How Sensitive is Old Age Poverty to Financial Crisis? A Micro-Simulation Experiment for Sweden.

Preliminary work in progress. Still incomplete! Do not quote or cite without permission!

20 May 2011

Abstract

Pensions are both directly and indirectly affected by financial crises. The reform of the Swedish pension system into a notional defined contribution system with a minor funded part has attracted international attention for its solutions to ensure fiscal sustainability. As the financial crisis devaluated the buffer funds this released the automatic balancing mechanism that is designed to decrease the pension liabilities. The pension system is, however, still in transition and the long-term consequences in a fully mature system cannot be straightforwardly deduced from this incident. We use an agent-based model approach to study how the mature Swedish pension system may react to a financial crisis. First of all, of course, the funded parts of both the public and the occupational pension system will be directly affected. Through the automatic balancing mechanism that ensures financial stability also the buffer funds will release an automatic cut in pension rights. In our results we try to establish what the effects on poverty rates are for birth cohorts who are at different stages in their life course when the financial crisis hits. Our preliminary results indicate that cohorts just on the verge of retirement will be hit hardest. In another dimension men are harder hit than women, partly due to the fact that only females are allowed to vary labour supply.

Acknowledgements

We are grateful for comments from participants in the WDA/scala workshop on Pension Challenge and the Financial Crisis, University of St. Gallen, 30 October 2009. Funding from Riksbankens Jubileumsfond, the National Insurance Agency and the Swedish Research Council is gratefully acknowledged.
Introduction

Using the agent based micro simulation model IFSIM at the Institute for Futures Studies, our paper study the linkages between the design of the new Swedish pension system and poverty outcomes in old age, and in particular how these outcomes are affected by financial shocks. The model allows for heterogeneity and micro-macro feedbacks that are hard to analyse with conventional theoretical approaches. The issue is topical for Sweden since Swedish pension funds have been experiencing large real losses; -34 percent on average in 2008 (Orange Rapport, 2009). Furthermore, the design of the automatic balancing mechanism (known as the “brake”) in the unfunded part of the public pension is sensitive to macroeconomic, demographic and financial risks. The purpose of our experimental simulations is to explore these risks in a more complex setting than is allowed by analytically tractable models. In this paper we focus on the financial risks and gendered poverty outcomes in retirement.

The Swedish public pension system became operational first in 1999 for the income pension and then in 2000 also the premium pension choice after a parliamentary decision 1994. Since there is a 20-year transition period with mixed pension rights for the birth cohorts 1934 to 1953 the poverty impact of the pure system cannot be assessed empirically. The new system is a Notional Defined Contribution (NDC) system—16 percent of wages— with PAYG financing (the so called income pension), and a minor funded system (the premium pension) with 2.5 percent of wages set aside for individual investment in a variety of mutual funds. Saving into the funded premium pension is mandatory. There is an additional element of pre-funding in the buffer funds of the PAYG income pension. The funds are invested by five different fund managements on the financial markets. The value of the buffer funds (AP funds) is a crucial element in the balancing of the system. On top of the public pensions, ca. 95 percent of workers rely on occupational pensions, mainly four different systems collectively agreed by unions and employers. For individuals below the ceiling for the income pension, currently around 80 percent of the population, it is of limited importance, but for the ca.20 percent who gets replacement above the income ceiling it is of paramount importance The occupational pensions also have mixed funding, hence also directly or
indirectly depend on the performance of financial markets (directly if DC, indirectly if defined benefit: DB). All in all, the average pensioner is therefore quite exposed to financial risks both during her productive years and also in her retirement.

The state offers also a universal minimum benefit (guaranteed pension) to all, which is paid out of general taxation and is gradually withdrawn as the individual becomes eligible for a sufficiently high contributory pension (i.e. income pension). Individual income pension rights are accumulated in notional accounts with contributions and grow with an income index reflecting the growth of wages. This index is adjusted downwards by the automatic balancing mechanism if it is required to preserve financial stability. The final pension received at retirement is an annuity calculated from the accumulated notional account on the basis of many parameters including life expectancy (unisex tables are used), the income index growth and any automatic balancing of the buffer fund. In general the income pension represents the largest chunk of an average pension (40-60 percent). The funded premium pension is subject entirely to market performance and individual investment decisions and represents a smaller share of the final pension (only around 3 percent today but estimated to represent 15-20 percent in the fully mature system). The occupational pension, either DB or DC on average represents around 15-20 percent of the final pension for the average person but for the high income population it may well dwarf the public pensions.

It follows that the exposure of the average Swedish pensioner to the funded part of her pension is therefore ca. 35-40 percent of the total pension (summing only the state premium pension and the occupational pension). However this exposure is higher if we include downward adjustment of the income pension through the turning on of the automatic balancing mechanism, which would be the case if the state buffer funds shrink too fast due to a financial shock.

Our aim is to investigate the behaviour of the system with respect to poverty outcomes in old age for different cohorts (e.g. retiring before or after a crisis) also with respect to gender. Even in the absence of a financial crisis, different cohorts do enjoy a different composition in their final pension (e.g. in the share of income pension versus guarantee pension) depending on demographic and macroeconomic conditions prevailing at the time of their retirement. The occurrence of a financial crisis will generate different
poverty results depending on when it strikes in relation to these normal variations in pension composition.

