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Intergenerational Redistribution in a Pay-as-you-go Pension System

Jacob Lundberg

Research Institute of Industrial Economics
P.O. Box 55665
SE-102 15 Stockholm, Sweden
info@ifn.se
www.ifn.se

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Jacob Lundberg*

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Abstract

This study provides a comprehensive analysis of the generational wealth transfer within Sweden's public pay-as-you-go pension system introduced in 1960. Using extensive administrative registers, the paper quantifies the contributions made and benefits received by each birth cohort. The findings reveal a substantial fiscal imbalance favouring the initial generation (born in the early 20th century), who received a net gain of $1.5 trillion in today's present value, equivalent to up to 13% of their discounted lifetime income. This windfall for the initial generation resulted in an implicit tax on current workers, accounting for 70% of their pension contributions. However, the study also highlights the effectiveness of Sweden's 1999 notional defined-contribution pension reform in stabilizing this imbalance. Unlike many international counterparts, Sweden's reformed system successfully mitigates further generational inequities in the pension system.

Keywords: Pensions, social security, pay-as-you-go, generational equity, generational accounting

JEL classification: H55, N34

*Research Institute of Industrial Economics (IFN), PO Box 55665, 102 15 Stockholm, Sweden. Email: jacob.lundberg@ifn.se. Construction of the dataset was done in cooperation with Kristina Karlsson. The author is grateful to Emil Bustos, Kristina Karlsson, Gabriella Massenz, David Sundén, Daniel Waldenström and seminar participants at IFN and the Swedish Pensions Agency for valuable comments. Financial support from the Jan Wallander and Tom Hedelius Foundation is gratefully acknowledged. Declarations of interest: none.

1 Introduction

Public pay-as-you-go (PAYGO) pension systems constitute a large share of income, savings and national wealth in developed countries. An increasing number of countries are coming under demographic pressure, which has brought pension reform to the political agenda.

In a PAYGO pension system, contributions are used to pay the current year's benefits. The first generation to participate typically receives benefits well in excess of its contributions. This is paid for by all subsequent generations, who get a lower return on their contributions to the pension system – wage growth instead of the return on financial markets (Lindbeck & Persson, 2003). This paper asks the question: How big is intergenerational redistribution in the Swedish pension system?

Sweden introduced an earnings-based, defined-benefit PAYGO pension system in 1960. In a reform that has been copied by other countries and attracted scholarly attention (Hagen, 2017; Hinrichs, 2021), the country transitioned to a notional defined-contribution system in 1999. In such a system, contributions are still used to pay current benefits, but are also recorded on individual notional accounts. The benefit is determined by the account balance upon retirement.

The main contribution of this paper is a comprehensive empirical analysis of intergenerational redistribution in the Swedish pension system. Using full population administrative registers, the paper calculates the amount of contributions paid and benefits received for each birth cohort and year since the 1960. This is the first time such an analysis has been made for Sweden, although a few older papers – published before the pension reform – have used stylized models or small samples (Kruse & Ståhlberg, 1977; Ståhlberg, 1990).

The paper adds to a literature quantifying intergenerational transfers through the pension system in countries such as Germany (Schnabel, 1998; Sinn, 2000), Italy (Kashiwase & Rizza, 2014), Japan (Oguchi et al., 2003; Kashiwase & Rizza, 2014) and the United States (Social Security Administration, 2022a, 2022b). A few comparative studies exist (Disney, 2004; Fenge & Werding, 2004; Fouejieu et al., 2021). Their findings for Sweden markedly differ from those of the present paper, in both directions, underscoring the importance of paying close attention to country-specific institutional details and, preferably, using register data for accurate calculations.

Several results come out of the analysis. First, net present values – the difference between discounted benefits and discounted contributions – are positive for cohorts born 1937 and earlier. Expressed in 2021 present value, these cohorts gained a total of \$1.5 trillion (SEK 15 trillion).[1] This amount – about the same size as the Norwegian oil fund or almost three years of current Swedish GDP – shows much much larger the Swedish pension fund would be today if the first generation only had received actuarially fair benefits. This transfer is paid for by younger generations through a tax implicit in the pension contribution.

[1] At the time of writing, 1 EUR ≈ 11.3 SEK and 1 USD ≈ 10.5 SEK.

Second, the biggest beneficiaries in absolute terms were not the post-war baby boomers, as one might think, but those born in the 1910s and early 20s, called the Greatest Generation in an American context. They gained the equivalent of a $70,000 (SEK 700,000) cheque in today's money on their 65th birthdays. Their discounted lifetime income increased up to 13 percent thanks to their participation in the pension system.

Third, the implicit tax is stable, at 8 percent of lifetime income, for birth years circa 1980 and later. If the expected surplus of the pension system is distributed to participants, it will decline somewhat. This is in contrast to most other countries, where the implicit tax is expected to increase over time as pension systems are not robust to aging (Fenge & Werding, 2004; Fouejieu et al., 2021). For example, under current law the Old-Age and Survivors Insurance Trust Fund in the US Social Security system will be depleted by 2034, according to official projections, requiring tax increases or benefit cuts (OASDI Board of Trustees, 2023). The Swedish experience indicates that NDC reform can be a tool for managing demographic pressure and preventing further generational imbalances.

In the main analysis, past payments are discounted with the pension fund return and future payments with a 5 percent real rate. Instead applying a real discount rate of 8 percent implies that the last net winning cohort was born in 1923 rather than 1937, while under a 2 percent real discount rate those born 1961 and earlier are net beneficiaries. However, the general pattern still holds: In relation to lifetime income, those born around 1915 gained the most. Younger contributors fare gradually worse for birth years until around 1980.

The paper is structured as follows. The next section presents the theoretical framework. In section 3, the former and current pension system of Sweden is described. Section 4 lays out the methodology. Section 5 presents the empirical results. Section 6 offers a comparison with related literature and section 7 concludes. Supplementary figures and in-depth information on the dataset are provided in the appendix.

2 Theoretical framework

We begin by defining a number of quantities – all related to the present value of contributions and benefits – which are standard in the pension literature and which will be calculated empirically below. The pension system's intertemporal budget constraint is then presented, highlighting its zero-sum nature. Lastly, the intergenerational redistribution inherent in PAYGO pension systems is discussed.

2.1 Quantities of interest

The *net present value* (NPV) is the difference between the present values of benefits and contributions, discounted to a baseline year (here taken to be the year 0):

$$\mathrm{NPV} = \sum_t \frac{b_t}{(1+r)^t} - \sum_t \frac{c_t}{(1+r)^t}, \tag{1}$$

where c_t is the contribution the individual pays to to the pension system in year t, b_t is the benefit she receives and r is the exogenous rate of return on capital and discount rate. The issue of risk is ignored for now but will be discussed in section 4.1.

With opposite sign, the NPV can be seen as an implicit tax, i.e., how much more the individual has to pay in contributions – as participation in a PAYGO pension system is mandatory – than what she receives in benefits. Absent financial market imperfections, the NPV is sufficient for making statements about individual welfare. That is, a rational agent would voluntarily choose to participate in the pension system if and only if the NPV is positive.[2]

The *money's worth ratio* (MWR) is the discounted benefit flow divided by the discounted contribution flow:

$$\mathrm{MWR} = \frac{\displaystyle\sum_t \frac{b_t}{(1+r)^t}}{\displaystyle\sum_t \frac{c_t}{(1+r)^t}}. \tag{2}$$

As it is a ratio, the year of discounting does not matter.

Lastly, the *internal rate of return* (IRR) is the discount rate that equalizes the present values of the benefit and contribution flows:

$$\sum_t \frac{b_t}{(1+\mathrm{IRR})^t} = \sum_t \frac{c_t}{(1+\mathrm{IRR})^t}. \tag{3}$$

Given that contributions are paid earlier than benefits and $\mathrm{IRR} > -1$, Descartes' rule of signs

[2] See Geanakoplos et al. (1999), p. 116, for a discussion about implications for social welfare.

guarantees a unique IRR.[3] The same assumption ensures that IRR $> r$ if and only if NPV > 0 (Gronchi, 1986).

2.2 The budget constraint of the pension system

Let us now take the pension system's perspective and set up its budget constraint. We denote by C_t and B_t respectively the total contributions and benefits paid in year t. Further, Z_t is other net transfers to and from the pension system, such as administration costs. All payments to and from the pension system are made through the pension fund, denoted F, which receives a return r on its assets; these may be negative, in which case r is the interest rate. Then, the following equation describes the evolution of the pension fund.

$$F_t = (1+r)F_{t-1} + C_t - B_t + Z_t = \sum_{k=1}^{t} (1+r)^{t-k} (C_k - B_k + Z_k) \tag{4}$$

We assume that the pension system launched at year zero with $F_0 = 0$. Equation 4 shows that the size of the pension fund today (year t) is the present value of historical net payments.

We divide both sides by $(1+r)^t$ to express the budget constraint in year zero's present value.

$$\frac{F_t}{(1+r)^t} = \sum_{k=1}^{t} \frac{C_k - B_k + Z_k}{(1+r)^k} \tag{5}$$

Now let $t \to \infty$. The transversality condition requires that $F_t/(1+r)^t \to 0$ as $t \to \infty$. In other words, we rule out explosive paths for the pension fund. It would not be optimal to let the pension fund grow without bound and never make use of the money. Explosive negative paths for the pension fund are also disallowed (the no-Ponzi condition) – the pension system cannot accumulate debt and roll it over without ever repaying.

We can now express the pension system's intertemporal budget constraint over an infinite horizon.

$$\sum_{k=1}^{\infty} \frac{C_k - B_k + Z_k}{(1+r)^k} = 0 \tag{6}$$

Equation 6 shows that the system's payments must equal its receipts in present value, echoing the standard result for the government's budget constraint (e.g., Leeper & Nason, 2005).

[3] In the empirical application, a second IRR might exist due to children receiving survivors' benefits from the pension system before they start paying contributions. This IRR is ignored in the presentation.

2.3 PAYGO pension systems and intergenerational redistribution

Pension systems are commonly classified as either fully funded or unfunded (also known as pay-as-you-go, PAYGO). In a funded pension system, contributions paid by participating workers are invested in stocks, bonds and other assets. The return on these assets, denoted r, accrues to the participants in the form of higher future pension benefits.

In a pure PAYGO system, no funds are accumulated: $F_t = 0$ for all t, implying that $B_t = C_t$ (assuming $Z_t = 0$) – benefits are paid with the same year's contributions. The first generation receives benefits without having contributed to the system. Assuming a constant contribution rate and no population growth or other demographic changes, aggregate benefits and contributions grow in line with average income growth, g, so that $B_{t+x} = (1+g)^x B_t = (1+g)^x C_t$. I.e., as the contribution base grows at the annual rate g between when the contributions are paid and the benefits are received, this is the internal rate of return in the system's mature phase.

Given dynamic efficiency ($r > g$), the pension system is a zero-sum game from a present value perspective.[4] Equation 6 shows that the NPVs of all individuals (along with any other payments), discounted to the same point in time, must sum to zero. If some individuals or cohorts get more than their money's worth (NPV > 0 or equivalently IRR $> r$), others will get less than their money's worth.

In a purely unfunded system, the "original sin" of the windfall gain for the first generation is paid by all subsequent generations through a lower return on contributions (IRR $= g < r$). In a partially funded system, the rate of return is in between the rates of return in unfunded or fully funded systems ($g <$ IRR $< r$).

[4] The generational accounting literature emphasizes that the same is true for the government as a whole (Auerbach et al., 1994).

3 The Swedish pension system

The analysis is restricted to the public earnings-based pension system because it is perceived to be a substitute for private pension arrangements – not a tax-financed government handout – by participants and policymakers alike. This is underscored by the link between individual contributions and benefits, and by the fact that the system has always been separate from the general government budget, with all payments going through the pension fund. Flat and means-tested pension benefits (*folkpension* in the old system and guarantuee pension in the new system), as well as occupational and private pension plans, are thus out of scope. The restriction to earnings-based pensions separates this paper from the generational accounting literature, which calculates intergenerational redistribution taking all government policies into account (Auerbach et al., 1994; Hagist et al., 2006).

The political background for Sweden's earnings-based pension system is a political debate that took place in the 1950s. The Social Democrats and blue-collar unions favoured a mandatory and unfunded pension system, while centre-right parties and employers' associations advocated a fully funded and voluntary or collectively bargained system. Following a tight referendum and Riksdag vote, the Social Democratic proposal emerged victorious and the general supplemental pension (*allmän tilläggspension*, ATP) was introduced in 1960.

After a few decades, policymakers realized that the system would become unsustainable under demographic pressure and that it produced perverse outcomes. A new, defined-contribution, pension system was introduced in 1999, this time amid consensus among the major political parties.[5]

The old pension system still applies to Swedes born in 1937 or earlier. Pensioners born in 1938 receive 80 percent of their pension from the old system and 20 percent from the new system. This proportion increases by 5 percentage points each year. Consequently, the first cohort entirely under the new pension system comprises those born in 1954.

3.1 The defined-benefit pension system (1960–1998)

Somewhat simplified, the old-age benefit under ATP was 60 percent of average income during the best 15 years of working life, in real terms. Only income between 1 and 7.5 price base amounts (which followed inflation) counted towards the pension.

The system was funded through contributions levied on employers as a component of the payroll tax.[6] Initially, the contribution (*ATP-avgift*) was levied only on the part of income that gave rise to pension rights. After 1982 the contribution was levied at a flat rate.[7]

[5]See Hagen (2017) for a historical overview of the Swedish pension system.

[6]The flat-rate *folkpension* was financed through a separate contribution, not considered here.

[7]The motivation was a simplification of the payroll tax (Swedish Government, 1981). Figure 28 on page 40 depicts the contribution rate over time.

