_{t=1957}^{t}(1+r_s)} \left[\prod_{t=1957}^{2014} (1+r_s) \right] \tag{3.1}$$

In Equation 3.1 variable $X_{i,t}$ (which is for illustrative purposes only) is first discounted back to 1957 and then discounted forward to the base year 2014. $\prod_{t=1957}^{2014}(1+r_s)$ denotes the product of sequences of the real interest rate r_s towards the base year 2014.
The fund's intertemporal budget constraint will be dealt with next.

3.2 Fund's intertemporal budget constraint

The intertemporal budget constraint of the fund is binding in the sense that the fund cannot be in deficit when it is terminated. Put simple: the fund cannot reimburse more money than the sum of what it currently has and in the future expects to acquire. This study will first provide statistics for the case in which the fund has a non-binding budget constraint. These observations will inform us about the residual fund reserve (which can either be a deficit or a surplus) at termination under unchanged pension policy and with trend-neutral economic growth. Afterwards the fund's binding intertemporal budget constraint will be assumed to hold. So if a residual fund reserve is found, policy measures will need to be resolve the fund's deficit or to determine how a surplus will be distributed over the participants. The fund can use four policy instruments (contribution rate, right accrual rate, pension benefits and the indexation regime) which leads to a large variety of policy measures.

The fund gathers pension contribution over the years in exchange for a nominal right accrual for the participant which at retirement is annuitized and disbursed as pension benefits at a fixed interval for the remainder of the participant's life. Between the moment of pension contribution collection and pension benefit disbursement the fund holds the contribution fee as a reserve. We assume that the full reserve is invested, as operational, personnel and overhead costs (i.e. ancillary costs) are assumed to be negligible. The fund is established in 1957, without any initial holdings (so the fund's initial wealth is negligible). The fund is established with the first contributions gathered from age cohort 1932, and the fund is terminated at the end of 2097, when the last participant born in 1988 passes away. The fund's intertemporal budget constraint is provided in Equation 3.2:

$$\sum_{i=1932}^{i=1988} NB_{i,2014} = \gamma_{2014} \tag{3.2}$$

The left-hand side of Equation 3.2 shows the summation of per cohort lifetime net pension benefits (NB_i) of all participating generations i, written in terms of 2014 euro. Age cohorts i are all generations which enter the fund during its existence (i.e. those born between 1932 and 1988, who enter the fund between 1957 and 2013). The right-hand side of Equation 3.2 shows the implicit debt of the fund with regard to the current arrangements (γ), also written in terms of 2014 euro. It must be noted that the life-time net pension benefits of an age cohort i depicts the pension benefits received net for contributions paid and the returns hereon from investment by the fund, written in terms of 2014 euro. The life-time net pension benefits thus depict the surplus a generation

receives from the fund over their pension entitlements.
The fund's intertemporal budget constraint is strongly reminiscent of Auerbach's and Kotlikoff's (1991, 1994, 1998, 1999, 2002) government intertemporal budget constraint as it equates the amount of transfers from the fund to its participants (left-hand side) to the amount the fund needs to settle its intertemporal budget constraint (the implicit debt of the fund; right-hand side). The fund's budget constraint thus makes accessible the cash flows to (left-hand side) and from (right-hand side) the pension fund to the public, all written in real values (i.e. discounted to 2014).
Whether or not the fund is able to hold its intertemporal budget constraint depends on the size of its reserve. This issue will be addressed in section 3.11. The next section discusses per cohort lifetime net pension benefits.

3.3 Per cohort lifetime net pension benefits

The per cohort lifetime net pension benefits are denoted in Equation 3.3:

$$NB_{i,2014} = \sum_{t=1957}^{t=2097} \frac{(b_{i,t} - p_{i,t})\Omega_{i,t}}{\prod_{t=1957}^{t}(1+r_s)} \left[\prod_{t=1957}^{2014} (1+r_s) \right] \tag{3.3}$$

in which $i \in [1932, \ldots, 1988]$ and $t \in [1957, \ldots, 2097]$.

Per cohort lifetime net pension benefit depicts the net present value of the differences of the pension benefits received from the fund and the contribution payments to the fund of generation i, discounted to the year 2014. Per cohort lifetime net pension benefit $NB_{i,t}$ is the balance of all current and future payments to (pension contributions $p_{i,t}$) and disbursements from (pension benefits $b_{i,t}$) the fund for an individual member of age cohort i in year t, discounted to year 2014 by use of the real risk-free interest rate r_s and multiplied by the number of survivors $\Omega_{i,t}$ of cohort i up to year t. The age cohort i consists of representative agents, who differ only in the age at which they pass away (e.g. who are treated equally by pension fund policy and do not differ in income or employment status). Pension benefits are received by an individual up to the moment of decease. So an age cohort receives pension benefits ($B_{i,t}$[9]) up to the moment that the last member of this age cohort has passed away (measured as the year of birth plus the maximum attainable longevity for this age cohort (D_i), so pension benefits are received up to $i + D_i$). The summation of all pension benefits received by this age cohort is decreased by the value

[9]Capital letters $B_{i,t}$ and $P_{i,t}$ represent benefits received and contributions paid by age cohort i as a whole in year t, lower case letters $b_{i,t}$ and $p_{i,t}$ represent benefits received and contributions paid by an individual member of age cohort i in year t. If $\Omega_{i,t}$ represents the number of survivors belonging to age cohort i in year t, then $B_{i,t} = b_{i,t} \cdot \Omega_{i,t}$ as cash flows to and from individuals belonging to the same age cohort in the same year are identical.

of pension contributions paid by the same age cohort, once again aggregated towards the appropriate number of survivors. Pension contributions are paid up to the moment the last member of this age cohort has retired (measured as the year of birth plus the maximum attainable length of employment (R_i), so up to year $i + R_i$). The maximum attainable length of employment is asymmetric between generation as a result of shifts in the arrangements for pre-superannuation retirement and shifts in the superannuation age from 2014 onwards.
The fund's demographics will be dealt with next.

3.4 The pension fund's population demographics

In this study the fund starts its pension scheme in 1957, when the employees born in 1932 enter the fund. All participants enter the fund at age 25. Each year another age cohort enters the fund, until the age cohort 1988 enters the fund in 2013, after which the fund does not allow any subsequent age cohorts to enter the pension scheme. So, from 1957 up to 2013 the fund's population grows yearly. The population has reached its maximum size at the start of 2014 (as all participating generations have then entered the fund, with the entrance of the youngest participant which is born on December 31, 1988) and gradually depletes afterwards as participants pass away. The last participant to pass away belongs to the youngest age cohort (1988) and deceases at the age of 109 in 2097.
The participants to the fund are identical within their generation in the sense that all have identical earnings while working and face identical pension policies (i.e. franchise, pension accrual rate, pension contribution rate, level of pension benefits and indexation regime). The sole difference between members of a specific age cohort are their chances of surviving up to the next year. Not all cohort members pass away at the same age. Identical circumstances are assumed regardless of gender, educational attainment, ethnical descent or all other demographic factors. The sole reason for intergenerational discrepancies hinges on the fact that different circumstances (e.g. labour earnings, pension policy, whether or not an individual is alive or accumulating pension earnings at times of economic downturn or economic prosperity) are faced by different age cohorts. Within an age cohort all individuals are representative agents, who enter the fund at age 25 and will remain full-time active pension contributors until the time of superannuation or decease, whichever comes first.
Individual members can exit the fund (possibly to other pension funds) by forsaking their job, but the assumption is made that vacancies are filled up by individuals belonging to the same age cohort (i.e. by individuals moving from another Dutch second pension pillar fund). The fund's participant is as such replaced by an identical individual, who has the same age, longevity perspectives and earns the same wage. Such a job transfer

is accompanied by a full transfer of past and future pension entitlements and obligations towards the new fund participant. In essence, the exiting of an individual from the fund for any other reason than the passing away of a participant does not alter the fund's or the respective age cohort's financial circumstances. Migration from and to the Netherlands is neglected in this study, this is discussed further in section 5.1.
The fund's demographic dynamics are denoted in Equations 3.4 through 3.7:

$$\Omega_{i,t} = Y_{i,t} \qquad \text{for } t = i \tag{3.4}$$

$$\Omega_{i,t} = \Omega^*_{i,t} - Z^*_{i,t-1} \qquad \text{for } t = i + 25 \tag{3.5}$$

$$\Omega_{i,t} = Y_{i,t} \qquad \text{for } i < t < i + 25 \text{ and } i + 25 < t < i + D_i \tag{3.6}$$

$$\Omega_{i,t} = 0 \qquad \text{for } t = i + D_i \tag{3.7}$$

Equation 3.4 states that the amount of survivors of age cohort i at time t equal to year i (i.e. $\Omega_{i,t=i}$; the birth year of this generation) is equal to the birth rate in that year. So, $Y_{i,t}$ depicts the numbers of births in year t, whom therefore belong to generation i. However, participants only enter the fund at an age of 25 years old. So, the second equation shows that the amount of participants entering the funds is equivalent to all those who have chosen to enter the labour force at age 25 and are hired by ABP-employers (the balance of which is depicted by $\Omega^*_{i,t}$), diminished by the number of individuals who pass away at age 24 (depicted by the mortality rate for the preceding year $Z^*_{i,t-1}$). Equation 3.6 shows the process of age cohort depletion: each year the preceding amount of age cohort members is diminished by the amount of those who pass away during the succeeding year, up to the moment that no one from this age cohort is left (Equation 3.7, in which $i + D_i$ depicts the maximum longevity of a member of age cohort i).

3.5 Aggregation of age cohorts

As all age cohorts exist of identical, representative agents, both aggregation and disaggregation is straightforward. Aggregation is constructed from individual generational accounts by multiplying all factors by the amount of survivors of generation i up to year t ($\Omega_{i,t}$), disaggregation curtails dividing the age cohort's generational account over all aggregated observations of the pool of survivors

3.6 Gross labour earnings

All participants to the pension fund who originate in the same birth year have equivalent labour earnings. As all individuals work full-time until either retirement or death (whichever comes first) crosses their path, a choice for part-time retirement (shortening of the working week) is not possible. For our goal there is no necessity to write gross labour earnings (i.e. before income taxation) in per hour terms, as all employees work an equivalent amount of hours at all times. Labour income taxation is abstracted from in this study. This can be done as labour markets effects of such taxation are abstracted for by the assumption of full-time labour. The abstraction from taxation on the proceeds of labour is convenient as it renders the incidence of contribution levying (on the employer or the employee) trivial: labour costs for the employer are equivalent to gross labour earnings of the employee.

The per annum gross labour earnings of a participant of age cohort i at time t are represented by $\lambda_{i,t}$, provided that $i + 25 \leq t < i + R_i$ (wages are only earned from the age of 25 until the retirement age). The lifetime gross labour income of age cohort i, discounted to base year 2014, is denoted in equation 3.8:

$$\sum_{t=i+25}^{t=i+R_i} \frac{\lambda_{i,t}\Omega_{i,t}}{\prod_{t=i+25}^{t}(1+r_s)} \left[\prod_{t=i+25}^{t=2014}(1+r_s)\right] = \sum_{t=i}^{t=i+D_i} \frac{\lambda_{i,t}\Omega_{i,t}}{\prod_{t=i}^{t}(1+r_s} \left[\prod_{t=i}^{t=2014}(1+r_s)\right] \tag{3.8}$$

Total lifetime labour income remains unaltered after retirement (until the moment of decease). Equation 3.9 shows per cohort lifetime net pension benefits as a percentage of discounted life income, to show the effects as a share of lifetime income rather than in nominal (2014 euro) terms:

$$NB_{i,2014}^{\text{real}} = \frac{NB_{i,2014}}{\sum_{t=i}^{t=i+D_i} \frac{\lambda_{i,t}\Omega_{i,t}}{\prod_{t=i}^{t}(1+r_s)}[\prod_{t=i}^{t=2014}(1+r_s)]} \tag{3.9}$$

The pension base and contributions will be discussed next.

3.7 Pension base and contributions

As explained in section 1.1, the Dutch pension scheme exists of three pillars. A certain part of income is not taken into consideration when paying contributions or acquiring pension rights in the second pillar. This share is known as the franchise. Deducting the franchise from gross labour earnings yields the pension base. Part of the pension contributions is the responsibility of the employer, part is accounted for by the employee. As the employer's labour costs and the employee's labour earnings are equated in this study, all pension contributions can be combined in one variable, without loss of explanatory power. This holds as the total amount of contributions paid (either by an age cohort or an individual) is the same irrespective of the source out of which the payments are levied. As this study abstracts from taxation, both labour earnings and the pension base are written in gross terms. Pension contributions are denoted in Equations 3.10 and 3.11:

$$P_{i,t} = (\rho_t + \rho_{i,t}^{\text{cu}} + \rho_{i,t}^{\text{VUT}})\psi_{i,t} \tag{3.10}$$

$$\psi_{i,t} = \lambda_{i,t} - F_t \tag{3.11}$$

Per cohort pension contributions $P_{i,t}$ depend on the size of the uniform contribution rate ρ_t, a possible catching-up contribution rate $\rho_{i,t}^{\text{cu}}$, a possible contribution rate for early retirement facilities $\rho_{i,t}^{\text{VUT}}$ and the pension base $\psi_{i,t}$, in all cases applicable for age cohort i during year t. The uniform contribution rate ρ_t is uniform in the sense that the rate is equal for all participants of all age cohorts, as explained in section 1.5. The other contribution rates can differ among generations if pension policy dictates so. Not all generations are susceptible to early retirement contribution payments (regardless of whether or not they contribute to the early retirement facility) and catching-up pension contributions are often asymmetrically distributed over the age cohorts (as the fund's ability to smooth shocks is bounded legally to a maximum of ten year). The pension base $\psi_{i,t}$ is obtained by taking the difference of gross labour earnings $\lambda_{i,t}$ and the uniform franchise F_t applicable during year t (Equation 3.11).

3.8 Right accrual

As described in section 1.6 accrual can be dealt with in two distinct ways. First, final wage, in which the pension accrual is indexed yearly for the growth of a participant's gross labour earnings through back-servicing. In essence the system of final wage pension right accrual guarantees that the participant's pension benefits amount to 70 per cent of the *last earned* wage. ABP had a system of unconditional back-servicing up to the end of 2002. Back-service (and price level indexation, which boils down to the same process as long as wages are indexed to price level developments) was conditional on the fund's financial health in 2003, which did not prevent back-servicing from being effectuated in 2003. From the beginning of 2004, ABP uses an average wage system for all its participants. An average wage system lacks back-servicing, thereby making pension benefits dependent on the price level indexation policy effectuated by the fund. The next section will expand on indexation of pension rights and benefits. In an average wage system the target is to offer participants 70 per cent of their *average* wage as pension benefits. In the likely scenario that a participant has at least one wage increase over the course of his or her time of employment it is straightforward to notice that a final wage systems yields higher pension benefits than an average wage system. This happens as all pension entitlements accrued up to that moment will be risen through the back-servicing process for the final wage system, whereas this does not happen for an average wage system in which pension right accrual is not back-serviced, but conditionally indexed for price inflation. Following the notion that individual seek to maximise their utility, which is positively influenced by their capacity to consume, it is clear that a final wage system is to be preferred over an average wage system by a utility-maximising individual, assuming that consumption is a normal good. This is the case as under a final wage system an individual's purchasing power is assured if the fund's coverage ratio is sufficient at retirement, which is not the case for an average wage system in which an individual will never catch up on indexation deficits, resulting from any deficiencies in the fund's coverage ratio over the full time span of the individual's employment. Under a final wage system a fund can be struck by financing problems if the reserves run too low, which will be detected by the fund's coverage ratio.

A final wage right accrual system is denoted in Equations 3.12 through 3.14:

$$\chi_{i,t}^{\text{FW}} = \sum_{t=1957}^{t=2097} \frac{\lambda_{i,t-1}\Delta_{i,t}}{\prod_{t=1957}^{t}(1+r_s)} \left[\prod_{t=1957}^{1=2014}(1+r_s)\right] \qquad \text{iff } t = i + R_i \leq 2003 \quad (3.12)$$

$$\Delta_{i,t} = \sum_{t=i+25}^{\min(t=i+R_i;t=2003)} \delta_t \qquad \forall\, i = i + 25 \leq 2003 \;\wedge\; 1957 \leq t \leq 2003 \quad (3.13)$$

$$\delta_t = 0.0175 \qquad \text{for } 1957 \leq t \leq 2003 \quad (3.14)$$

In Equation 3.12, $\chi_{i,t}^{\text{FW}}$ denotes the right accrual under a final wage right accrual system for an individual born in age cohort i at time t, and is equal to the wage earned in the year before retirement $\lambda_{i,t-1}$ times the total accrual rate $\Delta_{i,t}$. In Equation 3.13 $\Delta_{i,t}$ equates the summation of annual right accrual δ_t, up to the abolishment of the final wage right accrual system in 2003. Yearly right accrual was equal to 1.75 per cent annually (see Equation 3.14), which meant that after forty years of employment (from age 25 up to and including age 64) one would have acquired a right to a pension benefits amounting to 70 per cent of the last earned wage[10].

An average wage right accrual system is depicted in Equation 3.15:

$$\chi_{i,t}^{\text{AW}} = \sum_{t=1957}^{t=2097} \frac{\delta_t\lambda_{i,t}\prod_{t=i}^{t}\zeta_t}{\prod_{t=1957}^{t}(1+r_s)} \left[\prod_{t=1957}^{t=2014}(1+r_s)\right] \qquad \text{iff } t = i + R_i > 2003 \quad (3.15)$$

in which δ_t depends on pension policy[11] $\forall\, t > 2003$.

$\chi_{i,t}^{\text{AW}}$ denotes the right accrual under an average wage right accrual system for an in-

[10] As $40 \cdot 1.75\% = 70\%$

[11] See Section 5.5 for further detail.

dividual born in age cohort i at superannuation (i.e. at $t = i + R_i$), and is equal to the summation of the right accrued over the labour earnings up to retirement times the product of sequences of indexation $\prod_{t=i}^{t} \zeta_t$ up to year t, discounted to the base year $t = 2014$. For age cohorts which enter the fund before 2003, but retire after 2003, a final wage system is enforced until the end of 2003 and an average wage system is used from 2004 onwards. As these generations will retire under an average wage system, they are considered to be generations which fell under the average wage right accrual regime.
The yearly right accrual rate is not fixed under an average wage system and is susceptible to changes in the pension policy. This will be further discussed in Section 5.5.

3.9 Indexation of pension rights and benefits

From 2004 onwards, Dutch pension law provides a framework for indexation of pension right accruals and pension benefits, the Financial Supervision Framework (*Financieel Toetsingskader*, henceforth referred to as FTK; Staatsblad, 2014). The FTK only permits full indexation of rights and benefits if the financial health of a pension fund is sufficient. The financial health, or solvability, of a fund is measured by the coverage ratio of the fund. The coverage ratio divides the assets of a fund (contributions received during a year plus the reserves of the fund) by its liabilities (benefits to be disbursed during this year and future liabilities, as measured by the total accrued rights). Unfortunately this approach cannot be used in this research, as the coverage ratio is not robust to possible deficiencies in the fund's reserve and generally only works well if a fund has a full population (all age cohorts from age 25 to the maximum attainable longevity are constantly participating). Put differently: the coverage ratio works well if the fund is not assumed to be discontinued, which is not the case in this study.
As especially the latter is not the case in this research, in which the fund is gradually depleted, indexation cannot be dealt with in the proper manner as dictated by the FTK. Instead this research chooses three scenarios for indexation. Indexation is either done fully, without exceptions (so accrued rights and pension benefits are indexed to price level inflation regardless of the circumstances), indexation is effectuated in halve of the cases (i.e. pension rights and benefits are indexed for halve of price inflation) or indexation is never effectuated. In the case of full indexation real purchasing power of all participant's inlays is safeguarded (i.e. possible past indexation deficiencies are and possible deficiencies of the fund are exacerbated, in the case without indexation only the nominal value of the participant's contribution is kept, leading to a maximum loss of purchasing power and sketching a too bright picture of the financial wellbeing of the fund.

3.10 Pension benefit disbursement

The amount of pension benefits a participant receives is determined by the pension right which is accrued. Different levels of pension benefits arise when different systems of right accrual are utilised. Pension benefit disbursement is depicted in Equations 3.16 and 3.17:

$$B_{i,t} = \sum_{t=1957}^{2097} \frac{\chi^{\varphi}_{i,t=i+R_i} \prod_{t}^{t=i+D_i} \zeta_t}{\prod_{t=1957}^{t}(1+r_s)} \left[\prod_{t=1957}^{t=2014}(1+r_s)\right] \qquad \forall\, i+R_i \leq t < i+D_i \tag{3.16}$$

$$\varphi \in (\text{FW}; \text{AW}) \tag{3.17}$$

Retirement benefits $B_{i,t}$ for age cohort i at time t depend on right accrual under either final or average wage systems times indexation from the moment an individual is retired until the moment of decease, discounted to the base year 2014. After retirement the accrued rights will no longer be indexed, but rather the pension benefit itself will be indexed. The decision on both indexation in simultaneous and symmetrical.
The fund's termination will be dealt with in the next section.

3.11 Termination of the pension fund

After the decease of the fund's last remaining participant, the fund will be terminated. The termination itself can occur in two distinct ways, with a non-binding or a binding intertemporal fund budget constraint. With the former the fund will continue its operations as during normal circumstances until the decease of the last person. If the fund has a reserve deficit (for whatever reason) it will not be able to fulfil its obligations after the last euro has been spent and the last individuals to be part of the fund (i.e. be alive) will pay the price for this. This is the scenario Pikaart (2011, 2013) sketches, in which the youngest generations carry the burden of overly generous pension benefits received by the older generations. In essence in this case the youngsters pay the costs for the binding intertemporal budget constraint of the pension fund.
In the latter scenario (in which the fund's intertemporal budget constraint binds: $\sum_{i=1932}^{i=1988} NB_{i,2014} = \gamma_{2014}$) the pension fund is aware of its implicit debt and acts to ensure its financial reserves (ε_{2014}) are sufficient to offset the implicit debt. So:

$$\varepsilon_{2014} = -\gamma_{2014} \tag{3.18}$$

The result of Equation 3.18 is that the fund holds a financial reserve which is a mirror image of the summation of per cohort lifetime net pension benefits. The latter enters the equation negatively for the fund, as the gains of the participants over their entitlements are costs to the fund. This is depicted in Equation 3.19:

$$\varepsilon_{2014} = -\sum_{i=1932}^{i=1988} NB_{i,2014} \tag{3.19}$$

The only way in which an equilibrium can be reached between the participant's lifetime net benefits and the fund's reserve is when both are nil:

$$\varepsilon_{2014} = \sum_{i=1932}^{i=1988} NB_{i,2014} = 0 \tag{3.20}$$

The rationale behind this is that the fund's intertemporal budget constraint can only be held if the pension scheme is drafted exactly right. This occurs if the cash flows to the fund (existing of contribution payments and the financial returns on investing these) exactly offset the cash flows from the fund (the summation of pension benefits disbursed by the fund to all participants), all discounted to the base year 2014. This shows that the pension scheme indeed is a zero-sum game.