Due to the generally lower female labour force participation the gender aspect becomes very important. In Sweden, where female labour market participation is relatively high today (70 percent), we still observe large differences in pension entitlement between men and women indicating that inequalities from the working years linger on into future generations of retirees. Currently, around 35 percent of women still work part time, a much higher proportion than men (SCB Labour Force Survey, 2011). Also, the average time spent in the labour market is lower for women (ca. 37 years against 40 for men), the average wage is lower (84-92 percent of that of a man with the same job) and the actual retirement age is earlier (61.6 for women against 62.3 for men). When it comes specifically to parental leave, we know that for every child 80 percent of the allowed parental leave is taken out by the woman (Haataja, 2009); the woman tends to take out also most of the subsequent leave for caring for sick children up to 12 years old (Ekberg, Eriksson and Fieber, 2004).

Women’s direct absence from the labour market in connection to child-birth is partially compensated by the Swedish pension system (which contains childcare credits) but due to a multitude of factors female career prospects are in sum poorer, part time work much more common, and reliance on a higher share of guarantee pension is therefore more frequent than for men. The NDC system therefore places women at particular risk for poverty as the automatic balancing sets in. One issue of particular interest is therefore to what extent females are harder hit than similar males when a financial crisis strikes.

In order to study the impact of financial crisis on elderly poverty, we have adapted the agent based micro-simulation model IFSIM (see Baroni, Žamac and Öberg 2009 for a model description). It is important to stress that the model is not predictive but a theoretical device to experimentally gauge the net effects of a shock while keeping all other policy parameters constant. Thus, even if we initialise it with Swedish data in this paper, the outcomes of the basic setup as the model has stabilised would be the same for any country with similar institutions and the model can be recalibrated with a different set of institutions and initial values to simulate any country.
The basic definitions and measurements chosen to describe poverty are relative poverty rates that conform to standard relative poverty indexes as described in e.g. Atkinson (1987). The relative measure of poverty refers to the individual’s position within the income distribution rather than her degree of deprivation in terms of absolute human needs. Usually someone is considered “poor” if their income lies below the poverty line, which is commonly set to 60 percent of the median income. Most often household equivalised incomes are used rather than individuals’ in order to account for economies of scales related to household size. So our poverty definition refers to someone who lives in a household whose equivalised per capita income lies below the poverty line.

In the next section we describe more closely the relevant basic parts of the IFSIM model. In section 3 the setup of the specific simulation we report here is described. In section 4 the results are presented and section 5 concludes with a discussion of these results.

**The IFSIM Agent Based Model**

The model is initiated with Swedish micro data from the SESIM micro-simulation model (Flood et al. 2006) at the Ministry of Finance as input data and from that simulates an artificial panel of individuals and households for 150 years\(^1\). The main events being simulated are demographic (i.e. whether the individual survives, whether he gets married, and if so whether he or she has a child in that year), educational, both in terms of the level (i.e. whether the individual is in school or if not what is her highest degree), and the quality of her human capital (i.e. how skilled the individual is at any given time, also when in work), finally labor market status (i.e. if in work, full or part time or retired) is simulated with the restriction that only females may choose their labor supply, and his or her income as a function of accumulated human capital. Once the income is defined a rudimentary tax and benefit system is implemented to derive disposable income under the restriction that the public budget must balance.

The model incorporates four key agents: individuals, households, networks and the State. By agents here we mean JAVA objects belonging to a specific agent class to which certain actions and characteristics are ascribed. Individuals are of course the main

---

\(^1\) Note that in our analysis we disregard the first 80 years since we want to look at a population that is entirely born within the model.
agent type being simulated; they are uniquely identified, they can be born, die, mate, procreate, leave home, study, work or retire. Individuals are grouped into households which are separate agents in that they have characteristics of their own: a separate ID, a given size, number of children, household income, a history and special “links” between household members such as inheritability of certain personal features (e.g. initial skills are inherited as the average of both parents and consumption preferences are shaped by the household consumption). Networks are less tangible agents but still they exist as separate entities with a specific location and group composition that may affect for example fertility decisions. At the moment networks are lists of individuals grouped by age rather than household (i.e. an individual’s network does not directly include his or her household). Networks are programmed to perform certain actions for instance retrieve network characteristics such as mean participation or education rates which are used by the agents to make forward looking decisions by learning from their social network. Finally the State is the only single agent in the model i.e. the single class being instantiated only once. The State performs the tax and redistribution functions, including setting a local tax rate to keep the budget in balance, calculating and collecting income tax, paying teachers’ salaries, student allowances, parental leave benefits and pensions, and can set some policy targets through which it can affect micro behaviors and macro outcomes.

**The Pension System**

The pension system is modelled according to the new Swedish system with some simplifications. Thus the description here refers to the IFSIM implementation and does not in all details mimic the actual Swedish pension system. Every retiree is assigned a public pension which is comprised of three elements: a premium pension, an income pension and a guarantee pension.

