3 sides of 1 coin – Long-term Fiscal Stability, Adequacy and Intergenerational Redistribution of the reformed Old-age Pension System in Poland

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This paper should not be reported as representing the official views of the National Bank of Poland.

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List of abbreviations

AWG: Ageing Working Group (European Commission)
DB: defined benefit
FDC: Funded defined contribution,
FGB: Future Generations’ Burden
FR: Fertility rate
GA: Generational Accounting
GAs: Generational Accounts
MoF: Ministry of Finance
NDC: Notional defined contribution
PAYG: Pay-As-You-Go
ZUS: Zakład Ubezpieczeń Społecznych (Social Insurance Institution)
Abstract

In this paper we evaluate the long-term performance of the Polish public pension system from three perspectives: fiscal stability, intergenerational redistribution and adequacy of pension benefits. We assess the two recent public pension reforms undertaken in Poland: 1) the shift of a part of pension contributions from the funded to the unfunded pension pillar and 2) the gradual increase in retirement ages to 67 for both men and women. The results suggest that the combined effect of both reforms shows a significant improvement in cash balances until 2040. The burden of the reforms is shared relatively equally across generations. The effect of higher retirement ages on benefit levels is also positive, especially for those having standard job contracts. What is worrying, however, is the general future drop of benefit levels, in particular for the group of self-employed persons. Policy makers should, therefore, start discussing possible measures today if they aim to avoid a significant increase in old age poverty in the future.

Key words: Generational Accounting, fiscal sustainability, fiscal policy, Poland, pension reform

JEL Classification: H50, H55, H60, H68, J10, H30
Non-technical summary

During the coming decades Poland faces one of the most rapid population ageing process in the entire EU. In the light of this development the Polish government adopted a profound pension reform in 1999. Instead of the previous defined benefit system a new two pillar system, consisting of a notional defined contribution (NDC) and a funded defined contribution pillar (FDC), was introduced. After a decade of less profound pension reforms, the Polish government legislated two significant changes of the public pension system in 2011 and 2012: 1) a partial shift of contributions from the mandatory FDC to the NDC system – called here the FDC cut reform – and 2) a gradual increase in the statutory retirement age to 67 for both men and women.

Against this background, our paper aims to provide an evaluation of both recent pension reforms from three perspectives: 1) long-term cash balances, 2) intergenerational redistribution, and 3) adequacy of future individual pension levels. The ‘three sides’ perspective approach allows to evaluate simultaneously if the improvement from one perspective is followed by an improvement or worsening of the others.

Thanks to a new 1% data sample of ZUS contributors, we are able to differentiate the adequacy analysis by earnings groups and by types of job contracts, which vary in terms of amounts of pension contributions. We distinguish between standard job contracts and self-employed. On this basis we can evaluate the consequences of the choice of a particular job contract (employee or self-employed) on future pension levels.

Our results show that the cut of the FDC contribution rate significantly reduces the ZUS deficit over the next 30 years. In the very long perspective it has no effect on its deficit level. The consequences of this reform are shared relatively equally across generations. Finally, adequacy ratios – i.e. initial pension benefits in relation to the average earnings in the economy – do not change significantly with the FDC cut reform in the coming two decades. This fact can be explained by the little difference between the expected (accumulated) rate of return of the funded pillar assets and the notional accounts indexation over the coming 15 years. In the long-term, however, adequacy ratios may drop due to the FDC cut reform as the indexation of the NDC system is expected to shrink significantly in future decades in line with the ageing process.
The increase in retirement ages to 67, which will take its full effect in 2020 for men and 2040 for women has a positive impact on cash balances over the next three decades. A later retirement increases revenues and reduces the inflow of new pensioners until 2040 significantly. The increase in retirement ages does not imply significant intergenerational redistribution effects. Adequacy ratios increase due to longer accrual of pension entitlements and a shorter retirement period.

The miners’ pension subsystem is untouched by recent reforms. It shows a significant long term cash imbalance, significant intergenerational imbalance, and much higher adequacy ratios when compared with general employees and especially, the self-employed.

In conclusion, both recently adopted pension reforms show a positive (or relatively neutral) effect in all analysed perspectives. Worrying is, however, the general future drop in benefit levels. This decrease is driven equally by 1) the NDC benefit formula, automatically reducing benefits in line with the demographic development, and by 2) changes in the contribution history. The drop of future pension levels can be moderated by the analysed reforms only to some extent. In particular the group of self-employed persons can expect a tremendous shrinking of adequacy ratios in the coming decades, mainly due to the low income declared for pension contribution purposes. Researchers and policy makers should, therefore, start discussing possible measures today, if they aim to avoid a significant increase in old-age poverty in the future.
1 Introduction

In the coming decades Poland faces one of the most rapid population ageing process in the entire EU. In light of this development the Polish government adopted a profound pension reform in 1999. Instead of the old defined benefit system a new two pillar system, consisting of a notional defined contribution (NDC) and a funded defined contribution pillar (FDC), was introduced. Currently, after over a decade, the Polish government legislated two further significant reforms of the public pension system: 1) a partial shift of contributions from the mandatory FDC to the NDC system in 2011 and 2) a gradual increase in the statutory retirement age to 67 for both men and women in 2012.

The aim of this paper is to evaluate these recent changes of the Polish public pension system from three perspectives. First, we assess the fiscal long-term stability of the ZUS old-age pension fund estimating long-term cash balances and the sustainability gap. Second, we analyse the intergenerational redistribution effects of the recent pension reforms on the basis of generational accounts. Third, we evaluate the adequacy of future pension benefits by means of adequacy ratios. The evaluation of the undertaken reforms from these three perspectives, in our opinion, takes into account the interest of all actors involved in the reform process: the political decision makers and the managers of the public finances, who are interested in long-term fiscal stability; contributors and pensioners, who seek for adequate benefits to finance retirement, and, at last, but not least, all those, who are interested in the intergenerational redistribution effects of reform measures.

There are only a few similar studies on the Polish old-age pension system which have been carried out in the past years. This may be surprising given the fact that the common old-age pension system represents the largest public budget with 7.2% of GDP. Previous studies provide only a limited perspective on the long-term performance of the Polish old-age pension system. A part of the past studies focuses only on “one side of the coin” and addresses either total pension expenditures and revenues (EC, 2007; Kempa, 2010) or only adequacy (ISG, 2009). Two sides, namely adequacy and fiscal long-term stability are addressed by Chłoń-Domińczak and Gora (2006), Bielecki (2011), EC (2012) and Egert (2012). The methodological consistency in those latter studies may be, to some extent,
questionable (Chłoń-Domińczak and Góra, 2006; Bielecki, 2011). Additionally, these studies rely on discussible assumptions (e.g. Chłoń-Domińczak and Góra, 2006; Egert, 2012). The issue of minimum pensions was tackled in Chłoń-Domińczak and Strzelec (2010). To our knowledge none of the previous studies takes into account the full and actual contribution history of current contributors. Moreover, the “third side of the coin”, the intergenerational redistribution perspective is not considered in any of the former studies.

Our study seeks to bridge this gap of previous findings and aims to provide a more complete and consistent evaluation of the Polish pension system. It relies on a large panel dataset which covers the contribution history, i.e. the accrued pension rights, until the year 2011 of a representative 1% sample of all contributors in Poland registered in the Social Insurance Office database (Polish: ZUS). The 1% sample provides a background for the analyses of the distribution of future pension levels. Additionally, more precise forecasts of expected number of minimum pension beneficiaries are possible. Also an impact of the recently adopted increase in retirement ages on the long-term performance of the pension fund is analysed in this study for the first time independently of the official legal act justification.

The study is structured as follows: chapter 2 outlines the legal framework of the Polish old-age pension system and its latest reforms. The indicators used to assess the long-term performance of the pension system are described in chapter 3. Then, the computation approach for the projection of future pension benefits is presented in chapter 4. It includes a description of the pension data as well as of the assumptions taken. Chapter 5 presents the results of our study from three perspectives: 1) an assessment of the long-term cash balance forecast, 2) an analysis of the intergenerational redistribution and 3) of the adequacy of future pension benefits. Finally, chapter 6 provides a summary of the main findings and the outlook on future research.

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1 The authors apply a different wage growth for adequacy analysis than for the aggregate expenditure projections.
2 The outcomes provided by Bielecki (2011) are estimated by different institutions, consistency of the estimation approach is therefore questionable.
3 The authors take the simplifying assumption that individuals show no interruptions in their working career.
4 Egert (2012) e.g. bases on the assumption that all individuals born after 1948 participate in the FDC system.
2 Legal framework

The Polish old-age provision in its current shape was founded in 1999, when the NDC and FDC pillar was introduced. It replaced the old-age-pension provision system, with a traditional defined benefit formula (DB). In the following passages we outline the old pension rules set up during the transformation period (section 2.1). Thereafter, the benefit formula of the new NDC system introduced in 1999 is described (section 2.2). Finally, we illustrate the main changes introduced with the FDC cut (section 2.3) and the increase in retirement ages to 67 (section 2.4).