As we have already established that longevity has risen faster than expected, it is plausible to assume that pension benefits to be disbursed by the fund were higher than expected. The fund can prevent the occurrence of reserve deficits by cautious pension policy (e.g. demand pension contribution including a premium for advances in longevity). If however, imperfections arise in the pension policy (e.g. through an underestimation of the advances in longevity) the fund's reserve will not be a perfect fit with the participants' pension entitlements. The result of this could either be a reserve surplus at the fund's termination or a reserve deficit. In the former scenario, the participants would receive less in pension benefits than what the pension scheme entitles them to. This could be amended by the disbursement of additional pension benefits to the fund's participants. The latter scenario would boil down to the opposite: the fund would have to levy catching-up pension contributions, for which no additional pension right are accrued. In both scenarios the fund's participants are negatively affected: their pension benefits either have to be revised (the timing of which is not guaranteed, so participants could have to wait for the benefits they are entitled to) or they could be compelled to pay a larger amount of money than what they agreed upon with the fund by entering the pension scheme.

While the previous regards the fund's participants as one big pool of participants, the reality is that this pool consists of separate age cohorts with separate lifetime net pension benefits. As the implicit debt of the fund is only calculated in 2014, the separate age cohorts are affected asymmetrically by changes to pension policy. This is the case as part of the fund's population has already passed away in 2014, leaving them unaffected by any kind of policy changes. Moreover, a large share of the lifetime net pension benefits of the older generations will have already materialised by 2014 and will thus be shielded

from policy changes (which legally cannot be applied retroactively). So, while the fund can respect its intertemporal budget constraint without reserve surpluses or deficits, this only means that the *summation* of per cohort lifetime net pension benefits accounts to zero. In other words: for all participants combined the pension benefits received exactly matches the pension entitlements acquired by the contribution payments to the fund. This however, does not mean that for all *individual* age cohorts the pension benefits received match the pension entitlements acquired by contribution payment, for the reasons posited above. If the fund needs to take action to be able to hold its intertemporal budget constraints, intergenerational differences in lifetime net pension benefits are bound to arise. The fund has the following four policy instruments at its disposal: contribution rates, right accrual rates, pension benefits levels and indexation rates. It can also opt for a combination of instruments. The analyses in this study will explore it the fund does indeed need to take policy measures, and if so, what effects this will have on the per cohort net lifetime pension benefits. This will be discussed in chapter 6.
In the next chapter the modelling of a risk-free world will be discussed.

4 Risk-free modelling

In this study a model is utilised which contains both a retrospective and a prospective analysis. The retrospective analysis is based on real-life data which describes a world in which an investor (i.e. an individual saving for its retirement) has the option to invest in both risk-free and risk-bearing assets. The prospective non-stochastic analysis assumes a risk-free world in which the investor invests in risk-free assets solely. In this study the retrospective analysis considers the returns on investment of the fund as if they are resulting from a risk-free world, to match with the prospective analysis. This chapter will show that the fact that the model in this study is modelled in a risk-free world does not affect the validity of the results found. To this end a two-period overlapping generational accounting model in which uncertain cash flows are risk-neutrally valued by use of a stochastic discount factor is described. This model is taken from Mehlkopf (2015) and reaffirmed by the intuition found in Bovenberg and Mehlkopf (2014).
This chapter is structured as follows: section 4.1 explores a fairness criterion based on ex ante market value (pioneered by Teulings & De Vries, 2006), and section 4.2 explores a generational accounting model with uncertain cash flows.

4.1 Ex ante market value based fairness criterion

Section 1.4 on risk sharing in pensions showed that financial markets are incomplete, as they are unfit to provide a market place on which risks can be shared between current and future generations. This is due to the fact that both are not present on the market simultaneously, which poses a biological trading constraint (Bovenberg & Mehlkopf, 2014). A pension fund can resolve this constraint as it is long-lived (i.e. stretches over both the lifespan of the current and the future generations) and can provide a market place on which transfers can be made between both generations.
An ex ante market value based fairness criterion, as explored by Teulings and De Vries (2006), assumes that no market value is lost by any participating generation from sharing risks. As second pillar pensions are a zero-sum game, this implies that market risk shared intergenerationally equals zero too. Put differently: the market value of the risk shared by any generation with another is zero, so any deterministic intergenerational risk sharing is ruled out. If age cohorts share risk intergenerationally, this comes out of the excess return of risky assets over the risk-free rate, to accommodate risk which is shifted from one generation onto the next one. Bovenberg and Mehlkopf (2014) state that a full risk compensation is provided by the market when an ex ante market value based fairness criterion is used. This is beneficial to the youngsters, as any risk shifted onto them by a preceding generation is fully compensated.
Bovenberg and Mehlkopf (2014) use an ex ante market value-based generational accounting model, which is equivalent to the method used in this study. Per cohorts lifetime net

pension benefit are calculated as the difference between the cash flows from and to the pension fund (from the perspective of the participant, at discounted ex ante market value; Bovenberg and Mehlkopf, 2014). Bovenberg and Mehlkopf (2014) show that within value-based generational accounting the replication principle (on which asset pricing theory is based; Cochrane, 2001)) is applied. The replication principle states that the price of any stochastic cash flow can be distinguished by use of a replicating portfolio. The price of the replicating portfolio is equal to the price of the stochastic cash flow under the law of one price[12], if the no-arbitrage condition[13] holds on the financial markets. The no-arbitrage condition implies that *excess* returns of risk-bearing assets (i.e. returns on stocks over the risk-free rate) have no market value from an ex ante perspective. The rationale behind this is that an investor can get any multiple of the excess return of risk-bearing assets by purchasing risk-bearing assets with liquidity obtained by borrowing against the risk-free rate. Thus, the pay-offs of an investment in the risk-bearing asset and an investment in the risk-free rate have the same ex ante market value[14], as the no-arbitrage condition dictates that equivalent investments have equivalent ex ante market values (Bovenberg & Mehlkopf, 2014). *Excess returns on risk-bearing assets thus have zero ex ante market value.*

This finding is central to this study. As the excess returns from risk-bearing investments are worthless from an ex ante market value perspective, it is reasonable to model both the retrospective and prospective parts of the analysis in this study risk-free, as the ex ante market valuations under both conditions are equivalent. Transforming retrospective data to a risk-free world, which is continued in the prospective analysis thus does not affect the validity of the results of this study.

Section 4.2 provides a theoretical proof of this finding.

4.2 Value-based generational accounting model with uncertain cash flows

This section will reconstruct the model from Mehlkopf (2015), which demonstrates that excess returns on risk-bearing assets have zero ex ante market value. The analysis of Mehlkopf (2015) is complemented with the intuition found in Bovenberg and Mehlkopf (2014). First, the benchmark model will be outlined. Second, a model with an ex ante market value based fairness criterion will be analysed.

[12]The law of one price concerns the principle that an asset or commodity which is traded on different geographical markets should have the same price when expressed in the same currency (Burda & Wyplosz, 2009).

[13]The no-arbitrage condition refers to a situation in which all assets are appropriately price so an investor cannot reach higher profits without taking on additional risk (Burda & Wyplosz, 2009).

[14]Provided that the amounts invested in both assets are of an equivalent size.

4.2.1 Benchmark model

Consider a two period overlapping generations model in which an age cohort t lives for two periods. Generation t is active (i.e. works) in period t and passive (i.e. is retired) in period $t+1$. In each period t (the scheme is introduced at the beginning of $t = 1$) two generations are alive, the currently active generation (t) and the currently passive generation ($t-1$). All generations $t \geq 1$ are obliged to lay pension contribution into the pension scheme when young (p_t), which entitles them to pension benefits (b_{t+1}) when retired. The scheme is fully funded, so the currently passive generation ($t = 0$) receives no pension benefits during the first year the scheme exists ($b_1 = 0$), as this would render the scheme partially funded[15]. This generation ($t = 0$) also does not pay contributions to the scheme ($p_0 = 0$), as the fund does not exist yet when this generation is active[16] (at time $t = 0$).

Investors have two investment opportunities. They either invest in a risk-free asset with a time-invariant return $r^{rf} > 1$. Or they invest in a risk-bearing asset with a stochastic return r^s_{t+1}, which is i.i.d. distributed $\forall\, t \geq 1$ with a time-invariant mean $\bar{\mu} > r^{rf}$ and standard deviation σ. The risk-bearing asset is expected to yield a higher return than the risk-free rate: $\mathrm{E}_t[r^s_{t+1}] \equiv \bar{\mu} > r^{rf}$. The returns on the risk-bearing asset thus contain a risk premium for the risk (of an adverse outcome) taken on by the investor. The excess return on a risk-bearing asset is depicted by $\tilde{x}_t = \mu - r^{rf}$.

Bovenberg and Mehlkopf (2014) use a stochastic discount factor, which strips physical probabilities from the risk they contain (Cochrane, 2001). The stochastic discount factor therefore creates risk-neutral probabilities, which can also be acquired under risk-neutral pricing, which aid to get a risk-neutral valuation of stochastic cash flows (Mehlkopf, 2015). The risk-neutral probability is depicted as follows: $\mathrm{E}^Q_t[r^s_{t+1}] = r^{rf}$, in which Q depicts risk-neutrality. So the risk-neutral price of a stochastic cash flow is equal to the risk-free rate. The explanation for this is that under risk-neutrality the financial markets will yield a risk premium of $\tilde{x}_t = 0\ \forall\, t$, as the investor is by definition indifferent between the risk-bearing and the asset which yields the risk-free rate. So, there is no need to entice the investor to take on the residual risk of the risk-bearing asset by use of a risk premium.

Mehlkopf (2015) states that the "present value of a stochastic future payoff is equal to its expectation under the risk neutral probability measure, discounted against the risk-free rate". This means that an equivalent investment (of size k) in the risk-bearing asset and

[15] In fact disbursing pension benefits to the initial passive generation ($t = 0$) would introduce a pay-as-you-go element to the pension scheme, as this generation would have a windfall gain. As the fund analysed in this study is fully funded as well, the model of Bovenberg and Mehlkopf (2014) is appropriate.

[16] Assuming that retroactive levying of pension contributions is prohibited.

the risk-free rate have the same ex ante market value (Equation 4.1):

$$\frac{\mathrm{E}_t^Q[kr_{t+1}^s]}{r^{rf}} = k\frac{\mathrm{E}_t^Q[r_{t+1}^s]}{r^r f} = k \tag{4.1}$$

As determined in section 4.1, the excess return on risk-bearing assets has no ex ante market value, so the risk-neutral probability measure $\mathrm{E}_{t=0}^Q[\tilde{x}_t] = 0 \; \forall \; t$.

The pension scheme has a binding intertemporal budget constraint, written in surplus terms (s_t). Next period's surplus is equal to the reserve left from investing the summation of last period's reserve and this period's contribution payments and the returns on investing these, minus the benefits to be paid in the next period (Equation 4.2):

$$s_{t+1} = r_{t+1}^p(s_t + p_t) - b_{t+1} \tag{4.2}$$

In Equation 4.2 r_{t+1}^p depicts the investor's return on investment from period t to period $t+1$. The scheme has zero reserves/surpluses when it is established ($s_1 = 0$). The portfolio return r_{t+1}^p results from $r_{t+1}^p = fr_{t+1}^s + (1-f)r^{rf}$, which follows from investing a proportion f of the investor's assets in risk-bearing assets and a proportion $(1-f)$ in assets yielding the risk-free rate.

The generational account of generation t (GA_t) follows from the pension benefit (at ex ante market value) minus the pension contribution paid:

$$GA_t = \frac{\mathrm{E}_{t=1}^Q[b_{t+1}]}{r^{rf}} - p_t \tag{4.3}$$

When substituted in the budget constraint this yields:

$$GA_t = \begin{cases} -\dfrac{\mathrm{E}_{t=1}^Q[s_{t+1}]}{r^{rf}} & \text{for } t = 1 \\ \mathrm{E}_{t=1}^Q[s_t] - \dfrac{\mathrm{E}_{t=1}^Q[s_{t+1}]}{r^{rf}} & \text{for } t > 1 \end{cases} \tag{4.4}$$

In words Equation 4.4 states that the generational account of generation t is equal to the surplus (s_t) this generation receives from the preceding generation ($t-1$), minus the surplus (s_{t+1}) it shifts onto the next generation ($t+1$). As the fund is a zero-sum game it follows that the summation of generational accounts must be, by definition, equal to the reserves of the fund at establishment (which are zero):

$$\sum_{t\geq 1} \frac{GA_t}{(r^{rf})^{t-1}} = s_1 = 0 \tag{4.5}$$

Equation 4.5 shows that in this benchmark model a binding intertemporal budget constraint leads to equal generation accounts for all generations, which are equal to zero.

4.2.2 Model with an ex ante market value based fairness criterion

A pension scheme in which full compensation for intergenerationally shifted risks is provided will now be reviewed. Consider a fund which invests in risk-bearing assets (i.e. $0 < f < 1$). The fund determines benefits along a pre-specified line, which is depicted in Equation 4.6:

$$b_{t+1} = p_t r^{rf} + \eta p_t (r^p_{t+1} - r^{rf}) + s_t r^p_{t+1} \tag{4.6}$$

$0 < \eta < 1$ in Equation 4.6 determines the amount of contributions received over the previous year which are invested in risk-bearing assets. Inserting this in the equation depicting the fund's surplus yields (for $t \geq 1$) Equation 4.7:

$$\begin{aligned} s_{t+1} &= r^p_{t+1}(s_t + p_t) - b_{t+1} \\ &= (1-\eta) p_t (r^p_{t+1} - r^{rf}) \end{aligned} \tag{4.7}$$

So, a portion $(1-\eta)$ of the multiple of the excess return of the risk-bearing asset over the risk-free rate $(p_t(r^p_{t+1} - r^{rf}))$ is shifted from generation t to generation $t+1$ through the scheme's surplus (s_{t+1}). By taking the expected value of the surplus which is passed onto the next generation (s_{t+1}) it becomes evident that a surplus, which value is positive in expectation (as $0 < \eta < 1$ and the risk premium is positive $(r^p_{t+1} > r^{rf})$), is passed from generation t to generation $t+1$ (Equation 4.8):

$$\mathrm{E}_t[s_{t+1}] = \mathrm{E}_t[(1-\eta) p_t (r^p_{t+1} - r^{rf})] \tag{4.8}$$

Applying the risk-neutral probability measure on the transfer from generation t to generation $t+1$ yields a zero market value from ex ante perspective (Equation 4.9; bear in mind that $\mathrm{E}^Q_t[r^p_{t+1}] = r^{rf}$):

$$\begin{aligned} \mathrm{E}^Q_t[s_{t+1}] &= \mathrm{E}^Q_t[(1-\eta) p_t (r^p_{t+1} - r^{rf})] \\ &= (1-\eta) p_t (r^{rf} - r^{rf}) = 0 \end{aligned} \tag{4.9}$$

So, risks are shared with the next generation, but these risks are fully compensated (i.e. a positive buffer is shifted onto the next generation to compensate for the risk which is taken on by them). Therefore no generational effects from risk-sharing occur ($GA_t = 0 \; \forall \; t \geq 1$). Bovenberg and Mehlkopf (2014) offer a different perspective of the above model of

Mehlkopf (2015). Consider a two-period model, with overlapping generations (equivalent to Mehlkopf; 2015). The transfer[17] of the buffer from generation t to generation $t+1$ is denoted by $\tilde{\tau}_t$.

The model of Bovenberg and Mehlkopf (2014) defines linear transfers between generations as depicted in Equation 4.10:

$$\tilde{\tau}_t = \alpha_t + \beta_t \tilde{x}_t \tag{4.10}$$

In Equation 4.10 α_t is the deterministic components of the transfer (i.e. pre-determined and similar between all generations) and β_t denotes the volatility of the excess return on risk-bearing assets over the risk-free rate ($\tilde{x}_t$). With an ex ante market value based fairness criterion, deterministic transfers are ruled out (i.e. $\alpha_t = 0 \ \forall \ t$). Therefore $\tilde{\tau}_t = \beta_t \tilde{x}_t$ and the transfer onto the next generation thus becomes a multiple of the excess return on risk-bearing assets. This reaffirms the findings of Bovenberg and Mehlkopf (2014) and Teulings and De Vries (2006).

It can be proven that both models (i.e. the models of Mehlkopf, 2015 and Bovenberg & Mehlkopf, 2014) yield equivalent results. As the fund has a binding intertemporal budget constraint and pension saving is assumed to be a zero-sum game, $\tilde{\tau}_t$ is equivalent to s_{t+1} in a two-period model. Then, generational accounts (discounted to period t) can be written in terms of $\tilde{\tau}_t$ (Equation 4.11):

$$GA_t = \begin{cases} -\dfrac{\mathrm{E}^Q_{t=0}[\tilde{\tau}_t]}{1+r^{rf}} & \text{for } t = 1 \\ \mathrm{E}^Q_{t=0}[\tilde{\tau}_{t-1}] & \text{for } t > 1 \end{cases} \tag{4.11}$$

So the generational account of generation t is equal to the discounted ex ante market value of the transfer shift onto generation $t+1$ (which enters negatively in the upper case of Equation 4.11, as it is a cost to generation t). This transfer enters the generational account of generation $t+1$ (the lower case of Equation 4.11) positively (and not discounted as the transfer is received in the base year).

Concluding, it can be said that the ex ante market value of the excess return on risk-bearing assets over the risk-free rate is found to be nil theoretically. Transforming retrospective data to a risk-free world, which is continued in the prospective analysis thus does not affect the validity of the results of this study.

The data used in this research will be discussed in chapter 5.

[17] As the fund has a binding intertemporal budget constraint and pension saving is assumed to be a zero-sum game, $\tilde{\tau}_t$ is equivalent to s_{t+1} in a two-period model.

5 Data

In chapter 3 the model used in this research was introduced. The data used in this study will be further discussed in this chapter. First, the construction of the fund's population demographics will be discussed. Second, additional information on the construction of the fund's participators will be given, followed by an extension on their income and contributions. Next, we will turn to the processes of discounting, right accrual and indexation. Afterwards, the mechanics of the pension benefits and finally the fund's termination will be explored.

5.1 The fund's population demographics

This section will review the fund's demographics and will explain how the pool of fund participants was constructed. Figure 4 provides the development of the size of the population of the fund:

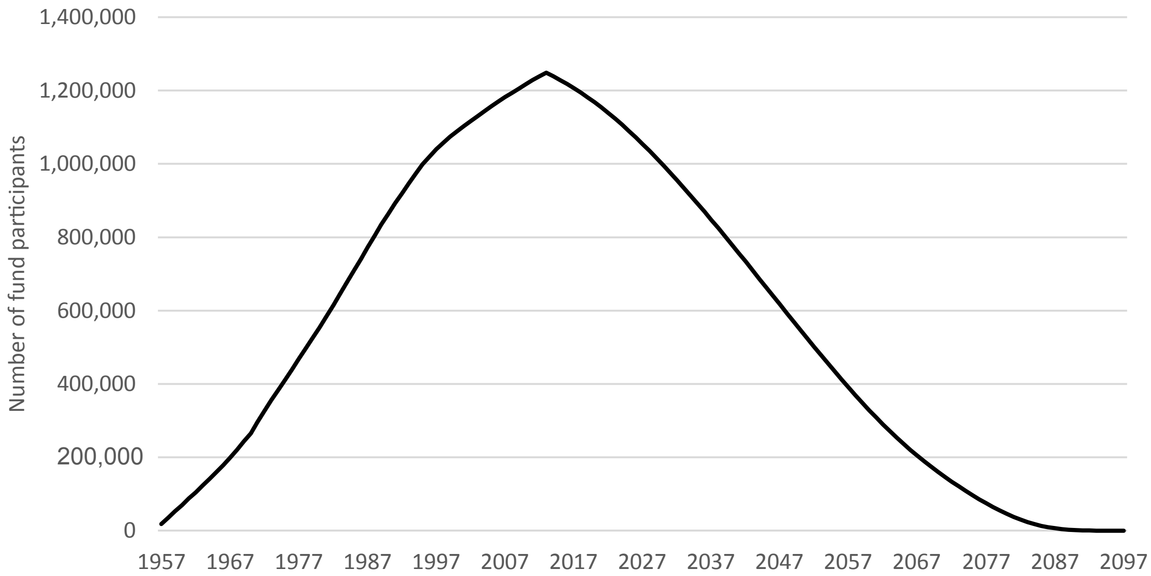


Figure 4: Total fund population by year, global maximum at 2014.

As stated in section 3.4, the fund's population peaks at 2014, as the youngest generation has entered the fund by then and the pool of fund participants will be depleted afterwards. When considering ABP's population statistics for 2014, five quarters of a million is a reasonable value given the fact that only full-time employees are considered (i.e. part-time labour is neglected).