The premium pension fund collects 2.5 percent of the individual yearly salary and invests into funds. Since in our model we do not have explicit capital markets, we assume that the returns to such funds are constant. This is to simplify interpretation of other variations in the model. Upon retirement that always takes place at age 65 the
value of the fund is indexed by a constant return. These simplifications allow us to focus on automatic balancing by limiting other sources of risk.

The income pension is based on the notional defined contribution accounts where the insured pays yearly 16 percent of income into a personal account but the contribution is not invested but used to finance current pensioners’ expenditure while being earmarked for the future at a given “interest” determined by the income index. At the time of retirement, the individual will therefore have accumulated a notional pension wealth converted into a yearly pension income. The pension annuity is calculated on the basis of a unisex life expectancy of 20 years at age 65 through a so called annuitization divisor, which assigns an expected “interest” of 1.6 percent, corresponding to expected income growth, on the remaining pension wealth after retirement. The actual value of the annuity is adjusted yearly for real growth deviating from 1.6 percent (i.e. if the growth is lower the pension benefit is reduced and vice versa), as well as occasionally by the brake.

The system’s overall balance is assessed by looking at the amount of “financially sustainable” pension debt in the system. Financial sustainability implies that the expected income pension liability must be set equal to the expected amount of contributions and assets in the system. The amount of expected contributions is obtained by multiplying current social insurance contributions $CW$ by a so called “turnover duration” factor which roughly measures the average contribution time (i.e. the total payable into each individual account by the current generation of workers, $W$ until retirement); this turnover rate is based on demographics and is kept constant in the model since life expectancy is kept constant. The amount of projected debt for total income pension benefits $S$ is computed in a similar way, as the sum of the expected pension liability to be paid both to the currently active and to those who have already retired, based on their respective life expectancies.

$$A_t + \sum_{i} CW = b \sum_{i} S$$

---

2 In reality the individual has the choice to annuitise the value at retirement to a fixed nominal amount or keep the share in funds and get the value of the annuity is recalculated each year. We chose the latter solution to emphasize the financial risk during retirement.
\( A \) is the value of the buffer funds at time \( t \), the sum of \( CW \) represents the estimate of current and future contributions at time \( t \), and the sum of \( S \) is the estimate of current and future liabilities for income pensions (both to the active population and to current pensioners). It follows from (2) that \( b = (A + \sum CW) / \sum S \) is the inter-temporal balancing index required to keep the income pension bill financially sustainable.

Once the income pension is calculated, the individual will be checked to see whether she will be eligible for some guaranteed pension. A guarantee pension will be awarded to all individuals who have an income pension below a level calibrated to the real system.

Beside the public pension, people with an income above 7.5 basic amounts (i.e. average earners and above) contribute into a DB occupational pension which on average pays in retirement around 65 percent of last earnings (above 7.5 basic amounts, 10 percent below). The contributions to the occupational pensions vary to keep the system balanced every year, and they increase with age. This is a stylised version of the main four occupational pension systems.

**The Automatic Balance Mechanism**

The decision to index the pension system with average wage growth instead of the growth of the wage sum (the contribution base) made it necessary to have an adjustment mechanism to preserve both financial balance and inter-generational fairness\(^3\) within the PAYG component of the public pension. The automatic balance mechanism was introduced to cut benefits when liabilities were deemed to exceed assets in the system. The brake allows keeping a fixed contribution rate while also preserving the long term financial sustainability of the PAYG system.

Formally the automatic balance mechanism is calculated by the following *Balance Ratio and Balance Index*:

\[
(3) \quad \text{Balance Ratio} = \frac{\text{Contribution Assets} + \text{Buffer Fund}}{\text{Pension Liability}}
\]

\(^3\) See O. Settergren, NFT 2/2003
Balance Index = BalanceRatio * IncomeIndex \( \text{if } BR < 1 \text{ or } BI < \text{Income Index} \)

The balance index—obtained by multiplying the income index by the balance ratio when the brake has hit—remains operational until the balance index equals or is greater than the income index. This means that even after the balance ratio has increased to above unity the balance index will remain in force in order to resume indexation at the income index level and thus restore the level of pension income relative to that of the wage earners. See Figure A1 in the Annex.

The system’s internal rate of return is a function of the growth in the contribution base (e.g. population aging would imply lower growth in the contribution base), of the change in age-related income and of returns to the buffer funds (e.g. a financial crisis). In the model we have sterilised the channel through which changes in life expectancy affect the growth of liabilities.

In practice, the triggering of the balance index means that all notional pension accounts as well as income pensions being paid out will be indexed by the system’s internal rate of return rather than the rate of growth in average incomes. As long as the balance index grows slower than the income index, the liabilities will start decreasing relative to contributions.

As Barr and Diamond (2011) note this has some peculiar consequences that so far have not been much debated. Over the period when the automatic balancing index is operative pensioners lose part of their otherwise expected annuities, some of those retiring within the period lose parts of their pension wealth, while those who actively contribute to the system and do not retire until after normal indexing is resumed will actually increase their pension wealth!