Initially set at 67, the retirement age was reduced to 65 in 1976. The retirement age was in theory flexible, with individuals retiring earlier receiving a lower replacement rate and vice versa.[8] In practice, however, most claimed old-age pension at the official retirement age.

Those who could not work until 67 or 65 for health reasons (or labour market reasons, in some cases) could claim early retirement benefit (*förtidspension*), which was calculated in the same way as the old-age pension, but with pension points awarded as if the individual had continued to work until the normal retirement age.

The ATP system also encompassed survivors' benefits. Widows were entitled to 40 percent of the husband's benefit, and minor children could also receive benefits.

3.2 The notional defined-contribution pension system (1999–)

In contrast to the defined-benefit ATP, the new system is defined-contribution, meaning participants are not guaranteed a specific benefit level. Instead the benefit depends on how much the individual has contributed to the system, as well as the return on those contributions. The system consists of two parts: the unfunded income pension and the fully funded premium pension. Contributions amount to 17.21 percent of income, with 14.88 percent allocated to the income pension and 2.33 percent to the premium pension. More details on contributions are provided in appendix section B.2.

The cap on pensionable income remained at the same level as the old system, but the indexing method shifted from price-indexing to income-indexing. The current income ceiling is around €52,000.[9]

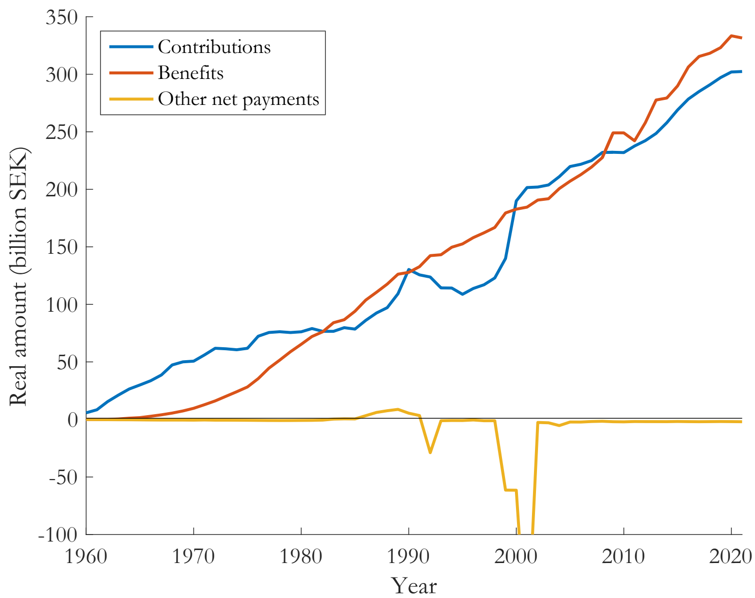
The premium pension was an innovation in that contributions are invested in mutual funds, which participants can choose actively if they wish. Contributions to the premium pension are not counted as taxes or as part of public sector finances for statistical purposes, per European Union rules. This system can be compared to compulsory saving. As it does not have an implicit tax component, the premium pension is not relevant for the purposes of the present paper and will be disregarded henceforth.

The income pension is a notional defined-contribution system. An individual's contributions are notionally deposited in her account, but are in reality used to pay for current pensions. The interest rate in the notional account is average income growth.

3.3 The evolution of the pension fund

The net payments and return of the pension fund are central to the analysis of the pension system. Figure 1 shows payments to and from Sweden's PAYGO pension system since ATP began operation in 1960. During the initial two decades, contributions exceeded benefits as the system was in its developmental phase, and individuals had not yet accumulated sufficient pension points to qualify for a full pension. The pension fund steadily expanded in size (see figure 2). This aligns with the reform's intentions, as the savings in the pension fund were designed to mitigate the anticipated decline in private pension saving. However, the system was never intended to be fully funded.

The surplus of the 1960s and 70s was invested in safe but low-yielding public sector bonds. This era was marked by financial repression and credit rationing, resulting in below-equilibrium yields and benefiting investment in public housing and other favoured projects.[10] Furthermore, inflation was unexpectedly high during the 1970s. In fact, the real rate of return was almost exactly zero during the 1960s and 70s (refer to figures 16 and 17 on page 32). In subsequent periods, the real return was higher – 6.2 percent during the 1980s and 90s and 5.2 percent during the 2000s –



Note: Shows payments to and from ATP and the income pension, i.e., the AP funds, in constant 2021 kronor. Other net payments are administration costs, revenues from the wage-earner funds (*löntagarfonder*) and compensation to the government for the transfer of early retirement benefits from the pension system around the turn of the millenium. A negative sign means net outflows from the pension system.
Source: Swedish Pensions Agency

Figure 1: Real payments of the Swedish pension system

[8]See Palme & Svensson (2010) for the historical early retirement penalty and late retirement bonus.

[9]A taxable income of 8.07 income base amounts, or SEK 600,000 in 2023, corresponding to a maximum pensionable income of 7.5 income base amounts.

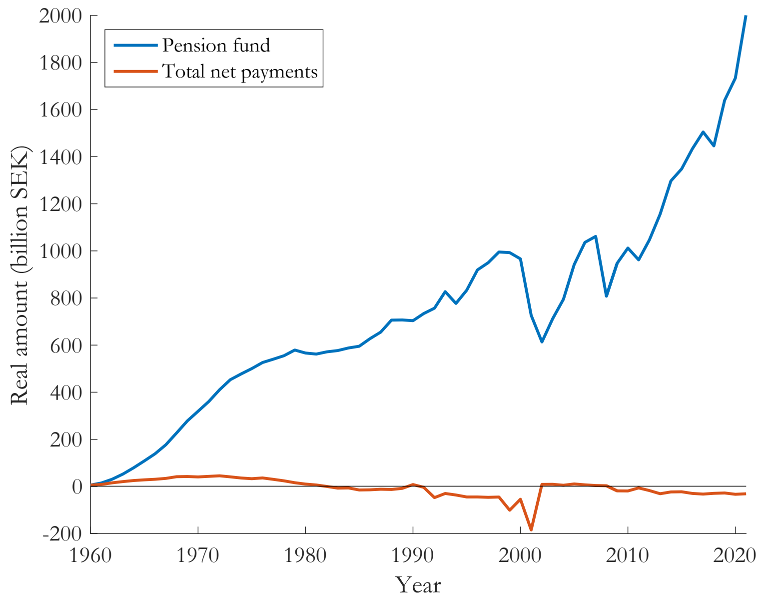
[10]Swedish Ministry of Finance (1978), p. 61 and 70; Ingves (1980); Wallander (1982).

albeit more variable due to a larger proportion being invested in equity, including international markets.

Despite higher contribution rates (see figure 28 on page 40), the system went into deficit in the 1980s as economic growth slowed. The economic crisis in the 1990s made a large dent in contributions. The system was overhauled as a result of the 1999 reform. Until the reform, the pension fund had consisted of a single fund called the AP fund (*Allmänna pensionsfonden*). As part of the reform, it was split into five different funds.[11] Here, they are collectively referred to as the pension fund.

Another aspect of the reform was the transfer of responsibility for early retirement benefits from the pension system to the state exchequer. In compensation, a series of large payments totalling SEK 320 billion in 2021 prices were made from the AP funds. At the same time, the universal pension benefit (*folkpension*) was transferred from the state exchequer to the pension system for those who qualified for earnings-related pensions (see appendix section C).

As the economy recovered in the 2000s, contributions once again exceeded benefits, but this reversed in the 2010s as the post-war baby boomer generation reached retirement age.



Note: Amounts in constant 2021 kronor. Shows the market value of the AP fund in the ATP system (20th century) and AP funds 1–4 and 6 in the income pension (21st century). Total net payments are contributions minus benefits and other transfers (see figure 1).
Source: Swedish Pensions Agency

Figure 2: The evolution of the Swedish pension fund

[11] AP funds 1–4 each receive a fourth of all contributions and pay a fourth of all benefits. There is no fifth AP fund. The sixth AP fund is closed, i.e., does not make any payments, but is part of the buffer fund of the income pension. The seventh AP fund is part of the the premium pension, as the default option, and hence not relevant for present purposes.

4 Data and methodology

The calculations are made using full population tax and social insurance records from Statistics Sweden and the Swedish Pensions Agency. The contributions and benefits are clearly delineated, given the self-contained nature of the systems with all transactions managed through the pension fund. The annual totals are adjusted in order to match aggregate totals actually paid to and from the AP funds.

The foundation of the analysis is a matrix of net payments (benefits minus contributions) by year and birth cohort, where the columns are years of birth and the rows are the years in which the payment was made.[12] The first cohort to participate in ATP was born in 1896 and contributions were first paid in 1960. A condensed version of the matrix, where the payments are summed by decade, is shown in table 1. Due to incomplete register coverage, benefits and contributions for pre-1910 cohorts in the 1960s and 70s must be extrapolated, introducing some uncertainty. The details of the construction of the dataset are given in appendix B.

Some payments of the pension fund are not assigned to any cohort for generational accounting purposes and are instead shown as a residual in the tables. These payments are primarily concerned with transfers of responsibility between the pension system and the general government budget around the turn of the millennium (see appendix section C). In order to maintain a correspondence between contributions paid and benefits received for each cohort, a part of benefits are not counted when calculating internal rates of return, money's worth ratios and other cohort-specific numbers. Administration costs and revenues from the wage earner funds (*löntagarfonder*) are also not assigned to any specific cohort.

Table 1: Real net payments to and from the pension system by year and cohort

	Year of birth											
(SEK billion)	1896–1909	1910s	1920s	1930s	1940s	1950s	1960s	1970s	1980s	1990–2021	Unassigned	Total
1960s	-12	-61	-73	-63	-43	-1	0				3	-250
1970s	139	34	-124	-139	-178	-80	-2	0			7	-343
1980s	125	475	135	-123	-231	-194	-104	0	0		-25	58
1990s	49	373	661	115	-251	-275	-275	-104	3	1	95	392
2000s	5	134	502	721	-117	-474	-548	-441	-150	-1	581	212
2010–2021	0	14	206	710	1326	-95	-812	-795	-652	-325	728	305
2022–	0	0	13	266	1540	2741	3543	3273	3154	10696	1239	*
IRR	28.7%	13.0%	7.7%	5.1%	3.4%	2.4%	1.9%	1.7%	1.6%	1.6%		

Note: Shows total benefits received minus contributions paid for each cohort, in billions of kronor expressed in 2021 prices. The columns are birth cohorts and the rows are years in which the payment was made.

* Not shown as cohorts born after 2021 are not included in the table.

[12] A very similar matrix, albeit transposed, is used by Geanakoplos et al. (1999) in an American context.

The analysis includes expected future contributions and benefits for now living cohorts. Future real income growth is assumed to be 1.5 percent, which was the annual increase over the period 2000–2022. The lifecycle profile of incomes and contributions is assumed to remain as it was in 2021. Benefits are calculated by cumulating notional account balances for each cohort. At age 65, they are divided by the annuity divisors provided by the Swedish Pensions Agency to obtain the benefit level. The population forecast is taken from Statistics Sweden.

The results show the redistribution of before-tax incomes. If one assumes that each cohort receives public transfers and services roughly equal to the taxes it pays, this will show actual redistribution of resources.

One can think of the counterfactual as being the centre-right proposal in the 1957 referendum (see section 3), i.e., a fully funded pension system. It is unlikely that such a system would have implied much redistribution between generations.

4.1 Discount rate

When calculating present values of past payments, the pension fund's rate of return is used as the discount rate, as it is the rate at which resources actually can be transferred across time by society. Results for the past should thus be interpreted as counterfactual values, showing the intergenerational redistribution that has taken place given the rates of return that Sweden actually experienced.

Future payments are discounted at a 5 percent real rate, which approximately corresponds to the average pension fund return during the 2000s.[13] The results should be interpreted as expected values, or as simple extrapolations into the future. This facilitates comparisons between past and future generations. If future payments were discounted at a lower rate, for example, the money's worth ratio would mechanically increase in the future.

An implicit assumption behind using the pension fund return to discount payments is that the rate of return would be the same even if the fund were several times larger, enough to fully cover the pension liability.[14] In a closed economy, the rate of return declines if the supply of capital increases (e.g., Auerbach & Kotlikoff, 1987, ch. 10). As Sweden is a small open economy, the assumption of constant rate of return seems reasonable.[15]

The use of the pension fund return as discount rate implies that those who lived through times of low real returns, perhaps due to high inflation and credit market regulation, are shown as bigger

[13] Between 2000 and 2021 (which is the latest year for which data is available), the real return of the pension system's AP funds was 5.2 percent, according to own calculations using Swedish Pensions Agency data. The fully funded component of the public pension system, the premium pension, achieved a similar rate of return.

[14] Sweden's national net wealth was SEK 33.4 trillion at the end of 2021, according to Statistics Sweden. A fully funded pension system would have implied that national wealth in 2021 was SEK 3.8 trillion, or 11 percent, higher.

[15] Currently, 64 percent of the pension funds' assets are foreign (Swedish Pensions Agency, 2023, p. 49).

beneficiaries as this raises the present value of benefits relative to contributions. Again, this is the true counterfactual if one assumes that a fully funded or private pension system would have achieved the same return as the public pension fund. Furthermore, those same generations may have benefited from the policies that produced low real returns through, e.g., greater government spending or subsidized housing.

Risk also matters for the choice of discount rate. In the Swedish NDC system, the individual receives a return on her pension claims equal to average income growth. The discount rate should therefore theoretically be the risk-free interest rate plus a premium for income growth risk.

One might intuitively argue that average income is less risky than the stock market, so that future benefits should be discounted at a lower rate than the return of the pension fund (where the majority is invested in stocks). However, the consumption capital asset pricing model (consumption CAPM) developed by Lucas (1978) and Breeden (1979) highlights that it is an asset's association with consumption that ultimately should matter for investors, as the purpose of saving money is to use them for consumption at some point. An asset that pays off in good times, when incomes and consumption are high, and the marginal utility of consumption therefore is low, is less valuable than an asset that pays off in bad times, when the marginal utility of consumption is high. From this perspective, an asset that follows Swedish labour income growth is obviously not a good investment for Swedish labour income earners.