Migration from and to the Netherlands would provide another avenue for the movement from and to the fund by employees. Ideally, one would like to correct for migration out of and to the nation, but sadly migration statistics are not detailed enough to state with certainty the age of a migrant. Figure 5 shows immigration (net for emigration) to the Netherlands as a percentage of total population (Statistics Netherlands, 2014d):

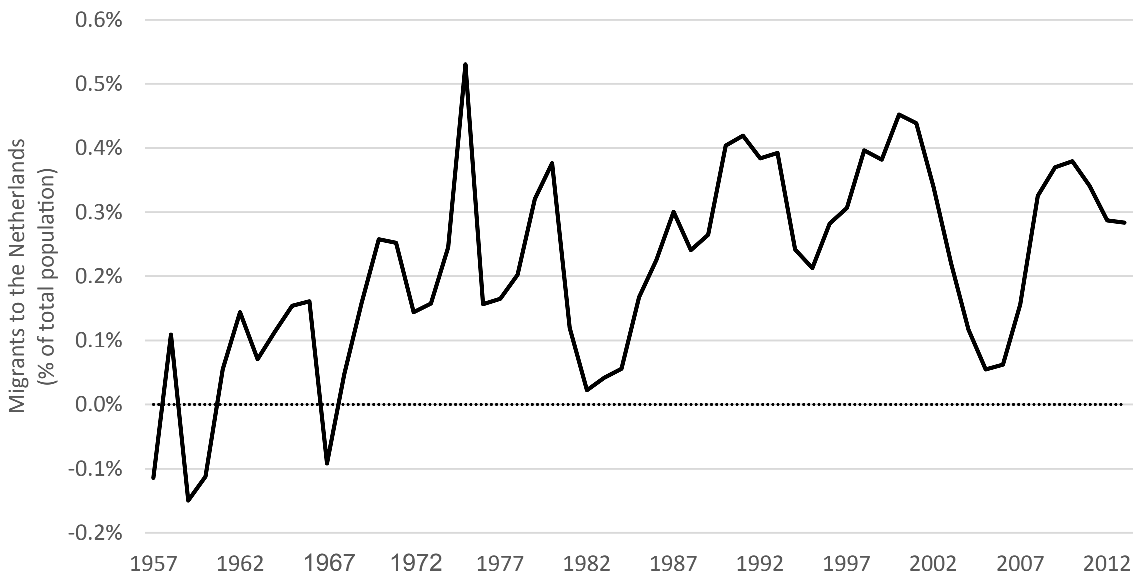


Figure 5: Migration (net for emigration) to the Netherlands 1957 - 2014, share of total population.

Given the scope of migration figures, neglecting the influence of migration on the fund's population does not strike as a particularly harsh assumption [18]. So, migration is neglected in this study.

Unfortunately, statistics on the Dutch labour force at age 25 specified by year of birth could not be found. For this reason we need to resort to a more tedious process. First, data on the number of births and the division by gender within a specific year is collected. Second, by use of gender-specific survival rates the number of survivors up to age 25 is calculated. Third, using empirical data on the share of the Dutch population which enters the labour force and by use of the empirical division of labour amongst economic sectors the amount of 25-year olds who enter ABP pension fund's population is calculated. As entering a pension fund is obligatory under Dutch law (as discussed in section 1.5) the number of newly-hired employees of employers represented by ABP pension fund and the new entrants to the fund are equivalent. Moreover, as the labour force share in the branch represented by ABP (central and decentral government and the education sector) is roughly fixed, the assumption that the amount of newly-hired

[18] As this study assumes that ABP pension fund is closed to new entrants in 2014, this study neglects possible effects from the increase in migrants as caused by the civil war in Syria and the effects thereof on migration to Europe from 2014 onwards.

employees is in accordance to the labour share employed by ABP-employers seems plausible. Furthermore, it should be noticed that the incidence of misrepresentation in the demographics used is limited in scale as an identical process is utilised in the gathering of this data for the entire fund's population (comprising over 55 age cohorts). Finally, once in the fund, employees work full-time until retirement or decease, whichever comes first. So using survival rates up to depletion of an age cohort, the development until the end of an age cohort can be sketched.
As stated above the fund's demographics are constructed manually. By use of birth figures, survival chances, general employment and sector employment data provided by Statistics Netherlands, age cohorts have been constructed. Birth statistics were complete for all years of observations as the total of births and the division over the sexes was available.
Survival rates were more tedious to construct, as Statistics Netherlands does not provide survival chances after the age of 98[19] and does not offer a full dataset containing survival chances up to 98 for the youngest cohorts. Survival chances have been extrapolated after 98 in a consistent manner, so biases are not expected to be overly sizable (particularly given the fact that a very small share of the fund's population reaches an age of over 98 years old). The voids in the dataset up to 98 years old were amended by reconstructing the process for the provided figures in the dataset and extrapolating these to the younger generations.
As stated above the population is cut at 25 years of age to coincide with the working force share of the total population. This sample is narrowed further to align with the share of individuals who find employment in the sectors represented by ABP (central and decentralised government and the education sector). ABP year statements[20] confirmed that the estimated population falls within a 95 per cent range of the real ABP-values.
The population data shows advancements in longevity over time. Figure 6 shows the survival rates for three different age cohorts, as percentage of the initial cohort size:

[19]Survival changes are combined from the age of 99.
[20]The author of this thesis managed to locate all ABP year statements, through the Internet, and a three-day visit to APG Heerlen (ABP's pension provider) and *Rijckheyt* (city archive of Heerlen).

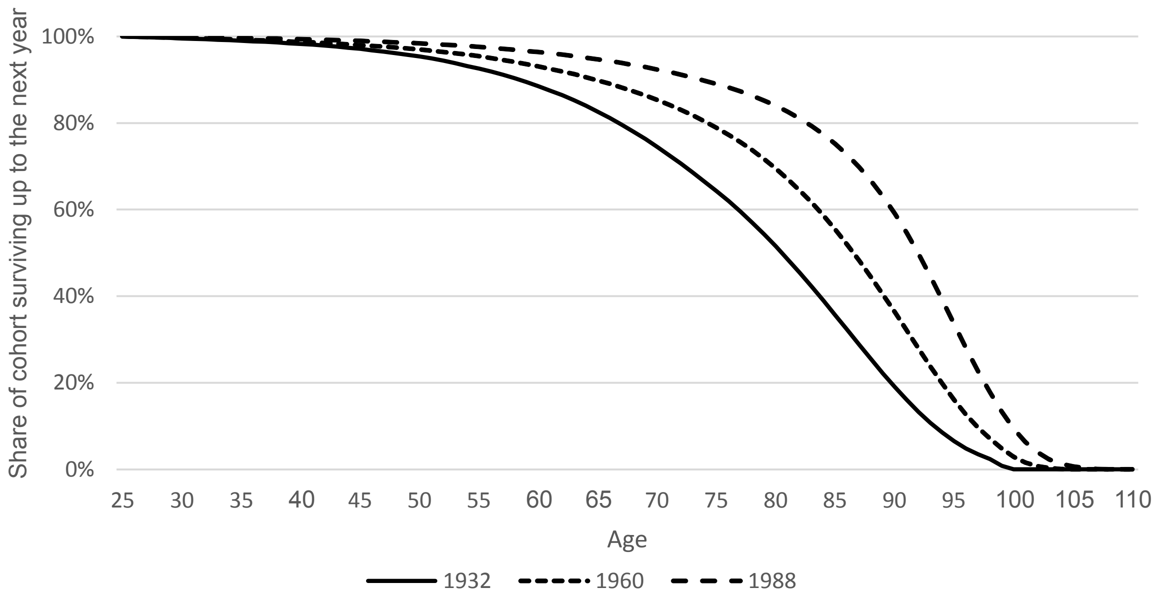


Figure 6: Survival rates for three different age cohorts, shares of the initial age cohort.

Figure 6 shows well why pension policy changes were imperative. The population is growing older steadily, thereby increases the pension benefits to be disbursed. As this advance in longevity was not foreseen (fully) the fund's financial reserve may be insufficient to cope with the pension benefits. As this is combined with decreases in fertility, the dependency ratio grows and the contribution base erodes, which puts pressure on the sustainability of the system.

Differences in longevity are also visible if the differences in the initial size of age cohorts are taking into consideration. If figure 6 is represented in terms of survivors, rather than survival shares, figure 7 emerges:

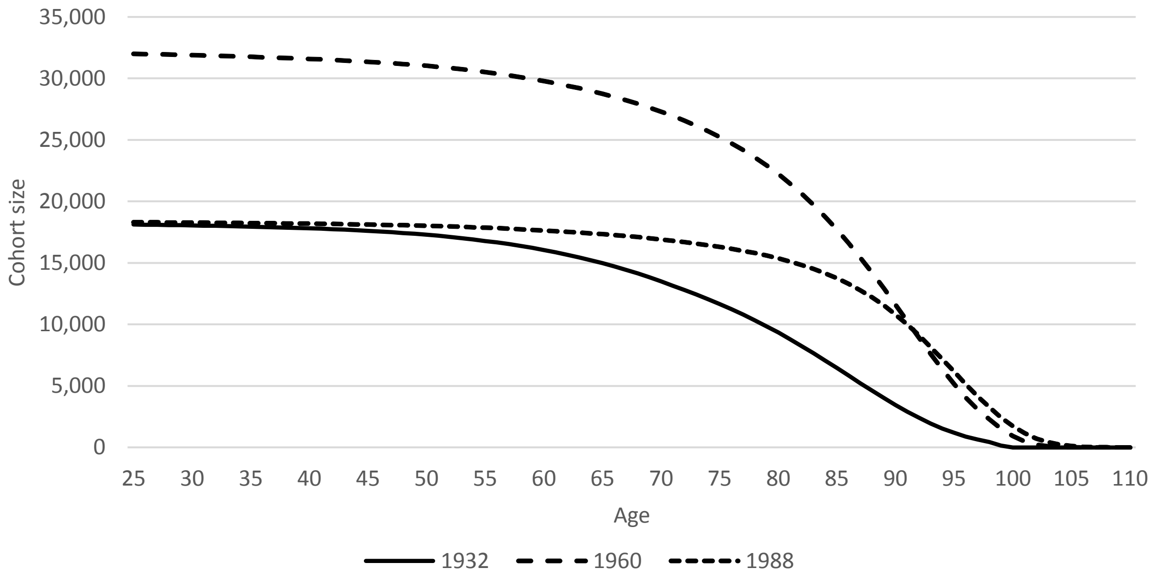


Figure 7: Survival rates for three different age cohorts, in terms of survivors out of initial cohort size.

Figure 7 shows that the absolute size of the age cohorts differs. This should be taken care of when making inference on an intergenerational level.
The next section discusses the retirement age.

5.2 Retirement age

Following the FTK, the legal superannuation age is fixed at 65 years of age from the start of the fund (1957) to the end of 2013. From 2014 the superannuation age is determined by the longevity of the age cohort which is approaching retirement. A discrepancy exists with the retirement age for first-pillar pensions, which increases gradually from 65 to 67 between 2014 and 2023 and is fixed to the longevity of the age cohort afterwards. From 2013 a divide is made between the legal retirement age, which is applicable to the first pillar, and the legal retirement directing age, which is applicable to the second pillar. The latter is increased to 67 years of age in 2014 and will be pegged to life expectancy from that year onwards (Rijksoverheid, 2012). Figure 8 shows the development of the second-pillar superannuation age, when applied to the longevity expectations used in this study:

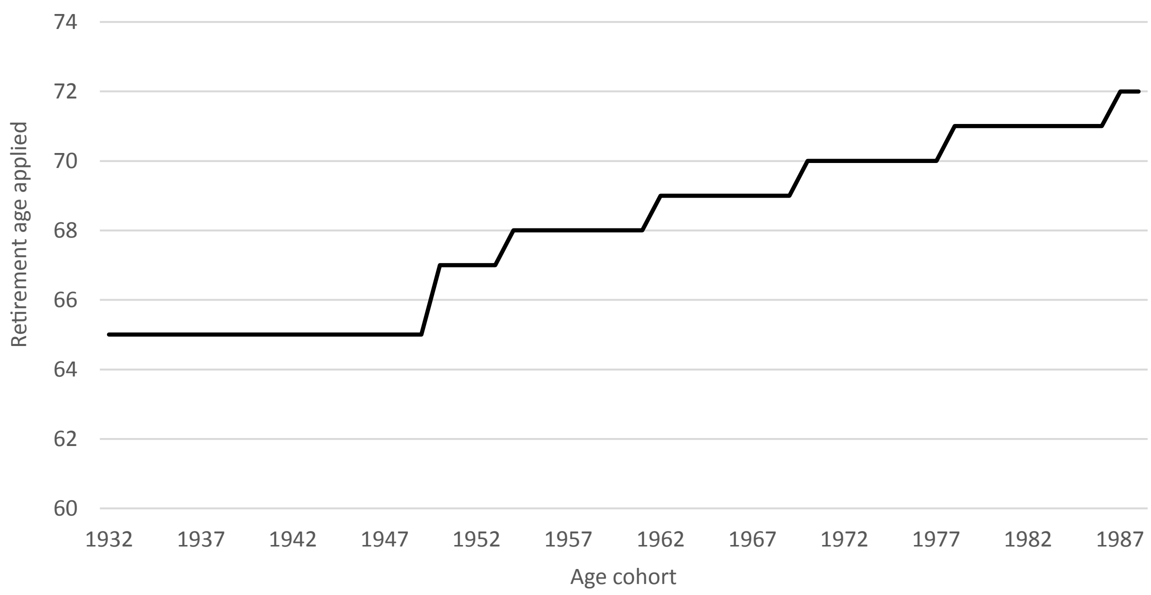


Figure 8: Applied retirement age by age cohort.

The labour income of the fund's participants and pension contributions levied on them will be discussed in the next section.

5.3 Labour earnings and pension contributions

The income of individuals has been determined by use of data of Statistics Netherlands for the retrospective part of the analyses. As wages are asymmetric between the different economic sectors ABP serves, the utilised wage level has been averaged annually over the number of individuals employed in these sectors. For the prospective part of the analyses the assumption is made that labour earnings grow with the nominal economic growth rate of 3.5 per cent (which is based on the greying studies of CPB; Van der Horst *et al.*, 2010).

As stated above, individuals are assumed to work full-time until retirement (or decease if this comes first). To prevent overestimation of the wage of an individual close to retirement (which generally works shorter hours resulting in lower labour earnings), wage profiles have been added. The wage profiles have been derived from Jacobs and Webbink (2006) and Webbink *et al.* (2013). In essence the wage profiles decrease labour earnings in the beginning and at the end of the employment cycle, in favour of labour earnings towards the middle of the employed life. This makes sure that a participant of an age cohort which just entered the fund does not on average out-earn a more experienced employee, even when corrected for productivity increases or excess returns to additional schooling of younger generations. Figure 9 gives wage profiles for the years 2011-2013:

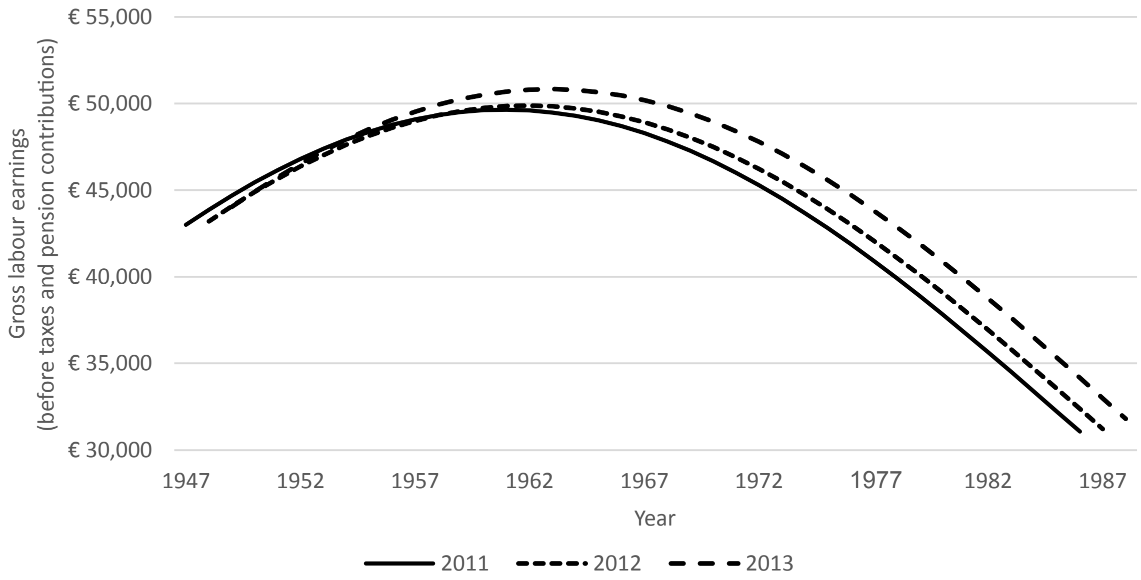


Figure 9: Wage profiles used for the year 2011 through 2013.

The stepwise movement to the right is a result of the yearly admission and exit of one age cohort into and out of employment. Figure 9 also shows that wage profiles are increasing for each next age cohort, depicting assumed advances in labour productivity over time. The wage profiles reach their maximum around the age of 50 (roughly halfway an individual's career). This may seem counterintuitive, as both theory and practice show that wages increase with experience (measured in years). This study, however assumes that full-time labour efforts are exerted by all participants during all years of their career. This does not hold in practice, as roughly forty per cent of all employed individuals work part-time (Statistics Netherlands, 2015). Figure 10 shows that the share of employed individuals opting to work part-time is increasing with age (Statistics Netherlands, 2015):

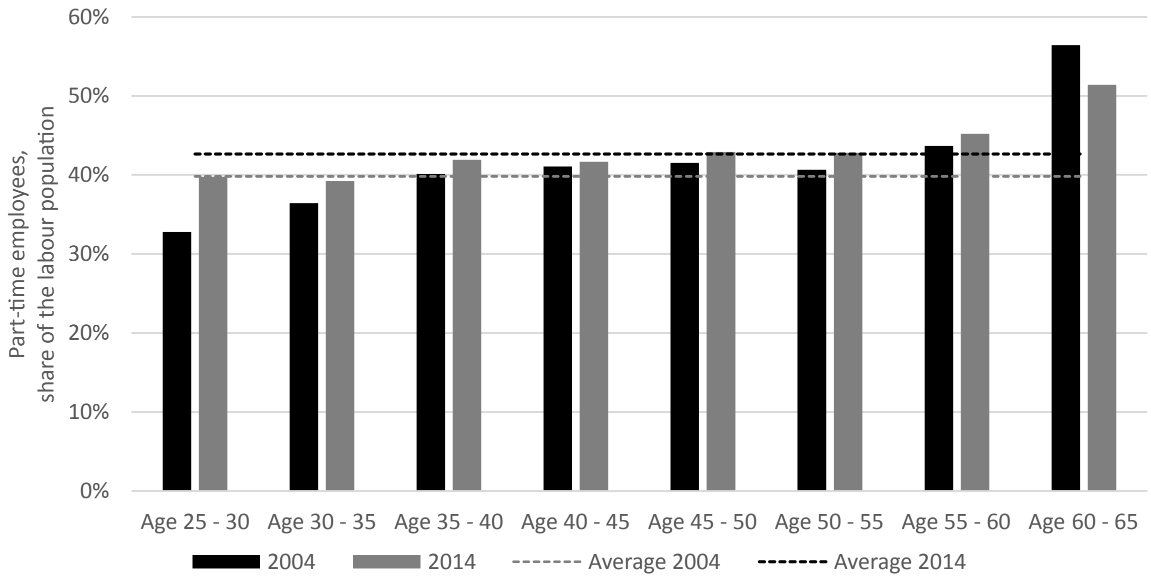


Figure 10: Part-time employed individuals for the years 2004 and 2014, share of labour population.

To incorporate the effect of diminishing labour efforts exerted with increasing age this study utilises the aforementioned labour earnings profiles which peak at age fifty. This age coincides with the point in the labour cycle at which the occurrence of part-time labour efforts starts rising. The curved labour earnings profiles thus partly resolve a possible overestimation of labour earnings at an advanced age: one is assumed to work more hours than in reality, but earns a lower wage than in practice. To overestimate labour earnings at an advanced age would result in an overestimation of per cohort lifetime net pension benefits as pension contributions paid in the second halve of an individual's career are eligible to higher pension benefits (than what is actuarially fair) as result of uniform contributions (Lever *et al.*, 2013a). This could in the end distort the results found in this study as this overestimation would only materialise for the age cohort which have yet to retire when the prospective analysis of this study starts (2014), which would render their lifetime net pension benefits too high when compared to that of older generations.

Data concerning the size of the franchise (utilised to calculate the contribution base) for the years 1957 to 2013 is derived from ABP. From 2014 onwards the franchise is pegged to the development of the labour earnings to ensure that the fund's participants do not acquire entitlements over the same euro in both the first and the second pillar. Due to the fact that the franchise is adapted at infrequent intervals this study focusses on monthly data, rather than yearly data.

The contribution rate for general old-age pension and early retirement over the period 1957 through 2013 has been gathered from ABP too. The contribution rate can be asymmetrical between generations as the obligation to contribute to the early retirement facility does not apply to each age cohort. From 2014 onwards the contribution rate is considered to be fixed. The contribution rate from 2014 onwards is used as an adjustable parameter (instrument) in this research.

5.4 Discounting

The process of discounting nominal figures is split in two parts: retrospection and prospection. The former is dealt with by taking the product of sequences of the observed real long-term interest rate up to the base year. The nominal long-term interest rates were obtained from the OECD (OECD, 2015) as these figures were not accessible from a Dutch source. The inflation figures were obtained from Statistics Netherlands. The prospective part is based on the Ultimate Forward Rate (UFR) of 4.2 per cent (Langejan *et al.*, 2013) as a proxy for the long-term interest rate and a 2 per cent inflation rate, as prospected by CPB (Smid *et al.*, 2014). The prospective real discount rate thus amounts to a product of sequences of 2.2 per cent annually. CPB uses 3 per cent as long-term real interest rate in their long-term studies (Smid *et al.*, 2014), which might render the results of this study overestimated (as future values are discounted too little). One could however defend a long-term real interest rate of 2.2 per cent under the notion that the UFR has been especially drafted to match the Dutch pension system, whereas Smid *et al.* (2014) use a rate which serves a more general purpose. The current historically low long-term nominal interest rates are inserted in the model up to the year 2013, after which the economy reverts to the ultimate forward rate in 2022. The adjustment process is dealt with in a linear fashion. Figure 11 shows the development of the nominal long-term interest rate (OECD, 2015 and UFR):

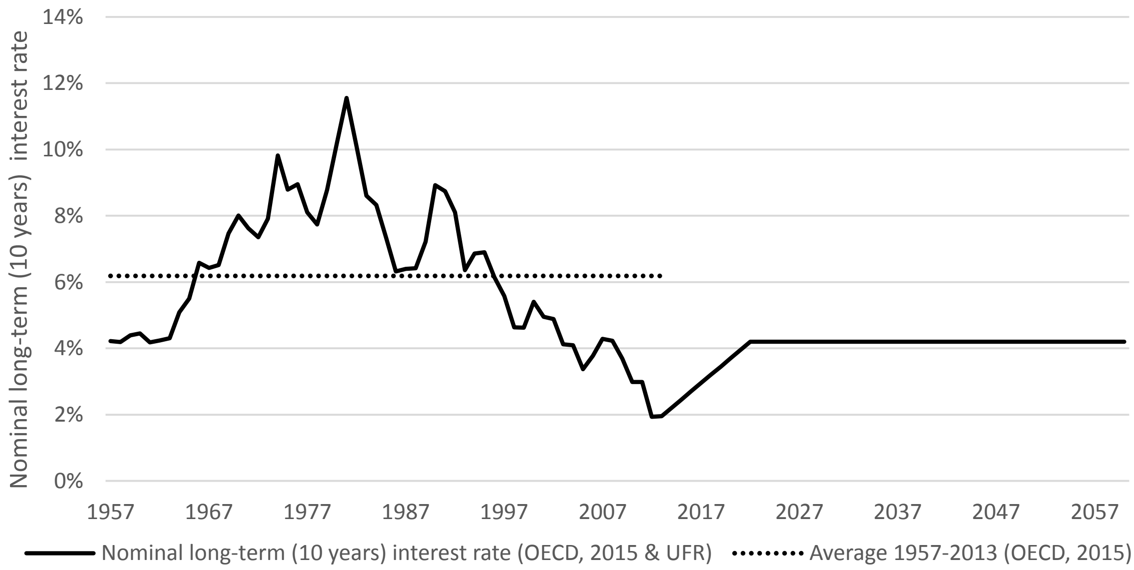


Figure 11: Nominal long-term (10 year) interest rate, 1957-2013 (OECD), 2022-2060 (UFR of 4.2 per cent).