In order to clarify exactly how this works a formal example can be helpful. Suppose the brake strikes in period 1 and in period 2 brings the balance index \( B^4 \) (multiplication

\[ B^4 \]  

4 N.B. in reality the balance indexing is applied with a two years lag (i.e. two years after the balance ratio has gone below 1). Here we model instead the balance index to take effect from the subsequent year. Moreover, the value of the buffer funds in the formula was changed after the financial crisis and is now computed as an average over three years in order to smooth the impact.
factor $B_{t+1} / B_t$, i.e. the growth rate in the index in the period) back to the level of the income index $W$ (multiplication factor $W_{t+1} / W_t$ in the period). For an individual with accumulated pension wealth $A$ and contributions in each period $c$, the accumulation of new pension wealth over the same period but without the brake striking would take place according to (ignoring all other differences between scenarios)

$$A_2 = \frac{W_2 W_1}{W_1 W_0} A_0 + \frac{W_2}{W_1} c_1 + c_2$$

If the brake strikes the accumulation is instead:

$$A_2^b = \frac{B_2 B_1}{B_1 W_0} A_0 + \frac{B_2}{B_1} c_1 + c_2$$

Simplifying the difference is

$$A_2 - A_2^b = \left(\frac{W_2}{W_0} - \frac{B_2}{B_1}\right) A_0 + \left(\frac{W_2}{W_1} - \frac{B_2}{B_1}\right) c_1.$$ 

By construction the first term is zero since $W_2 = B_2$ (as in period 2 the balance index has reached again the level of the income index). From this also follows that the second term is negative since $W_1 > B_1$. In other words the value of the account at period 2 will be larger than what it would have been if the income indexing would have been on instead. Thus active contributors will at given labour supply and income unambiguously gain compared to a situation when the brake would have been off. As long as pension wealth has not been annuitized (i.e. unless someone retires before the balance is turned off) the effect of the balancing is not only neutralised but total future pension liabilities will actually increase. Thus the brake has the strange property that those who can adjust their labour supply to compensate for the balancing have no reason to increase but rather to decrease their labour supply. Those who no longer can adjust their labour supply take the whole hit of the balancing. In our simulation adjustment of labour supply is exclusively a female prerogative and based on rather myopic expectations formed by observing ten years older peers, since the main aim of the paper is focused on poverty rates and financial risks. 

---

5 In a later companion paper labour supply choice will be analysed in a more general setup.
**Description of our Simulations**

We review our simulation results by comparing a baseline version to one alternative where we simulate an exogenous financial shock. By financial shock we shall mean one year in which the value of funded pension assets drop by an extraordinary rate of 20 percent (which is similar to what the Swedish buffer fund has experienced in the latest financial crisis).

In principle we can generate data for everything that happens in the model, but we focus on those features of the pension system that are going to be directly affected by a financial shock, namely the value of individuals’ premium pension accounts as well as the value of the state’s buffer fund, which will affect the system’s assets and its internal rate of return. Both premium pension accounts and the state buffer fund are made to drop by 20 percent.

Since the share of pension income coming from the premium pension is small (roughly 10-20 percent), the (poverty) impact of the financial crisis is expected to be most felt through its effects on the buffer fund, the automatic balancing mechanism and the income pension. The income pension will grow more slowly for a while and pension accounts of workers will, as shown above, tend to increase in response to a financial crisis, but second order effects working through labour supply for women and incentives for a host of other decisions on education, family formation and so on may cause it to grow even slower and perhaps even decrease for a while. The individual impact also depends on where in the lifecycle different individuals are when the crisis hits, e.g. if in late career, in early working years or in retirement.

**Our Hypotheses**

The timing of a financial crisis releasing automatic balancing matters in relation to an individual’s life cycle. Being exposed to a crisis in retirement always implies a loss regardless of indirect effects as discussed above but in other cases indirect effects may moderate responses in other directions. We will investigate the following three hypotheses:

1. Being exposed to a crisis in working years does not imply a lower amount of pension entitlements. The age and size of contributions is
important to determine this outcome in relation to repercussions on labour supply and economic growth. The closer to retirement the more vulnerable an individual should be. **Those who are about to retire when the brake is released are worse off than those who retire when it is just being released.**

2. **The gender gap might be reduced by a financial crisis** as an indirect consequence of the on-setting of the brake, due to increasing reliance on the guarantee pension by men and the scope for female adjustment by increasing labour supply.

3. Since liabilities to the working population increases ceteris paribus, the brake may be insufficient to bring back long-term stability and the financial crisis unleashes repeated brake periods unless new capital is added to the buffer funds.

In order to test whether these effects go through when we allow for interaction in the population and long-term effects on education and fertility we choose to follow the pension wealth accumulation and decumulation of three separate cohorts.

Table 1.