The stock market, on the other hand, may offer valuable diversification. Lundberg (2022) finds that the correlation between annual Swedish income growth and a kronor-denominated global stock index was 0.06 over the period 1970–2021, i.e., practically no correlation. This implies that a Swedish investor would not demand a risk premium in order to invest in a global index fund. Hence, the discount rate on future NDC pension benefits should be *higher* than the expected stock market return. However, the equity premium puzzle – the observation that the historical risk premium on stocks is much higher than consumption CAPM predicts (Mehra & Prescott, 1985; Mehra, 2007) – makes it difficult to make definitive statements about the correct discount rate.[16]

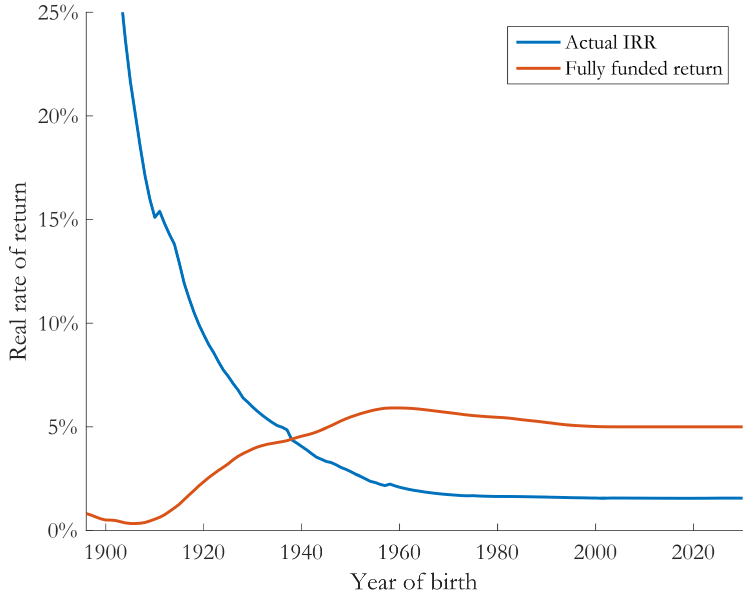
In general, the choice of discount rate is a complicated issue, as highlighted by the discussion on its application to climate change (Gollier & Hammitt, 2014). Consumption CAPM nonetheless lends support to the discounting of pension benefits with a rate higher than the risk-free rate. As we shall see in section 6, the discount rate used in previous studies varies. In the present paper, sensitivity analyses are provided, showing results for both lower and higher discount rates than the historical rate of return.

[16]See also the discussion in Geanakoplos et al. (1999), p. 119.

5 Results

Table 1 and figure 3 illustrate the real internal rate of return (IRR) attained by each cohort, i.e., the discount rate whereby the present value of contributions equals the present value of benefits (see equation 3 on page 4). It is decreasing almost monotonically by year of birth. The initial generations participating in the system, born during the late 19th century, contributed for only a few years before reaching retirement age. They received a substantial annual real return of 30–50 percent on their contributions. For the most recent cohorts, the IRR is around 1.5 percent, reflecting assumed future average income growth.

To determine which cohorts benefit and which lose out, this return should be compared to a counterfactual return for the case where the contributions are invested in a fully funded pension scheme. The most natural point of comparison is the return achieved by the pension fund.[17] Figure 3 shows this for each cohort, i.e., the rate of return that would have been attained if the contributions had been invested in the pension fund while keeping the time profile of contributions and benefits unchanged. The future real rate of return is assumed to be 5 percent. As the figure illustrates, the hypothetical fully funded rate of return exceeds the actual rate of return in



Note: The actual IRR is the return experienced by the cohort in the Swedish PAYGO pension system. The IRR for the 1896 cohort is calculated to be 48 percent. The fully funded return, shown for comparison, is the hypothetical return that the cohort would have experienced if its contributions instead were invested in a fully funded and actuarially fair pension scheme where the rate of return equals the rate of return of the pension fund. The future real rate of return is assumed to be 5 percent and the future real income growth rate 1.5 percent.

Figure 3: Real internal rate of return compared with return in a hypothetical fully funded pension system, by cohort

[17]The Social Security Administration (2022a) uses the Social Security Trust Funds to calculate money's worth ratios in the United States.

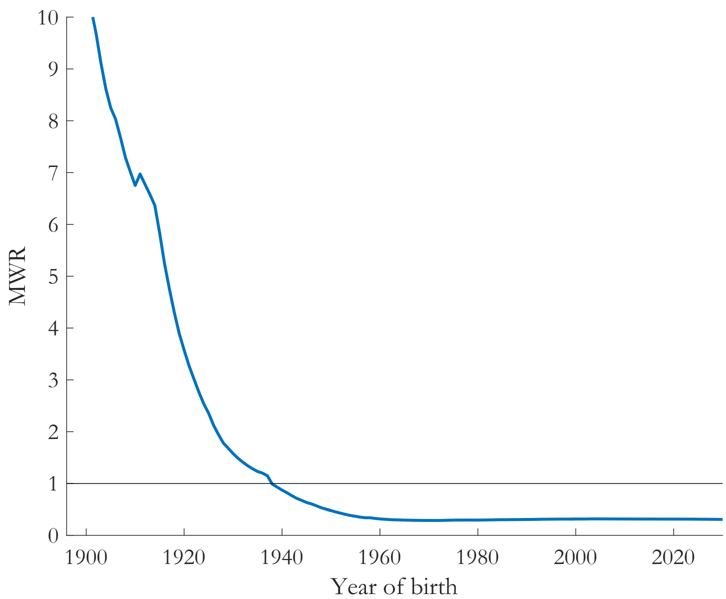
the PAYGO pension system for all cohorts born 1938 or later. This implies that the pension system benefits those born 1937 or earlier at the expense of younger generations. This happens to coincide with the cohorts that are fully covered by the old ATP system. One can also note that that those who were eligible to vote in the 1957 referendum on pension policy were born 1937 or earlier.

Being a net winner is equivalent to having a money's worth ratio (MWR; see equation 2 on page 4) above one. It is illustrated in figure 4. For younger generations, the MWR flattens out around 0.3. This follows from our assumptions about future income growth and rate of return.

The redistribution between cohorts can be quantified by discounting contributions and benefits, using the pension fund's rate of return as the discount rate; see table 2. All payments are discounted to the end of 2021, implying that they show the effect on the current size of the pension fund. This can be verified by seeing that the net present value of all cohorts (as well as the residual) until 2021 sums to the pension fund in 2021 (SEK 2 trillion) with opposite sign – reflecting equation 4 on page 5.

In figure 5, net present value (NPV; see equation 1 on page 4) by cohort is displayed, once again highlighting 1937 as the cutoff year. Collectively, cohorts born 1896–1937 gained SEK 15.2 trillion in 2021 present value. This corresponds to 1.5 percent of the present value of Sweden's GDP from 1960 onwards. As highlighted by equation 6 on page 5, this gain must be matched by an equivalent loss for younger generations.

By this metric, the very first cohorts were not the biggest beneficiaries. The benefits that they



Note: MWR = present value of benefits / present value of contributions. The MWR for the 1896 cohort is calculated to be 18.

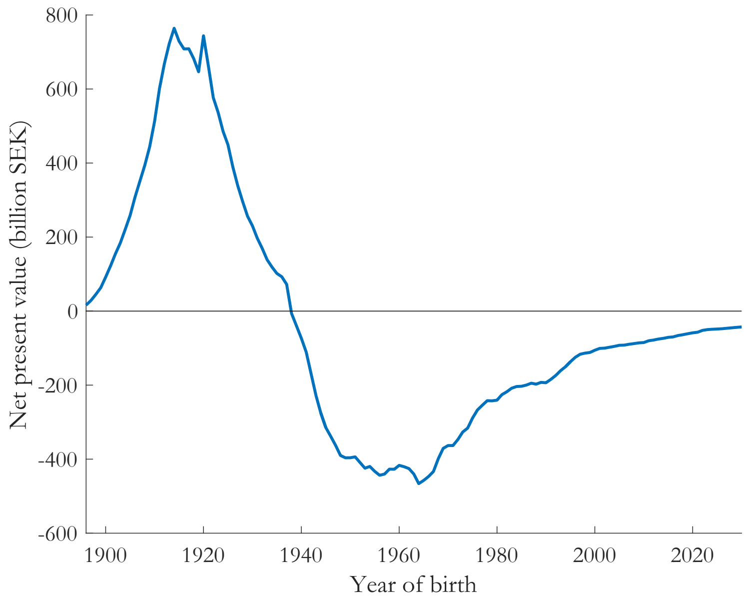
Figure 4: Money's worth ratio by cohort

Table 2: Net payments by cohort and year in present value

	Year of birth											
(SEK billion)	1896–1909	1910s	1920s	1930s	1940s	1950s	1960s	1970s	1980s	1990–2021	Unassigned	Total
1960s	-122	-576	-684	-591	-401	-12	0				32	-2354
1970s	1305	370	-1142	-1294	-1664	-760	-23	0			69	-3139
1980s	1193	4389	1064	-1159	-2130	-1776	-897	7	4		-191	504
1990s	291	2095	3486	364	-1413	-1490	-1453	-484	14	2	387	1799
2000s	17	433	1582	2210	-425	-1463	-1687	-1351	-439	-3	1801	675
2010–2021	0	31	418	1325	2252	-392	-1440	-1388	-1101	-483	1289	511
Subtotal	*2684*	*6742*	*4724*	*855*	*-3781*	*-5893*	*-5500*	*-3216*	*-1522*	*-484*	*3393*	*-2004*
2022–	0	0	12	221	1122	1678	1224	205	-561	-2713	739	*
Total NPV	*2683*	*6743*	*4735*	*1076*	*-2660*	*-4214*	*-4276*	*-3011*	*-2084*	-3196	*4132*	
MWR	8.17	5.45	2.45	1.24	0.66	0.39	0.30	0.29	0.30	0.31		

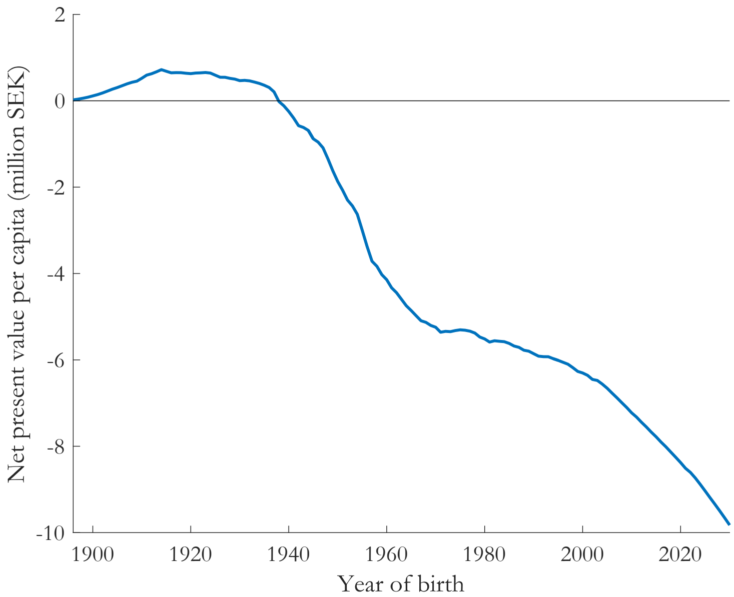
Note: Shows the present value in 2021 of benefits received minus contributions paid for each cohort, in billions of kronor. The present value is calculated by applying the cumulative return of the pension fund from the year of payment to 2021. The columns are birth cohorts and the rows are years in which the payment was made.

* Not shown as cohorts born after 2021 are not included in the table.



Note: Shows net present value of pension system participation, i.e., the discounted value (in 2021) of benefits minus the discounted value of contributions, by year of birth. The present value is calculated by applying the cumulative return of the pension fund from the year of payment to 2021.

Figure 5: Net present value in 2021 by cohort



Note: Shows benefits minus contributions discounted to the 65th birthday for each cohort and expressed per capita (with the denominator being the maximum number of people in that cohort that were alive in Sweden at any time).

Figure 6: NPV per capita at retirement

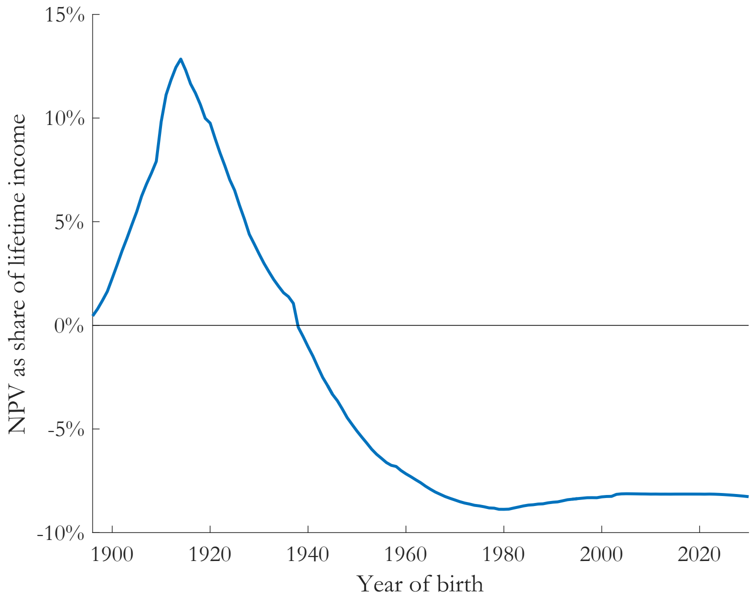
received were large relative to their contributions, but still small in absolute value. Those who gained the most in present value were instead born in the 1910s and early 1920s.