2.1 The ‘old’ defined benefit formula

The pension benefit formula for the old system (persons born before 1949 and miners\(^5\)) is a quite complex procedure, so the initial remarks on the computation stages and used variables might be useful. The calculation of the pension benefit amount for year \(j\) consists of several steps. Firstly, a person that applies for the old-age pension chooses any 10 consecutive years from his/her career path, out of the last 20 years of the career \((j-20)\) that will serve as a background for the individual index of the basis for contribution rates (IBCR), expressed in percentage points. Obviously, 10 consecutive years with the highest salaries are chosen: the IBCR is an average of the annual gross income earned in the chosen 10 consecutive years in relation to respective annual average salaries in the economy. The IBCR maximum level is limited to 250%. The individual IBCR serves then as a multiplier for the general base amount (BA), a countrywide figure common for all types of social benefits. BA is computed as an average gross salary in the entire economy in the last quarter of the year \(j-1\) net of the social contributions. In effect, the individual basis for contribution rates (BCR) is expressed in Polish zloty.

\[
(1) \quad BCR = IBCR \times BA
\]

Further crucial individual indicators necessary to calculate the benefit level are: the number of contributory periods\(^6\) \((x_{CP})\) and non-contributory periods \((x_{NCP})\). The contributory periods are those when the social contributions were actually paid, whilst non-contributory periods are those for which the given person was regarded as insured.

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\(^5\) The formula for miners is slightly different, nevertheless we do not enter into details in this paper.

\(^6\) Expressed in months. For the purpose of this study we round them to full years.
though the contributions were not paid. The non-contributory periods taken to the old-age pension formula cannot exceed 1/3 of contributory periods.

\[
\max x_{\text{NCP}} \leq \frac{1}{3} \times x_{\text{CP}}
\]

The initial monthly old-age pension for a person (OAP) who applied for a benefit in year \( j \) is computed as follows:

\[
OAP_j = 24\% \times BA_j + 1,3\% \times BCR_j \times x_{\text{CP}} + 0,7\% \times BCR_j \times \max x_{\text{NCP}}
\]

### 2.2 1999 reform: introduction of the NDC & FDC schemes

In the new mixed system based on individual funded and unfunded accounts the statutory retirement age remained unchanged: 60 years for women and 65 years for men. However, after 1999, the possibility to retire earlier, easily accessible to many professions included in the new system (e.g. miners, railway workers, teachers, persons working in specific conditions), hampered the positive, self-stabilizing effect of the new NDC rules. Early retirement was partly abolished in 2008. The only professional group which kept their early retirement privileges in an infinite time horizon, are miners. For the other groups a temporary ‘bridging pension’ system was installed to ease the process of the abolition of early retirement. The new reformed NDC system treats insured persons differently depending on their year of birth:

- For persons born before 31st December 1948 all paid contributions remained in the old system, so for them the pension is calculated using the old rules.
- Persons born between 1st January 1949 and 31st December 1968 could choose whether to stay only in the NDC system or enter the one with split contributions between NDC and FDC schemes. Despite their choice the ‘initial capital’ was computed to reflect the notional contributions virtually collected during the working life by persons with work experience before 1999. Initial capital was computed to translate the pre-reform working career to NDC contributions.
- All contributors born after 1st January 1969 are mandatorily covered by the new, shared NDC/FDC system.

Since the pension reform of 1999 the Polish general pension system is based on a three pillar system, consisting of the following public and private schemes:
1. 1st pillar: mandatory notional defined contribution scheme (NDC), where amounts of contributions are recorded on individual accounts, set for every insured person. The actual contributions are spent on current social benefits. The collected, “virtual” amounts are indexed annually with the floating interest rate, currently reflecting ZUS pension contributions fund growth. The sum of contributions collected over lifetime and indexed is divided upon retirement by the number of (expected) months of remaining life. Life expectancy tables are unisex, officially published and updated annually by the NSI.

2. 2nd pillar: mandatory funded defined contribution schemes, so called open pension funds (FDC), where around 60% of employee contributions from the 1st pillar is transferred and then invested.

3. 3rd pillar: consists of diverse forms of private voluntary pension insurance funds.

The pension benefit which applies for the NDC old-age pension (NOAP) in year (j), equals the quotient of the basis for contribution rates (BCR) and the expected unisex life expectancy at the age (reached in year x) of the pension applicant (LE_j) expressed in months.

\[ \text{NOAP}_j = \frac{\text{BCR}_j}{\text{LE}_x} \]

The individual benefit basis BCR is equal to the sum of pension contributions collected on the notional individual pension account (NDC) and the initial capital (IC).

\[ \text{BCR}_j = \text{NDC}_j + \text{IC}_j \]

The stock of the initial capital is computed similarly to the OAP (3), although, always for the 1 January 1999, and then increased with the use of full wage indexation until the moment of application for computation, e.g. upon retirement. Comparing with the DB old-age pension formula, there are a few modifications: there’s no limitation on the number of non-contributory periods considered in the formula, as in the case of OAP – the entire proven career path is considered. Secondly, the so called social part is computed with the use of basis amount (see (1)) from the second quarter of 1998\(^7\) (BA\(_{IC}\)) and the \(p\) factor, which is calculated on the basis of the age of a contributor \(age_n\), contributor’s work

\(^7\) PLN 1220.89. More insight into actual IC figures in Annex 2.
experience \( (x_{CP}, x_{NCP}) \) and the required number of contributory and non-contributory periods \( x_{CP,NCP}^{req} \) (gender specific: 20 years for women, and 25 years for men). The \( p \) is limited to 100\%. The retirement age \( pens \ age_h \) is administratively set to the age of 60 for women, and 65 for men, the unisex life expectancy in 1999 for a person aged 62 (\( LE_{IC} \)) amounts to 209 months, whilst the number 18 (in \( p \)) refers to the presumed starting point of the professional career, replaced possibly by the actual age, upon verification.

\[
p = \sqrt{\frac{\text{age}_{h} - 18}{pens\ age_{h} - 18} \times \frac{\Sigma (x_{CP} + x_{NCP})}{x_{CP,NCP}^{req}}}
\]

\[
IC_{h} = \left( 24\% \times BA_{IC} \times p + 1,3\% \times BCR_{h,IC} \times x_{CP} + 0,7\% \times BCR_{h,IC} \times x_{NCP} \right) \times LE_{IC}
\]

where:

\[
BCR_{h,IC} = IBCR \times BA_{IC}
\]

The insured persons born after 1969 and those who had chosen to participate in the FDC scheme have their pensions raised by the adequate portion of the FDC contributions:

\[
BCR_{j,FDC} = \frac{NDC_{j} + FDC_{j} + IC_{j}}{LE_{age_j}}
\]

There are also other systems, established for certain professions, e.g. farmers, uniformed services and judges and prosecutors. These systems are in principle based on defined benefits formulas, and are not covered by this paper.

### 2.3 FDC cut

In 2011 the government decided to change the proportions between the notional and funded part of the old-age pension contribution. Since the introduction of the NDC/FDC reform in 1999, the contribution rates remained unchanged until 2011, amounting, as stated above, to 12.22\% notionally recorded on the individual NDC account, and 7.3\% actually saved on the FDC account. Due to public budget constraints and sluggish

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8. The rules have not changed after the introduction of RA67 reform. Such change would increase the denominator in the \( p \) factor and decrease the level of initial capital, especially for women.

9. For a more comprehensive description see chapter: Revenue side – NDC system.
investment policy of the FDC managing funds, the government changed in 2011 the proportions of the contributions transferred to the unfunded and funded pillar.

In May 2011 the new split of contributions was introduced: the FDC part was lowered from the initial 7.3% to 2.3% and the NDC part was split into two subaccounts: NDC 1 and NDC 2. The indexation rules for the NDC 1 remained unchanged and equal to the nominal growth of the wage fund in the economy, whilst the new NDC 2 part, held also in the ZUS, will be indexed in accordance with the average past 5 year nominal growth of the GDP. The table below explains the exact contribution split in the coming years between NDC 1, NDC 2 and FDC:

Table 1: Old-age pension contribution rates for NDC 1, NDC2, and FDC in the coming years

<table>
<thead>
<tr>
<th>Years</th>
<th>NDC 1 in % of gross income</th>
<th>NDC 2 in % of gross income</th>
<th>FDC in % of gross income</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999 - May 2011</td>
<td>12.22</td>
<td>0.0</td>
<td>7.3</td>
</tr>
<tr>
<td>May 2011-2012</td>
<td>12.22</td>
<td>5.0</td>
<td>2.3</td>
</tr>
<tr>
<td>2013</td>
<td>12.22</td>
<td>4.5</td>
<td>2.8</td>
</tr>
<tr>
<td>2014</td>
<td>12.22</td>
<td>4.2</td>
<td>3.1</td>
</tr>
<tr>
<td>2015</td>
<td>12.22</td>
<td>4.0</td>
<td>3.3</td>
</tr>
<tr>
<td>2017 onwards</td>
<td>12.22</td>
<td>3.8</td>
<td>3.5</td>
</tr>
</tbody>
</table>

Source: own illustration based on official act

Moreover, the contribution fees of FDC accounts were cut from the possible maximum of 7% to 3.5%. The structure of investment of the FDC will change as well in the future: the limit of the investment in shares\textsuperscript{10} will be raised gradually from 40% now to 90% in 2034. However, the limit for investment in foreign assets will remain unchanged at 5%.