<table>
<thead>
<tr>
<th>Cohort birth year</th>
<th>Retirement year</th>
<th>Experience of ABM in Baseline</th>
<th>Experience of ABM due to a crisis in 2100</th>
</tr>
</thead>
<tbody>
<tr>
<td>2025</td>
<td>2090</td>
<td>Both in working years and in retirement</td>
<td>In mid retirement</td>
</tr>
<tr>
<td>2040</td>
<td>2105</td>
<td>Both in working years and in retirement</td>
<td>Just before retirement</td>
</tr>
<tr>
<td>2065</td>
<td>2130</td>
<td>Both in working years and in retirement</td>
<td>In early-to-late working years and in retirement</td>
</tr>
</tbody>
</table>

Simulation ResultsOur baseline simulation is calibrated to initially reproduce the Swedish demographic parameters, in terms of fertility and mortality rates. This means
we are ignoring migration and tend to get no natural population increase. The age-specific fertility rate follows the shape of 2006 Statistics Sweden data, while for mortality we use Statistics Sweden’s life expectancy projections by age up until 2055, after which time we fix life expectancy to that level (i.e. a life expectancy of ca. 20 years at 65, assuming that life expectancy will not grow indefinitely). We analyse simulated data between model year 2080 and 2150 for the purpose of our analysis, and over this period we observe a low constant population growth rate. During the initial period we observe an aging population as the old age dependency ratio (65+/20-64) rises from 0.15 to between 0.41 to 0.43 over the period we study. The total fertility rate also stabilises around an average of 2 children per woman (with yearly fluctuations above or below this level).

Over the years 2080-2150 the baseline shows in Figure 1 an increasing share of women that choose full time labour supply (from 69 to 73 percent of all women of working age). Recall that all men work full time.

Figure 1. Breakdown of female labour market status indexed by model year 2086=100.

As the share of workers in the labour force increases increased female participation, the growth in GDP per worker decreases over time (Figure 2).
Everyone retires at age 65 making choice of labour supply exclusively a female prerogative. Without any financial crisis the brake strikes a couple of times in the baseline scenario. The first year the brake strikes is in 2070. This is due to a slightly falling population size at that time, which progressively reduces the contributory base and pushes old age dependency upwards. Subsequently the brake strikes mildly a couple more times (see Table 2 below).

When we let the crisis hits in 2100, the pension system assets suddenly drop by 20 percent thus reaching the liabilities level. An expected effect of the crisis in 2100 is to set off the so called automatic balancing mechanism at once. The sudden drop in the buffer fund destabilises the system by suddenly making assets insufficient to cover liabilities. Since the labour supply effects are very small GDP growth as compared to the baseline changes negligibly.

Furthermore the crisis leads to automatic balancing striking more often after 2100 and in a more repetitive pattern, see table 2 and figure 3 below.

<table>
<thead>
<tr>
<th>Balance Ratio</th>
<th>Model Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>2085</td>
</tr>
<tr>
<td></td>
<td>2115</td>
</tr>
</tbody>
</table>

Table 2. Automatic Balancing in both scenarios
As we can notice from the table the crisis leads to more frequent striking of the brake after 2100 compared to the baseline. This can be explained by indirect effects and complex feedbacks in the system (e.g. labour supply responses, or possible gains for some cohorts as highlighted by our theoretical model in the earlier section).

<table>
<thead>
<tr>
<th>Crisis</th>
<th>0.965</th>
<th>2100</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.995</td>
<td>2105</td>
</tr>
<tr>
<td></td>
<td>0.990</td>
<td>2118</td>
</tr>
<tr>
<td></td>
<td>0.990</td>
<td>2127</td>
</tr>
</tbody>
</table>

The rate of return of the buffer fund, set at 3.25 percent annually, is not sufficient to counterbalance the negative demographic development and guarantee stability of the public pension system.

Moving on to data on the average gross replacement rate of the elderly in Figure 4, measured as the first public pension relative to the last wage, is quite stable in the baseline until 2110 (ca. 55 percent average over time) but tends to decrease from roughly 2110 (with women preserving on average a higher replacement rate from the total public pension due to lower last earnings relative to men). This means that, despite
a slowing down of wage growth, on average over time pensions will tend to decrease relative to average income. This must be attributed to pensions decreasing relative to wages. In fact, we see from Figure 2 that from year 2110 ca. GDP growth (which in our case equals income growth) goes below 1.6 percent yearly thus leading to decreased pensions since income pensions are constructed to cover only growth above this rate. It follows that from this year on they will stop growing, thus making retirees continuously slightly worse off in terms of the replacement rate. In the crisis scenario in Figure 4, however, the gender gap tends to increase, contrary to our expectations.

At an aggregate level, the relative poverty rate of women (at 60 percent of median equivalised household income) of the elderly tends to slightly decrease in the baseline scenario (see Figure 3); The latter is an effect due to an albeit small increasing labour market participation of women (who would have been most likely to be poor) in combination with the slowing down of the economy below 1.6 percent from 2110 (as above). While income pensions should be decreasing from this moment on due to lower indexation, greater entitlement more than compensates for this so that average pension entitlements for females increase from this year.

When relating the poverty line (measured as 60% of median income) to average GDP per worker the poverty line is increasing, i.e. the income distribution tends to become more equal over time. The trend in fact implies that the average income grows more slowly than the median, or that the median grows closer to the average. This effect might be determining the overall lowering in poverty. Furthermore, since poverty is calculated on equivalised household incomes, women’s increased work force participation will affect the household standard and reflect in lower average poverty rates for men also. Since men always work full time in the model their old age poverty rate is initially substantially lower than women’s, but in the long run they tend to converge. In the Crisis Scenario in Figure 6 this convergence does not take place, again contradicting our hypothesis.
Figure 3. Average Replacement Ratio in Baseline Scenario from Income, Premium and Guarantee Pensions of Pensioners by sex, over model years.