There are several reasons for this. As the first cohorts had to work for 20 years to earn the full pension, and pension points were awarded starting in 1960, the first cohort to receive the full ATP benefit was those retiring in 1980, i.e., born around 1915. Contribution rates were low during the early years of ATP (see figure 28 on page 40). These cohorts also benefited from the lowering of the retirement age from 67 to 65 in 1976. As shown in figure 3, the real rate of return on financial assets was low during the lifetime of this generation, further increasing their NPV as each cohort is effectively subsidized by the difference between the IRR on its contributions and the pension fund's rate of return.

Calculating the present value today of payments that took place many decades ago yields very large numbers that may seem out of proportion – as Geanakoplos et al. (1999) note, discounting when $r > g$ "makes the past loom large". Nonetheless, the fact is that the current pension fund would have been much larger if no redistribution towards older generations had taken place.

At the same time, the present value of future payments goes to zero the further into the future they are. The sinus-like shape of figure 5, tending to zero for future cohorts, is typical for generational accounting analyses of maturing welfare states (Hagist et al., 2012, p. 26).

Showing today's present value for different cohorts (as in figure 5) is useful for illustrating the zero-sum nature of PAYGO pension systems, but not very informative about the impact on



Note: Net present value (discounted benefits minus discounted contributions) in relation to the present value of lifetime income.

Figure 7: NPV by cohort as a share of lifetime income

living standards of pensioners who may be long deceased. Figure 6 instead discounts to the 65th birthday of each cohort. For the generations that gained the most, born in the 1910s and early 1920s, the difference between what they received in benefits and what they paid in contributions is about SEK 700,000 in today's money – that is, equivalent to receiving a SEK 700,000 cheque on their 65th birthday (around 1980). For later cohorts, the pension system becomes an ever greater burden. A PAYGO pension system is equivalent to constantly growing government debt, where workers are taxed to prevent it from exploding as a proportion of GDP. As the debt is always growing, this implicit tax is also always growing in absolute value.

Of course, future generations will be richer. Figure 7 expresses the net present value in relation to discounted lifetime income. The 1914 cohort is the biggest winner. The pension system has increased its lifetime income by 13 percent. On the other hand, cohorts born since the 1970s see their lifetime income decline by 8 percent.

Figure 8 shows contributions and benefits separately. Benefits are increasing sharply by birth year in the early 20th century, reflecting the qualification rules for ATP. Contributions increase much more slowly, as cohorts are exposed to higher contribution rates for a larger portion of their working lives. Cohorts born circa 1980 or later only contribute to the new pension system, where the contribution rate is constant over time. Their contributions amount to 12 percent of lifetime income in present value, and benefits 4 percent.

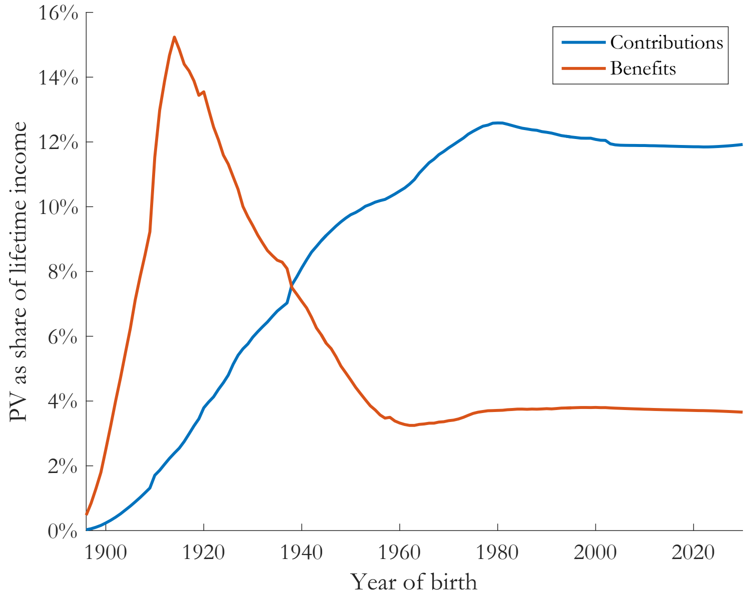


Figure 8: Discounted contributions and benefits as a share of lifetime income

5.1 Sensitivity analysis

Figures 9, 10 and 11 show a sensitivity analysis for different values of the real discount rate. As expected, the NPV variations between cohorts are amplified with higher discount rates, and more cohorts are net losers (note that the critical year for when the sign changes corresponds to the real discount rate in figure 3). For discount rates lower than 1.5 percent, all generations are winners as the economy would suffer from dynamic inefficiency.

The money's worth ratio and NPV in relation to lifetime income decrease as the discount rate increases. For very high discount rates, the MWR approaches zero as benefits become very small in relation to contributions. In that case, practically the entire pension contribution constitutes an implicit tax. For younger generations, this implies that NPV approaches –12 percent of discounted lifetime income, as contributions constitute 12 percent of lifetime income (c.f. figure 8).

In general, the sensitivity analysis shows that the ranking of cohorts is robust to the choice of discount rate. In relation to contributions, older cohorts fare better, almost monotonically, until stabilizing in the 1960s. In relation to lifetime income, the greatest beneficiaries were born around 1915. The NPV then declines by birth year until around 1980.

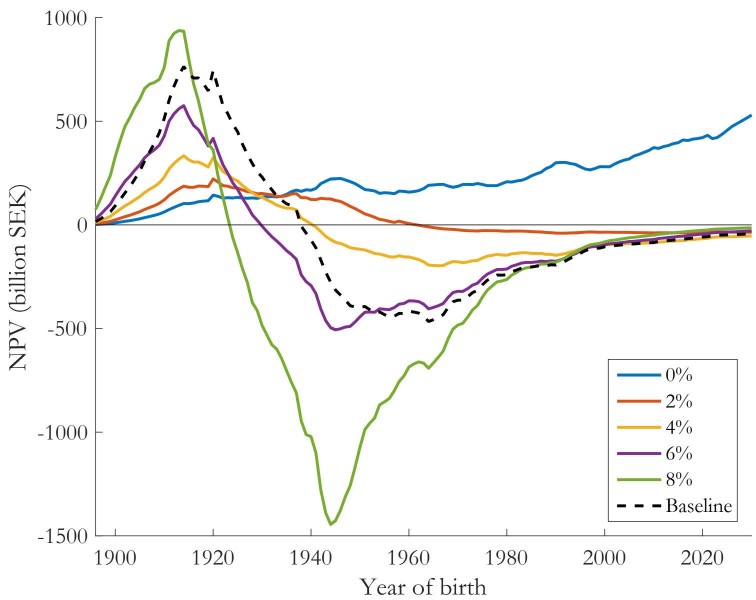


Figure 9: Net present value in 2021 by cohort, for different real discount rates

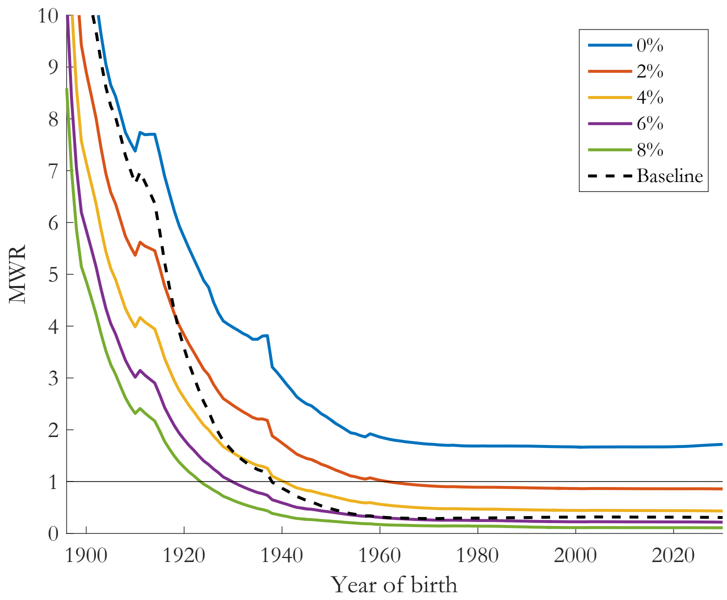


Figure 10: Money's worth ratio by cohort, for different real discount rates

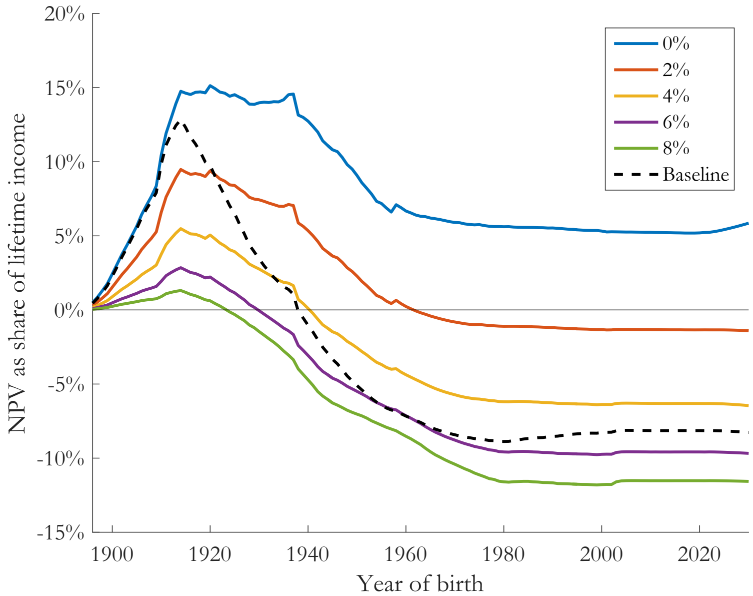


Figure 11: Net present value in relation to lifetime income, for different real discount rates

5.2 The pension system's balance sheet

The balance sheet of the pension system is central to discussions on generational fairness, and related to its intertemporal budget constraint (see section 2.2) and hence its long-run sustainability. The balance sheet can be calculated in two different ways.

Table 3a shows the official balance sheet of the income pension, as reported by the Swedish Pensions Agency. The methodology behind this balance sheet, meant to capture the long-term solvency of an NDC pension system, was developed as a part of the 1990s pension reform (Settergren & Mikula, 2005). The main innovation is the contribution asset, which shows the pension liability that the current year's contributions, with constant demography and incomes, could sustain in the long run. It is calculated as the current year's contributions multiplied by the turnover duration, the expected number of years a krona stays in the system before it is paid out as benefits.

The pension liability is simply the sum of all individual notional account balances, as well as expected future benefits for the already retired. If liabilities exceed assets, benefits and notional account balances are automatically reduced through a balancing mechanism, popularly called "the brake". This has happened once, after the financial crisis of 2008. Currently, the system is in surplus, thanks to labour force growth and strong returns for the system's buffer funds. Policymakers have indicated a willingness to distribute the surplus through a bonus indexation, which would be the opposite of the brake, a "gas pedal".

While the official balance sheet is a useful tool for evaluating the solvency of a PAYGO pension system, it deviates from a traditional balance sheet in its methodology. A private pension plan,

Table 3: Balance sheets of the income pension at the end of 2021

a) Official balance sheet

Assets:		*Liabilities:*	
Contribution asset	9,188	Pension liability	9,991
Pension fund	2,004	Surplus	1,201
Total	*11,192*	*Total*	*11,192*

Billion SEK. *Source:* Swedish Pensions Agency (2022)

b) Traditionally calculated balance sheet

Assets:		*Liabilities:*	
Pension fund	2,004	Pension liability	5,781
		Deficit	–3,776
Total	*2,004*	*Total*	*2,004*

Billion SEK. *Source:* Own calculations (see text) for example, cannot consider future contributions as an asset on its balance sheet. In addition, future benefit payments would be discounted. Notional account balances currently total SEK 10 trillion. If they are discounted assuming that the discount rate exceeds income growth by 3.5 percentage points (e.g., 1.5 percent real income growth and 5 percent discount rate), the pension liability is SEK 5.8 trillion.[18] As the buffer funds total 2 trillion, the system has a deficit of 3.8 trillion (see table 3b). This is of course what should be expected of a PAYGO pension system – future contributions are needed to pay for future benefits. Nonetheless, the system's true funding rate is higher than reported in the official balance sheet.

5.3 Future financial situation

Both balance sheets show that the Swedish pension system is currently not a pure PAYGO system, but partially funded. In the absence of bonus indexation, the system's financial situation should be expected to improve over time. Population growth adds to this improvement. The projection for the future in the present paper is not meant to be a full-fledged forecast, but indicates that the pension fund will exceed the present value of the pension liability in the mid-2060s and notional account balances ten years later, at which point the system will be fully funded.[19]

This makes it likely that bonus indexation will take place at some point. The model developed for this paper indicates that the rate of notional account indexation could exceed average income growth by about one percentage point, i.e., 2.5 percent rather than 1.5 percent, and the system would still be solvent in the long run, given 5 percent real rate of return. Such bonus indexation would raise the money's worth ratio for future generations from 0.3 to about 0.4. The NPV improves from about –8 percent to –7 percent of discounted lifetime income.[20]

[18]See appendix section D for the methodology behind this calculation and results using different discount rates.

[19]Granseth (2023) calculates that this will occur around 2065 in an optimistic scenario with 5.5 percent real return, 2 percent income growth and high population growth.