2.4 Increase in legal retirement ages to 67

With the reform proposal, passed by the Parliament in May 2012, the statutory retirement age for men and women insured in the general public old-age pension system (NDC/FDC) will gradually rise for women from 60 to 67 (from 2013 until 2040) and for men from 65 to 67.

\textsuperscript{10} Only these quoted on the domestic stock exchange (GPW).
67 (from 2013 until 2020). Actually, the retirement age would be increased by 3 months each year, but our model recognizes whole years cohorts, so in the results we will observe retirement age increase by 1 full year every 4 years. In principle the retirement age (RA) for men would increase as follows: 2016 RA=66; 2020 RA=67. Regarding women, their retirement age would be increased as follows: 2016 RA=61, 2020 RA=62, 2024 RA=63, 2028 RA=64, 2032 RA=65, 2036 RA=66, 2040 RA=67. The detailed table with birthdates, ages, and respective earliest retirement dates can be followed in Annex 3. The reform leaves unchanged the special privileges granted in the past decades e.g. to miners, bridging pensioners, teachers or pre-retirement beneficiaries.

To ease the possible social tensions related to the extended working period, the reform introduces the possibility to retire before the statutory retirement age under a mechanism of a so-called partial old-age pension (POAP). The POAP would apply if the following conditions were met for women: 62 years of age and 35 years of working experience (insurance)\(^{11}\) and for men respectively: 65 years of age and 40 years of working experience (insurance). Where these conditions are satisfied, the POAP will be possible, amounting to 50% of the full old-age pension (FOAP). The POAP would not be increased to the level of the minimum pension, however, it would be indexed in accordance with the standard rules applied to FOAP and other social benefits. The POAP would be paid despite (dis)continuation of work. Therefore, in practice it would be possible to reduce partly the workload from the age of 62/65 for women/men with a partial reduction of the salary replaced to some extent by the POAP. Upon reaching the statutory retirement age, an insured person could apply for the retirement, and then the POAP would turn into FOAP. In such cases, the basis for the calculation of the FOAP would be reduced by the gross amounts of already paid POAP benefits. The capital (funded) old-age pension would be adequately affected, too. Specifically, the temporary capital old-age pensions (TCOAP), paid currently until the age of 65, would have to be adjusted to the extended working period of women. Therefore, in the transition period of 2014-2020, the age required in order to be able to receive the TCOAP would be extended from 65 to 67. After a woman reaches the statutory retirement age, the TCOAP would transform into the lifetime capital

\(^{11}\) To be precise, it denotes so-called contributory and non-contributory periods. Contributory periods entail employment or self-employment. Non-contributory periods mean the periods of insurance, when contributions were paid for the insured person, e.g. during unemployment or a maternal leave. The non-contributory periods may amount to up to \(\frac{1}{4}\) of the overall working experience (e.g. studies).
old-age pension (LCOAP). The TCOAP is a temporary instrument, applicable until the full phase-in of the gender-unified retirement age.\textsuperscript{12}

The minimum pensions were also adjusted: the working experience (insurance) period required to obtain entitlement to compensation of the pension to the minimum level will be extended gradually for women from 20 to 25 years. The transition periods starts in 2014, and since then the working experience period will be extended 1 year every two years, until the end of 2021.

\textsuperscript{12} Temporary pensions (POAP and TCOAP) will not be addressed in the results for the first two facets: cash flows and intergenerational redistribution. We will tackle them shortly in the part devoted to adequacy ratios.
3 Applied Indicators

To assess the long-term performance of the pension system a number of indicators are applied in this study. Our indicators of the long-term fiscal stability are based on the methodology of Generational Accounting which is outlined in section 3.1. The applied indicators of fiscal sustainability and intergenerational redistribution are described in section 3.2. Thereafter, the applied adequacy indicator is presented in section 3.3.

3.1 The methodology of the Generational Accounting

To measure the sustainability of a country’s public sector we use the method of Generational Accounting developed by Auerbach, Gokhale and Kotlikoff (1991, 1992 and 1994). In contrast to traditional budget indicators which are based on annual cash flow budgets, Generational Accounting is founded on the intertemporal budget constraint and therefore the long-term implications of a current policy can be computed.

The intertemporal budget constraint of the public sector, expressed in present value terms of a base-year \( b \) is:

\[
B_b = \sum_{k=b}^{b-D} N_{b,k} + \sum_{k=b+1}^{\infty} N_{b,k}
\]

Let \( D \) denote agents’ maximum age and \( N_{b,k} \) the present value of year \( b \)'s net tax payments, i.e. taxes paid net of transfers received, made by all members of a generation born in year \( k \) over the remaining lifecycle. Then, the first right-hand term of equation (11) represents the aggregate net taxes of all generations alive in the base-year \( b \). The second term aggregates the net tax payments made by future generations born in year \( b + 1 \) or later. Together this is equal to the left-hand side of equation (11), \( B_b \), which stands for the net debt in year \( b \). That means if the sum of all living generations’ net taxes, \( \sum_{k=b}^{b-D} N_{b,k} \), is negative (i.e. if they receive a net transfer) and the net debt, \( B_b \), positive, the sum of future

generations’ net taxes has to be positive to balance the government’s intertemporal budget i.e. in a long-term perspective net transfers received by living generations plus the net debt of the base-year have to be financed by net taxes paid by future generations.

To calculate generations’ aggregated lifecycle net tax payments, the net payment terms in equation (11) are decomposed into:

\[ N_{b,k} = \sum_{s=\max(b,k)}^{k+D} T_{s,k} P_{s,k} \left(1+r\right)^{b-s} \]

In equation (12), \( T_{s,k} \) denotes the average net tax paid in year \( s \) by a representative member of the generation born in year \( k \), whereas \( P_{s,k} \) stands for the number of members of a generation born in year \( k \) who survive until year \( s \). To compute the remaining lifetime net payments of living generations, the future demographic structure is specified conducting long-term population forecasts.

Typically, Generational Accountants disaggregate equation (12) even further. To incorporate gender-specific differences in average tax payments and transfer receipts by age, separate aggregation of the average net taxes paid by male and female cohort members is required. The products aggregated in equation (12) represent the net taxes paid by all members of generation \( k \) in year \( s \). For generations born prior to the base-year the summation starts from year \( b \), while for future born cohorts, the summation starts in year \( k > b \). Irrespective of the year of birth, all payments are discounted back to the base-year \( b \) by application of a real interest rate \( r \).

The age-specific net tax payment in year \( s \) of agents born in year \( k \) can be decomposed as

\[ T_{s,k} = \sum_i h_{s,k,i} \]
$h_{s,k,i}$ stands for the average tax or transfer of type $i$ paid or received in year $s$ by agents born in year $k$, thus of age $s-k$. In equation (13), $h > 0$ indicates a tax payment, whereas $h < 0$ defines a transfer.

Applying the method of Generational Accounting it is conventionally assumed that the initial fiscal policy and economic behaviour are constant over time. Under this condition it is possible to project future average tax payments and transfer receipts per capita from the base-year age profile of payments according to

\[ h_{s,k,i} = h_{b, b-(s-k),i} (1 + pg)^{s-b} \]

where $pg$ represents the annual rate of productivity growth. Equation (14) assigns to each agent of age $s-k$ in year $s$ the tax and transfer payment observed for agents of the same age in base year $b$, uprated for gains in productivity. The base-year cross section of age-specific tax and transfer payments per capita is generally determined in two steps. First, the relative position of age cohorts in the tax and transfer system is estimated from micro-data profiles. In a second step the relative age profiles are re-evaluated proportionally to fit the aggregated expenditure and tax revenues of the base-year.

### 3.2 Long-term fiscal stability and intergenerational redistribution Indicators

**Generational Accounts**

For living and future generations, the division of the aggregate remaining lifetime net tax payments by the number of cohort members alive in year $s$ defines the cohort’s Generational Account in year $s$:

\[ GA_{s,k} = \frac{N_{s,k}}{P_{s,k}} \]

Generational Accounts are constructed in a purely forward-looking manner, only the taxes paid and the transfers received in or after the base-year are considered. As a consequence, Generational Accounts cannot be compared across living generations because they incorporate effects of differential lifetime. One may compare, however, the

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14 In the case of an analysis of isolated subsystems of public finances, like health care or pensions as conducted in the following chapters, $i$ is chosen so that all relevant payment streams are included in the analysis.
Generational Accounts of base-year and future born agents, who are observed over their entire lifecycle. Additionally, one may compare generational accounts before and after the introduction of a fiscal reform to measure intergenerational redistribution effects, i.e. to estimate which cohorts bear the highest burden of a legislative change. This latter approach is applied in section 5.