Figure 11 shows the volatility of the nominal long-term interest rate (10 years; OECD, 2015) over the period 1957 to 2013, which is caused by economic shocks. The average nominal long-term interest rate over this period is approximately 6.2 per cent. This is higher than the UFR and the 3 per cent used by CPB. The reason for this is that, as a result of the financial and sovereign debt crises, monetary policy was used. By lowering nominal interest rates central banks aim to boost consumption. The forecasts for the development of the nominal long-term interest rates were revised downward as a result of this. Whether the choice between the UFR and CPB's 3 per cent affects the results will be analysed when checking the robustness of the results of this study.

5.5 Right accrual

For the retrospective part of the analysis right accrual rates have followed legal provisions. The uniform right accrual rate developed as follows:

Time period	Uniform right accrual rate (%)
1957-2003	1.750
2004-2005	1.900
2006-2013	2.050
2014	1.950
2015	1.875

Table 1: Uniform right accrual rates 1957-2015.

Following a uniform right accrual rate of 1.875 per cent and a legal second-pillar superannuation age of 67 years (so 42 years of employment), leads to a right accrual to pension benefits amounting to 78.75 per cent of average wage. Future right accrual rates are unknown as those are yet to be determined by the fund, the social partners and the legislator. In order to be able to make inference on per cohort lifetime net pension benefits for current and future generations the following procedure is used. For the prospective part (after 2014) a regime holds that right accrual must amount to 78.75 per cent of average lifetime labour earnings, such that the right accrual regime enforced by the fund stays equivalent to its 2013 value. Increases of the superannuation age (as a result of advances in longevity) lead to decreases in the yearly uniform right accrual rate such that at retirement an equivalent share of average lifetime labour earnings have accrued as pension rights by all age cohorts who retire from 2013 onwards.
In the analysis in which the intertemporal budget constraint of the fund is strictly binding the rate of right accrual can be used as an instrument by the fund to resolve possible budget deficits. If this instrument is used the yearly right accrual per cohort is diminished by the same index number. So generations who are close to retirement are affected by such policy changes less than age cohorts who have a longer time to go to superannuation.
Indexation of pension rights and benefits to price inflation will be discussed in the next section.

5.6 Indexation of pension rights and benefits

As described above, indexation is determined by the pension fund policy. Over the retrospective period ABP indexed pension rights and benefits fully to price level inflation over the period 1957 through 2003. From 2004 onwards indexation is conditional on the coverage ratio of the fund, which (instigated by financial shocks) lead to an indexation deficit of 13.64 per cent at the end of 2014. In the previous chapter three different regimes were sketched to deal with indexation. First, the fund can opt to index pension right and benefits to price inflation fully over the prospective period, while catching-up with possible past indexation deficiencies. Second, it has the option to not index to price inflation at all. Or third, the fund can opt to index pension rights and benefits for half of future price inflation, while leaving past indexation deficiencies as they are. The indexation regime is used as an adjustable parameter (a fund instrument) in the remainder of this study, and the results of this practice will be reported in the chapter 6.

5.7 Pension benefits disbursements

Pension benefit disbursement of second-pillar old-age benefits follows directly from the right accrual utilised in this study. This process is straightforward, as pension accruals are uniform and the fund's population consists of identical, representative agents within the age cohorts. The process is somewhat different for the age cohorts who have the opportunity to retire before the superannuation age (age cohorts 1932 through 1949). The year statements of ABP show that a negligible part of employees moves into retirement before the age of 60. For this reason this study abstracts from pre-retirees of an age younger than 60 years old. Loosely based on the ABP year statements the assumptions concerning retirement age are as follows:

Age	Share of population retiring (%)
60	30
61	15
62	5
63	5
64	5
65	40

Table 2: Share of population retiring before or at the retirement age.

The assumption that over half of the fund's population opts for early retirement is in accordance to ABP's reporting. The crux however is that under ABP policy an early retiree is not entitled to the same old-age pension benefits as an individual who did not retire before the superannuation age. Entitlements to pension benefits are build up until the moment of early retirement, so early retirees will have to settle for lower pension benefits from the legal retirement age than those who do not retire early.

5.8 Financial wellbeing of the pension fund

The financial wellbeing of the fund hinges on two aspects, which the fund can influence[21] (indirectly): the return on investments and the fund reserve[22]. If the fund opts for a different investment strategy (e.g. invest only in stocks instead of a mixture of stocks and bonds) the return on investment will differ. It should however be noted that excess returns on risk-bearing assets (over the risk-free rate), have an ex ante market value of zero, as discussed extensively in chapter 4. The excess returns are a compensation for the risk that is shifted from one generation onto the next one. So the fund's reserves have no ex ante market value, as these are the summation of the compensation past generations passed onto future generations. For this reason the model utilised in this study is modelled in a risk-free world, so excess value over the risk compensation for future generations is out of order.

[21]Other factors influence the financial wellbeing of the fund too, such as but not limited to: demographics and the development of labour productivity, wage and economic growth. The robustness of the results of this study to these factors will be reviewed in section 6.1.3.

[22]The initial assets of the fund are assumed negligible, as the fund is fully funded by its participants and ancillary costs (e.g. for marketing or the fund's operations) are abstracted from.

The funds reserve follows from all cash flows into and out of the fund up to the moment of observation. These cash flows differ in size when different pension policies are enforced. As the fund faces a perfectly certain cash inflow and outflow (as it is perfectly informed about the hiring policy of ABP-employers, labour earnings, pension policy, longevity perspectives and early retirement decisions of its participants) the sole cause of uncertainty lies within the returns yielded on investments. For the 1957-2013 period this study uses retrospective data acquired from ABP's year statements which, to the best of the author's knowledge, is a unique measure. Before the privatisation of the fund in 1996 the fund was not allowed to invest in risk-bearing assets (i.e. stocks), which greatly simplified the process of finding the fund's riskless return. From 1996 through 2013 a divide has been made between risk-bearing and riskless yields on returns. From 2022 the fund is assumed to extract yields equivalent to the ultimate forward rate (of 4.2 per cent nominally). This assumption is necessary, as any rate in surplus to the UFR would cause the fund's assets to grow faster than its liabilities. If this were to hold it would pay off for the fund to postpone the payments due to the participants to the latest moment possible, as the real value of these payments would decline over time. Put differently: if the fund sees the real value of its reserves grow faster than that of the real value of the differences between the pension contribution received and the pension benefits to be disbursed (i.e. its liabilities), the fund should opt to rest on its laurels as the real value of its debt would be at a minimum at the latest pay date possible. However, this kind of money machine does not exist: so therefore the fund's assets should by construction grow at a rate exactly equal to the discounting of its liabilities, to prevent the fund's reserve from growing boundlessly. From 2014 through 2021 the return on risk free assets of the fund grows gradually towards the ultimate forward rate. The development of the nominal and real yields on risk free assets of the fund are depicted below:

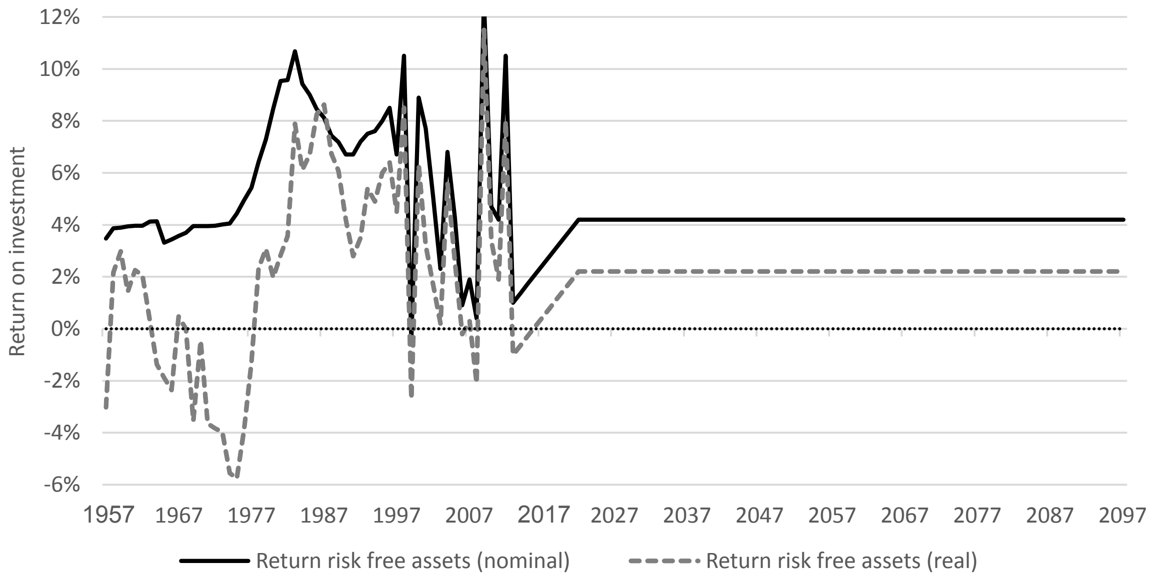


Figure 12: Nominal and real yield on risk free assets ABP pension fund, 1957-2097.

Figure 12 shows that the real yield on the risk free assets of the fund is negative for most years prior to the oil shocks as a result of soaring price inflation rates. On average the ultimate forward rate lies slightly below the average of the 1957-2013 period (4.20 versus 5.71 per cent, respectively). This might put downward pressure on the fund's reserve, but taking lessons of the financial crisis and arguing that the high yields of the nineties are unlikely to be repeated in the future this future rate seems defendable. CPB Netherlands Bureau for Economic Policy Analysis (Smid *et al.*, 2014) shows a more bleak perspective for the future (when compared to the past six decades) in its greying studies, which serves as more evidence that the future assumptions are not in thin air. A robustness check will be conducted to show the sensitivity of the results for deviations from the ultimate forward rate used in the prospective part of the analysis.
The next chapter will discuss the results of this study.

6 Results

This chapter will discuss the results yielded from the model. Section 6.1 will sketch the baseline observations for three indexation scenarios and discuss the robustness of these result against a set of alternative parameter values. In this section pension arrangements are unchanged until the termination of the fund, in line with the first analysis. From section 6.2 onwards possible surpluses/deficits of the fund's reserve at the termination of the fund have to be resolved as the fund's intertemporal budget constraint binds, which is in line with the second analysis. Section 6.2 provides results from a single instrument approach by the fund. Section 6.3 will give intuition for multiple instruments approaches, which boils down to combinations of the single instrument approaches. Section 6.4 offers policy recommendations.

6.1 Analysis 1: Baseline scenarios

This section contains the first analysis. It shows the results from unchanged pension arrangements, given that the pension fund has a non-binding intertemporal budget constraint. So, the fund can have a residual reserve (either positive or negative) at termination (i.e. once all age cohorts are depleted, which occurs in 2097). The assumption is made that pension policies, concerning the contribution rate, the accrual rate and pension benefits, are kept constant at their 2013 values until the termination of the fund. One can imagine that pension accrual and disbursement for a pool of over 1,300,000 individuals leads to large figures which may be incomprehensible. The baseline results provide a useful means of comparison for further inference as they help us to put sub-results into perspective.
Section 6.1.1 provides the baseline results for the three indexation regimes. Section 6.1.2 presents the take-ways from Analysis 1 and section 6.1.3 provides robustness checks of the baseline results.

6.1.1 Baseline results

Figure 13 depicts discounted[23] per cohort lifetime net pension benefits in terms of billions of 2014 euro for different age cohorts throughout the full sample period. Per cohort lifetime net pension benefits depict the net present value of the differences of the pension benefits received from the fund and the contribution payments to the fund by an age cohort, discounted to the year 2014. The sample period runs from 1957 (the year in which cohort 1932 enters the fund) until 2097 (the year in which the fund's population is depleted, i.e. the year in which the last individual born in 1988 passes away). Figure

[23]All per cohort lifetime net pension benefits in this chapter 6 are discounted to the base year (2014). To save space the word discounted is omitted when discussing per cohort lifetime net pension benefits.

13 shows discounted per cohort net lifetime pension benefits when indexation is effectuated in each year[24], for the situation in which accrued pension rights and benefits are not indexed altogether[25], and for the case in which right accruals and pension benefits are indexed to half of price inflation only[26]. The fund catches up on past indexation deficiencies (amounting to 13.64 per cent in 2013; ABP/Pensioenraad, 1958-2014) in the full indexation scenario only, past indexation deficiencies are taken as given for the other indexation scenarios.

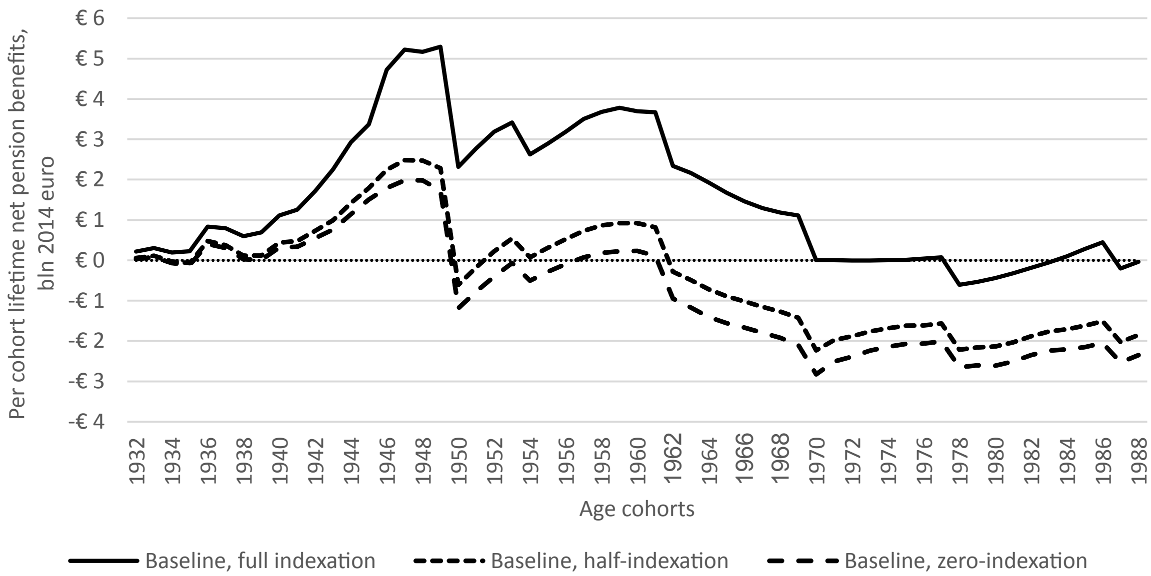


Figure 13: Per cohort lifetime net pension benefits for all indexation regimes, in billions of 2014 euro.

Before figure 13 is analysed, it must be remarked that the line which depicts per cohort lifetime net pension benefits for a regime of half-indexation, is not situated in the middle of the full indexation and zero-indexation scenarios. The indexation regimes are revised from 2014 onwards, so past indexation deficiencies cause different results for full indexation (in which past indexation deficiencies are resolved and pension benefits and rights are indexed to price inflation fully to guarantee the real value/purchasing power of the pension entitlements), half-indexation (in which indexation only accounts to half of the difference between the real value and the nominal value of pension entitlements) and zero-inflation (in which only the nominal value of pension entitlements are guaranteed). As past deficiencies ultimo 2013 account to 13.64 per cent in terms of price inflation (ABP/Pensioenraad, 1958-2014), the difference between full indexation

[24]Henceforth referred to as "full indexation".
[25]Henceforth referred to as "zero-indexation".
[26]Henceforth referred to as "half-indexation".

and half-indexation exceeds the difference between half-indexation and zero-indexation. The reader should bear in mind that only under a fully indexed scenario pension benefits received have the purchasing power equivalent to the target value set for these (70 per cent of average wage). Any departure from full indexation therefore is costly to the fund's participants, because as a result from this purchasing power of pension entitlements declines.

Several observations can be made about concerning Figure 13. First, it must be noted that nearly all per cohort lifetime net pension benefits are positive in the full indexation scenario. A positive per cohort lifetime net pension benefit in essence means that a generation receives a higher cash flow from the fund than the value of the cash flow paid to the fund (contribution payments and the returns yielded on investing these). Put differently: a positive per cohort lifetime net pension benefit shows that the fund has been *too generous* in its benefit disbursements. *Positive per cohort lifetime net pension benefits have to be matched by negative per cohort lifetime net pension benefits to keep the fund's reserve sustainable (at zero).*

Figure 13 shows that the summation of per cohort lifetime net pension benefits is positive. Nearly each generation receives more than it is entitled to, but the fund lacks the financial capacity to do this. The result of this is that *the fund will be in deficit at termination*, as the fund's reserve is the negative mirror image of the summation of per cohort lifetime net pension benefits[27]. A preliminary conclusion is that *the fund will not be able to close its intertemporal budget constraint under unchanged pension arrangements.*

A second finding related to Figure 13 is that *per cohort lifetime net pension benefits differ per age cohort*. For the fully indexed scenario the lifetime net pension benefit of the largest beneficiaries (1949) exceeds that of the most modest (1978) fund participants by thirteen times (per cohort lifetime net pension benefits amounting to 5.3 bln euro and −0.6 bln euro, respectively). So, age cohort 1949 gets more money out of the pension scheme than what it is entitled to, which is partly paid for by age cohort 1978, which receives back too little.

The stakes for the unindexed scenario are somewhat less dispersed, but in this case most age cohorts born after 1961 have negative lifetime net pension benefits. These generations thus receive a lower pension benefit (in real terms) than the contributions they laid in plus the yield hereon. These generations therefore are contributors to the pension scheme (as the fund fails to reimburse to them the amount of pension benefits they are entitled to), while all generations born between 1932 and 1949 are beneficiaries (as the fund reimburses to them more than the amount of pension benefits they are entitled to).

Third, the effects of the abolishment of early retirement (effectuated at once for all age cohorts born from 1950 onwards) is visible, as lifetime net pension benefits are plummeting after age cohort 1949. This provides evidence that the early retirement provision

[27]This holds as pension saving in the second pillar is a zero-sum game, as outlined in section 2.1.

is beneficial to those who can make use of this facility, at the expense of those who are contributing to this facility but lack the opportunity to retire early themselves. The latter (generations 1950 and younger) pay contributions for which they do not acquire pension entitlements; they therefore pay for the early retirement of others (generation 1949 and older). So, *per cohort lifetime net pension benefits are higher for cohorts which can retire before the legal superannuation age, than for cohorts which lack this option.*
Fourth, another factor which might explain differences found between age cohorts up to 1949 and from 1950 is the switch from a final to an average wage system in which unconditional back-servicing is replace by conditional indexation of right accrual and pension benefits to price inflation. As the conditionality led to partial indexation between 2007 and 2013 this influences younger cohorts to a larger extent as these will remain in the fund for a longer time. Figure 14 shows how much lower per cohort lifetime net pension benefits are for zero-indexation and half-indexation, with respect to full indexation:

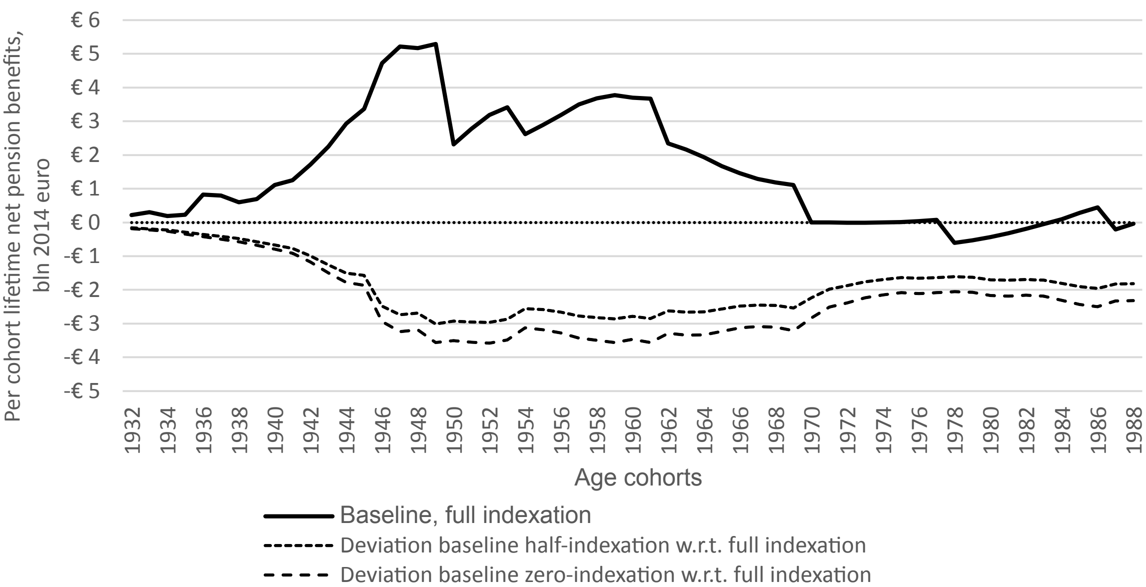


Figure 14: Deviations from the baseline full indexation result as a result of enforcing half-indexation or zero-indexation, in billions of 2014 euro.