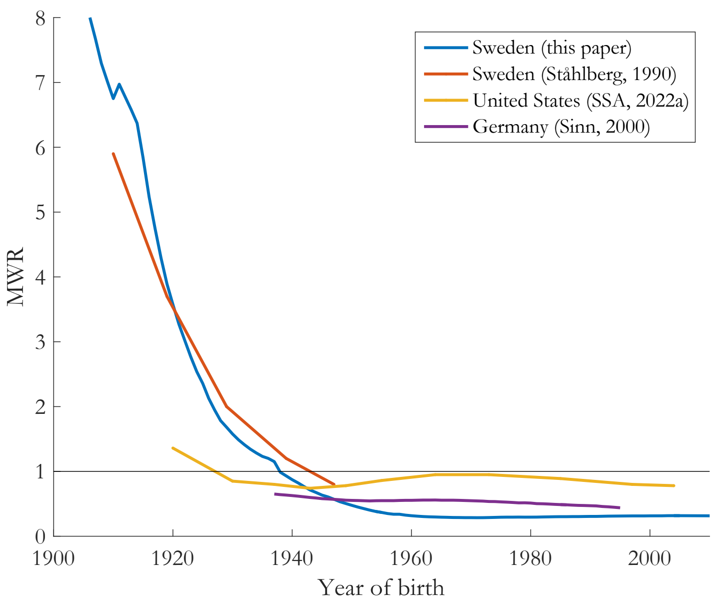
[20]Swedish Ministry of Health and Social Affairs (2022, p. 28) calculates that if the real pension fund rate of return is 3.25 percent and income growth 1.8 percent, bonus indexation of about 0.4 percentage points per year is possible. The model for the present paper reaches the same conclusion.

6 Comparison with related literature

This paper contributes to an international literature on intergenerational redistribution through pension systems. For Sweden, a number of older studies exist, using stylized numerical calculations or small samples. Kruse & Ståhlberg (1977) found that the first generation covered by ATP (those born 1896–1923) gained SEK 150 billion at 1976 prices, about 700 billion in today's money, from their participation in the system. The authors used a 0 percent real discount rate, i.e., compared real net payments (like table 1 on page 11), and assumed 0 percent real wage growth. The present paper finds that the 1896–1923 cohorts gained SEK 1.8 trillion in real terms – significantly more. The reason is probably that Sweden has experienced significant real wage increases, which has raised pension benefits in real terms.

Ståhlberg (1990) calculated the MWR for some cohorts in Sweden, using a 2 percent real discount rate. She found that cohorts born before the mid-1940s were net beneficiaries. As shown in figure 12, her results are relatively close to this paper's main analysis, where the pension fund return is the discount rate. However, when compared with the MWR calculated using a 2 percent discount rate (figure 10 on page 21), her MWRs are significantly lower for the 1930s and 40s cohorts (who had not retired at the time of her study).

Fenge & Werding (2004) simulate the pension systems of a number of developed countries for a representative worker earning average income. For Sweden, they find that the implicit tax



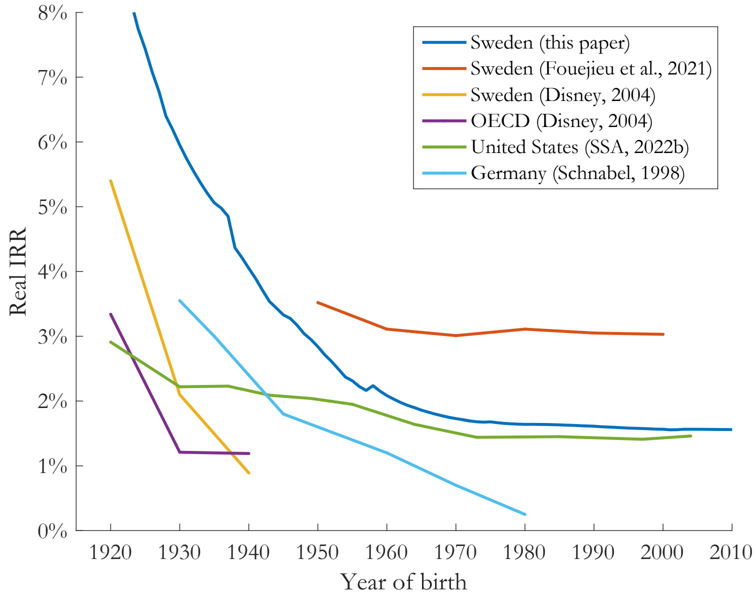
Note: The estimates are not directly comparable due to different choices of discount rate. Ståhlberg (1990) used a 2 percent real discount rate. Estimates from the Social Security Administration (2022a) are for a male medium earner and refer to the scenario where benefits are reduced to keep the system solvent. The Social Security Trust Funds rate of return is used discount rate. Sinn (2000) uses a 4 percent real discount rate.

Figure 12: Money's worth ratio in different studies

is 6 percent of lifetime income for the 1940 cohort, increasing by year of birth until it levels off at 12 percent for cohorts born in the mid-1950s or later, i.e., those covered by the reformed pension system. Thus, despite using a lower real discount rate (4 percent), they find generally higher implicit tax rates than this paper, although the general trend is similar.[21] If the pension reform had not taken place, the authors calculate that the implicit tax would have increased monotonically by birth year, exceeding 20 percent for those born in the 1990s. The reform meant that Sweden went from having among the highest implicit tax rates for the 1950 cohort (among the seven countries studied) to being clearly below average for the 2000 cohort.

Italy is an example of a country with a generous pension system and demographic challenges. Kashiwase & Rizza (2014) calculate that current retirees receive 4 percent of lifetime income on net, while current workers pay 7 percent and future workers almost 15 percent (calculated using a 3 percent real discount rate).

Japan also faces an aging population, but has a less generous pension system. Kashiwase & Rizza (2014) calculate that current retirees see their lifetime incomes increase by 7 percent thanks to the pension system. For current workers, the net effect is near zero and future workers pay an implicit tax of 3 percent of lifetime income (the seven-year government bond yield is used as discount rate). Oguchi et al. (2003) calculate by cohort and find that those born in the 1950s and earlier and net winners while those born later are net payers. The youngest cohorts pay



Note: Estimates from Disney (2004) are for retirement at 65. Estimates from the Social Security Administration (2022b) are for a male medium earner and refer to the scenario where benefits are reduced to keep the system solvent. Schnabel (1998) refers to estimates for married men in the status quo scenario.

Figure 13: Real internal rate of return in different studies

[21]This implies that Fenge & Werding (2004) find that fewer cohorts are net beneficiaries than the present paper, where those born 1937 or earlier are winners. While they do not provide estimates for birth years earlier than 1940, a linear extrapolation suggests that their model would find the cutoff birth year to be circa 1930.

about 10 percent of lifetime income on net (a 3.5 percent real discount rate is used; this may explain the discrepancy with Kashiwase & Rizza, 2014).

Many developing countries have recently started experiencing demographic challenges. Brazil, for example, has a notoriously unsustainable pension system. Oguchi et al. (2003) calculate money's worth ratios of about 3 for currently working men and 5 for women.

The literature calculating internal rates of return generally finds that they are decreasing over time (figure 13). For example, Disney (2004) concludes that this is the case in most OECD countries, based on an analysis of aggregate data. Disney (2004) seems to underestimate the IRR in Sweden, probably because he calculates contributions rates indirectly, rather than using actual rates. In a similar analysis, Fouejieu et al. (2021) compare internal rates of return in Europe. For Sweden, they find higher IRRs than the present paper, probably because they include means-tested and disability benefits that are paid from general funds and therefore excluded from the calculations in this paper.

Redistribution within generations is out of scope for the present paper, but has been analyzed by Ståhlberg (1990). She found that men fared better than women under ATP, and white-collar workers better than blue-collar workers.

The broader question of redistribution between generations through the public sector has been examined in the generational accounting literature (Auerbach et al., 1994). In addition to the pension system, this literature takes into account taxes and benefits, and sometimes in-kind transfers. Calculations specific to Sweden reveal that cohorts born after 1960 are net contributors, while those born earlier are net beneficiaries. The 1999 pension reform reduced the burden on the younger generations (Hagist et al., 2012).

7 Conclusion

As a result of the introduction of an earnings-based, pay-as-you-go pension system in 1960, a very large intergenerational transfer has taken place in Sweden. In today's present value, cohorts born 1896–1937 received SEK 15 trillion more in benefits than they paid in contributions, equivalent to 1.5 percent of the present value of Sweden's GDP from 1960 onwards. This increased their discounted lifetime income by up to 13 percent, while currently working generations see their lifetime incomes decrease by 8 percent, using a 5 percent real discount rate. Similar redistribution has taken place in other developed economies, with younger cohorts receiving a lower return on their contributions. As in Sweden, the net winners were typically born during the first half of the 20th century.

Can one say anything normative about this redistribution? One might argue that transfers to older, poorer generations are warranted on distributional grounds, but the earnings-based pension system may not be a very precise tool for that purpose. In the Swedish case, the big winners were relatively high-earning men born in the 1910s and 20s.

It is not possible to undo this redistribution, but the 1999 pension reform seems to have spread the burden evenly among now active and future generations. As opposed to, e.g., Social Security in the United States, the Swedish pension system is solvent and even in slight surplus, which probably will somewhat reduce the implicit tax imposed on future contributors. This suggests that a reform in the direction of a notional defined-contribution pension system may help in ensuring generational equity.

Despite being central to discussions on generational equity, indicators like the money's worth ratio and the internal rate of return are not commonly reported by government agencies – the US Social Security Administration being the exception. Social insurance agencies in other countries should follow their lead.

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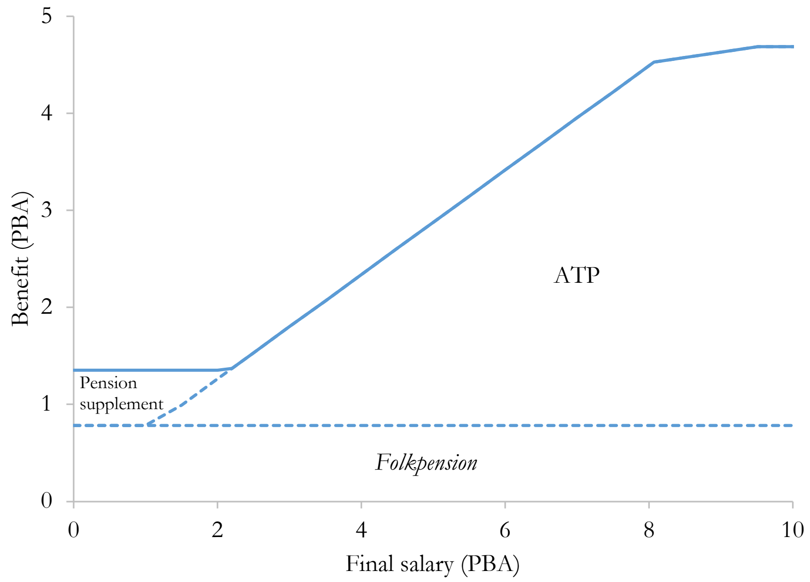
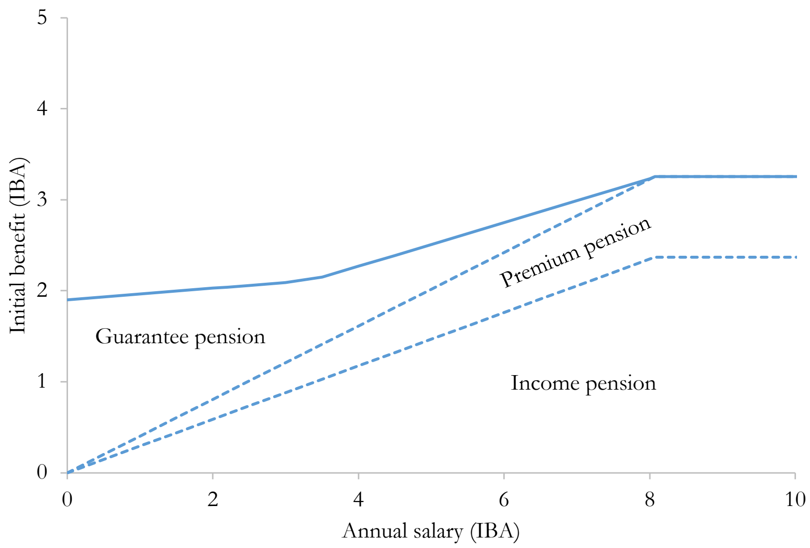
A Supplementary figures



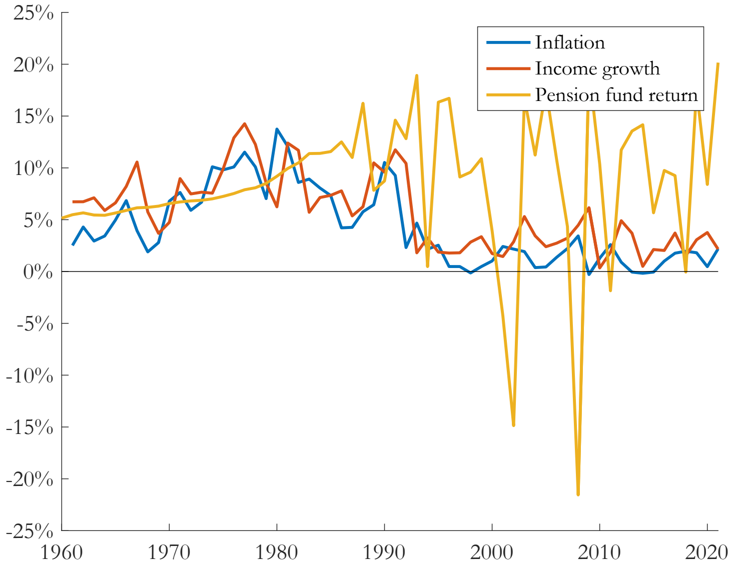
Note: Expressed in price base amounts (PBA). Assumes annual real wage increases of 1.5 percent. The *folkpension* and pension supplement (*pensionstillskott*) are shown as they were calculated in the late 1990s. Note that they were tax-exempt.