The Sustainability Gap

To illustrate the fiscal burden of current fiscal policy we use seven sustainability indicators. The starting points for the first indicators are the intertemporal public liabilities which can be computed by the assumption that the intertemporal budget constraint of the public sector (11) is violated:

\[
IPL_b = B_b - \sum_{k=b-D}^{\infty} N_{b,k}
\]

The amount of intertemporal public liabilities \((IPL)\) measures aggregate unfunded claims on future budgets, assuming that the present policy will hold for the future. The first sustainability indicator, the sustainability gap \((SG_b)\), can be derived if the intertemporal public liabilities are set in relation to base-year’s GDP \((GDP_b)\). This indicator is akin to the debt quota well known since the Maastricht Treaty but it addresses the debt which will occur in the future and in the past:

\[
SG_b = \frac{IPL_b}{GDP_b}
\]

As Benz and Fetzer (2006) have shown all the indicators described above are computed with an infinite time horizon. In the practical calculation all relevant variables like population or cohorts’ tax payments are projected for 300 years from the base-year on. Afterwards a geometrical series is used to determine the remaining net tax payments. The

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15 For a discussion of measuring fiscal sustainability and the development of sustainability indicators, see Raffelhüschen (1999) and Benz and Fetzer (2006).
choice of 300 periods is nearly completely arbitrary and just reflects a good approximation point for our analysis.\footnote{Due to the higher level of discount in relation to the growth rate fiscal flows in the very remote future do not play a large role for our present value calculation since they are highly discounted. Therefore, it has only a marginal effect if one ends the projection after 300 years instead of 300 + x years.}

**Annual Cash Flows of revenues and expenditures**

The above presented indicators measure sustainability by one single number. This approach is valuable as it provides a comprehensive indicator of sustainability. It is especially appropriate for comparisons of reforms and between fiscal systems. Most policy makers are, however, not yet familiar with such aggregated figures and the underlying concepts. Therefore, we provide the standard indicator of annual cash flows, too. On this basis we demonstrate the development of aggregate expenditures $Exp$ and revenues $Rev$ in future years $s$. Additionally, cash flows are valuable as they outline “timing effects”. In other words, one may illustrate the extent of deficits and surpluses of a fiscal system for a given future year. They are simply estimated by a multiplication of age average contributions $Con$ and $Ben$ (per capita of the population) with the respective cohort sizes $P$ of the population in year $s$.\footnote{We further differentiate the estimation by gender. For reasons of simplicity this aspect is left out in the equations above.}

\begin{align}
    Rev_s &= \sum_{j=b}^{b+D} Con_{s,j} \cdot P_{s,j} \\
    Exp_s &= \sum_{j=b}^{b+D} Ben_{s,j} \cdot P_{s,j}
\end{align}

### 3.3 Adequacy Indicators

**Adequacy ratios**

The standard figure for adequacy analysis is the replacement rate (RR). The RR expresses the pension level in relation to earnings. Usually, pensions are compared to the pre-retirement income of the pensioner. The idea is that the individual aims to (at least partly) replace former earnings. In other words, a pensioner wants to have a certain proportion of his former earnings. We deviate from this approach and relate the initial pension benefit to the average wage in the economy for two reasons: 1) For some employment groups,
namely the self-employed, the contribution basis is rather low and does not provide an indication for the earnings which need to be replaced. 2) For some individuals the pre-retirement earnings are very low or even zero due to unemployment. Therefore, we opt, like Egert (2012), for the average wage in the economy as a benchmark for pension levels. This adequacy ratio (AR) is formally estimated for a year $s$, age $x$ and gender $g$ by dividing the new pension benefit in year $s$ by the average wage in the economy in year $s$.

\[ AR_{s,x,g} = \frac{Ben_{s,x,g}}{wage_s} \]
4 Computation Approach

To cover all three perspectives of the pension system evaluation we rely on two pension models. We start with a brief description of the demographic developments in section 4.1. The applied micro-simulation model and the respective data inputs used for the calculation of adequacy ratios is described in section 4.2. The cohort model to project future aggregate expenditures and revenues and to estimate generational accounts is presented in the following section 4.3. Both models are based on a consistent framework of data inputs as well as of demographic and economic assumptions, as far as feasible.

4.1 Population projection

The projections used to compute the the fiscal projection of the Polish pension system is based on assumptions of EUROPOP2010, the latest population projection of Eurostat, which is consistent with the available national forecasts of the CSO.

Based on different assumptions about the three main demographic drivers, i.e. life expectancy, fertility and migration it is possible to derive a population projection for various demographic scenarios. Own calculations are necessary for the reason of GA assumed infinite time horizon: the official projections end in 2060 while we apply a 300 years projection period. For these calculations we rely on the data and assumptions of Europop 2010 (convergence scenario) which give assumptions on the above mentioned parameters until the year 2060. After this year the demographic parameters are held constant. Table 2 shows those central assumptions for our standard scenario.
Table 2: Assumptions of the demographic scenarios

<table>
<thead>
<tr>
<th></th>
<th>Standard scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female life expectancy at birth in 2010</td>
<td>80,1</td>
</tr>
<tr>
<td>Male life expectancy at birth in 2010</td>
<td>71,7</td>
</tr>
<tr>
<td>Female life expectancy at birth in 2060</td>
<td>87,9</td>
</tr>
<tr>
<td>Male life expectancy at birth in 2060</td>
<td>82,4</td>
</tr>
<tr>
<td>Fertility – 2010</td>
<td>1,40</td>
</tr>
<tr>
<td>Fertility – 2060</td>
<td>1,56</td>
</tr>
<tr>
<td>Net migration 2010</td>
<td>11.732</td>
</tr>
<tr>
<td>Net migration 2060</td>
<td>14.123</td>
</tr>
</tbody>
</table>

Source: own illustration based on Eurostat

Figure 1 illustrates our population projection – the main basis for our calculations. It is said that demography reflects to a great extent the history of the respective country. This becomes apparent when looking at Poland’s age specific population structure in the base year 2010. First of all, one can clearly identify the impact of World War II on the cohorts born between 1941 and 1946. As commonly observed during periods of war and unrest, birth rates were relatively low, resulting in relatively small cohorts aged around 65 in 2010. After the end of World War II the fertility rate recovered quite rapidly, which led to strong cohorts aged 45 to 60. During the 1960s and 1970s the total fertility rate decreased from nearly 3.0 to 2.2 children per woman. This explains to some extent the drop in cohort sizes, which can be observed around the age group of 40 in 2010. The subsequent gains in birth numbers can be traced back to the fact that the respective cohorts have been born by those aged 45 to 60 in 2010. Due to the fact that these are quite large in numbers, their children are numerous as well. After the opening of the Iron Curtain in 1989, however, Poland displayed a steep fall in natality—as in most formerly communist countries. In order to project Poland’s demographic future, assumptions about fertility rates and life expectancy for the coming decades are needed. In accordance with the population projection, Europop2010 (conducted by Eurostat) we assume that the fertility rate will remain low and will only slightly increase from currently 1.4 children per woman to 1.56 until 2060. The assumed evolution of life expectancy in Poland is broadly similar to the rest.
of Europe. While an average male (female) born in 1990 could expect to live for 66.3 (75.3) years, this value is assumed to rise to 71.7 (80.1) for a male (female) born in 2010. In comparison to most other EU countries this increase in life expectancy by three months per year is particularly fast. According to Eurostat life expectancy of a male (female) newborn will further increase by around eleven (seven) years until 2060.

Figure 1: Structure of Polish population

Both, declining fertility rates and the ongoing and rather steep increase in life expectancy lead to a significant ageing process in Poland. As a result, the Polish population pyramid’s appearance will considerably change in the coming decades (see Figure 2). The pace of this aging process is exceptional—compared with other European countries. This can be illustrated by the old-age dependency ratio, defined as the number of persons aged 65 and older, relative to those between 15 and 64. As illustrated in Figure 2, this indicator will rise from about 20% in 2010 to roughly 70% in 2060, which is a steeper increase than in any other EU country, except Slovakia. The demographic development of this kind puts substantial pressure on a pay-as-you-go (PAYG) pension system and can thus be understood as the main reason for the sweeping pension reforms that are described in detail in chapter 2.3 and 2.4. As Figure 2 outlines, our demographic projection follows closely the forecast of the Eurostat.
4.2 **Micro-Simulation Model**

Having available the 1% sample data, which contains very broad information collected by the ZUS about the contributors and the beneficiaries of the public pension system, we differentiate between sub-groups of contributors, whose old-age pension settings vary between each other. One group, the employees, has to declare the entire gross income for contribution calculation, whilst the other group, the self-employed, may declare only a part of it. Additionally, we differentiate into FDC participants and those who decided to collect all their contributions only on the NDC account. Due to a new pension formula, which makes the pension benefit strictly dependent on the contributions collected on the NDC (&FDC) account, the varying declared income should have a very significant influence on the adequacy ratios. The FDC and non-FDC division may be interesting if a considerable difference in internal rate of return would occur in the future between NDC and FDC schemes. Therefore, the 1% sample was divided into 4 groups:

- Employees, members of the FDC,
- Self-employed, members of the FDC,
- Employees, not participating in the FDC*,

---

**Figure 2: The development of the age dependency ratio in Poland**

![Chart showing the development of the age dependency ratio in Poland](chart.png)

*Source: own calculations*
• Self-employed, not participating in the FDC*.18

More detailed description of the data can be found in Annex 2 on the input data.