Figure 14 shows that *the oldest age cohorts (1932-1945) are less susceptible to indexation regimes than succeeding generations are.* The main reason for this is that the share of per cohort lifetime net pension benefits which already has materialised is increasing in age. As changes to the inflation regime are only enforced from 2014 onwards, this leaves all net pension benefits realised up to 2013 unaffected.
Next to this, larger per cohort lifetime net pension benefits are more affected by inflation regime changes than moderate ones. This is a result of that fact that per cohort lifetime net pension benefits are increasing in the size of the pension benefits a generation receives.

If a generation has larger pension entitlements, the effect of an indexation regime change (in absolute terms) is more pronounced. This explains why *the youngest generations (1975-1988) are less effected by indexation regime changes than the middle generations (1946-1974)*: the nominal size of their pension entitlements is smaller, as they acquire the same pension rights as older generations (70 per cent of the average wage), but are retired for a shorter period in time (as a result of increases in the retirement age).
Table 3 provides the top-3 and bottom-3 age cohorts in terms of per cohort lifetime net pension benefits for the three baselines explored above:

Rank	**Indexation regime**		
	Zero	*Half*	*Full*
Top #1	**1948 (2.0 bln euro)**	**1947 (2.5 bln euro)**	**1949 (5.3bln euro)**
Top #2	1947 (2.0 bln euro)	1948 (2.5 bln euro)	1947 (5.2 bln euro)
Top #3	1946 (1.8 bln euro)	1949 (2.3 bln euro)	1948 (5.2 bln euro)
Bottom #1	**1970 (-2.8 bln euro)**	**1970 (-2.2 bln euro)**	**1978 (-0.6 bln euro)**
Bottom #2	1978 (-2.7 bln euro)	1978 (-2.2 bln euro)	1979 (-0.5 bln euro)
Bottom #3	1980 (-2.6 bln euro)	1979 (-2.2 bln euro)	1980 (-0.4 bln euro)

Table 3: Top 3 and bottom 3 age cohorts in terms of per cohort lifetime net pension benefits for full, half and zero-indexation regimes, in billions of 2014 euro.

As a general conclusion it can be stated that age cohorts born in the second half of the 1940's (the so-called *babyboomers*) are among those with the highest lifetime net pension benefits, whereas those born from 1970 onwards (especially towards 1980) have the least favourable lifetime net pension benefits in the baseline scenarios. Analysis 1 thus appoints age cohorts 1946-1949 as main beneficiaries of the pension scheme, whereas generations 1970 and 1978-1980 are the main contributors to the scheme. *A conclusion from these observations is that this pension fund does not yield actuarially fair results, as equivalent amounts of contributions paid result in different amounts of pension benefits collected by different age cohorts. The fund thus redistributes money to and from age cohorts, whereas this is not an objective in the second pension pillar.* **This confirms the first hypothesis of this study: "discrepancies exist between the per cohort lifetime net pension benefits."**

Analysis 1 appoints age cohort 1949 as Generation Lucky and age cohort 1978 as Generation unlucky as these generations have extreme values of per cohort lifetime net pension benefits (5.3 bln euro and −0.6 bln euro, respectively) for the fully indexed scenario (in which pension entitlements are aimed at retaining full purchasing power).
Moreover, *under each baseline scenario, at least some generations encounter negative lifetime net pension benefits.* The prevalence of negative lifetime net pension benefits range from 10 age cohorts in the full indexation regime to 36 age cohorts for the scenario without indexation, out of a total of 57 age cohorts. *These generations thus lose money when participating in this pension scheme, and optimally would opt out if mandatory participation would not prohibit this.*
For the sake of clarity, Figure 15 presents the age cohort net lifetime benefits in relative terms (as a share of discounted lifetime labour income):

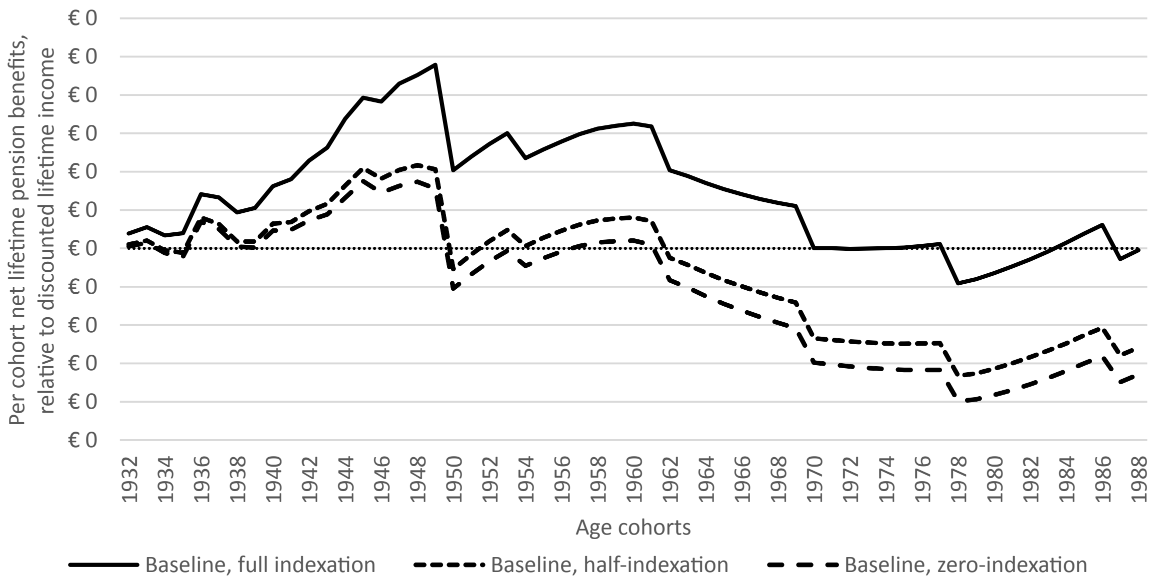


Figure 15: Per cohort lifetime net pension benefits for all indexation regimes, relative to discounted lifetime labour income.

Once again it must be noted that the difference between full indexation and half-indexation is not exactly fifty per cent of the price inflation from 2014 onwards, but larger due to catching-up indexations in the full indexation scenario.
Figure 15 serves an illustrative purpose, showing that the lifetime net pension benefits are ranging from −2 to 10 per cent in terms of discounted lifetime labour income for different age cohorts if full indexation is effectuated, which are the upper limits. The lower limits, for the zero-indexation scenario, lay between −8 and 4 per cent. It must be noted that, *irrespective of the indexation regime enforced, cohorts 1977-1983 and 1987 are net contributors to the scheme.* These generations pay a price too large for the pen-

sion entitlements they receive.

This subsection has established that the fund runs deficits at termination. The fund's reserve at termination is the mirror value of the summation of per cohort lifetime net pension benefits: all revenue the cohorts receive (in the form of excess pension benefits over their contributions and the yield thereon) are losses to the fund. The fund's reserve at termination is equivalent to the resources needed to solve the fund's intertemporal budget constraint.

In Table 4 the size of the fund's reserve at time of termination is presented for the different indexation scenarios:

	Indexation regime		
	Zero	*Half*	*Full*
Fund's reserve at termination	46.8 bln euro	20.9 bln euro	−87.3 bln euro
(% of 2013 ABP assets = 299.9 bln euro)	(15.6%)	(7.0%)	(−29.1%)

Table 4: Fund's reserve at termination for all indexation regimes, in billions of 2014 euro.

Table 4 shows that the fund's reserve decreases (i.e. the fund's deficit at termination worsens) if indexation is effectuated more often. *The indexation mechanism however would be sufficient to close the intertemporal budget constraint of the fund for some percentage between 50 and 75 per cent.* The exact value will be determined in the second analysis (see section 6.2).

The summation of per cohort lifetime net pension benefits amount to 87.3 bln euro (for the fully indexed scenario), the negative mirror image of which is the fund's deficit at termination. One should bear in mind that only in the fully indexed scenario the *real* value (or purchasing power) of pension benefits is preserved fully. If the fund decides to discontinue indexation of pension rights and benefits altogether, the fund's reserves at termination would be in surplus by 46.8 bln euro. This would amount to a cumulative negative lifetime net pension benefit of all participating generations. In the unindexed scenario the fund only strives to preserve the *nominal* value of the contributions of its participants, which as a result will lose purchasing power.

The next section will wrap up the results of Analysis 1.

6.1.2 Baseline results: take-aways

The benchmark results of Analysis 1 described above make the following clear:

1. The summation of per cohort lifetime net pension benefits is positive for the full indexation scenario, therefore the fund's reserve at its termination is negative for this scenario;

2. The fund thus cannot close its intertemporal budget constraint in the full indexation scenario;
3. Per cohort lifetime net pension benefits differ per age cohort for all indexation scenarios. The intergenerational dispersion is most pronounced for the full indexation scenario;
4. The pension fund does not yield actuarially fair results. The fund thus redistributes money to and from age cohorts;
5. Per cohort net lifetime pension benefits are higher for cohorts which can retire before the legal superannuation age, than for cohorts which lack this option;
6. The oldest age cohorts (1932-1945) are less susceptible to indexation regimes than succeeding generations are;
7. Larger per cohort lifetime net pension benefits are more affected by inflation regime changes than moderate ones;
8. The youngest generations (1975-1988) are less effected by inflation regime changes than the middle generations (1946-1974);
9. *Analysis 1 appoints generations 1946-1949 as Generations Lucky, whereas generations 1970 and 1978-1980 are considered Generations Unlucky.*

The following subsection tests the robustness of the model against a set of different parameter values.

6.1.3 Robustness checks

In this section the robustness of the baseline results for the zero-indexation and full indexation scenarios against a set of alternative parameter values will be outlined. These scenarios are chosen as they represent the lower and upper limits, as the *real* value of pension benefits is guaranteed in the full indexation scenario whereas the *nominal* value of pension benefits is guaranteed in the zero-indexation scenario. Put differently: with full indexation the purchasing power of the pension entitlements (seventy per cent of average wage) is safeguarded, whereas under zero-inflation the nominal value equivalent to seventy per cent of average wage is safeguarded. As prices rise from year to year, purchasing power is not guaranteed for the zero-inflation scenario. Both indexation scenarios have been tested for the sensitivity of the observations for different values of economic growth, different returns on the investment of the fund and for different labour earning profiles of the participating individuals.
With regard to economic growth, the model assumes a nominal economic growth rate of

3.5 per cent, which corresponds to 1.5 per cent real economic growth per annum (i.e. corrected for price inflation). These are the same values as are used in CPB's greying studies designed especially for the Netherlands (Van der Horst *et al.*, 2010). The robustness of the baseline results is tested against nominal growth rates of 3.0 and 4.0 per cent (so changes of 0.5 per cent real economic growth, assuming price inflation does not change with respect to the baseline scenario). The alterations to economic growth enter the model through the labour earnings of the participants, which as a result of the alternative parameter setting for economic growth develop to an increasing or decreasing degree. It must also be noted that the franchise (accounting for first pillar pension provision) is adjusted along with the advances to the nominal economic growth rate. The hypothesis is that the baseline results are robust to the alternative parameter values for economic growth, as the different pace to which labour earning develops will be matched by both cash flows to (through uniform contributions) and from (through uniform right accrual) the fund.

The sensitivity analysis for different returns on investment of the fund is effectuated through a systematic increase (decrease) of 1.0 percentage point of the real Ultimate Forward Rate utilised from 2022 onwards to 3.2 (1.2) per cent. The adaption of the fund's return on investment from 2014 to 2021 is dealt with in a linear fashion. Alternative values are taken for the real UFR rather than the nominal UFR to simplify comparison between the zero-indexation and full indexation scenarios. The hypothesis is that the baseline results are not robust to the alternative parameter values for the returns on investment of the fund, as these changes would constitute more (less) returns on investment in a risk-free world. This could only be the result of changes to economic fundamentals or structural changes to financial markets, both of which lay beyond the scope of this study and the model used. As a systematic one per cent increase to the returns on investment of the pension fund would result in a 128 per cent increase[28] in the returns on an investment between 2014 and 2097 (the time frame for the prospective part of the analysis), this would constitute a large difference for which no theoretical basis can be found. Put differently: if the assumption is made that the economic models through which the nominal Ultimate Forward Rate of 4.2 per cent is estimated are plausible, there is no reason to assume that the annual returns on investment will differ systematically. Systematically changing parameter values will therefore alter the results found as these changes alter the structure of the model used, not its validity.

The sensitivity of the results to the steepness of the labour earning profiles is also analysed. This is effectuated through an alteration of the labour earning profiles taken from Jacobs & Webbink (2006) and Webbink *et al.* (2013). The labour earnings pivot around the wage received halfway through the employment period (± 45 years of age), so total earnings remain the same. The hypothesis is that the baseline results are robust to the

[28]This result is obtained through $(1.01)^{2097-2014} - 1 = 1.28$.

alternative parameter values for the steepness of the labour earning profiles, as the total value of both the cash flows to (through uniform contributions) and from (through uniform right accrual) the fund are equivalent to the baseline value with unchanging pension arrangements. This occurs as total labour earnings are robust to alternative parameters for the steepness of the labour earning profiles (i.e. total labour earnings remain the same, even though yearly labour earnings are different).
The sensitivity of the results found for the zero-indexation and full indexation scenarios against alternative parameters for the nominal economic growth rate, the return on investment of the fund and the steepness of the labour earnings curve is provided in Table 5:

Sensitivity analyses of fund's reserve at termination (in bln 2014 euro)		
Variable (Description of sensitivity analysis) (*Baseline value*)	**Indexation regime** *Zero* (*−46.8 bln euro*)	**Indexation regime** *Full* (*−87.3 bln euro*)
Nominal economic growth rate		
(+0.5% w.r.t. Van der Horst *et al.*, 2010)		
Fund's reserve at termination	−5.2 bln euro	−5.9 bln euro
(*Deviation from baseline value*)	(−11.1%)	(−6.8%)
Return on investment of the fund		
(+1.0% w.r.t. real UFR of 2.2%)		
Fund's reserve at termination	+49.3 bln euro	+49.3 bln euro
(*Deviation from baseline value*)	(+105.3%)	(56.5%)
Steepness of the labour earnings curve		
(+10.0% w.r.t. Webbink *et al.*, 2013)		
Fund's reserve at termination	−5.8 bln euro	−6.3 bln euro
(*Deviation from baseline value*)	(−12.4%)	(−7.2%)

Table 5: Sensitivity analyses for zero-indexation and full indexation (sensitivity to alternative values for nominal economic growth rate, return on investment of the fund and steepness of the labour earnings curve), values in 2014 euro.

The findings of Table 5 are roughly in line with the hypotheses stated above. As hypothesised, the fund's reserve at termination is not robust against alternative parameter values for the real return on investment of the fund. As stated above this is a result of the fact that larger real returns on investment of the fund in a risk-free world are unintuitive if economic fundamentals, the structure of the financial markets and pension policy are left unaltered. Departures from the real Ultimate Forward Rate of 2.2 per cent, estimated especially for Dutch pension funds, could only be defended by pointing to misspecifications to the economic models which were used in the parameter estimation of the Ultimate Forward Rate. This, however, is beyond the scope of this study. It should be noted that the fact that the fund's reserve is not robust against alternative parameter values for the Ultimate Forward Rate does not determine that the model used in this study is misspecified.

Contrary to the hypothesis formulated above, the fund's reserve at termination is negatively impacted by higher parameter values for the steepness of the labour earnings profile, albeit that the effect is limited in size. A conclusion resulting from this is that increasing the steepness of the labour earning profiles leads to larger per cohort lifetime net pension benefits. This shows that individuals with a steeper career path are favoured by ABP's pension scheme. The underlying reason for this is the uniform contribution rate. The rationale for this is that contributions paid at the beginning of an individual's career (i.e. at age 25) yield returns on investment for a longer period in time than contributions paid at the end of an individual's career (i.e. at age 64). However, the relative contributions paid and relative rights accrued are equivalent, as both contribution payments and right accrual are uniform over all age cohorts. So, contributions paid when young (old) earn lower (higher) pension entitlements than what is actuarially fair. This means that if an individual's labour earnings were to rise faster (i.e. this individual has a steeper labour earnings profile) than average, this individual would earn larger pension entitlements under the uniform pension scheme than under an actuarially fair pension scheme. This mechanism occurs in ABP pension fund, whose pension scheme therefore is more beneficial to individual's with a more-than-average steep career path than to those with a less-than-average steep career path.

Also contrary to the hypothesis formulated above, the fund's reserve at termination is negatively impacted by higher parameter values for the nominal economic growth rate, albeit that the effect is limited in size. The underlying reason for this is analogous to the rationale for the steep labour earnings curve: pension benefits are positively affected if labour earnings increase faster in the second half of the career with respect to the first half of the career, due to the system of uniform contributions and right accrual. As the alternative parameter values for the nominal economic growth rate can only be effectuated in the prospective part of the analysis (i.e. from 2014 onwards), the results are that the labour earnings of different age cohorts face an increase to their labour earnings growth rate at different points during their careers. Figure 16 shows the baseline results and the results for alternative parameters discussed above (+0.5 per cent economic growth, +1.0 per cent return on investment of the fund and +10.0 per cent steepness of the labour earnings curve) for the full indexation scenario:

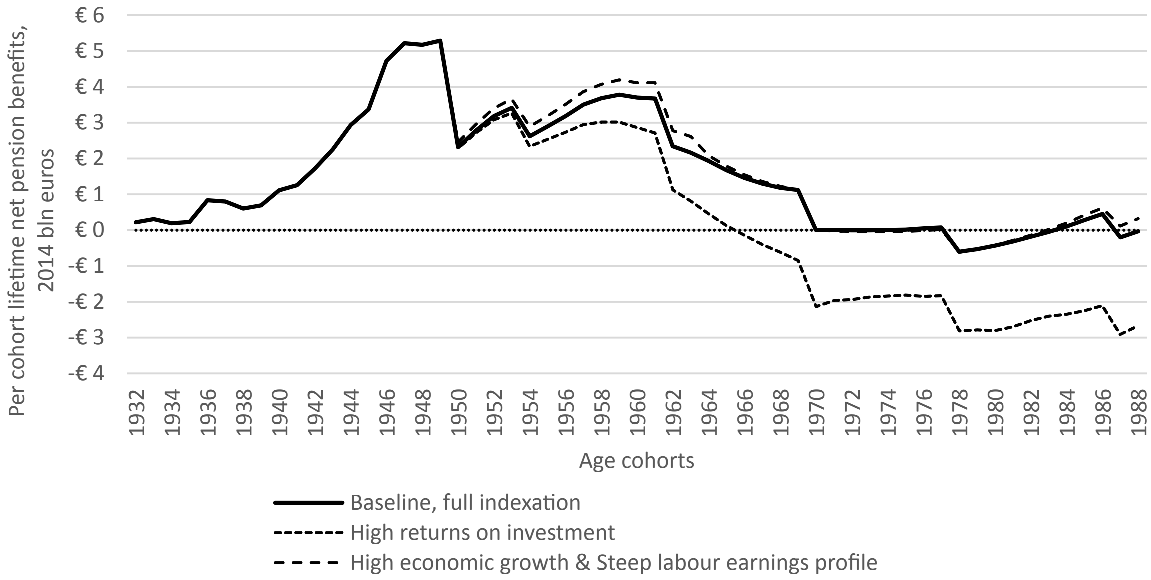


Figure 16: Baseline and sensitivity scenario adjusted per cohort lifetime net pension benefits, full indexation regime, in billions of 2014 euro.

Figure 16 shows that higher economic growth rates and a steeper labour earnings profile lead to similar results[29]. Both divert from the baseline results for the oldest active age cohort (1949) up to generations which are roughly halfway their career (age cohorts 1950-1968). For younger age cohorts this effect is not prevalent, as the effects (lower right accrual when young and higher right accrual when old with respect to an actuarial fair scheme) are traded off against each other.

Figure 16 provides additional evidence that the model used is robust against alternative values of the nominal economic growth rate and the steepness of the labour earnings profile, whereas it is not robust against alternative parameters for the real return on investments of the pension fund.

The following section will abandon the assumption of a non-binding intertemporal fund budget constraint and assume that the fund will need to solve its residual reserve before termination. The efficacy of different (combinations of) policy measures will be explored next. This will be done for the full indexation regime solely, as this enables inference about the potential losses of purchasing power.

[29]However, the results for these two sensitivity analyses are not equivalent, as the per cohort lifetime net pension benefits differ for age cohorts 1950 and younger. The differences are small in size, ranging from 0.2 *mln* euro for generation 1963 to 28.2 *mln* euro for generation 1978 (taking absolute values).

6.2 Analysis 2: Solving the fund's intertemporal budget constraint using a single instrument approach

Analysis 1 shows that ABP pension fund faces a deficit at termination. The current arrangements thus are not sustainable if the fund wishes to fully index pension right accrual and pension benefits to price inflation and faces a binding intertemporal budget constraint. Concluding, it must be noted that ABP pension fund is not able to guarantee the real value of its pension benefits without adapting pension policy. So, *the purchasing power of pension entitlements cannot be guaranteed for the current pension scheme provided by ABP pension fund*. The conclusion of this is that ABP pension fund fails to offer its participants a pension benefit with which they have the purchasing power equivalent to 70 per cent of the average wage they earn during their career.

This section contains results of Analysis 2. Since the fund is obliged to solve its intertemporal budget constraint, non-zero values for the fund's reserve at termination are impossible. Subsections 6.2.1 through 6.2.4 will show the results for single instrument policies, subsection 6.2.5 wraps up.