Figure 14: Pre-reform benefits as a function of labour income



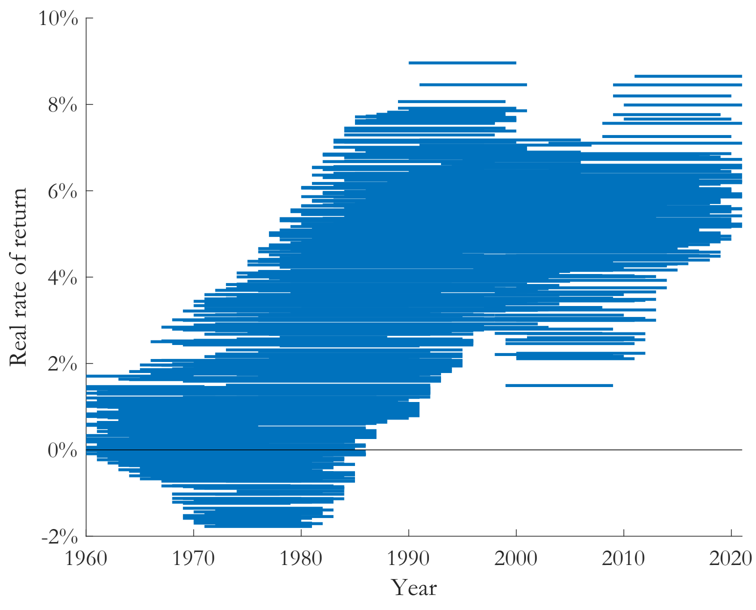
Note: Expressed in income base amounts (IBA). Assumes annual real wage increases of 1.5 percent and 5 percent real return on the premium pension. As the individual is assumed to experience income growth in line with society at large, her annual salary is constant in IBA terms. Premium pension is calculated for a person who contributed to it her whole working life. The guarantee pension is shown as it was calculated in the early 2000s (when the income and price base amounts were approximately equal). Note that for the purposes of guarantee pension means-testing, a return in line with income growth is assumed for the premium pension.

Figure 15: Post-reform benefits as a function of labour income



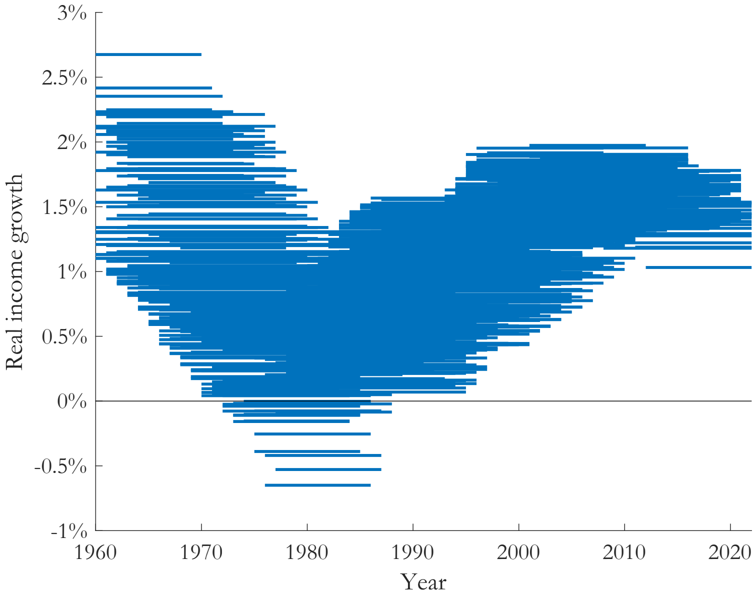
Source: Swedish Pensions Agency, Statistics Sweden

Figure 16: Nominal rate of return, average income growth and inflation in Sweden



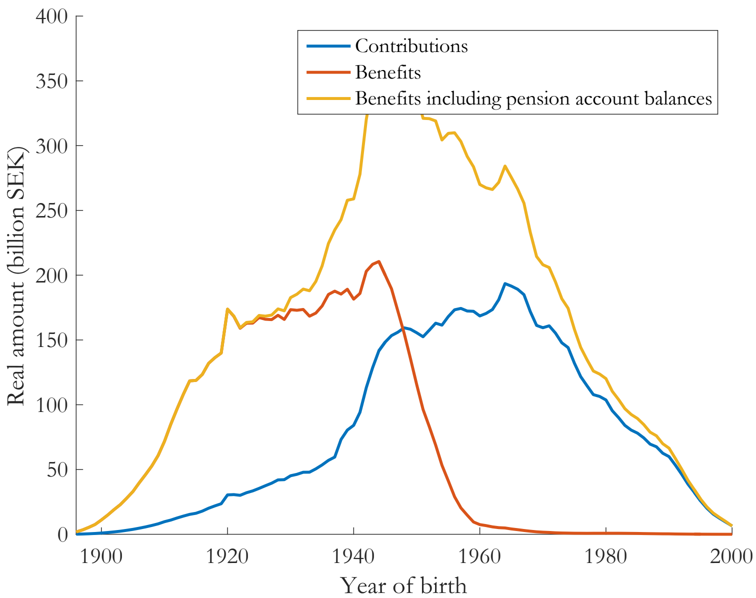
Note: Each line shows the average annual real rate of return over the period indicated by its start and end points. All possible start and end years (1960–2021) at least 10 and at most 30 years apart are shown.
Source: Swedish Pensions Agency, own calculations

Figure 17: Real return of the Swedish pension fund over all possible 10–30-year periods



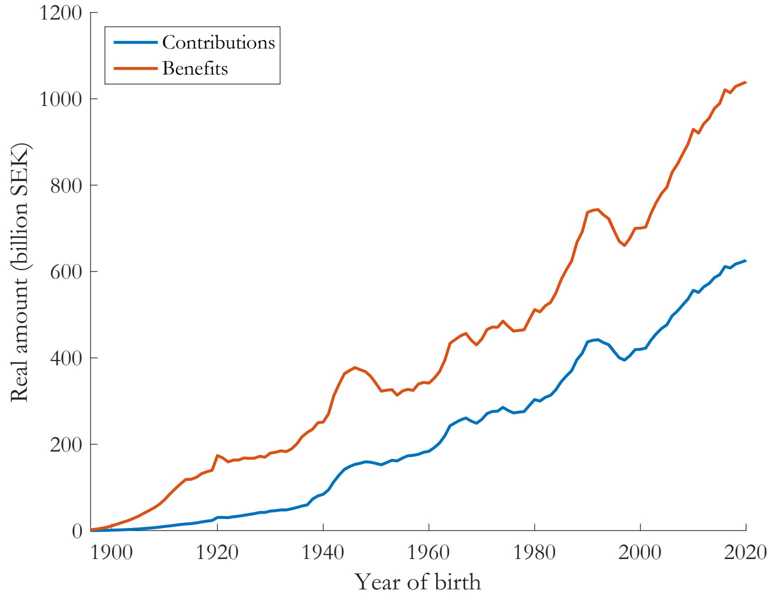
Note: Each line shows the average annual real rate of increase of the income index over the period indicated by its start and end points. All possible start and end years (1960–2022) at least 10 and at most 30 years apart are shown.
Source: Swedish Pensions Agency, own calculations

Figure 18: Real income growth in Sweden over all possible 10–30-year periods



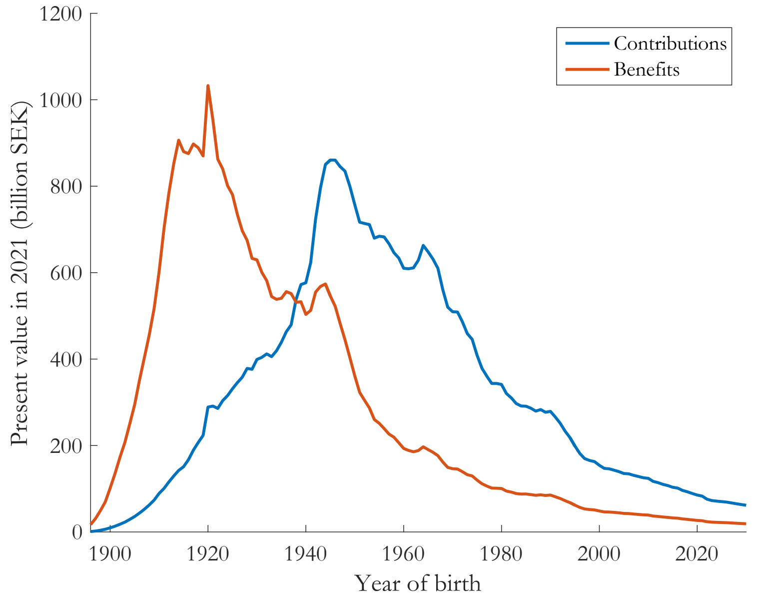
Note: Shows only contributions and benefits paid up to 2021. Pension account balances are at the end of 2021.

Figure 19: Total contributions and benefits until 2021 by cohort in 2021 prices



Note: Includes both past and projected future payments.

Figure 20: Total contributions and benefits by cohort in 2021 prices



Note: Includes both past and projected future payments.

Figure 21: Present value in 2021 of contributions and benefits by cohort

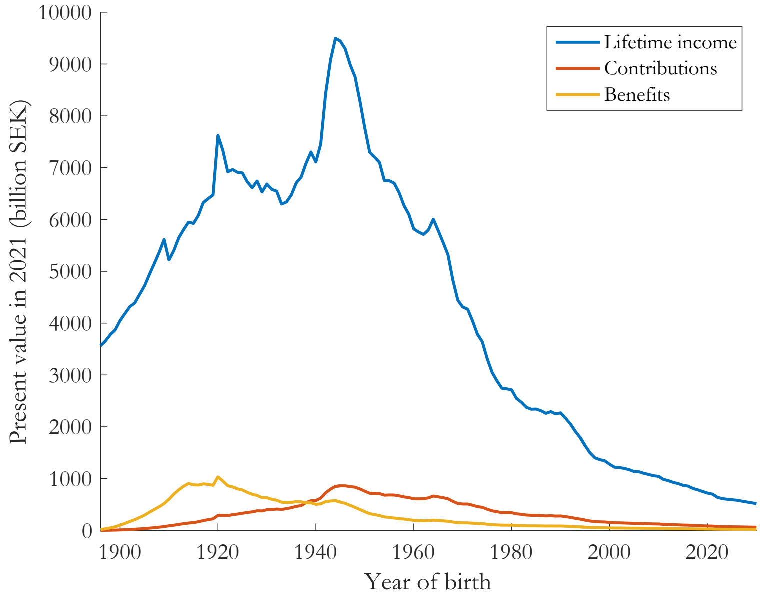
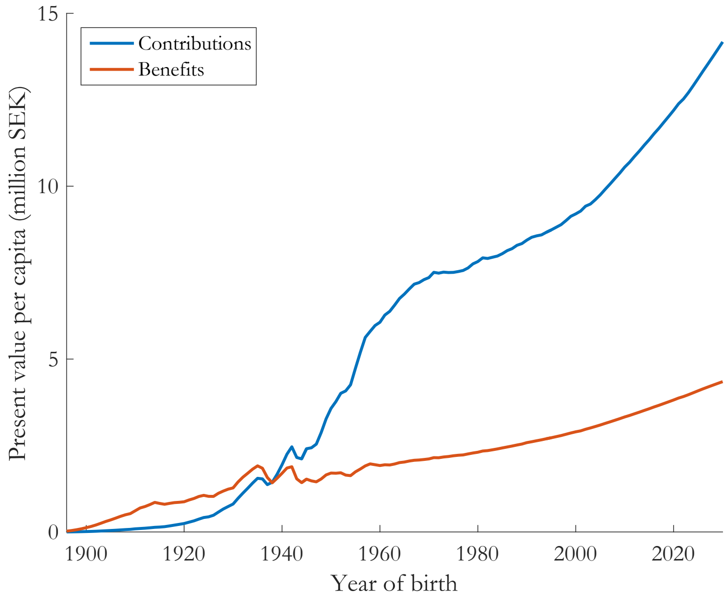


Figure 22: Present value in 2021 of lifetime income, contributions and benefits by cohort



Note: Amounts in 2021 prices.