The micro simulation model is used for the estimation of future adequacy ratios. The main input data represent the initial capital as well as NDC and FDC contributions paid since 1999 – described in section 4.1.1. Based on this past contribution history future contributions are projected until the point of retirement – outlined in section 4.1.2.

4.2.1 Contribution history – initial capital and NDC/FDC contributions

4.2.1.1 Initial capital

The initial capital (IC), which reflects the contribution career before 1999, if any, computed by the ZUS for each individual who decided to declare it upon the introduction of the reform in 1999, shows interesting regularities, to be followed in details from Figure 3 to Figure 6. First, it has to be noted that the 1% sample IC data was full of empty records. Often the two lower quartiles were filled with zeros. According to our estimates based on data provided by the ZUS, nearly 35% of insured persons born between 1950 and 1980 have not applied yet for the initial capital calculation. Therefore, the lower 35% distribution of the IC data was removed for these cohorts, assuming that the statistical distribution of the initial capital for these persons will follow the data of persons who have already applied for the initial capital calculation. For a detailed description of the consequences and a profound description of the input data see Annex 2. Regarding the meaning of the remaining 65% of the initial capital, men’s accounts are more numerous and have recorded slightly higher values for all statistical measures than women’s – from the 1st quartile up to a margin of statistical error (97.5%), as shown in Figure 3. The dump in early data for females stems most probably from the fact that women retire earlier by 5 years. As a consequence, older cohorts are less covered in the database – as they have already retired.

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18 * Due to the fact non-FDC members to a large extent show very similar characteristics as FDC members, we describe them in Annex 1.
Figure 3: Initial capital of employees, FDC members, indexed to January 2011

Source: own calculations based on 1% sample provided by the ZUS

Figure 4: Initial capital of self-employed FDC members, indexed to January 2011

Source: 1% sample provided by the ZUS

19 The zigzag shape of the chart for all analyzed measures is due to the smaller number of representatives in the self-employed persons’ group, compared with employees, see Figure 53 - Figure 55.
4.2.1.2 Pension contributions (NDC or NDC&FDC) paid between 1999 and 2011

The following passages will be devoted to the analyses of the amount of contributions paid by the ZUS contributors in the base year 2010, using also 1% sample filtered data. According to existing rules, the employees are required to declare full income for pension contribution purposes. The law imposes a minimum contribution threshold via the minimum salary level for employees.\(^\text{20}\) The contributions paid on this basis amount to PLN 257 in the base year. The self-employed have a choice to declare their entire income or its amount limited to the minimum of the annual floor of 60% of the average salary in the economy. The pension contributions paid on this basis amounted to PLN 368 in the base year.

**Figure 5: Employees FDC members, pension contributions (NDC&FDC), 2010**

The gender specific distribution of the contributions paid by employees shows no significant differences. Two horizontal lines in Figure 5 represent the lowest possible amounts of payable contributions: solid line gives an indication of the contributions related to the minimum possible amount payable by the self-employed (60% of the average salary) – expected to be prominent in the self-employed group, however present

\(^{20}\) For details see Annex 2.
also in the employees group.\textsuperscript{21} Second horizontal line (dotted black) represents the minimum contribution level paid on the basis of the minimum salary. Apparently, in the group of employees these two margins serve as ‘resistance levels’\textsuperscript{22} for individuals, who pay the median contributions. The 3rd quartile and the average employee, irrespective of gender, show gradual decrease in the salary/contribution starting from the birth year around 1972, which may prove to be the effect of the shorter promotion path decreasing with each consecutive birth year.

\textbf{Figure 6: Self-employed FDC members, monthly pension contributions (NDC&FDC), 2010}

The differences between particular contribution sub-groups are more visible in the group of self-employed persons, depicted in Figure 6. The outliers (97.5% quintile), who pay the highest contributions, declare half of the earnings compared to employees-outliers. The third quartile self-employed contributors (75%) pay a minimum possible amount of PLN 368, until the birth year of around 1970, when all referred statistical measures start

\begin{itemize}
\item \textsuperscript{21} An individual is classified as employee (self-employed) if for the majority of the 1999-2011 period he has an employee (self-employed) record. As a consequence, some individuals from the group of employees may in fact be self-employed in the base year, or vice versa.
\item \textsuperscript{22} The references we make to each group will be used later in the description of adequacy rates, where we will look how the minimum salary and the 60% of the average salary correspond to the replacements rates for particular cohorts.
\end{itemize}
decreasing (short career path effect). Figure 5 and Figure 6 show significant difference between the average values and the median: the reason lies in the method of data selection, which in the base year includes all IDs for which the IC or any contributions were recorded in the period 1999-2010. In consequence, the average is ‘polluted’ by individuals, who did not declare any contributions in the base year or were unemployed without resorting to an unemployment benefit.

In conclusion to the analyses of the pre- and post-1999 reform records of the registered labour activity for pension contribution purposes, we may summarize our findings as follows:

- There are no significant differences in the amount of the initial capital recorded so far on men’s and women’s accounts;
- The initial capital as well as the NDC/FDC pension contributions of self-employed persons amount roughly to half of these recorded on average in the case of employees;
- Up to 75% of the self-employed pay the lowest allowed amount of contributions (or less); 50% of employees declare the minimum salary (or less) in the ZUS records.
- Around 25% of employees declare gross income ranging from the minimum to average salary level in the economy (3rd quartile) for pension purposes.
- If employees switched to self-employment after 2005, the median of their declared income would fall to around the 60% of the average salary in the economy.
- Statistical measures are highly affected by individuals who evade the registered forms of the employment or who are indeed inactive on the labour market (significant number of empty or nearly empty accounts).

4.2.2 Projection of future pension benefits

The level of future pension benefits depends first of all on the pension rights accrued-to-date until the end of base year b, in our case the year 2010. With the use of the 1% sample, described in the previous section, we can estimate these pension entitlements on the basis of data of actual contribution histories. Furthermore, the 1% sample provides the
basis to differentiate the estimation of pension rights by one year cohorts of age \( x \), by
gender \( g \) and by group types \( t \).\(^{23}\)

We divide the calculation of pension rights accrued until the end of base year \( b \) into NDC
\( (TA_{x,g,b,t}^{NDC,accrued-to-date}) \) and FDC \( (TA_{x,g,b,t}^{FDC,accrued-to-date}) \) pension entitlements — as
illustrated in the equations below.

\[
(21) \quad TA_{x,g,b,t}^{NDC,accrued-to-date} = \left( IC_{x,g,1999,t}^{actual} \prod_{1999}^{b+1}(1 + i_{NDC,past}^{t}) + \sum_{s=1999}^{b} C_{s-c,g,s,t}^{NDC,actual} \prod_{s+1}^{b+1}(1 + i_{NDC,past}^{t}) \right)
\]

\[
(22) \quad TA_{x,g,b,t}^{FDC,accrued-to-date} = \sum_{s=1999}^{2010} C_{s-c,g,s,t}^{FDC,actual} \prod_{s+1}^{b+1}(1 + i_{FDC,past}^{t} - F_{i_{account}}^{t}) \]

The level of the total NDC account in 2010 depends on the actual level of initial capital
\( (IC_{x,g,1999,t}^{actual}) \) of the year 1999 indexed to the end of the base year as well as on the actual
NDC contributions paid in the period 1999-2010 \( C_{s-c,g,s,t}^{NDC,actual} \) of a birth year cohort \( c \). The
level of the total FDC account in 2010 is determined by FDC contributions \( C_{s-c,g,s,t}^{FDC,actual} \)
paid from 1999 till 2010. For the estimation of FDC pension rights we take additionally
into account the FDC contribution fees \( (F_{i_{account}}^{account}) \).\(^{24}\)

All past contributions as well as the initial capital are reevaluated to the base year. This is
carried out via the valorisation factor which reflects the product of past NDC
\( (i_{NDC,past}^{t}) \) and FDC \( (i_{FDC,past}^{t}) \) rates of return from the year after the contribution was
made until the year \( b+1 \). In the case of FDC we additionally consider the account fee
\( F_{i_{account}}^{account} \).\(^{25}\) Table 3 summarizes the applied valorisation factors for NDC and FDC.