6.2.1 Single instrument policy: Adjusting the contribution rate

The first instrument the fund has at its disposal is to raise the contribution rate paid from 2014 onwards. By increasing the contribution rate for all employed age cohorts the fund aims to attract additional liquidity. The excess contributions are catching-up contributions in the sense that they yield no additional right accrual. The results for the baseline and the policy adjustment scenarios are depicted in Figure 17:

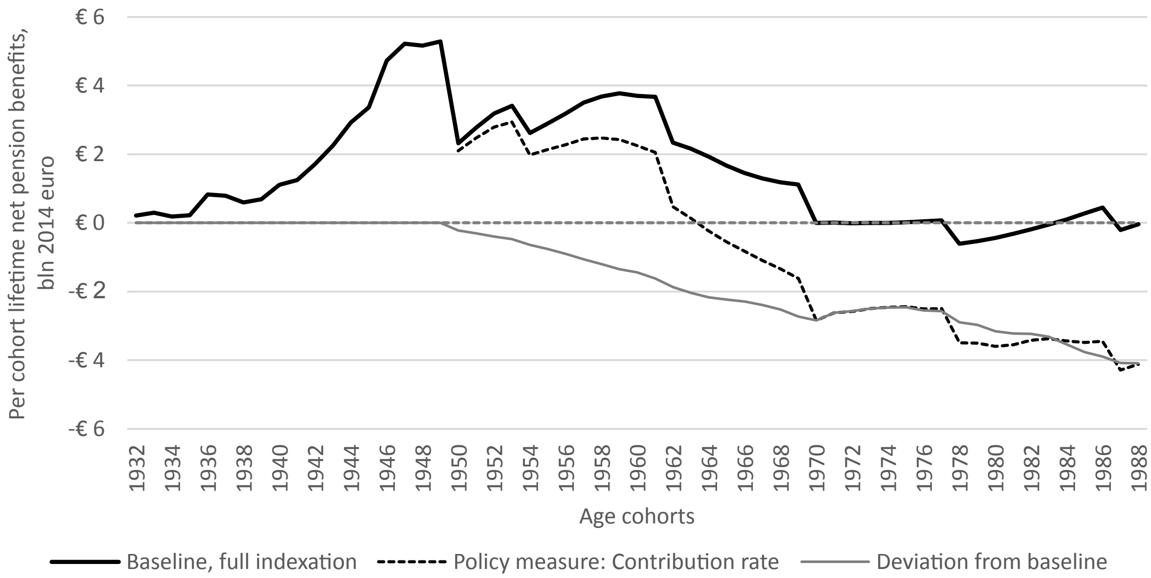


Figure 17: Baseline and contribution rate adjusted per cohort lifetime net pension benefits, full indexation regime, in billions of 2014 euro.

The policy measure is effectuated by a one-off increase of the contribution rate enforced in 2014, which is continued until fund termination. Figure 17 shows that per cohort lifetime net pension benefits of generations 1949 and older are unaffected by this policy change. As these age cohorts are already retired, they are unaffected by increases in the contribution rate (i.e. they do not pay pension contributions anymore). As per cohort lifetime net pension benefits of all age cohorts 1932 through 1949 are positive, this means that these generations are net beneficiaries of the fund (i.e. they receive a higher cash flow from the fund, than their contribution payments and the returns on investing these entitles them to). These generations leave the fund with a negative reserve, which can only be resolved if the generations 1950 and younger are net contributors to the fund for at least the amount which was disbursed to the generations 1949 and older in excess of their entitlements. Graphically, the area of the region enclosed by the line depicting the per cohort lifetime net benefit resulting from the policy change should be zero (the area above the x-axis should be of equal size to the area under the x-axis). So, excess disbursements to age cohorts by the fund should be compensated by excess cash flows from other age cohorts to the fund.

ABP documents its expectation concerning the contribution rate to be 21.6 per cent for 2014 (ABP, 2014b). The model used in this study shows that the proposed contribution rate would not suffice to resolve the fund's deficit at termination. Rather, *a contribution rate of 30.7 per cent* (or an increase of 42.3 per cent of the contribution rate proposed for 2014 by ABP pension fund) *from 2014 onwards is needed to close the fund's intertemporal budget constraint at the fund's demise.* This does however not take into consideration that the amount of participants to the fund shrinks (as individuals either retire or pass away). In reality the contribution base is eroding too, as the labour population shrinks (due to the de-greening process discussed in section 1.6). So, *the contribution base of 30.7 per cent is a lower limit, notwithstanding the fact that the fund is urged to raise its contribution rate.*

A second result is that adjusting the contribution rate solves the fund's financial issues at termination by making all age cohorts who have yet to retire in 2014 worse off. This is shown by the grey line depicting the deviation from the baseline caused by the policy change in Figure 17. So, *each fund participant born from 1950 onwards will face a lower lifetime net pension benefit as a result from increases in the contribution rate necessary to solve the fund's implicit debt accumulated up to 2014.*

Third, the net benefits are affected in an increasingly negative manner for age cohorts which are further away from retirement. This is a direct result from the fact that these generations are liable to contribution payments for a longer period of time. So, *the negative effects of increasing contribution rates on the lifetime net pension benefits of participants are rising with the year in which a participant is born.*

Fourth, *closing the intertemporal budget constraint through increasing the contribution rate requires sizable transfers from young to old.* From age cohort 1964 onwards, per cohort lifetime net pension benefits are negative. If the fund closes its intertemporal budget constraint through altering the contribution rate, generations born up to 1963 are net beneficiaries of the fund and generations 1964 and younger are net contributors to the fund. As the fund's population from 2014 until fund termination is known, inference can be made about the actual transfer made by each age cohort to solve the fund's deficit. The transfers are calculate as the deviation from the baseline scenario of the observations for the policy measure. So, the values reported below are excess transfers above the transfer already made from an age cohort to the fund in the baseline scenario. Per cohort transfers are within the range of 0.1 bln euro (age cohort 1950) to 4.1 bln euro (age cohort 1988), while generations 1932 through 1949 are unaffected by this policy change. This amounts to 402 euro (generation 1950) to 3,520 euro (generation 1988) on a yearly basis per member of the age cohort[30], from the year 2014 until the year of retirement. This transfer is in terms of annual payments per member of an age cohort, from the year 2014 until the year of decease.

Generation Lucky after applying contribution rate policy is generation 1949 as it is both unaffected by the policy change and has the highest lifetime net pension benefit (5.3 bln euro). This is a result of the fact that generation 1949 is Generation Lucky for the fully indexed baseline scenario as it faces the most favourable pension policy (with respect

[30]Annual transfers by an individual member of an age cohort are calculated by dividing the total transfer due by this generation over the remaining life years of all its members. This can be done as the fund's population is deterministic on account of the prospection in the model.

to early retirement facilities, past contribution rates and indexation policy and pension benefit disbursements) and is among the age cohorts with the most sizable population. *Generations Unlucky are generation 1987* (which has the lowest lifetime net pension benefit, −4.3 bln euro) *and generation 1988* (which has the largest decline in lifetime net pension benefit, −4.1 bln euro). This is a result of the fact that these generations have to pay the higher contribution rate for the longest period in time possible (as they will retire the latest) and face least favourable pension policy (highest retirement age and average wage system. Table 6 summarises the findings of this subsection:

Summary table of per cohort lifetime net pension benefits (in bln 2014 euro)

Variable	**Baseline value**	**Value after policy adjustment**	**Difference w.r.t. the baseline value**
Fund reserve at termination	−87.3 bln euro	nil	+87.3 bln euro
Contribution rate (% of baseline value)	21.6 % (100 %)	30.7 % (142.3 %)	+ 9.1% (+ 42.3%)
Cohort with *lowest* adjustment w.r.t. baseline values	1932-1949 Baseline values	1932-1949 Baseline values	1932-1949 nil
Cohort with *higest* adjustment w.r.t. baseline values	1988 −0.03 bln	1988 −4.1 bln	1988 −4.1 bln
Number of cohorts affected		39 out of 57	39 out of 57
Generation Lucky (*largest*lifetime net pension benefit)	**1949** 5.3 bln euro	**1949** 5.3 bln euro	**1949** nil
Generation Unlucky (*smallest*lifetime net pension benefit)	**1987** −0.2 bln euro	**1987** −4.3 bln euro	**1987** −4.1 bln euro

Table 6: Summary of results from contribution rate policy changes to close the fund's intertemporal budget constraint, in billions of 2014 euro.

6.2.2 Single instrument policy: Adjusting the rate of indexation

The second single instrument policy the fund has at its disposal is to (partly) discontinue indexation of right accrual and pension benefits to price inflation. In section 6.1 the prediction already was made that effectuating indexation in the range of 50 to 75 per cent with respect to price inflation would solve the fund's intertemporal budget constraint. This is confirmed by the model: effectuation of indexation for 66.2 per cent of price inflation during the years from 2014 until fund termination solves the fund's intertemporal budget constraint. It must be noted that this boils down to an erosion of per cohort lifetime net pension benefits as pension right accrual is not indexed for one-third of price inflation after 2013 until the year of retirement. From the moment of retirement until the moment of decease pension benefits are also not indexed for one-third of price inflation, further eroding pension benefits received by the participants. By use of alternative indexation regimes the pension fund aims to cut its present and future liabilities, as lower indexation erodes the real value of the pension benefits (to be) disbursed. The results for the baseline and the policy adjustment scenarios are depicted in Figure 18:

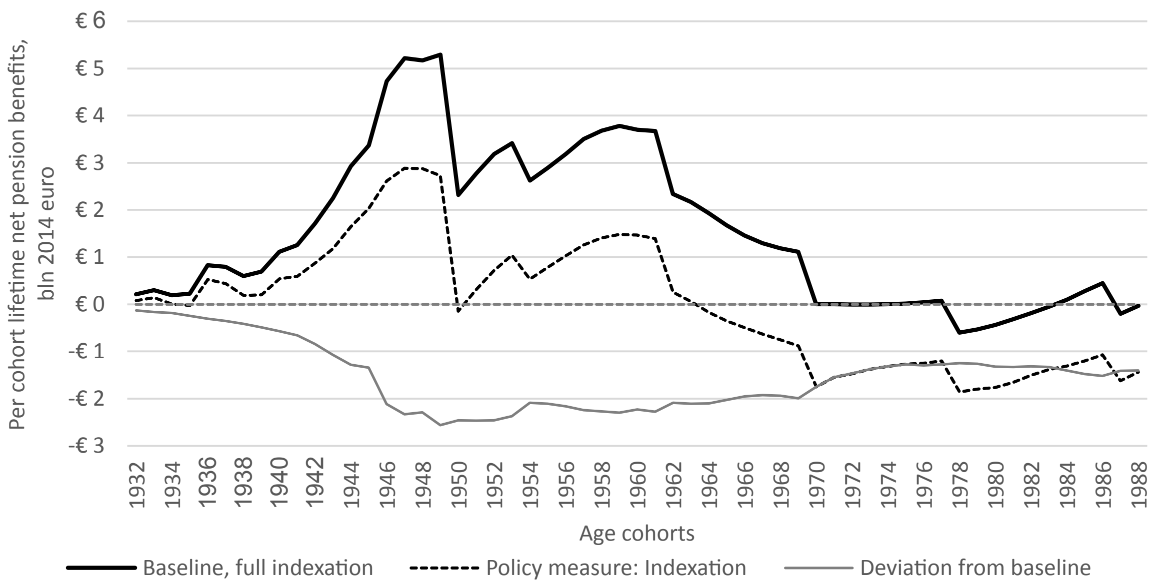


Figure 18: Baseline and indexation adjusted lifetime net pension benefits for all age cohorts, full indexation regime, in billions of 2014 euro.

The policy measure is effectuated by a one-off decrease in all indexation rates of 33.8 per cent of the annual price inflation from 2014 until fund termination. So, if price inflation is 2 per cent, pension benefits and pension rights are indexed by $(1-0.338)\cdot 2.0\% = 1.324\%$. This leads to the following results. First, *limiting indexation makes all age cohorts worse off with respect to the baseline.* All participants receive lower pension benefits than otherwise would be the case. This is depicted by the deviation from the baseline, which is

negative for all age cohorts. So, as a result of the indexation instrument, all per cohort lifetime net pension benefits are decreased with respect to the baseline. Thus, all generations are contributing more to the pension fund as a result of the policy change.
Second, 2014 retirees are affected less than 2014 non-retirees as these will receive pension benefits (which is directly affected by the indexation regime) for a shorter time span after 2013 than those are yet to retire (as their longevity perspectives are lower than that of younger generations). For these generations (1932-1945) a larger share of per cohort lifetime net pension benefits has already materialised in 2013, than for generations 1946 and younger. Younger generations (age cohorts 1946 and above) are hit harder as they will receive pension benefits for a longer period in time. *All age cohorts are negatively affected by downward changes to pension benefits, but younger generations (1946 through 1988) are hit harder than older generations (1932 through 1945).*
Third, *generations with larger lifetime net pension benefits are affected to a larger extent (on average) than generations with more modest lifetime net pension benefits.* A preliminary finding is that the indexation regime seems to be an effective tool to redistribute per cohort lifetime net pension benefits more evenly.
Fourth, for age cohorts 1935, 1950 and 1964 and younger, per cohort lifetime net pension benefits are negative. So, *generations 1935, 1950 and 1964 and younger are net contributors to the pension scheme as a result of changes to pension benefit policy, generations 1932 through 1963 (with the exception of 1935 and 1950) remain main beneficiaries even after the policy change.*
Per cohort transfers are within the range of -0.1 bln euro for age cohort 1932 to -2.6 bln euro for age cohort 1949. The minimum transfer is paid annually by a member of generation 1950 (700 euro), whereas the maximum transfer is paid by an individual born in 1986 ($2,800$ euro).
Generations Lucky from indexation regime policy are generations 1932 as it is affected by the policy change to the minimum extent (-0.1 bln euro) *and generation 1947 as it has the highest lifetime net pension benefit* (2.9 bln euro) *after the policy change.* The low extent to which age cohort 1932 is affected is a result of the fact that for this age cohort the largest share of lifetime net pension benefits have already materialised (with respect to all other generations), as it is the eldest. Generation 1947 has the highest lifetime net pension benefit after the policy change as it already ranked among the top before the policy change (along with generation 1949), but is less populated than age cohort 1949 (so therefore is affected to a lesser extent). *Generation Unlucky is generation 1978 as it has the lowest lifetime net pension benefit* (-1.9 bln euro) *as a result of the policy change*[31]. Generation 1978 is affected to this extent as its lifetime net pension benefits already is

[31] Technically age cohort 1949 is Generation Unlucky too as it faces the largest decline in lifetime net pension benefit (-2.6 bln euro). But, as generation 1949 retains the third highest lifetime net pension benefit of all generations it does not seem appropriate to appoint is as a generation with back luck. Therefore age cohort 1949 is not considered as Generation Unlucky.

at the bottom of all generations in the fully indexed baseline. Limiting indexation would render this generation an even larger net contributor to the fund. A conclusion is that *even though the effect of the indexation instrument is increasing in the size of per cohort lifetime net pension benefits, it also affects the per cohort lifetime net pension benefits of the largest contributors to the fund under the baseline.*
Table 7 summarises the findings of this subsection:

6.2.3 Single instrument policy: Adjusting the right accrual rate

By decreasing the right accrual rate for all employed age cohorts the fund aims to cut its future liabilities (in terms of pension benefits to be disbursed). The results for the baseline and the policy adjustment scenarios are depicted in Figure 19:

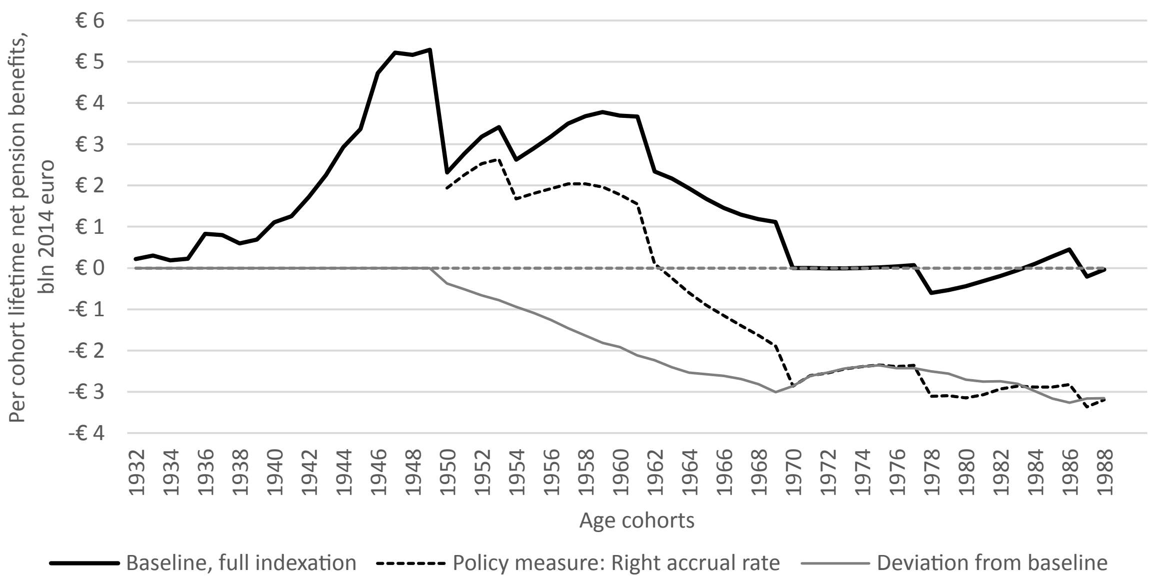


Figure 19: Baseline and right accrual rate adjusted per cohort lifetime net pension benefits, full indexation regime, in billions of 2014 euro.

The right accrual rate for 2014 is legally set at 1.95 per cent annually. For the years 2015–2017 the value of 1.875 per cent per annum is utilised, which for a period of full employment (from ages 25 to 67 years of age, so 42 years) boils down to a total right accrual of 78.75 per cent of the average wage of a participant. The right accrual rate is adjusted such that a fixed share of the full right accrual is guaranteed yearly (e.g. a 10 per cent policy decrease would lead to a full employment right accrual of $(0.9 \cdot 78.75\% =) 70.88\%$.

Summary table of per cohort lifetime net pension benefits (in bln 2014 euro)

Variable	**Baseline value**	**Value after policy adjustment**	**Difference w.r.t. the baseline value**
Fund reserve at termination	−87.3 bln euro	nil	+87.3 bln euro
Share of price inflation to which pension rights and benefits are indexed	100 %	66.2 %	−33.8%
Cohort with *lowest* adjustment w.r.t. baseline values	1932 0.2 bln euro	1932 0.08 bln euro	1932 −0.1 bln euro
Cohort with *higest* adjustment w.r.t. baseline values	1949 5.3 bln euro	1949 2.27 bln euro	1949 −2.6 bln euro
Number of cohorts affected		All	All
Generation Lucky (*largest*lifetime net pension benefit)	**1947** 5.2 bln euro	**1947** 2.9 bln euro	**1947** −2.3 bln euro
Generation Unlucky (*smallest*lifetime net pension benefit)	**1978** −0.6 bln euro	**1978** −1.9 bln euro	**1978** −1.3 bln euro

Table 7: Summary of results from indexation regime policy changes to close the fund's intertemporal budget constraint, in billions of 2014 euro.

The model used in this study shows that cutting pension right accrual by 32.3 per cent would solve the fund's intertemporal budget constraint. This means that total right accrual would decrease from 78.75 per cent of average labour earnings to $(1 - 0.323) \cdot 78.75\% = 53.34$ per cent of the average earnings, to resolve the fund's deficit at termination.

Once again, in interpreting these results the reader must be aware of the fact that the area above the x-axis enclosed by the baseline (black, uninterrupted line) is matched in size by the area below the x-axis enclosed by the deviation from the baseline resulting from the policy change (grey, uninterrupted line). The summation of the area enclosed by the policy measure (black, interrupted line) both above and below the x-axis is equal to zero, which denotes the zero-sum game which holds as a result from the fund's binding intertemporal budget constraint.

Several results follow. First, *adjusting the right accrual rate makes all age cohorts who have yet to retire in 2014 worse off.* As a result from right accrual erosion, each euro laid into the pension scheme by a participant is eligible to a lower pension right accrual than before 2014. So, with each euro this participant become a larger net contributor (i.e. lays in an excess contribution over the actuarially fair pension entitlements).

Second, *the younger generations are hit harder as they are acquiring pension rights for a longer time to come, and have acquired little pension rights up to 2013.* The result of this is that age cohorts become larger net contributors to the pension scheme the younger they are. Generations 1969 through 1988 are affected most by the policy change[32].

Third, from age cohort 1962 onwards per cohort lifetime net pension benefits are negative. *All age cohorts 1962 and younger are net contributors to the pension scheme as a result of the right accrual policy changes, all age cohorts 1961 and above are main beneficiaries of the pension scheme under this policy change.* So, the pension benefits in excess of the pension entitlements received by age cohorts born before 1962 are paid for by generations born after 1961.

Fourth, generations 1950 and younger have lower per cohort lifetime net pension benefits as a result of the policy change. Age cohorts' 1949 and above lifetime net pension benefits are unaltered by the policy change. So, generations 1950 and younger are paying for the excess benefits received by generation 1949 and older, albeit that generations 1950 through 1961 still receive larger pension benefits than they are entitled to. *Closing the intertemporal budget constraint through alternate pension right accrual policy thus requires transfers from young to old.*

Per cohort transfers are within the range of −0.4 bln euro for age cohort 1950 to −3.3 bln euro for age cohort 1986, whereas per cohort lifetime net pension benefits of generations

[32]The curve in the line depicting the deviation in per cohort lifetime net pension benefits as a result of the policy change (between generations 1969 and1986), is the result of asymmetric size of these age generations.

1932 through 1949 are unaffected by this policy change. This amounts to a minimum of 700 euro (1950), and to a maximum of 2,800 euro (1986) on a yearly basis per member of the age cohort, from the year 2014 until the year of retirement (or decease, if it comes first).

Generation Lucky from the right accrual rate instrument is generation 1949 as it is both unaffected by the policy change and has the highest lifetime net pension benefit (5.3 bln euro). This is a result of the fact that generation 1949 is Generation Lucky for the fully indexed baseline scenario as it faces the most favourable pension policy (with respect to early retirement facilities, past contribution rates, past indexation policy and pension benefit disbursement) and is among the age cohorts with the most sizable population. *Generations Unlucky are generation 1987* (which has the lowest lifetime net pension benefit, −3.4 bln euro) *and generation 1986* (which has the largest decline in lifetime net pension benefit, −3.3 bln euro) as a result of the policy change. This is a result of the fact that these generations still need to acquire the largest share of their right accrual (as they just started their careers). Generation 1988 would have been Generation Unlucky if its population would not have been slightly smaller than that of 1986 and 1987.