Figure 4. Average Replacement Ratio from Income, Premium and Guarantee Pensions of Pensioners by sex, over model years in crisis scenario.
From Figure 5 and 6 we can see that the crisis leads over time to a greater divergence in replacement ratios of men and women (while in the baseline they tend to converge towards 2140).

Figure 5. Average Poverty Rate (at 60 percent of Median Disposable Income) of pensioners in Baseline Scenario

Figure 6. Average Poverty Rate (at 60 percent of median income) of pensioners in the Crisis Scenario.
Looking at the data in another way we see in Figure 7 and Figure 8 we see that males are actually harder hit by the crisis relative to the baseline replacement ratios but are converging faster than the females to the baseline scenario. Thus our hypothesis is partly correct, but the lower rate of female convergence to the baseline scenario makes it look within our period of observation as if they were harder hit.

Figure 7. Average Replacement Rate from Income, Premium and Guarantee Pensions of Female Pensioners by Scenario over model years.
Figure 8. Average Replacement Rate from Income, Premium and Guarantee Pensions of Male Pensioners by Scenario over model years.
Cohort Analysis in the Baseline-

We now focus on the three separate cohorts described in Table 1 to see how their life cycle incomes and poverty risk evolves. We will later compare these results with the crisis scenario to see whether some of the differences in their retirement outcome can be attributed to experiencing the financial crisis (in particular, the associated balancing mechanism) in different moments of their life-cycle.

Figure 9 below shows first of all the value of the three cohorts’ respective notional pension accounts up to age 64, as percentage of GDP per worker. Here we show that, given a situation where all cohorts are hit by the brake, the accumulation of pension accounts is smooth and cohort 2065 has on average a pension account 5.8 times the GDP per worker when they are 64 while cohort 2025 has 5.5 times the GDP per worker in the year when they are about to retire and cohort 2040 ends up with 5.2 times the GDP per worker.

From age 65, income pensions are indexed by income growth minus 1.6 percent (recall that the annuitization factor preliminarily assumes growth at 1.6 percent). If we normalise pension incomes to average GDP per worker, they will therefore grow more slowly than incomes over time. In our economy, the average yearly growth rate is 1.8 percent, but from ca. 2120 the average growth remains almost always below 1.6 percent (see Figure 2). This will therefore also affect the rate at which income pensions will be paid out from that year onwards. More generally, the fact that income growth decreases over time means that, for a given pension account size, younger cohorts will always get a lower annuity compared to older ones. However, as long as the economy has growing GDP per capita they start out from a higher level of pension wealth on average.
Figure 9. Lifetime accumulation of Notional Pension Account by Cohort as a proportion of yearly GDP per worker.

We thus repeat the same cohort analysis for average income pensions received from age 65 up to 75. Figure 10 shows the average income pension for each of our three cohorts from the age of retirement (65) to age 75, expressed again as a percentage of average GDP per worker. Having accumulated similar pension accounts, we see that these cohorts retire with rather similar income pensions in relative terms (and similar rates of decrease over time), between 30 and 33 percent of average GDP per worker.

When looking at the entire income composition of the average pensioner we also see that the proportion coming from different sources varies only slightly between our cohorts (Figure 11). The average pensioner in cohort 2065 has a slightly lower share of her income from the guarantee pension than cohorts 2025 and 2040. Most noticeably the share of income coming from the funded premium pension and occupational pensions has increased compared to the earlier two cohorts. In general however, we can say that the income composition is pretty stable across cohorts.
Turning now to relative poverty statistics, we present below our baseline results for the over 65, defining relative poverty as equivalised household incomes which lie below the poverty line set at 60 percent of (equivalised) median income (for the whole population). All sources of income contribute to the household disposable income. This means that the poverty statistics is sensitive to household composition changes. We should also note here that the risk of being poor is always associated to having some or all of one’s pension coming from the guarantee pension; 95 percent of those who have
some or all of their pension income from the guarantee pension are in fact poor in our model\textsuperscript{6}.

Figure 12 below (white columns) shows that the highest poverty rates (between 65 and 80 years old) are found in cohort 2025 and 2040. Cohort 2025 experiences thus the highest poverty levels, but we see that cohort 2065 actually have lower poverty rates for females, again reflecting the convergence we saw in the baseline cross-section.

![Figure 12. Elderly Poverty Rates (60 percent) by cohort, age 65-80](image)

**Cohort Analysis in the Crisis Simulation**

We now move on to see how our three cohorts fare in terms of their pension income under the crisis scenario compared to the baseline. As shown in table 1, cohort 2025 will now be affected by the 2100 crisis in mid retirement (at age 75). Cohort 2040 will be affected 5 years before its retirement year (at 60), and beyond, while cohort 2065 will be affected earlier in working years (when they are 35), as well as at and in early retirement.