\(^{23}\) We differentiate our calculations by one year age groups from age 20 to 60 in 2010, by male and female
gender as well as by the four groups 1) employed FDC member, 2) employed non-FDC member, 3) non-
employed FDC member and 4) non-employed non-FDC member. For a further description of group types see
the previous section and the annex on input data.

\(^{24}\) The past FDC contribution fees amount to 7% of contributions in our computations for the years 1999 until
2009. Thereafter, they add up to 3.5% of contributions.

\(^{25}\) The past FDC account fee is set at 0.6% (annually) of the total FDC account for the years 2000 until 2009. For
the years after 2009, they amount to 0.5% of the total FDC account.
Table 3: Valorisation factor of the FDC contributions and of NDC contributions & the initial capital

<table>
<thead>
<tr>
<th>Year the contribution was made</th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>FDC valorization factor to the year 2011</td>
<td>289%</td>
<td>268%</td>
<td>243%</td>
<td>220%</td>
<td>192%</td>
<td>168%</td>
<td>146%</td>
<td>134%</td>
<td>123%</td>
<td>113%</td>
<td>109%</td>
<td>104%</td>
</tr>
<tr>
<td>NDC valorization factor to the year 2011</td>
<td>225%</td>
<td>199%</td>
<td>187%</td>
<td>183%</td>
<td>180%</td>
<td>174%</td>
<td>164%</td>
<td>154%</td>
<td>136%</td>
<td>117%</td>
<td>109%</td>
<td>105%</td>
</tr>
</tbody>
</table>

*Source: own estimation based on ZUS (2012) and KNF data.*

The total of pension entitlements at the effective retirement age \( r \) in a future year \( f \) depends on the pension rights accrued until the base year (see first squared bracket in the two equations below) and the pension rights accrued after the base year until the future year \( f \) (see second squared bracket in the two equations below: (23) and (24)). We divide the estimation of future total pension entitlements into NDC1, NDC2 and FDC.\(^{26}\)

\[
(23) \quad T_{r,g,f,t}^{\text{NDC}_1,\text{future}} = \left[ T_{r-(f-b),g,b,t}^{\text{NDC}_1,\text{accrued-to-date}} \ast \prod_{i=b+1}^{f} (1 + i_i^{\text{NDC}_1,\text{future}}) \right] + \\
\left[ \sum_{s=b+1}^{f} c_{s-c,g,s,t}^{\text{NDC}_1,\text{projected}} \ast \prod_{i=s+1}^{f} (1 + i_i^{\text{NDC}_1,\text{future}}) \right]
\]

\[
(24) \quad T_{r,g,f,t}^{\text{FDC},\text{future}} = \left[ T_{r-(f-b),g,b,t}^{\text{FDC},\text{accrued-to-date}} \ast \prod_{i=b+1}^{f} (1 + i_i^{\text{FDC},\text{future}} - F_{i}^{\text{account}}) \right] + \\
\left[ \sum_{s=b+1}^{f} c_{s-c,g,s,t}^{\text{FDC},\text{projected}} \ast (1 - F_{s}^{\text{contrib}}) \ast \prod_{i=s+1}^{f} (1 + i_i^{\text{FDC},\text{future}} - F_{i}^{\text{account}}) \right]
\]

\[
(25) \quad T_{r,g,f,t}^{\text{NDC}_2,\text{projected}} = \left[ \sum_{s=b+1}^{f} c_{s-c,g,s,t}^{\text{NDC}_2,\text{projected}} \ast \prod_{i=s+1}^{f} (1 + i_i^{\text{NDC}_2,\text{projected}}) \right]
\]

All pension entitlements are revaluated to the future year of retirement \( f \) considering the respective rates of return of each scheme illustrated in Figure 7 as well as changing retirement ages. The development of the internal rates of return is based on the macroeconomic assumptions of the AWG of the European Commission.\(^{27}\) The NDC1 rate of return is equal to the ZUS wage bill growth which develops in line with the sum of employment and productivity growth rates. The NDC2 rate of return follows the 5 year average of the past GDP growth. It is similar to the NDC1 rate of return except for the incorporated time lag. The FDC rate of return is set at a constant level of 3% (net of

\( ^{26} \) For a background on this differentiation see section 4.3.

\( ^{27} \) For more details see EC (2011).
administrative costs). Also for the choice of the FDC rate of return we follow the AWG assumptions.\textsuperscript{28} We demonstrate in section 5.3, that the deviation of the FDC rate of return from the NDC1 and NDC2 rates of return is crucial for the evaluation of the FDC cut reform.

\textbf{Figure 7: Overview of the future rates of return}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure7.png}
\caption{Overview of the future rates of return}
\end{figure}

\textit{Source: own estimation based on AWG assumptions.}

Future contributions are projected on the basis of age specific contribution profiles in the base year. In order to model changes of contribution rates to NDC1 ($\tau_{s}^{\text{NDC1}}$), to NDC2 ($\tau_{s}^{\text{NDC2}}$) and to FDC ($\tau_{s}^{\text{FDC}}$) we first project total contributions ($C_{t}^{\text{total}}$), i.e. 19.52\% of the contribution base, to a future year $s$. The applied wage growth $w_g$ follows the productivity growth assumptions of the EC (2011). Additionally, in our micro-simulation we consider the age-specific career path – observed in the base year for each group type $t$ and gender $g$.\textsuperscript{29}

\textsuperscript{28} See EC (2011), p. 142f.

\textsuperscript{29} With the current relatively early retirement, well before the age of 65, our data sample covers only a small number of individuals older than 60. In fact, for some groups, namely FDC participants, the observations are not very numerous for cohorts aged 55+. Therefore, we apply a flat contribution profile for these cohorts aged 55 and older.
Finally, the future initial pension benefit is estimated by dividing the sum of pension entitlements accrued until the effective retirement age \( r \) by the unisex life expectancy \( LE_{r,f}^{unisex} \). The latter factor is age specific and changes in line with the increase in life expectancy.\(^{30}\)

\[
\begin{align*}
\text{(26)} & \quad C_{x,g,s,t}^{\text{total,projected}} = C_{x,g,b,t}^{\text{total}} \prod_{j=b+1}^{b} (1 + w_g^{AWG}) \\
\text{(27)} & \quad C_{s-c,g,s,t}^{\text{NDC1,projected}} = C_{s-c,g,s,t}^{\text{total,projected}} \cdot t_{s}^{NDC1} \\
\text{(28)} & \quad C_{s-c,g,s,t}^{\text{NDC2,projected}} = C_{s-c,g,s,t}^{\text{total,projected}} \cdot t_{s}^{NDC2} \\
\text{(29)} & \quad C_{s-c,g,s,t}^{\text{FDC,projected}} = C_{s-c,g,s,t}^{\text{total,projected}} \cdot t_{s}^{FDC}
\end{align*}
\]

Our estimated pension benefits are computed on a gross basis. We discard coincidence pensions (e.g. when an individual is entitled to a pension from the farmers’ system, a civil servant scheme or survivors’ pensions) as well as benefits paid by pension schemes from abroad.

### 4.3 Macro Cohort Model

In the next section we describe the computation of the NDC pension system and its gradual transformation over the coming decades. The model is structured in such a way as to isolate the most important factors determining the future levels of pension expenditures and revenues. In particular we consider:

- the changing cohort specific participation rates in the single (NDC) and mixed pillar system (NDC + FDC).
- the changing cohort and gender specific retirement ages and consequent alterations of old-age as well as disability retirement probabilities.

\(^{30}\) Our assumptions on the future life expectancy development are based on EUROPOP2010 provided by Eurostat.
First, we outline the age and gender specific computation of future aggregated pension revenues step by step (section 4.2.1). Thereafter, we describe the approach to estimate future pension benefits and expenditures (section 4.2.2). A separate estimation approach has been applied for miners’ pensions and it is outlined in section 4.3.

4.3.1 Revenue side – NDC system

For the estimation of revenues we first calculate the contribution basis of an average participant in ZUS. In our former estimations we applied the NSI gross wage profile (illustrated in Figure 8 for the year 2010). With this earnings profile, however, we largely overestimate the contribution basis of an average contributor. The latter representative is with a certain probability active – paying some positive value of contributions in the base year 2010 – and with a certain probability inactive or dormant – paying no contribution in the base year.

Interestingly, the average contribution basis of an active contributor (derived from the 1% sample) is much lower than gross earnings recorded by the NSI statistics (see Figure 8). Reasons for this gap have been discussed in the previous section and Annex 2. A few shall be repeated here: a number of active contributors are self-employed and only pay the minimum threshold of 60% of the average salary in the economy. Moreover, a large proportion of employees only pay contributions based on the minimum wage. And last but not least, some ZUS scheme members are unemployed but pay contributions. Their contributions are significantly lower than the average NSI earnings, too.

In our calculations we consider the average contribution basis profile of an average participant in ZUS (see solid line in Figure 8). This profile runs lower than the respective data of an active contributor as it covers also dormant contributors who are not contributing. According to our estimations roughly one third of scheme members are not actively contributing in the base year.