Table 8 summarises the findings of this subsection:

Summary table of per cohort lifetime net pension benefits (in bln 2014 euro)

Variable	**Baseline value**	**Value after policy adjustment**	**Difference w.r.t. the baseline value**
Fund reserve at termination	−87.3 bln euro	nil	+87.3 bln euro
Right accrual rate (& of initial value)	78.75 % (100 %)	53.34 % (67.7 %)	−25.41% (−32.3%)
Cohort with *lowest* adjustment w.r.t. baseline values	1932-1949 Baseline values	1932-1949 Baseline values	1932-1949 nil
Cohort with *higest* adjustment w.r.t. baseline values	1986 0.4 bln euro	1986 −2.9 bln euro	1986 −3.3 bln euro
Number of cohorts affected		39 out of 57	39 out of 57
Generation Lucky (*largest*lifetime net pension benefit)	**1949** 5.3 bln euro	**1949** 5.3 bln euro	**1949** nil
Generation Unlucky (*smallest*lifetime net pension benefit)	**1987** −0.2 bln euro	**1987** −3.4 bln euro	**1987** −3.2 bln euro

Table 8: Summary of results from right accrual rate policy changes to close the fund's intertemporal budget constraint, in billions of 2014 euro.

6.2.4 Single instrument policy: Adjusting the benefits disbursements

The fund can also opt to slash pension benefits for all participants. This is seen as a last resort measure, as it influences all the fund's participants and is claimed to have large effects on retirees. The rationale behind this is that retired individuals cannot cushion a cut to their pension benefits, as they are not employed any more (i.e. they cannot earn additional labour income to make up for the losses in pension benefits).
By slashing the pension benefits for all fund participants the fund aims to cut its present and future liabilities. The results for the baseline and the policy adjustment scenarios are depicted in Figure 20:

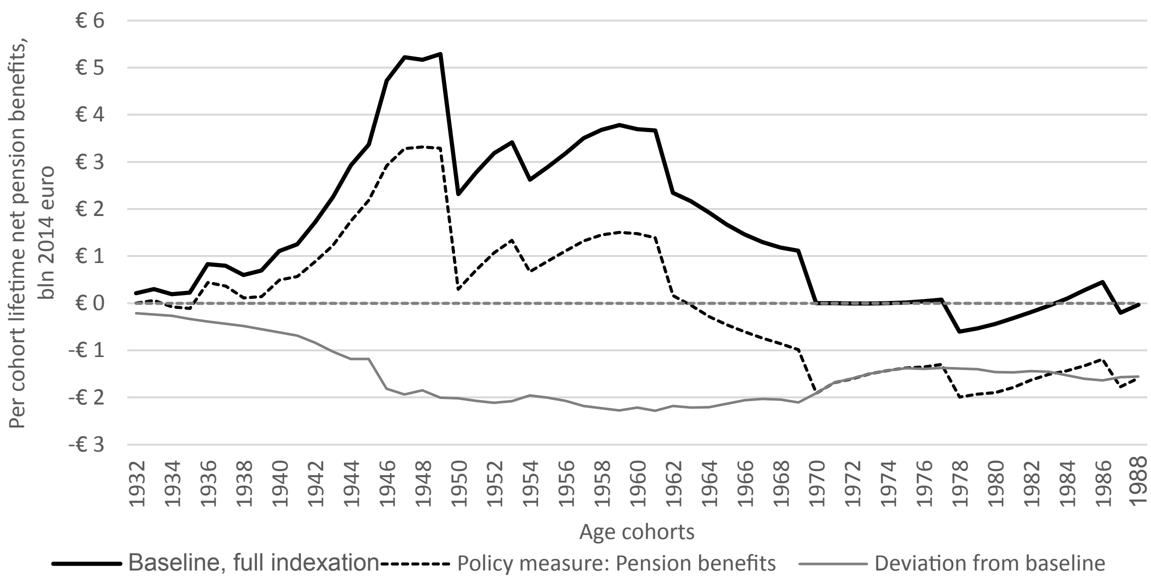


Figure 20: Baseline and pension benefit adjusted lifetime net pension benefits, full indexation regime, in billions of 2014 euro.

The model used in this study shows that a one-off benefit cut of 15.82 per cent enforced from 2014 until fund termination is needed to close the fund's intertemporal budget constraint. It should be noted that this affects all pension disbursals from the fund to its participants as for each euro which would normally be disbursed, after the policy change 0.84 euro is disbursed (all in terms of 2014 euro).
This leads to the following results. First, *slashing pension benefits makes all age cohorts worse off with respect to the baseline.* All participants receive lower pension benefits than otherwise would be the case. So, the costs to close the fund's intertemporal budget constraint are borne by all participating generations.
Second, the total effects are less for 2014 retirees than for 2014 non-retirees, as the former will receive pension benefits for a shorter time span (i.e. they are already in their

retirement and have fewer years until they will pass away). For these generations (1932-1949) a larger share of per cohort lifetime net pension benefits has already materialised in 2013, than for generations 1950 and younger. Younger generations (age cohorts 1950 and above) are hit harder as they will receive pension benefits for a longer period in time. *All age cohorts are negatively affected by downward changes to pension benefits, but younger generations (1950-1988) are hit harder than older generations (1932-1949).*

Third, for age cohorts 1934, 1935 and age cohorts 1963 and younger, per cohort lifetime net pension benefits are negative. So, *generations 1934, 1935 and 1963 and younger are net contributors to the pension scheme as a result of changes to pension benefit policy, generations 1932, 1933 and 1936 through 1962 remain main beneficiaries even after the policy change.*

Per cohort transfers are within the range of -0.2 bln euro for age cohort 1932 to -2.3 bln euro for age cohort 1961. On an annual, basis cohort 1944 is affected minimally ($-1,350$ euro) and cohort 1987 is affected maximally ($-4,050$ euro), from the year 2014 until the year of decease.

Generation Lucky from the benefit disbursal instrument are generations 1932 (as it is affected by the policy change to the minimum extent; -0.2 bln euro) *and generation 1948* (as it has the highest lifetime net pension benefit; 3.3 bln euro) after the policy change. The low extent to which age cohort 1932 is affected is a result of the fact that for this age cohort the largest share of lifetime net pension benefits has already materialised (with respect to all other generations). Generation 1948 has the highest lifetime net pension benefit after the policy change as it already ranked among the top before the policy change (along with generation 1949), but is slightly less populated than 1949 (so therefore is affected to a lesser extent). *Generation Unlucky is generation 1961* as it has both the lowest lifetime net pension benefit (-2.0 bln euro) and the largest decline in lifetime net pension benefit (-2.3 bln euro) as a result of the policy change. Generation 1961 is affected to this extent as its lifetime net pension benefits already ranks among the top of the active generations (along with generations 1959 and 1960), but is less populated than 1959 and 1960 (so therefore is affected to a lesser extent).

Table 9 summarises the findings of this subsection:

Summary table of per cohort lifetime net pension benefits (in bln 2014 euro)

Variable	**Baseline value**	**Value after policy adjustment**	**Difference w.r.t. the baseline value**
Fund reserve at termination	−87.3 bln euro	nil	+87.3 bln euro
Pension benefit disbursement	100 %	84.2 $	−15.8%
Cohort with *lowest* adjustment w.r.t. baseline values	1932 0.2 bln euro	1932 0.0 bln euro	1932 −0.2 bln euro
Cohort with *higest* adjustment w.r.t. baseline values	1961 3.7 bln euro	1961 1.4 bln euro	1961 −2.3 bln euro
Number of cohorts affected		All	All
Generation Lucky (*largest*lifetime net pension benefit)	**1948** 5.2 bln euro	**1948** 3.3 bln euro	**1948** −1.9 bln euro
Generation Unlucky (*smallest*lifetime net pension benefit)	**1978** −0.6 bln euro	**1978** −2.0 bln euro	**1978** −1.4 bln euro

Table 9: Summary of results from pension benefit disbursement policy changes to close the fund's intertemporal budget constraint, in billions of 2014 euro.

6.2.5 Single instrument policy: take-aways

This subsection will present take-aways of single instrumental policies aimed at solving the fund's intertemporal budget constraint. Figure 21 and Table 10 show a summary representation of the all policy adjustments:

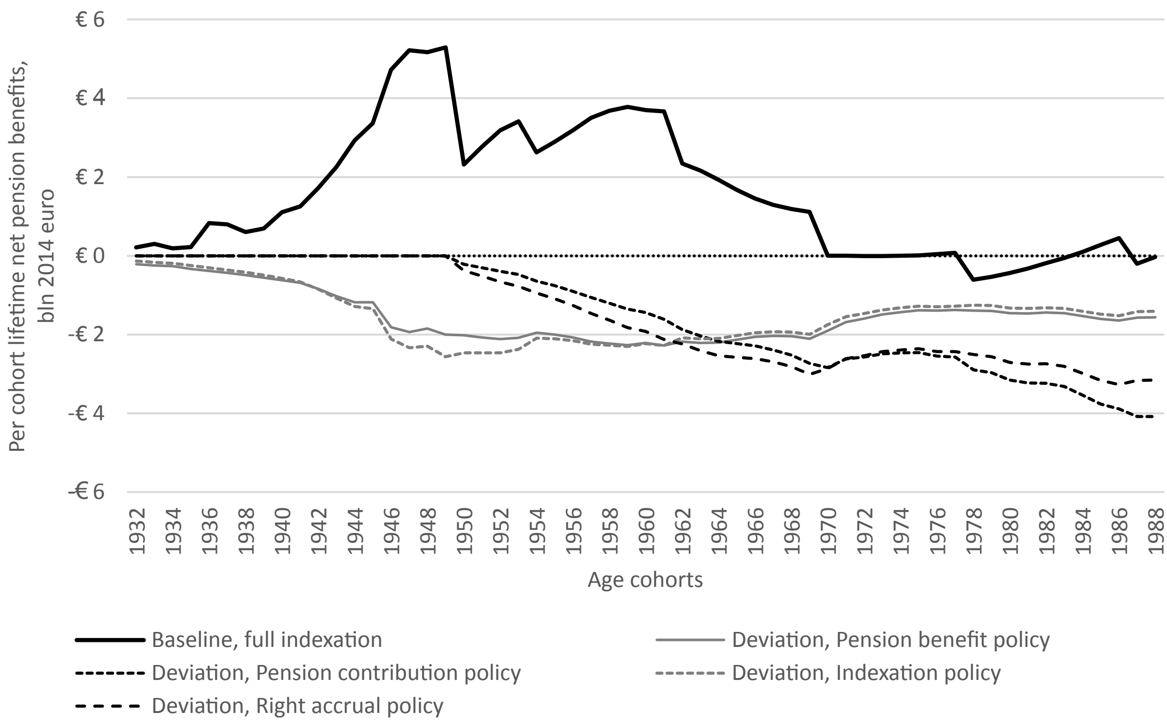


Figure 21: Baseline and deviations caused by all types of single instrument pension policy, full indexation regime, in billions of 2014 euro.

The main take-away is that *policy changes are imperative to solve the fund's intertemporal budget constraint*. Figure 21 shows that different policies affect different age cohorts to a different extent. For generations 1950 and younger it holds that their lifetime net pension benefits are negatively affected, irrespective of the kind of policy chosen by the pension fund. For age cohorts 1949 and older this only happens if the fund opts to change its indexation regime or would slash pension benefits.
The indexation mechanism seems most successful in distributing the costs evenly, as most per cohort net lifetime pension benefits are brought closer to the actuarially fair value of zero. Slashing pension benefits is a potent instrument too, although this instrument shifts a larger portion of the costs onto babyboomers. Least efficient in distributing costs evenly are the contribution and right accrual rates, as these only affect age cohorts 1950 and younger.

Summary table of per cohort lifetime net pension benefits (in bln 2014 euro)

Variable	**Contribution rate**	**Indexation of pension rights and benefits**	**Right accrual rate**	**Benefit disbursement**
Fund reserve at termination	nil	nil	nil	nil
Adjustment of policy parameter (Initial value of policy parameter)	+9.1 % (21.6 %)	−33.8% (100 %)	−25.41% (100 %)	−15.8% (100 %)
Cohort with *lowest* adjustment w.r.t. baseline values	1932-1949 nil	1932 −0.1 bln euro	1932-1949 nil	1932 −0.2 bln euro
Cohort with *higest* adjustment w.r.t. baseline values	1988 −4.1 bln euro	1949 −2.6 bln euro	1986 −3.3 bln euro	1961 −2.3 bln euro
Number of cohorts affected	39 out of 57	All	39 out of 57	All
Generation Lucky (*largest*lifetime net pension benefit)	**1949** 5.3 bln euro	**1947** 2.9 bln euro	**1949** 5.3 bln euro	**1948** 3.3 bln euro
Generation Unlucky (*smallest*lifetime net pension benefit)	**1987** −4.3 bln euro	**1978** −1.9 bln euro	**1987** −3.4 bln euro	**1978** −2.0 bln euro

Table 10: Summary of adjustments caused by all policy changes to close the fund's intertemporal budget constraint, in billions of 2014 euro.

Having to pitch in extra does not automatically mean that a generation would optimally not be participating in the pension scheme. If the lifetime net pension benefits of a generation is positive, this age cohort still receives a higher cash flow from the fund (in terms of pension benefits) than what the pension contract entitles them to (on a basis of the contribution they paid and the returns of investment of those) even after possible policy interventions. But, as this pension scheme is a zero-sum game it holds that if some generations are net beneficiaries of the fund, other generations must be net contributors to the fund by definition. Figure 22 shows the average price a generation pays from policy changes (averaged over the four possible policy changes the fund has) in terms of lifetime net pension benefit losses with respect to the fully indexed baseline. Figure 22 also shows the per cohort lifetime net pension benefits after the average policy change (averaged over the four policy instruments):

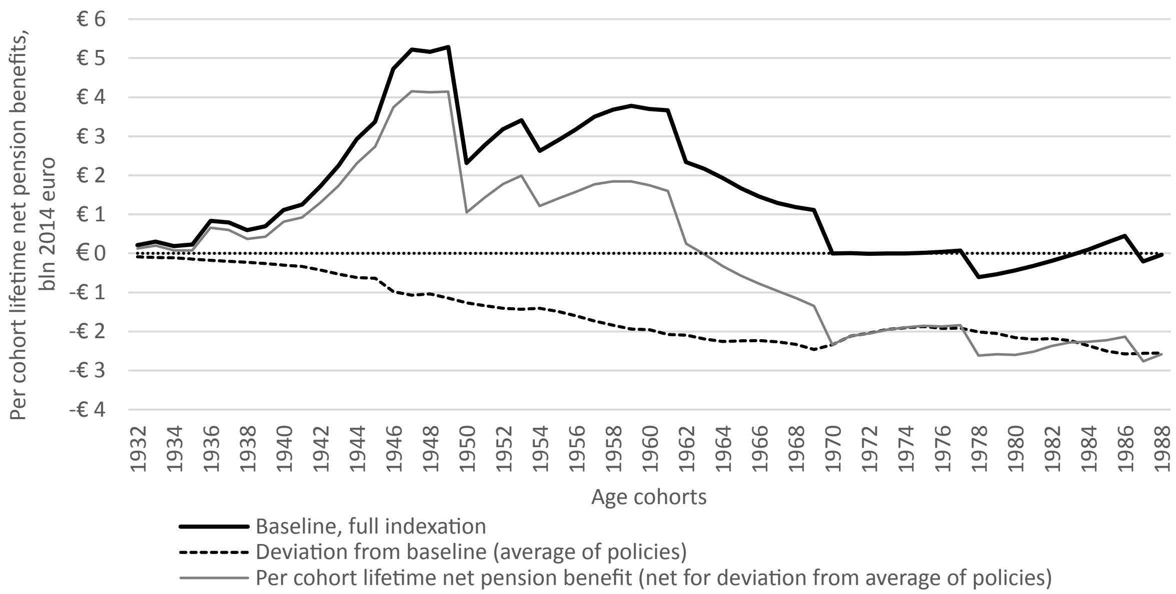


Figure 22: Baseline, average deviation caused by pension policy and average per cohort lifetime net pension benefit after pension policy changes has been enforced, full indexation regime, in billions of 2014 euro.

Figure 22 demonstrates that the price paid by age cohorts is increasing in birth year of the cohorts. The highest price is paid by generations 1969, 1984 and beyond, with age cohort 1986 bearing the largest costs (−2.6 bln euro in terms of lifetime net pension benefits). The most modest price is paid by generation 1932 (−0.1 bln euro on average). After the deviation from the baseline caused by the average impact of the policy changes, a divide can be made between generation 1932 through 1962 (who are net beneficiaries) and generation 1963 through 1988 (who are net contributors). **This confirms the second hypothesis of this study: "per cohort lifetime net pension benefits of the**

oldest age cohorts exceed those of later born generations, as shocks to the fund's reserve are shared forwards solely and the generosity of pension policy declines over the years."
Table 11 gives the top and bottom threes in terms of per cohort lifetime net pension benefits resulting after the average of policy responses:

Rank	**Per cohort lifetime net pension benefits** (*full indexation scenario*)
Top #1	**1947** **(4.2 bln euro)**
Top #2	1949 (4.1 bln euro)
Top #3	1948 (4.1 bln euro)
Bottom #1	**1987** **(- 2.8 bln euro)**
Bottom #2	1978 (−2.6 bln euro)
Bottom #3	1980 (−2.6 bln euro)

Table 11: Top 3 and bottom 3 age cohorts in terms of per cohort lifetime net pension benefits, full indexation scenario adjusted for average of policies, in billions of 2014 euro.

Table 11 shows that *age cohort 1947 emerges as Generation Lucky from Analysis 2* (using single instruments), whereas *Generation Unlucky is age cohort 1987.* Analyses 1 and 2 thus lead to roughly similar results: generations 1947-1949 are main beneficiaries from the pension scheme under both analyses, whereas generations born in the late seventies retain their net contributor position. Generation 1987 is affected most negatively from the necessity to close the fund's intertemporal budget constraint.
As a stylised finding it can be noted that:

ABP pension fund does not offer an actuarially fair pension scheme. Instead the pension scheme offered requires intergenerational transfer, typically from young to old.

The next section will explore whether these findings change when policy instruments are combined by the fund.

6.3 Analysis 2: Solving the fund's intertemporal budget constraint using a multiple instruments approach

This section abandons the assumption that a single instrument policy is chosen by the fund, but rather assumes that instruments can be used in conjunction. It must be noted that the results from a multiple instruments approach in essence are combinations of the single instrument approaches presented in section 6.2. As such, the conclusions rather than the results will be presented here. A table summarising the results of all possible multiple instruments policy changes is provided in the Appendix (Section 9.2).

The following is found when solving the fund's intertemporal budget constraint using a multiple instruments approach. First, *using multiple instruments makes parameter adjustments less extreme when compared to the single instrument adjustments*. The rationale for this is that when more than one instrument is used the costs of closing the fund's intertemporal budget constraint can be distributed more evenly over the participating age cohorts. The fund can for instance use the contribution instrument (which only affects the young) together with the indexation instrument (which affects the old to a stronger extent than the young).

Second, *Generations Lucky and Unlucky are robust to using multiple instrument approaches*. The babyboomers retain their position as main beneficiaries of the pension scheme, just as generations 1978 and 1987 remain the main contributors to the fund (all in terms of per cohort lifetime net pension benefits discounted to 2014).

Third, *from a point of view of actuarial fairness, it would be preferred to adjust pension benefits and the indexation regime simultaneously, as this distributes the costs of solving the fund's intertemporal budget constraint in such a way that per cohort lifetime net pension benefits are closest to zero for all generations.* An alternative policy would be to adjust right accrual, pension benefits and the indexation regime (second most preferred option) or adjust contribution rates, pension benefits disbursement and indexation together (third most preferred option). These three policy combinations distribute the costs of closing the fund's intertemporal budget constraint most evenly (i.e. are most egalitarian). Table 12 summarises the results of the top 3 most egalitarian policy combinations:

Summary table of per cohort lifetime net pension benefits (in bln 2014 euro) for most egalitarian policy measures

Variable	**Benefit disbursment + Indexation regime**	**Right accrual rate + Benefit disbursement + Indexation regime**	**Contribution rate + Benefit disbursement + Indexation regime**
Fund reserve at termination	nil	nil	nil
Parameter values (initial values)			
Contribution rate (21.6 %)			22.59 %
Right accrual rate (78.75 %)		75.59 %	
Benefit disbursement (100 %)	86.68 %	88.42 %	88.72 %
Indexation (100 %)	100.26 %	100.44 %	99.67 %
Cohort with *lowest* adjustment	1932	1932	1932
w.r.t. baseline values	−0.2 bln euro	−0.2 bln euro	−0.2 bln euro
Cohort with *higest* adjustment	1949	1949	1949
w.r.t. baseline values	−2.6 bln euro	−2.4 bln euro	−2.4 bln euro
Number of cohorts affected	All	All	All
Generation Lucky	**1948**	**1948**	**1948**
(*largest*lifetime net pension benefit)	2.83 bln euro	3.0 bln euro	3.0 bln euro
Generation Unlucky	**1978**	**1978**	**1978**
(*smallest*lifetime net pension benefit)	−1.8 bln euro	−1.9 bln euro	−2.0 bln euro

Table 12: Summary of adjustments caused by most egalitarian policy changes to close the fund's intertemporal budget constraint, in billions of 2014 euro.