Figure 23: Per capita present value at 65th birthday of contributions and benefits by cohort

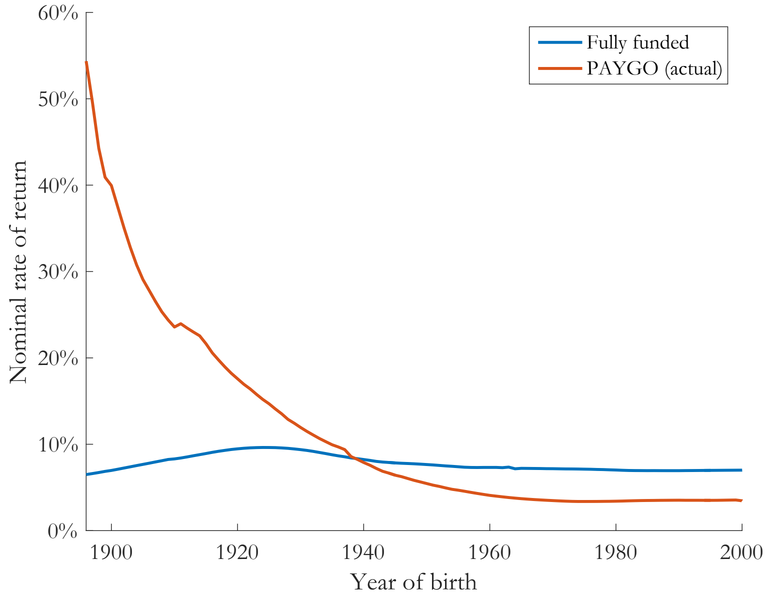
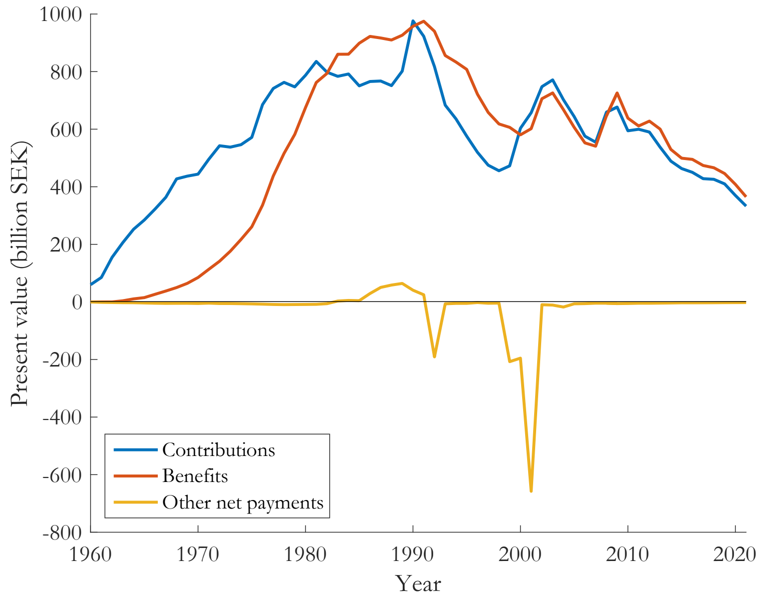


Figure 24: Nominal internal rate of return in the PAYGO pension system and in a hypothetical fully funded system, by cohort



Note: Shows the present value in 2021 of payments made during a particular year, i.e., how that year's payments affect the size of the pension fund in 2021.

Figure 25: Present value of contributions and benefits by year

B Construction of the dataset

Administrative register data is used in the paper to calculate the benefits received and contributions paid by each cohort. Aggregate statistics on benefits and contributions are provided by the Swedish Pensions Agency, but not by cohort.

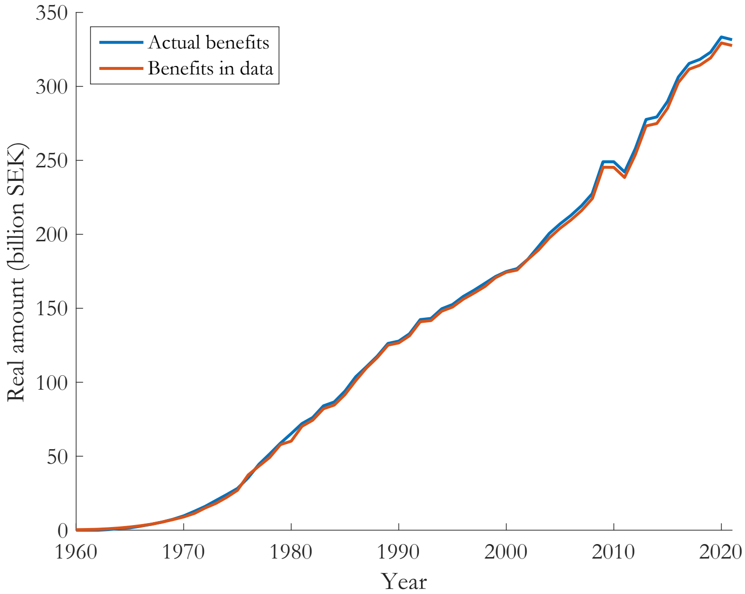
Two registers are used. The first is the Income and Taxation Register, a full population register mainly sourced from tax returns and provided by Statistics Sweden. The second is the Pension Points Register provided by the Swedish Pensions Agency. It spans the whole duration of the ATP system, 1960–1998, but is restricted to individuals born 1910 or later. The data is anonymized but with individual identifiers, allowing registers to be linked.

B.1 Benefits

In general, data availability improves over time. Data on ATP pension benefits (and subsequently income pension benefits) is available in the Income and Taxation Register from 1981, but only for individuals born 1900 or later. Benefits during the 1960s and 70s are estimated using the following approach.

- *Born 1900– and living in 1981:* Extrapolate ATP benefit backwards from 1981 using the price base amount.
- *Born 1910– and deceased in 1981:* Calculate ATP benefit using data on pension points.
- *Born 1896–1899 or born 1900–1909 and deceased in 1981:* Extrapolate pension points for each year using information on average income and the age–income profile in 1974, then calculate benefit using the statutory formula.

Prior to 1981, individuals are assumed to retire at the official retirement age (67 until 1975, then 65). Early retirement benefits are also considered. The Pension Points Register contains a variable indicating whether the individual's points are assumed points (*antagandepoäng*), allocated to early retirees. Individuals with such an indicator are assumed to receive full-time early retirement benefits. It was possible to receive early retirement benefits part-time, but Kruse & Ståhlberg (1977, p. 35) note that 90 percent of men who received early retirement benefits were full-time recipients. Those born before 1910 are not covered by the Pension Points Register, so early retirement benefits are instead calculated at the cohort level by assuming that older cohorts are as likely to receive early retirement benefits at a given age as the 1910 cohort, and that the ratio of real early retirement benefits to old-age retirement benefits is the same. Survivors' benefits are not included before 1981.



Source: Swedish Pensions Agency, own calculations

Figure 26: Comparison of real total benefits by year

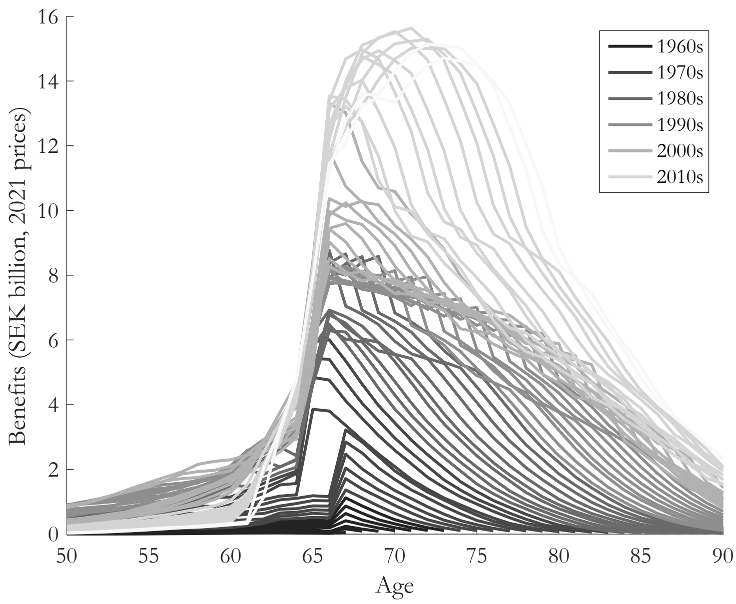


Figure 27: Total benefits by year and age

As shown by figure 26, this method appears to capture benefits quite well in aggregate. In relative terms, benefits are substantially overestimated during the 1960s (by a factor of 3 in 1963 and 1.5 in 1966), but the absolute amounts are small.

For the calculations in the paper, benefits are scaled up so that the totals match aggregate statistics. Deviations between the estimated and actual annual totals are therefore only problematic insofar as they affect cohorts differently. Analysis of the dataset has not revealed any evidence of such bias. For example, the age distribution of each year's benefits does not contain any significant irregular or unexplained patterns (see figure 27).

B.2 Contributions

Contributions are somewhat harder to estimate at the individual level, as they are for the most part formally paid by employers. All taxes are ultimately paid by individuals and for the purposes of generational accounting, all pension contributions have to be assigned to a specific cohort. The present paper follows standard practice in the literature by assuming that the long-run incidence of pension contributions is fully on employees.[22]

Until 1981, contributions were capped, only paid on the part of income that gave rise to benefits (see section 3.1). Contributions can therefore be calculated using the Pension Points Register.

For individuals born earlier than 1910, who are not covered by the Pension Points Register, pension points are extrapolated using average income and the 1974 age–income profile. Contributions for individuals born 1896–1909 are then scaled down by 15 percent to maintain the trend between cohorts seen for those born 1910 or later.

In 1982, the cap on contributions was removed, so contributions were paid on the entire income at a flat rate. Contributions are calculated using data on taxable income (excluding public and private pension benefits, which are not themselves pensionable).

Until 1994, the employer pension contribution was the AP fund's (and thus the pension system's) only source of income, and all revenues from the contribution flowed to the AP fund. In anticipation of the pension reform, this changed in 1995. A portion of the contribution was set aside for the new fully funded individual accounts, the premium pension. Further, the share of revenues corresponding to incomes over the ceiling for pensionable income was redirected to the state exchequer, as it is regarded as a pure tax.

An employee-paid pension contribution (*allmän pensionsavgift*) was also introduced in 1995, payable only on pensionable income. Since 2006, this contribution is matched by an income tax credit, effectively being paid by the state exchequer on behalf of workers. However, this tax

[22] Fullerton & Metcalf (2002), p. 1,821.

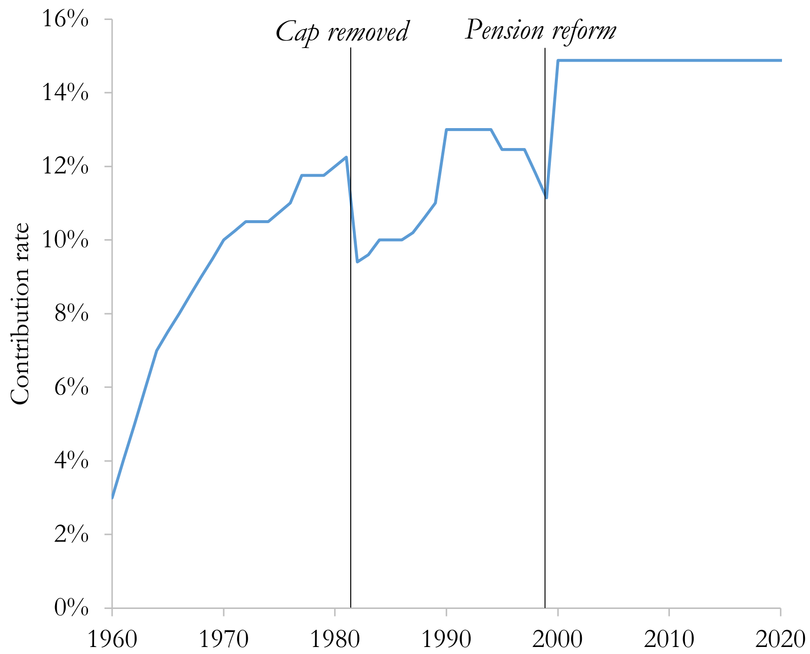


Figure 28: Contribution rate to Sweden's PAYGO pension system

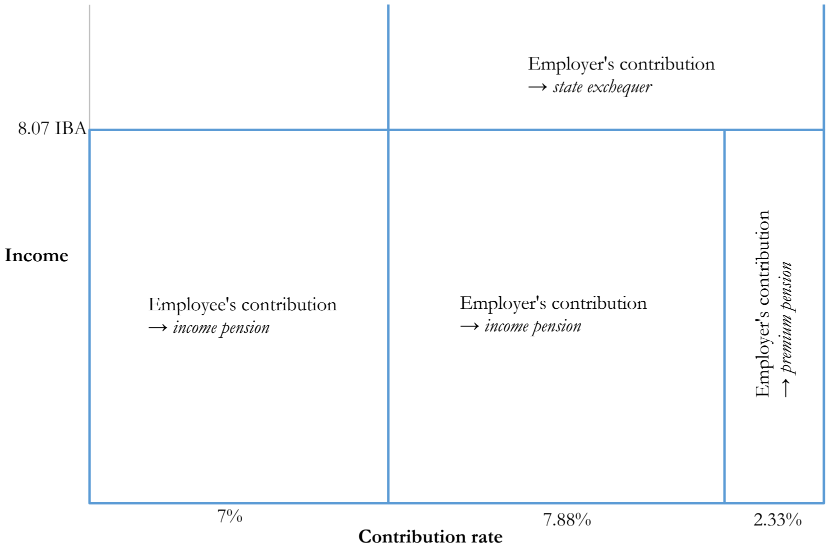
credit needs to be paid for by someone. This paper makes the assumption that it is paid for by essentially the same individuals (or at least the same cohorts) that receive it, e.g., through the non-earmarked part of social security contributions (*allmän löneavgift*).

Since 2000, the contribution to the income pension, which is what is relevant for the paper, has been 14.88 percent of income up to a ceiling of 8.07 income base amounts (IBA). This is financed by the nominal employee's contribution (7 percent) and by part of the employer's contribution (7.88 percent). The part of the employer's contribution allocated to the premium pension and the general budget is not relevant for the paper (see figure 29).

Social insurance benefits, such as sick pay, have been pensionable since 1974. However, it was only after the 1999 pension reform that the government started compensating the pension system for these benefits. The compensation (called *statlig ålderspensionsavgift*) is paid at the same rate as the employer's pension contribution. It is here assigned to the same individuals that receive the benefit in question, in effect assuming that the benefit had been higher if it were not pensionable.

Figure 30 shows how total annual contributions, as calculated above, compare with aggregate statistics. Contributions are underestimated during the 1990s, when the contribution structure changed several times and an economic crisis reduced the tax base. Since the pension reform of 1999, contributions are underestimated by about 5 percent. As with benefits, the annual total is scaled up to match official statistics, so deviations will not matter for the conclusions as long as they affect all cohorts equally.[23] Figure 31 shows the age distribution of each year's contributions.

[23]In addition to wages and social security benefits, pension rights are also awarded for participation in higher



Note: Neither the employer nor the employee contribution are included in pensionable income, implying that pensionable income is 93% of taxable income. Hence the total contribution is 18.5% of pensionable income, of which 16% goes to the income pension and 2.5% to the premium pension.