---

31 Jabłonowski et al. (2011).
On the basis of this 1% profile covering active and inactive contributors we derive the average monthly contribution basis $CB_{x,g,b}$ by age and gender in the base year 2010. For the calculation of this monthly contribution basis in future years $f$ we adjust the base year profile with the productivity growth forecast $wg$ of the AWG.

\begin{equation}
CB_{x,g,f}^{\text{expect}} = \left[ \prod_{j=0}^{f-b} (1 + wg_j) \right] \times CB_{x,g,b}
\end{equation}

The next step in our procedure reflects the probability of being either an NDC or an NDC/FDC member. The probability was estimated on the basis of a 1% sample of FUS members. The resulting age and gender specific participation rates in the FDC system are shown in Figure 9 below. These probabilities are required to estimate average contribution rates by gender and birth year. On this basis we can model the aggregate impact of changing contribution rates.
For all persons born before 1949 (i.e. aged 62 and older in the base year) the probability to be a member of the NDC and FDC system ($p_{f-part FDC}^{g,c}$) is zero as these birth years had no option to participate in the FDC system. Hence, their average contribution rate ($\tau_{x,g,f}^{average}$) is 19.52% of gross earnings (see Figure 10) – reflecting the single pillar contribution rate ($\tau_{single pillar}^{single pillar}$). Some cohorts had, however, an option to participate in the FDC system, namely cohorts born after 1948 and before 1969. For these age groups we apply the FDC participation rates (shown in Figure 9) to estimate average contribution rates. The resulting cohort and gender specific average contribution rates are shown exemplarily for males in Figure 10 (see cohorts aged 42-61). All persons born in 1969 and later enter the mixed NDC/FDC scheme. They have an average contribution rate of 12.22% of gross earnings in 2010 which corresponds to the standard mixed pillar contribution rate ($\tau_{mixed pillar}^{mixed pillar}$).

$$\tau_{x,g,f}^{average} = p_{f-part FDC}^{g,c} * \tau_{f}^{mixed pillar} + (1 - p_{f-part FDC}^{g,c}) * \tau_{f}^{single pillar}$$
Additionally, we reflect an increase in NDC contribution rates adopted in 2011 (see also section 2). This reform step leads to a significant rise of average contribution rates, in particular for cohorts born after 1968 who fully participate in the FDC system. The impact of the 2011 reform is exemplarily shown in Figure 10 for the average male contribution rates in 2020. The dashed line represents the legal status quo, i.e. the adopted increase in contribution rates from 12.22 to 16.02% of gross wages (after 2016). The dotted line, on the contrary, outlines the average contribution rates in 2020 in a scenario without increase in contribution rates. In the latter scenario – reflecting the legal status before the 2011 reform – all age groups would pay significantly lower average contribution rates in the long run than their 2010 counterparts. This scenario would have led to a significant mismatch of ZUS revenues (in % of GDP) in the long-term and to a challenge for the mid-term fiscal stability of the ZUS fund. In the 2011 reform scenario, on the contrary, all cohorts who participate (to a large degree) in the mixed FDC/NDC system pay higher contributions than current contributors. The increase in the NDC contribution rates with the 2011 reform more than outweighs the decrease in average contribution rates due to
outflowing single pillar members. In the 2011 reform scenario almost all cohorts pay higher contributions in 2020 than in 2010.

After the application of cohort specific contribution rates to the expected contribution basis \( w_{x,g,f}^{\text{expect}} \) we receive contributions per contributor \( C_{x,g,f}^{\text{average}} \) – see Figure 11.

\[
C_{x,g,f}^{\text{average}} = \tau_{x,g,f}^{\text{average}} \cdot w_{x,g,f}^{\text{expect}}
\]

To show the isolated effect of changing contribution rates on future contribution levels we neglect wage growth in Figure 11. In line with the increase in contribution rates also future monthly contribution levels will rise. The impact of the 2011 and 2012 pension reform is reflected in Figure 11. As shown exemplarily for the year 2020 most contributors’ cohorts will pay higher average contributions to the NDC system in future years.

**Figure 11: Monthly average male NDC contributions per contributor: 2010 vs. 2020**

In the next step age/gender specific contributions are weighted with the probability to be a NDC contributor \( p_{x,g,f}^{\text{contrib}} \). This approach is taken as we finally multiply the average

\[32\] For illustrative reasons wage growth is set at zero.
contributions per capita of population by the respective population sizes in order to derive total revenues. The initial value of $p_{x,g,f}^{\text{contrib}}$ is calculated by dividing the number of contributors $Z$ by the overall population sizes $P$ in each cohort and for both sexes.

$\begin{align*}
(34) \quad p_{x,g,f}^{\text{contrib}} &= \frac{Z_{x,g,b}}{p_{x,g,b}} \quad \text{for } x < 45
\end{align*}$

By means of example Figure 12 outlines the resulting $p_{x,g,f}^{\text{contrib}}$ contribution probabilities for males. Not surprisingly, the probability to be a contributor is initially increasing with age as more individuals enter the labour market. It reaches its maximum for male cohorts aged 33. At this age about 74% of the overall population is paying contributions to ZUS. Thereafter, the probability drops due to cohort effects. Older cohorts participate to a higher degree in other schemes (farmers’ and miners’ pension schemes). Moreover, contribution probabilities are decreasing after the age of 33 due to rising disability and old-age retirement.

---

33 The estimation of average contributions not per capita of contributors but per capita of population provides the basis to model changing participation rates in ZUS and an inflow of special employment groups such as farmers or civil servants.

34 One may additionally reflect an inflow of contributors into ZUS due to the future transformation of the farming sector and mining sector. Such an approach has been e.g. chosen in Jablonowski et al. (2011).
For our calculation we assume that the probability to contribute to the NDC system (per capita of the population) is constant over time and we keep the (age-specific) probability to contribute to the NDC system fixed until the age of 45.

For older age groups, however, it is necessary to reflect the impact of changing retirement patterns on probabilities to be a contributor. In order to model the change of future retirement behaviour – due to the increase in legal retirement ages as well as due to decreasing disability prevalence rates – we separate the influence of retirement decisions in our computation. For this reason we first keep the probability to be a contributor constant for cohorts aged 45 and older (see dotted line in Figure 12). In a second step we correct for outflows of the labour market into retirement. More precisely $p_{\text{contrib}}$ depends for these older cohorts ($x>44$) on the probability to be already retired into old-age $p^{\text{old}}$, the probability $p^{\text{disab,c}}$ to be completely unable to work and receive a disability benefit, the probability $p^{\text{disab,p}}$ to be partially unable to work and receive a disability benefit and the probability $p^{\text{bridge}}$ to benefit from a bridge pension. We assume that about 30% of all...
partial disability beneficiaries work partially and contribute to ZUS. The residual roughly 70% is not contributing to ZUS anymore.

\[ p_{x,g,f}^{\text{contrib}} = p_{x,44,g,b}^{\text{contrib}} \times \epsilon_{x,g,f} \quad \text{if } x > 44 \]

\[ \epsilon_{x,g,f} = 1 - p_{x,g,f}^{\text{old}} - p_{x,g,f}^{\text{disab,c}} - 0.7 \times p_{x,g,f}^{\text{disab,p}} - p_{x,g,f}^{\text{bridge}} \]

The single probabilities or prevalence rates to be in one of the old-age, disability (complete and partial) and bridge pension statuses in a future year \( f \) depend not only on the respective past prevalence rates in the base year \( b \) but also on entrance/incidence rates \( i \) of the respective statuses. Namely the probability to enter into old-age \( (i_{x,g,f}^{\text{old}}) \), into complete disability \( (i_{x,g,f}^{\text{disab,c}}) \), into partial disability \( (i_{x,g,f}^{\text{disab,p}}) \) and into the bridge pension scheme \( (i_{x,g,f}^{\text{bridge}}) \) need to be considered. In the case of bridge pensions we do not allow any new entrants after 2014.