\textsuperscript{6} The poverty line in the model varies around 30 percent of average GDP per worker, and the maximum level of guarantee pension is ca. 33 percent of the average wage.
We first look at the value of accumulated (notional) income pension accounts by age 64, by cohort in Figure 13. Comparing this to Figure 9 we see that the crisis per se does not seem to have majorly impacted the growth rate of cohort 2065’s pension account overall: by age 60 they have reached almost the same pension account as they would have had in the baseline, while by 64 they have reached 96.2 percent account value in the baseline, not so much due to the crisis but to repeated strikes of the brake (the brake strikes again in year 2127) and indirect labour supply effects (see Figure 19 later on). Yet the average yearly growth in their account is ca. 12 percent in both scenarios. While not making a gain this cohort has recuperated almost entirely the potential losses initially triggered by the crisis, but are caught just before retirement by another brake episode which shows in figure 15 below.

Figure 13. Lifetime accumulation of Notional Pension Account by Cohort and scenario as a proportion of yearly GDP per worker in the Baseline Scenario.

Rather differently, we see that the crisis per se has impacted more on cohort 2040 (who is 60 at the time it strikes), reducing quite substantially the value of the account by age 64 compared to the baseline. We know that for cohort 2040 this is because the balance index has not yet returned to its original level when they are 64. Cohort 2025 sees no change.
Table 3  Average Income Pension as a share of baseline GDP per worker.

<table>
<thead>
<tr>
<th>Cohort</th>
<th>Scenario</th>
<th>Age 66</th>
<th>Age 67</th>
<th>Age 68</th>
<th>Age 69</th>
<th>Age 70</th>
<th>Age 71</th>
<th>Age 72</th>
<th>Age 73</th>
<th>Age 74</th>
<th>Age 75</th>
</tr>
</thead>
<tbody>
<tr>
<td>2025</td>
<td>Baseline</td>
<td>0.303</td>
<td>0.298</td>
<td>0.294</td>
<td>0.289</td>
<td>0.285</td>
<td>0.28</td>
<td>0.268</td>
<td>0.258</td>
<td>0.251</td>
<td>0.246</td>
</tr>
<tr>
<td></td>
<td>Crisis</td>
<td>0.303</td>
<td>0.298</td>
<td>0.294</td>
<td>0.289</td>
<td>0.285</td>
<td>0.28</td>
<td>0.268</td>
<td>0.258</td>
<td>0.251</td>
<td>0.246</td>
</tr>
<tr>
<td>2040</td>
<td>Baseline</td>
<td>0.295</td>
<td>0.292</td>
<td>0.287</td>
<td>0.281</td>
<td>0.276</td>
<td>0.266</td>
<td>0.257</td>
<td>0.251</td>
<td>0.25</td>
<td>0.244</td>
</tr>
<tr>
<td></td>
<td>Crisis</td>
<td>0.284</td>
<td>0.273</td>
<td>0.269</td>
<td>0.264</td>
<td>0.26</td>
<td>0.258</td>
<td>0.255</td>
<td>0.25</td>
<td>0.247</td>
<td>0.239</td>
</tr>
<tr>
<td>2065</td>
<td>Baseline</td>
<td>0.329</td>
<td>0.324</td>
<td>0.317</td>
<td>0.312</td>
<td>0.308</td>
<td>0.304</td>
<td>0.297</td>
<td>0.291</td>
<td>0.286</td>
<td>0.283</td>
</tr>
<tr>
<td></td>
<td>Crisis</td>
<td>0.317</td>
<td>0.311</td>
<td>0.307</td>
<td>0.301</td>
<td>0.298</td>
<td>0.294</td>
<td>0.288</td>
<td>0.284</td>
<td>0.279</td>
<td>0.274</td>
</tr>
</tbody>
</table>

In **Fel! Hittar inte referenskälla.** we change the perspective (how so?) by using baseline GDP per worker to evaluate the income pensions in the first ten years of retirement. Here we see that cohort 2025 has not changed its relative position while the other cohorts have slightly worsened their situation, particularly cohort 2040 which was hit by the crisis just before retirement. Since this may be hard to determine directly from the graph, the information is repeated in Table .

Another important effect of the crisis is to suddenly reduce the value of a premium pension account by 20 percent. In this case, the crisis affects mostly retirees from cohort 2025 and 2040 (who just retires after the crisis) since they see the value of their premium pension suddenly drop by 20 percent without possibility for this loss to be compensated by their own actions (since those from 2025 are already retired, they do
not contribute to the account any longer). In particular, as we clearly see in Fel! Hittar inte referenskälla. and Table , cohort 2040 receives a substantially lower premium pension after retirement (in 2105). Cohort 2065 instead sees almost no change in their funded pension due to the fact that its premium account can recuperate most of its pre-crisis value over the years before retirement.

If we take stock of what we have seen so far, we can therefore say that overall, the cohort which experiences the crisis at the youngest age, while in work (cohort 2065) is hardly much worse off than in the baseline, despite spending a longer amount of time under the ensuing balancing regime. However, it will be affected by the crisis in retirement, not directly (since they retire in 2130, well after the crisis) but indirectly (as the crisis tends to set off repeated and more serious brake periods).