Table 12 shows that *age cohort 1948 emerges as Generation Lucky* (from Analysis 2 using multiple instruments), whereas *Generation Unlucky is age cohort 1978.* Analyses 1 and 2 thus lead to roughly similar results: generations 1947-1949 are main beneficiaries from the pension scheme under both analyses, whereas generations born in the late seventies retain their net contributor position. Generation 1978 is affected most negatively from the necessity to close the fund's intertemporal budget constraint, when policy combinations which are most preferable from an actuarial fairness perspective are effectuated.
Table 12 also shows that benefit disbursements are slashed (with decreases around 10 per cent) for all policy combinations which are most egalitarian. The indexation regime is used to solve residual deficiencies or surpluses and thus is subject to little change. So, the real value (i.e. purchasing power) of participants is not affected beyond the rate at which pension benefits are cut. When a third policy instrument is used, the changes to this instruments are moderate. Concluding, it can be stated that slashing benefits is the most powerful instrument at the fund's disposal. Moreover, from an actuarial fairness point of view, the benefit disbursement instrument should be the fund's first instrument of choice. The rationale behind this, is that the benefit disbursement instrument is most potent in decreasing the excess pension benefits received by net beneficiaries of the fund over their pension entitlements.
This is shown graphically in Figure 23, which depicts the deviations from the baseline as caused by the first and second most preferred policy combinations:

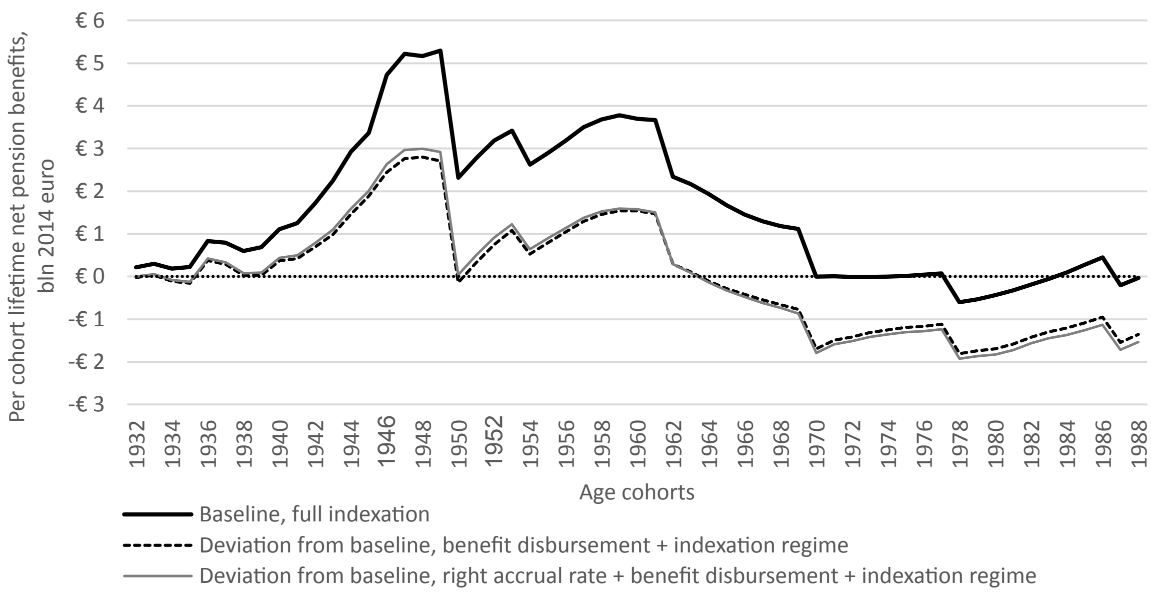


Figure 23: Baseline and adjusted per cohort lifetime net pension benefits for top 2 most preferred policy combinations, full indexation regime, in billions of 2014 euro.

For both policy combinations (i.e. adjustment of pension benefit disbursement and the indexation regime, or combining these two with an adjustment of the right accrual rate) all age cohorts born from 1964 onwards (and age cohorts 1934 and 1935) are net contributors to the fund. For the policy combination with two instruments, generations 1932 and 1950 have negative per cohort lifetime net pension benefits too after the policy change has been effectuated.
Figure 23 shows that the policy measure altering benefit disbursement and the indexation regime yields a more egalitarian result than the policy measure which also alters the right accrual rate. This is a result of a trade-off between benefit disbursements (which affects all participants alive) and right accrual (which only affects the participants who have not retired yet in 2014). Most egalitarian results yield from the two-instrument policy option as the annual effect on all age cohorts is equivalent. If, however, the fund desires to affect per cohort lifetime net pension benefits of its retirees to the minimum extent possible (as retirees lack the capacity to cushion pension benefit cuts as they are not employed anymore)), while still effectuating an egalitarian policy, it should opt for the three-instrument policy option. This policy option shifts a larger share of the costs to settle the fund's intertemporal budget constraint to the active part of the fund's population.
The average per cohort transfer[33] for these age cohorts amounts to −1.0 bln euro for the most preferred policy combination (i.e. adjustment of pension benefit disbursement and the indexation regime) and −1.2 bln euro for the runner-up policy combination. So, the most egalitarian manner to solve the fund's intertemporal budget constraint is through a joint adjustment of pension benefits and the indexation regime, which causes an average −1.0 bln euro reduction in per cohort lifetime net pension benefits of age cohorts 1932, 1934, 1935, 1950 and all cohorts from 1964 onwards.
This shows that for the majority of retired age cohorts slashing pension benefits will not affect their per cohort lifetime net pension benefits to the extent that they are becoming net contributors to instead of net beneficiaries from the fund. Even when pension benefits are slashed with 10 per cent, retirees (age cohorts 1949 and older) are still better off than non-retirees (generation 1963 and younger), as the latter pay a cash flow to the fund which ends up in the pockets of the former (instead of back to the latter). Moreover, the generations who retired closer to 2013 (the babyboomers) still have higher (and positive) per cohort lifetime net pension benefits than all other fund's participants. The conclusion from this is that, even though slashing benefits directly affects retirees, using the pension benefit disbursement instrument will not affect these generations to a larger extent than

[33] The average per cohort transfer is calculated as the total transfer to be paid (i.e. the summation of either the positive or negative per cohort lifetime net pension benefits resulting after the policy change) over the number of age cohorts with a negative per cohort lifetime net pension benefit after the policy change. This is equivalent to dividing the area of the negative part of the area of the deviation line by the number of age cohorts for which it is negative.

other generations. So, *there is no viable reason to render an adjustment of pension benefits undesirable.*

Concluding, *Analysis 2 appoints age cohorts 1948 as Generation Lucky and age cohort 1978 as Generation Unlucky and gives evidence that taboos on slashing pension benefits should be eradicated.*

The next section will give recommendations for policy changes.

6.4 Policy recommendations

This section will recommend (combinations of) policies. As this study refrains from taking a stance on equity, policies will be evaluated on the extent to which they distribute the costs of solving the fund's intertemporal budget constraint evenly (i.e. treating all age cohorts equally in terms of per cohort lifetime net pension benefits). One must bear in mind that this policy recommendations are for the sake of efficiency only, as this study will not engage in the questions of equity as this would require a redistributive ideology. The question of equity is left to social partners, ABP pension fund's board and politician as making inference on equity is beyond the domain of an economist.

If the policymaker wants to make sure that each generations is neither a contributor to, nor a beneficiary of the pension scheme, but instead gets a cash flow as close as possible to the value of the contributions this generation laid in plus the return on investing those, it should opt for a combinations of policies with an egalitarian result. As stated above, the following top 3 would be preferred from an actuarially fairness/egalitarian point of view:

1. Adjustment of benefits and indexation;
2. Adjustment of right accrual, benefits and indexation;
3. Adjustment of contributions, right accrual and indexation.

As argued in section 6.3, there is no viable reason to consider adjustments to the disbursement of pension benefits as a last resort. This policy instrument treats each euro laid into the pension scheme equally, irrespective of the generation whose cash flow into the pension scheme this euro originates from. Slashing benefits is to be preferred from a point of view of actuarial fairness, as it affects a generation more if its per cohort lifetime net pension benefits are higher (i.e. they are larger beneficiaries of the fund) under the baseline scenario. This does however not mean that these policy combinations are optimal, as discrepancies between per cohort lifetime net pension benefits are not resolved completely. This study shows that for each combination of pension policy imaginable retirees (with an emphasis on the babyboomers) are net beneficiaries of ABP's pension scheme, while the young active (age cohorts born from the late seventies onwards) pay

for the excess benefits received by the retirees.
Using the pension benefit disbursement instrument moreover, makes changes to the indexation regime redundant, thereby safeguarding the real value of pension entitlements (i.e. the purchasing power of retirees) beyond the one-off cut to pension benefits.
From an actuarial fairness point of view this study comes to the following conclusion:

Adjusting the rate to which pension benefits are disbursed is the most actuarial fair policy choice, as it is most potent in resolving the fund's intertemporal budget constraint while equalising per cohort lifetime net pension benefits to the largest extent possible. This does however not fully resolve that the babyboom generations (most notably age cohorts 1947 through 1949) are Generations Lucky from participating in ABP's pension scheme, whereas the youngest generations (most prominently age cohorts 1978 and 1987) are Generations Unlucky.

If the pension fund would be to, for whatever reason, favour one generation over another (i.e. consider it desirable that some generations benefit from the pension scheme, whereas others contribute to it more than they receive back from it) other policy option could be preferred. This study will not provide policy recommendations for this, but the reader is invited to look up what (combination of) policy measure(s) would be most or least advantageous for an individual born in her/his birth, in the graph provided in the Appendix (Section 9.3).
The next chapter concludes this study.

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7 Conclusion

The public debate about retirement benefits is one of the most prominent and intriguing of these days. This study hopes to be of value to this discussion by analysing discounted cash flows to and from a second pillar pension fund by Dutch civil servants and employees in the educational sector. Inspired by the generational accounting method of Auerbach & Kotlikoff (1991, 1994, 1998, 1999, 2002) this study constructs per cohort lifetime net pension benefits discounted to 2014 euros for participants (born between 1932 and 1988) in ABP's pension scheme over the period 1957 through 2097. Per cohort lifetime net pension benefits give the balance of a participant's cash flows to and from the fund, written in real values (i.e. discounted to the base year 2014). The fund invests the contributions paid by the fund's participants in order to be able to index its pension liabilities (i.e. the accrued pension rights and current pension benefits) to price inflation. A positive lifetime net pension benefit means that for each euro contributed to the fund, a participant gets a higher pension benefit in return (all discounted to the base year 2014); so this participant's purchasing power will increase as a result of the fund. Evidently, the opposite holds as well: a participant with a negative lifetime net pension benefit loses purchasing power as a result of its participation to the fund. An actuarially fair result is reached if a participant's reimbursement (i.e. its pension benefit) has the same real value as its contribution, this is equivalent to a zero lifetime net pension benefit.

This study finds that ABP pension fund will have a deficit of 87.3 billion euro at its termination (in 2097, i.e. after its last remaining participant passes away) if pension arrangements are unaltered after 2013, and pension rights and benefits are fully indexed to price inflation[34]. Lifetime net pension benefits are found to differ per cohort, which means that ABP's pension scheme does not yield actuarially fair results (i.e. a euro contributed to the scheme results in a contrasting amount of pension benefits disbursed to different age cohorts). Per cohort lifetime net pension benefits are highest for the babyboomers (with a maximal value of 5.3 bln euro for generation 1949) and most modest for individuals born from the second half of the seventies onwards (with a minimal value of −0.6 bln euro for generation 1978). These differences are the result of pension policy, such as early retirement facilities, final versus average wage systems, the legal retirement age and the indexation of pension right accruals and benefits to price inflation. Differences in economic circumstances also play an important role as these influence the return on investment of the fund, and its reserve as such. Next to this, the fund is found to favour individuals with a higher capacity to earn income, over those who have lower-than-average earnings capacities.

This results are found to be robust against alternative parameter values for economic

[34]This includes a retroactive indexation of 13.64 per cent to catch-up to indexation deficiencies accrued up to 2013.

growth and the participant's labour earnings profile. The results are not robust against departure from the real Ultimate Forward Rate of 2.2 per cent, depicting the real return on investment of the fund. Raising the fund's return on investment by 1.0 per cent decreases the fund's deficit at termination by 49.3 bln euro. It must however be noted that this would constitute a *risk-less* increase of the fund's return on investment, which would result in an accumulated 128 per cent *excess* return on the fund's investments. Given the size of this deviation, combined with the fact that the Ultimate Forward Rate is a widely-accepted parameter resulting from empirically-based macroeconomic models drafted especially for the Dutch pension sector, this study sees no valid reason to revisit the parameter chosen for the fund's return on investment.

If the fund has a binding intertemporal budget constraint (i.e. the fund cannot leave a deficit after its termination), it has a liquidity reserve to fully guarantee the pension entitlements of its participant. More specifically, the fund lacks the capacity to guarantee the *real* value of its pension benefits (i.e. the purchasing power of the pension benefits paid to retirees in the scheme). Pension policy can be altered in several ways to solve the fund's intertemporal budget constraint. That is, the fund has four policy instruments (and all possible combinations of these) to either boosts the incoming cash flow (by raising the contribution rate) or decreasing the outgoing cash flow (by cuts to pension right accrual or pension benefits, or through (partly) stopping to index pension rights and benefits to price inflation).

This study finds that sizable policy changes are required to solve the fund's intertemporal budget constraint. A silver lining, however, is that the fund is not beyond repair. The fund could be terminated without a residual deficit (or surplus) by either raising the contribution rate to 30.7 per cent (from 21.6 per cent projected by ABP pension fund for 2014), decreasing right accrual over a participants average wage to 53.34 per cent (instead of 70 per cent), slashing pension benefits by 15.8 per cent or by indexing to two-thirds of price inflation only, all effectuated through one-off changes from 2014 onwards. Measures using multiple policy instruments lead to a combination of these results, with slightly lower parameter adjustments.

These policy changes have an asymmetric impact on the age cohorts participating in ABP's pension scheme. As contributions are levied on and pension rights are accrued by the active generations (i.e. those who are not yet retired) only, adapting these policy instruments leave the lifetime net pension benefits of the passive generations (i.e. the retirees) untouched. Slashing pension benefits or changing the fund's indexation regime affects all participating generations. A general finding is that for each possible combination of policy measures, all age cohorts born from the 1960's onwards contribute more to the pension fund than they receive back, whereas the reverse holds for all generations born before the sixties (see Figure 22). The largest beneficiaries are the babyboomers, born shortly after the end of World War II. The largest contributors to the fund are individuals born after 1970, with a special emphasis on those born in the second half of the seventies. The intuition here is that the excess returns of the beneficiaries are paid for by the excess contributions of the contributors, as this pension scheme is a zero-sum game. So, *in ABP's pension scheme transfers are made from young (age cohorts 1963-1988) to old (age cohorts 1932-1962).*

This study finds that age cohorts 1947 through 1949 are Generations Lucky, as their lifetime net pension benefits are ranked at the top regardless of the question whether or not the fund's intertemporal budget constraint binds, or (if it binds) what (combination of) policy measure(s) is (are) effectuated. Generations Unlucky are age cohorts 1978 and 1987 as their lifetime net pension benefits are ranked at the bottom end in all possible scenarios.

As stated before, ABP's pension scheme is not beyond repair, but changes to its policy are required immediately. This study recommends an egalitarian policy, in which all participants share the costs of closing the fund's intertemporal budget constraint in such a way that a larger share of the costs is borne by those with the highest lifetime net pension benefits in the baseline scenario. The most egalitarian policy option is found to be a simultaneous cut on pension benefits (by 13.3 per cent, effectuated from 2014 onwards) while slightly raising indexation of pension rights and benefits (see Table 12 and Figure 23). The runner-up most egalitarian policy option would be to slash pension benefits (by 11.6 per cent, effectuated from 2014 onwards) and pension right accrual (by 3.3 per cent) while slightly raising indexation of pension rights and benefits. This study finds the policy measure of cutting pension benefits most potent to solve the fund's intertemporal budget constraint, while letting the ones with the largest per cohort lifetime net pension benefits bear the costs of this. It must be noted that, even after cutting pension benefits by over 10 per cent, virtually all age cohorts born before 1950 retain positive per cohort lifetime net pension benefits and thus remain net beneficiaries of the fund. **This study recommends ABP's policy makers to eradicate taboos on pension policy which constitutes cuts to pension benefit disbursements, as this is the sole manner to solve its intertemporal budget constraint while reaching a higher degree of actuarial fairness in its pension scheme**.

Heemskerk (2014) claimed that "pensions will be less certain, and certainly less", which on the basis of this study seems a warranted claim. This study makes clear that Generation Lucky exists, while also stresses the existence of Generation Unlucky. Unfortunately, all generations will have to accept to be somewhat less lucky in order to prevent that youngest (and therefore last in line to reap benefits of the pension scheme) from finding a depleted fund before they received back a single euro.

The time of wavering is over: reforms in pension policy are needed, and they are needed urgently.

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9 Appendix

9.1 List of symbols

Latin symbols

AW	Average wage system for pension right accrual
B/b	Pension benefits on aggregate/individual level
D	Maximum attainable longevity
F	Franchise
f	Proportion of assets invested in risk-bearing assets
FW	Final wage system for pension right accrual
GA	Generational account
i	Age cohort/birth year of an age cohort (*except for chapter 4*)
NB	Per cohort lifetime net pension benefits
P/p	Pension contributions on aggregate/individual level
Q	Risk-neutrality
R	Maximum attainable length of employment (*i.e. from age 25 until retirement*)
r^{rf}/r_s	Risk-free interest rate
r^s	Stochastic return on risk-bearing asset
s	Pension fund surplus
t	Time/year/birth year of an age cohort (*only in chapter 4*)
$\tilde{x}$	Excess return on risk-bearing assets over the risk-free rate
Y	Number of births
Z	Proportion of non-survivors in an age cohort

Greek symbols

α	Deterministic component of intergenerational transfer $\tilde{\tau}$
β	Volatility of intergeneration transfer $\tilde{\tau}$ w.r.t. the excess return on risk bearing assets over the risk-free rate
γ	Implicit debt of the pension fund when current pension arrangements are unaltered until the fund's termination
$\Delta\ /\delta$	Pension right accrual (total/annual rate)
ε	Financial reserves of the pension fund
ζ	Price indexation of pension rights and benefits
η	Proportion of contributions received in year $t-1$ that is invested in risk-bearing assets during year t
λ	Individual gross labour earnings per annum
μ	Mean of the return on risk-bearing assets
ρ	Uniform pension contribution rate

ρ^{cu}	Catching-up pension contribution rate
ρ^{VUT}	Pension contribution rate for early retirement facilities
σ	Standard deviation of the return on risk-bearing assets
$\tilde{\tau}$	Intergenerational transfer from generation t to generation $t+1$
φ	Discrete choice variable between FW and AW
χ	Total pension right accrued
ψ	Pension base
Ω	Proportion of survivors in an age cohort

Mathematical symbols

$\in$	For the values
$\prod$	Product of sequences
$\sum$	Summation
$\forall$	For all
$\mathrm{E}_t[\ldots]$	Expectations operator conditional on information available at time t

9.2 Summarising table of all possible policy combinations

Summary table of per cohort lifetime net pension benefits (in bln 2014 euro) for multiple instrument policy measures (part I)

Variable	**Contribution + Right accrual**	**Contribution + Benefits**	**Contribution + Indexation**	**Contribution + Right accrual + Benefits**	**Contribution + Right accrual + Indexation**
Fund reserve at termination	nil	nil	0.4 % of baseline value	nil	nil
Parameter values (initial values)					
Contribution rate (21.6 %)	24.96 %	22.72 %	25.58%	22.71 %	24.27 %
Right accrual rate (78.75 %)	62.77 %			75.86 %	68.12 %
Benefit disbursement (100 %)		86.12 %		87.73 %	
Indexation (100 %)			86.76 %		96.44 %
Cohort with *lowest* adjustment	1932-1949	1932	1932	1932	1932
w.r.t. baseline values	Baseline values	−0.2 bln euro	−0.1 bln euro	−0.2 bln euro	−0.1 bln euro
Cohort with *higest* adjustment	1987	1986	1987	1969	1986
w.r.t. baseline values	−3.5 bln euro	−2.2 bln euro	−2.4 bln euro	−2.3 bln euro	−2.7 bln euro
Number of cohorts affected	39 out of 57	All	All	All	All
Generation Lucky	**1949**	**1948**	**1947**	**1949**	**1941**
(*largest*lifetime net pension benefit)	5.3 bln euro	3.5 bln euro	3.6 bln euro	3.7 bln euro	3.6 bln euro
Generation Unlucky	**1987**	**1978**	**1987**	**1978**	**1987**
(*smallest*lifetime net pension benefit)	−3.7 bln euro	−2.2 bln euro	−2.7 bln euro	−2.3 bln euro	−2.9 bln euro

Table 13: Summary of adjustments from multiple instrument policies to close the fund's intertemporal budget constraint, bln 2014 euro.

Summary table of per cohort lifetime net pension benefits (in bln 2014 euro) for multiple instrument policy measures (part II)

Variable	**Contribution + Benefits + Indexation**	**Right accrual + Benefits**	**Right accrual + Indexation**	**Right accrual + Benefits + Indexation**	**Benefits + Indexation**
Fund reserve at termination	nil	nil	16.2 % of baseline value	nil	nil
Parameter values (initial values)					
Contribution rate (21.6 %)	22.59 %				
Right accrual rate (78.75 %)		75.82 %	58.32 %	75.59 %	
Benefit disbursement (100 %)	88.72 %	85.26 %		88.42 %	86.68 %
Indexation (100 %)	99.67 %		99.56 %	100.44 %	100.26 %
Cohort with *lowest* adjustment	1932	1932	1932	1932	1932
w.r.t. baseline values	−0.2 bln euro	−0.2 bln euro	−0.1 bln euro	−0.2 bln euro	−0.2 bln euro
Cohort with *higest* adjustment	1949	1961	1986	1949	1949
w.r.t. baseline values	−2.4 bln euro	−2.3 bln euro	−2.7 bln euro	−2.4 bln euro	−2.6 bln euro
Number of cohorts affected	All	All	All	All	All
Generation Lucky	**1948**	**1948**	**1947**	**1948**	**1948**
(*largest*lifetime net pension benefit)	3.0 bln euro	3.4 bln euro	4.2 bln euro	3.0 bln euro	2.8 bln euro
Generation Unlucky	**1978**	**1978**	**1987**	**1978**	**1978**
(*smallest*lifetime net pension benefit)	−2.0 bln euro	−2.1 bln euro	−2.1 bln euro	−1.9 bln euro	−1.8 bln euro

Summary table of per cohort lifetime net pension benefits (in bln 2014 euro) for multiple instrument policy measures

Variable	**Contribution + Right accrual + Benefits + Indexation**
Fund reserve at termination	nil
Parameter values (initial values)	
Contribution rate (21.6 %)	22.46 %
Right accrual rate (78.75 %)	75.61 %
Benefit disbursement (100 %)	90.43 %
Indexation (100 %)	99.46 %
Cohort with *lowest* adjustment	1932
w.r.t. baseline values	−0.2 bln euro
Cohort with *higest* adjustment	1949
w.r.t. baseline values	−2.2 bln euro
Number of cohorts affected	All
Generation Lucky	**1948**
(*largest*lifetime net pension benefit)	3.2 bln euro
Generation Unlucky	**1978**
(*smallest*lifetime net pension benefit)	−2.1 bln euro

9.3 Most and least preferred policy options per cohort w.r.t. the full indexation baseline results