Figure 29: Structure of pension contributions since 2000

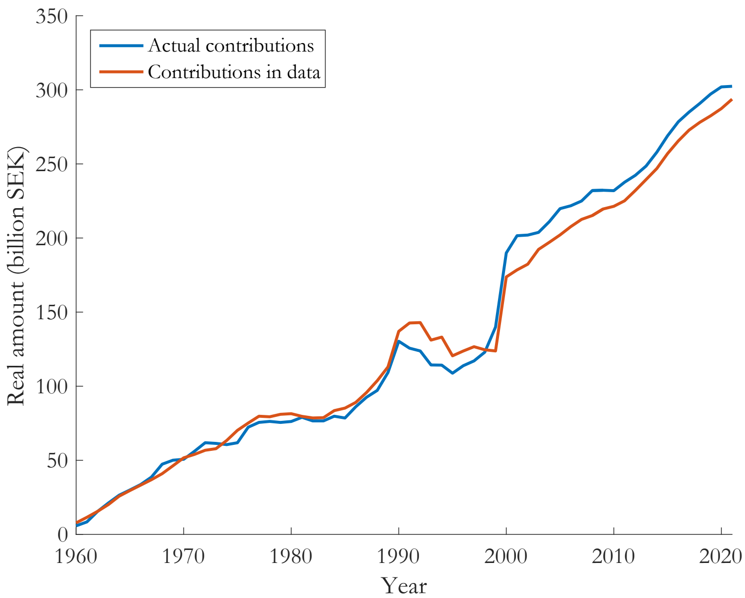


Figure 30: Comparison of real total contributions by year

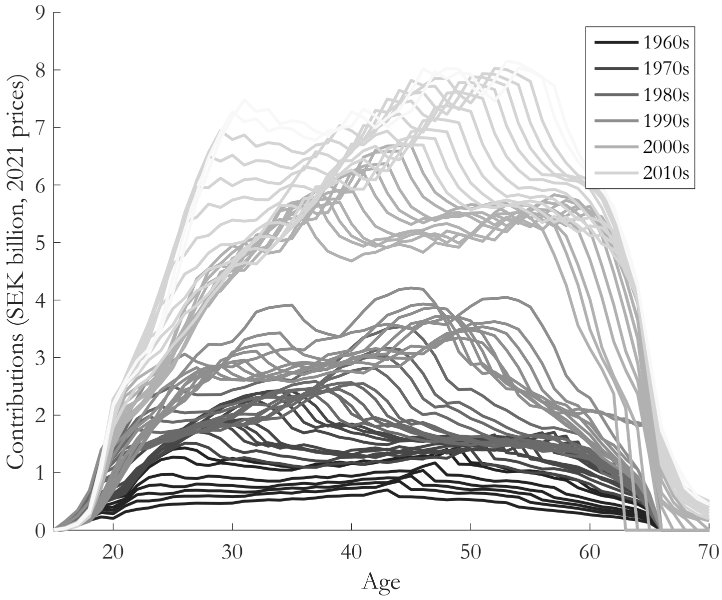


Figure 31: Total contributions by year and age

B.3 Incomes

In order to calculate net present values as a percentage of discounted lifetime income, annual income totals must be calculated for each cohort. The income concept used is taxable income (*kommunal taxerad inkomst/taxerad förvärvsinkomst*). This is available in the administrative dataset starting in 1968 (1974 for those born before 1910). For the years 1960 to 1967 (or 1973), average incomes are extrapolated using the income index and the 1968 (or 1974) age–income profile. For the period before 1960, the nominal GDP per capita series from Edvinsson (2005) is used for extrapolation. The thus calculated per capita incomes are then multiplied with historical population for each cohort and year provided by Statistics Sweden.

Future average incomes are estimated by taking the 2021 age–income profile as given and assuming 1.5 percent annual real income growth. Population forecasts from Statistics Sweden are used to calculate the totals.

To calculate present values, the government long-term bond index from Waldenström (2014) is used until 1960 and the pension fund return thereafter. For future incomes, a 5 percent discount rate is applied.

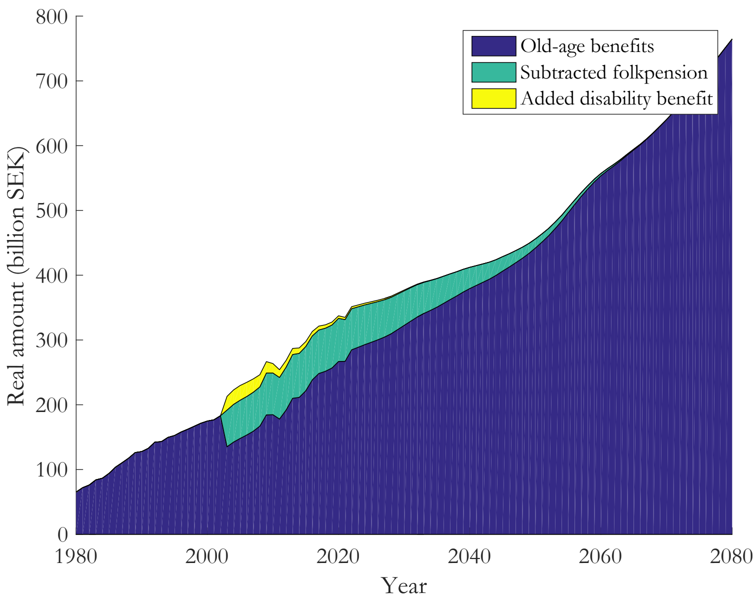
education, military service and having young children. These make up a small part of the total. As they are not included in contributions in the dataset, they are apportioned proportionally to income, in effect assuming that they are paid by proportional taxes.

C Adjusting for the pension reform

The pension reform implied some transfer of responsibility between the pension system and the government exchequer. Specifically, in 2003 the *folkpension* was transferred from the general government to the pension system and early retirement and survivor's benefits were transferred from the pension system to the general government. In order to maintain a correspondence between contributions and benefits, benefit levels must be adjusted for cohorts who contributed under the old system but receive benefits under the new system.

Folkpension. Under the old pension system, everyone received a flat-rate *folkpension* in addition to the income-related ATP. This was paid for by general taxes (chiefly the *folkpension* contribution which was levied as part of the payroll tax, but not included in the pension contributions here). As part of the reform, the technique for the provision of a minimum benefit changed. The universal *folkpension* was replaced by the means-tested and tax-funded guarantee pension (compare figures 14 and 15 on page 31). This implies that the *folkpension* part of the income-related pension (for both the younger cohorts who participate in the new system and the older cohorts who remain in the old system) is paid from the AP funds from 2003 onwards.[24] At the same time, the contribution rate to the earnings-related system was raised substantially in 2000.

Early retirement benefits. Early retirement benefits were part of ATP. In 2003, they were



Note: Old-age benefits shown here are always assigned to cohorts. Disability benefit shown here is the part of disability benefit that was earned before the pension reform and therefore is added to benefits for generational accounting purposes (even though it is paid by general government revenues). *Folkpension* shown here is the part that is deducted from benefits despite being paid from the pension fund.

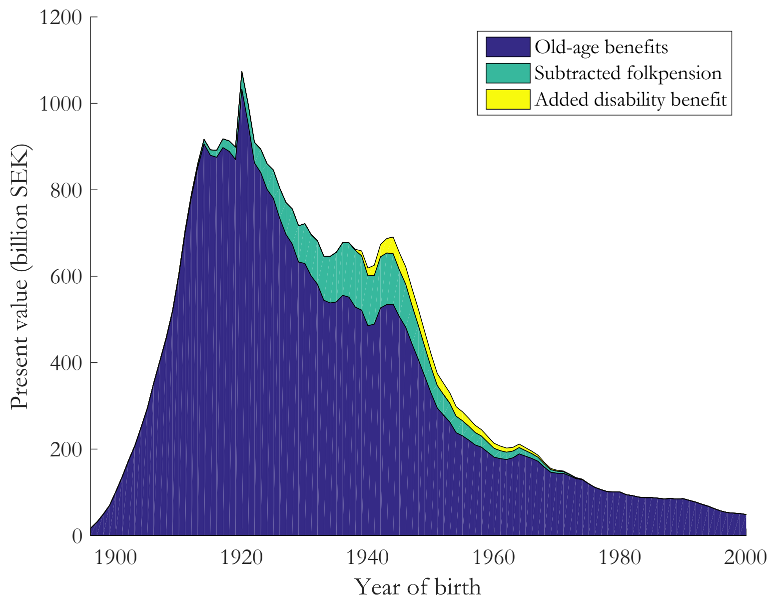
Figure 32: Effect of pension reform adjustment on annual benefit totals

[24]As a transition measure, a certain benefit (*bosättningsbaserad folkpension*) totaling SEK 6 billion was paid from the AP funds during 1999–2002.

renamed disability benefit (*sjukersättning*) and transferred to the state exchequer. Instead of adjusting the contribution rate, the state exchequer was compensated through a number of lump-sum payments from the pension fund around the turn of the millennium.

Not accounting for these transfers would distort the picture of intergenerational redistribution. For example, the 1945 cohort contributed to the pension system from, say, 1970 until retiring around 2010. For three quarters of their working lives, they paid the ATP contribution to the AP fund and paid taxes to finance the *folkpension*. However, when they retired, they received their *folkpension* (except the guarantee pension) from the AP funds. In order to remove the upward bias of the NPV for the 1945 cohort, three quarters of their *folkpension* is subtracted from the benefit totals. At the same time, three quarters of their post-reform disability benefit is added to their benefits, as disability benefit was financed by the pension system during three quarters of the period they contributed to it.

In general, for every cohort, post-2003 *folkpension* is subtracted and disability benefit is added in proportion to the share of the cohort's working life – taken to be ages 25–64 – that took place before 2000 (see figures 32 and 33). So for cohorts born 1975 and later, no adjustment is necessary as they contribute to the new system for practically their entire working lives. These adjustments are shown as residual payments by the pension fund, not assigned to any cohort. Survivor's benefits are now relatively small, so are not adjusted for.



Note: See the notes to figure 32.

Figure 33: Effect of the pension reform adjustment on discounted benefits by cohort

D The pension system's balance sheet

Denoting the total notional balance of everyone born in year ω by $K_{\omega t}$, the present value of future pension entitlements in 2021 can be expressed:

$$\begin{aligned}\mathrm{PV}(K_{\omega,2021}) &= \sum_{t=q}^{q+P} \frac{b_t}{(1+r)^{t-2021}} = \left(\frac{1+g}{1+r}\right)^{q-2021} \frac{K_{\omega,2021}}{\delta} \sum_{t=1}^{P} \left(\frac{1+g}{(1+r)(1+f)}\right)^{t} \\ &= \left(\frac{1+g}{1+r}\right)^{q-2021} \frac{K_{\omega,2021} f}{1-(1+f)^{-P}} \frac{1+g}{(1+f)(1+r)-(1+g)} \left[1 - \left(\frac{1+g}{(1+f)(1+r)}\right)^{P}\right], \end{aligned} \quad (7)$$

where r is the discount rate, g is income growth, f is the advance rate (*förskottsränta*) which governs the indexing of pension benefits, δ is the annuity divisor (*delningstal*) which is used to convert the notional account balance into an annuity, q is the year of retirement and P is the length of retirement. The expression endogenizes the annuity divisor, which simplifies calculations and makes sure that the annuity divisor and life expectancy are internally consistent, but results in a slight underestimation of the present value as the annuity divisor in reality is calculated based on historical mortality. For retired individuals, the expression is the same but with $q = 2021$. Note that if $r = g$, the equation reduces to $\mathrm{PV}(K) = K$, i.e., the notional account balance is the present value of future benefits discounted with income growth. As we normally assume $r > g$, the present value is lower than the nominal value.

Table 4 shows the present value of the pension liability for different discount rates.

Table 4: Present value of the pension liability by discount rate and counterfactual pension fund

Discount rate/ real return	*Present value of pension liability (SEK billion)*[a]	*Counterfactual pension fund (SEK billion)*[b]	*Funding rate*[c]
0%	13497	-372	-3%
1%	10988	-179	-2%
2%	9128	216	2%
3%	7721	957	12%
4%	6635	2285	34%
5%	5781	4594	79%
6%	5097	8528	167%
7%	4543	15129	333%
Special cases:			
1.5%[d]	**9991**	-14	0%
1.54%[e]	9925	**0**	0%
3.83%[f]	6800	**2004**	29%
5.30%[g]	5561	5561	**100%**

[a]The present value in 2021 of the pension liability. Calculated using equation 7 on the preceding page and assuming a 1.5 percent average income growth rate. If the discount rate equals expected income growth, the present value is the same as the nominal value, which is the sum of notional account balances and future benefit payments for the already retired.

[b]The size of the pension fund in 2021 if the historical real rate of return had been different, but the payments to and from the pension system had stayed the same (and assuming that the pension fund had the ability to borrow).

[c]The pension fund in 2021 as a percentage of the discounted pension liability in 2021 for a given discount rate/rate of return. If the funding rate is 100 percent, the system is fully funded and no future contributions are needed to cover the existing pension liability.

[d]If the discount rate coincides with assumed income growth, 1.5 percent, the present value of the pension liability is the same as its notional amount, SEK 9,991 billion.

[e]The historical real rate of return (and interest rate, for periods when the system would have to borrow) that would have resulted in a pension fund of exactly zero in 2021, i.e., the discount rate where historical contributions, benefits and other payments cancel out in present value.

[f]The actual capital-weighted real rate of return since 1960, i.e., the rate of return that, if it were constant over time, would have resulted in today's pension fund of SEK 2 trillion.

[g]The discount rate and historical rate of return that would make the system fully funded, i.e., where the pension fund in 2021 exactly equals the discounted pension liability.