![Figure 15 Average Premium Pension by cohort and scenario as a proportion of baseline GDP per worker.](image)

**Table 4 Average Premium Pension by cohort and scenario as a proportion of baseline GDP per worker.**

<table>
<thead>
<tr>
<th>Cohort</th>
<th>Scenario</th>
<th>Age</th>
<th>66</th>
<th>67</th>
<th>68</th>
<th>69</th>
<th>70</th>
<th>71</th>
<th>72</th>
<th>73</th>
<th>74</th>
<th>75</th>
</tr>
</thead>
<tbody>
<tr>
<td>2025</td>
<td>Baseline</td>
<td></td>
<td>0.093</td>
<td>0.095</td>
<td>0.098</td>
<td>0.101</td>
<td>0.104</td>
<td>0.108</td>
<td>0.112</td>
<td>0.114</td>
<td>0.117</td>
<td>0.121</td>
</tr>
<tr>
<td></td>
<td>Crisis</td>
<td></td>
<td>0.093</td>
<td>0.095</td>
<td>0.098</td>
<td>0.101</td>
<td>0.104</td>
<td>0.108</td>
<td>0.112</td>
<td>0.114</td>
<td>0.117</td>
<td>0.121</td>
</tr>
<tr>
<td>2040</td>
<td>Baseline</td>
<td></td>
<td>0.096</td>
<td>0.099</td>
<td>0.101</td>
<td>0.105</td>
<td>0.109</td>
<td>0.112</td>
<td>0.117</td>
<td>0.121</td>
<td>0.121</td>
<td>0.121</td>
</tr>
<tr>
<td></td>
<td>Crisis</td>
<td></td>
<td>0.073</td>
<td>0.075</td>
<td>0.078</td>
<td>0.079</td>
<td>0.082</td>
<td>0.085</td>
<td>0.088</td>
<td>0.091</td>
<td>0.095</td>
<td>0.099</td>
</tr>
</tbody>
</table>
The other two cohorts (2025 and 2040) instead are affected by the crisis once again only as retirees or near retirees; in particular, cohort 2040 is now affected just before and in the retirement year. While the youngest and oldest cohort do not experience any serious direct loss in their notional accounts the value of their lifetime income pension is more or less reduced by the crisis. Furthermore, since we do not model the premium pension as a fixed annuity set at retirement but rather we recalculate the annuity yearly ?? Unfinished sentence

We do note a slight increase in labour supply for cohort 2040 (Figure 16), since their expectations of future income pension will be lower due to losses made in previous cohorts (on whose income they base their projections). Cohort 2065, however base their expectations on the 10 year older cohort 2055 which is not affected in the same way and hence actually lower their labour supply in the last years, see Figure 17.

Figure 16 Labor supply by Scenario for Cohort 2040, age 55-65.
Looking at the poverty statistics will help summarise which of these effects, i.e. being hit by the brake in retirement or in working year, will prevail in determining the final welfare of different cohorts.

When we look at the relative poverty statistics all cohorts have an increase in poverty rates in old age compared to the baseline (Figure 18). For cohort 2065 the increase in female poverty rates is high enough to change the relative position of the genders. Cohort 2040 is the one with the relatively highest increase in elderly poor (from ca. 13 percent to nearly 15 percent). Cohort 2025 experiences these effects in late retirement, hence also a negative effect on poverty, albeit smaller. Cohort 2065 is less affected than 2040 since they have a longer time to recuperate, which is important for the premium pension Overall they tend to confirm our hypothesis 1 but not 2.
Preliminary Conclusions

Our analysis aims to establish a link between when in the lifecycle one is hit by a financial crisis (and the subsequent on-setting of the automatic balancing mechanism) and poverty outcomes in old age. The analysis is done by looking at three different cohorts.

The main hypothesis that we see confirmed through our simulations are that:

(i) the timing of the striking of the crisis / automatic balancing in relation to an individual’s life cycle matters. In particular, being exposed to a crisis in retirement always amounts to a real income loss although poverty rates do not rise dramatically; being exposed to a crisis in working years might under some circumstances imply a lower notional pension account and for certain it lowers the premium pension account, but this is not enough to make one worse off than someone who is exposed to the crisis in or just before retirement (and who is making a loss in pension benefit while the brake is on). What will be decisive for losses in the working population is the time left to recuperate.

(ii) we cannot however, unambiguously confirm our hypothesis that the gender gap decreases as females are allowed to increase their labour supply. The gender gap in poverty rates has a slight tendency to be reduced when the brake is on due to more reliance on the guarantee pension by men but also to some small
extent because female labour supply at old age increases. However, in the long
run female relative poverty to males actually rises.

(iii) we do see a clear tendency that once the brake strikes due to a financial crisis it
tends to strike more often and more strongly.

What we have shown here is only preliminary. At this point more work needs to be
done to establish firmly these results, especially the link with the poverty outcomes
since the effects of the crisis / brake on the income distribution have not been studied in
sufficient detail.
Annex

Schematic of the working of the automatic balancing index.

Figure A1. Automatic Balancing and Timing of Retirement

Automatic Balancing

Index

Income Index

BR > 1
Balance Index

BR = 1
Gains if increasing contributions

BR < 1

Loss if Retiring

No Loss if Retiring now

Year
References