For the estimation of disability prevalence rates we consider two further aspects: First, retirement before our cutting age of 45 is possible – though rare. Such retirement patterns are already reflected in the base year profile. In fact, the inflow into disability may to some extent explain the dropping contributors’ probabilities from age 33 onwards. Against this background, we correct for the probabilities to be a disability pensioner before the age of 45 by subtracting the \( p_{x,44,g,b}^{\text{disab}} \) disability prevalence rate at age 44. Second, exit probability rates \( e_{x,g,f}^{\text{disab,c}} / e_{x,g,f}^{\text{disab,p}} \) to leave the disability scheme after a complete/partial disability due to reasons such as death, loss of eligibility, etc. are considered. Also in the case of bridge pension we have to consider that after the statutory retirement age all beneficiaries leave the system and switch to old-age pension with a certain probability \( e_{x,g,f}^{\text{bridge}} \).

\[ p_{x,g,f}^{\text{old}} = p_{x-(f-b),g,b}^{\text{old}} + \sum_{j=45}^{f} i_{x,g,f}^{\text{old}} \]

\[ p_{x,g,f}^{\text{disab,c}} = [p_{x-1,g,f-1}^{\text{disab,c}} \times (1 - e_{x,g,f}^{\text{disab,c}}) + i_{x,g,f}^{\text{disab,c}}] - p_{44,g,b}^{\text{disab,c}} \]

This assumption is based on the information that 18% of all disability beneficiaries are employed (see OECD (2009), p.33) – the lowest level of all OECD countries. We assume that only the partially disabled work and they represent about 63% of all disability beneficiaries. Consequently, we may presume that roughly 30% of all partially disabled – which represent 18% of all disabled – are employed.
Under the changing retirement age scenario (2012 legal status) we take into account that incidence and exit rates change in line with the increase in statutory retirement ages. With the given probability $p_{x,g,f}^{\text{contribute}}$ to be a NDC contributor we finally receive the contributions per capita of population $c_{x,g,f}^{\text{average}}$ — see Figure 13.

$$c_{x,g,f}^{\text{average}} = c_{x,g,f}^{\text{average}} * p_{x,g,f}^{\text{contribute}}$$

**Figure 13: NDC contributions per capita of population**

The dotted line in Figure 13 is a sign of the ‘walking profile’ over the years — clearly showing that in 2020 all cohorts will be paying higher contributions due to increased contribution rates for NDC schemes after 2010. Also the impact of the later retirement is

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36 For a further description of the impact of increasing statutory retirement ages on disability incidence and exit rates see also Jablonowski et al. (2012).

37 For illustrative reasons wage growth is set at zero.
remarkable. The increase in statutory retirement ages and the abolishment of early retirement channels will significantly increase the contribution levels of cohorts aged 60 and older in the years to come (see dotted line in Figure 13).

In order to guarantee a match with actual aggregate data we finally rescale these computed contributions to the sum of actual contributions in 2010 \((TC_p)\). We apply the rescale factor \(\theta\), which is equal for all ages, gender and years.\(^{38}\) On this basis we derive the corrected contributions per capita of the population \(c_{x,g,b}^{av,\theta}\).

\[
\theta = \frac{TC_p}{\sum_{i=20}^{70} \sum_{j=0}^{1} c_{i,j,b}^{av} \cdot p_{i,j,b}}
\]

\[
c_{x,g,f}^{av,\theta} = \theta \cdot c_{x,g,f}^{av}
\]

Finally, for the estimation of future ZUS total revenues \(TR_f\) we weight average contributions per capita of the population with the respective cohort sizes \(P\) in future years.

\[
TR_f = c_{x,g,f}^{av,\theta} \cdot P_{x,g,f}
\]

### 4.3.2 Expenditure side – NDC system

For the modelling of expenditure side we compute future pension benefits. For this calculation not only future contributions (estimated in the previous section) but also pension rights accrued in the past have to be taken into account. These current pension entitlements are recorded on NDC accounts which reflect accumulated contributions (since 1999) plus the initial capital (i.e. entitlements accrued before 1999). The applied average NDC account levels for our calculation are shown in Figure 14 differentiated by age and gender and measured per capita of the population.

NDC values shown in Figure 14 are based on average NDC accounts of ZUS participants \((NDC_{x,g,b}^{av,ZUS\; part})\). To derive the average NDC account per capita of the population

\(^{38}\) With our computation we are able to match the actual sum of contributions in 2010 very closely. The rescale factor amounts to 1.06.
\( (NDC^{\text{av,pop}}) \) we multiply average NDC accounts of ZUS participants by the approximated ZUS participation rate \( p_{\text{part ZUS}} \).

\[
NDC_{x,g,b}^{\text{av,pop}} = NDC_{x,g,b}^{\text{av,ZUS part}} \cdot p_{g,b}^{\text{part ZUS}}
\]

Figure 14: Average NDC accounts per capita of the population (incl. initial capital and pre1999 contributions) indexed to 2010

Source: own calculations based on the ZUS cohort data

The amount of NDC accounts in future years depends on the indexation of pension entitlements i. With the introduction of a second separate NDC account \( NDC2 \) from 2011 onwards (see section 2.2) two different indexation regimes have to be reflected in our estimations. The first initial NDC account \( NDC1 \) is annually adjusted by the wage bill

\( p_{\text{part ZUS}} \) differs from the probability to contribute to ZUS \( p^{\text{contrib}} \) (estimated in the previous section). In fact, a slightly higher share of the population participates in ZUS than contributes to ZUS. Some participants may be “dormant contributors” not contributing for some period (see Figure 8). We approximate that \( p_{\text{part ZUS}} \) amounts to 75.8% of the population for males and 72.5% for females. The value of \( p_{\text{part ZUS}} \) is estimated by dividing the number of old-age beneficiaries at age 66 (61) by the respective population sizes. Miners are not included in these figures but estimated separately. For younger cohorts this approach may lead to an underestimation of \( p_{\text{part ZUS}} \) because in this age groups more citizens may participate in ZUS than in older cohorts. In contrast to these older age groups, younger cohorts are less likely to join other non-ZUS schemes such as famers’, miners’ or civil servants’.
growth $i^{NDC1}$. The second newly introduced NDC account is indexed in accordance with the average 5-year nominal growth of GDP $i^{NDC2}$. A closer look reveals that in theory both GDP and the wage bill growth should be equal as both reflect the sum of employment and labour productivity growth. As a consequence, the interest rate $i^{NDC2}$ is only slightly higher in the mid-term than $i^{NDC1}$ due to the 5-year time lag.

\begin{align}
NDC_{x,g,f}^{\text{av,\,pop}} &= NDC_{x,g,f}^{\text{1,\,av,\,pop}} + NDC_{x,g,f}^{\text{2,\,av,\,pop}} \\
NDC_{x,g,f}^{\text{1,\,av,\,pop}} &= NDC_{x-1,g,f-1}^{\text{av,\,pop}} \cdot i_{f-1}^{NDC1} + C_{x-1,g,f-1}^{NDC1} \\
NDC_{x,g,f}^{\text{2,\,av,\,pop}} &= NDC_{x-1,g,f-1}^{\text{av,\,pop}} \cdot i_{f-1}^{NDC2} + C_{x-1,g,f-1}^{NDC2}
\end{align}

Additionally, NDC accounts are increasing with contributions paid over the life-cycle to $NDC1 (C_{NDC1})$ and 2 ($C_{NDC2}$). The contributions in our calculation are again estimated per capita of the population. In other words, they reflect the contributions of an average citizen who is with a certain probability $p_{x,g,f}^{\text{contrib,\,non-OA\,retired}}$ contributing to ZUS, i.e. has not retired yet. For cohorts aged below 45 $p_{x,g,f}^{\text{contrib,\,non-OA\,retired}}$ is equal to $p_{x,g,f}^{\text{contrib}}$. For older age groups we additionally take into account that our standard individual is with a low (but increasing with age) probability not contributing (due to disability or due to receiving a miner’s pension). The sum of these contribution probabilities is reflected in the parameter $p_{x,g,f}^{\text{contrib,\,non-OA\,retired}}$. In comparison to the estimation of $p_{x,g,f}^{\text{contrib}}$ old-age retirement probabilities are not yet taken into account at this stage, as we aim to reflect the average contribution of individuals who have not retired on account of old age yet. Old-age retirement probabilities are considered at a later stage when estimating the expected pension benefit per capita of the population.

\begin{align}
&\quad p_{x,g,f}^{\text{contrib,\,non-OA\,retired}} = p_{x,g,f}^{\text{contrib}} \quad \text{if } x < 45 \\
&\quad p_{x,g,f}^{\text{contrib,\,non-OA\,retired}} = p_{44,g,b}^{\text{contrib}} \cdot \varepsilon_{x,g,f}^{\text{non-OA\,retired}} \quad \text{if } x > 44 \\
\varepsilon_{x,g,f}^{\text{non-OA\,retired}} &= 1 - p_{x,g,f}^{\text{disab,c}} - 0.7 \cdot p_{x,g,f}^{\text{disab,p}} - p_{x,g,f}^{\text{bridge}}
\end{align}

NDC contributions are then corrected by the rescale factor $\theta$ – estimated in the previous section (4.1). Finally, to compute the amounts paid into NDC1 and NDC2 we split
contributions $c_{x,g,f}^{av,\theta,\text{non-OA retired}}$ in accordance with the year specific share to be paid in NDC1 ($\gamma_f^{\text{share NDC1}}$) and NDC2 $(1 - \gamma_f^{\text{share NDC1}})$.\(^{40}\)

\[
(52) \quad c_{x,g,f}^{av,\theta,\text{non-OA retired}} = \theta \cdot c_{x,g,f}^{av} \cdot p_{x,g,f}^{\text{contrib,non-OA retired}} 
\]

\[
(53) \quad C_{x,g,f}^{\text{NDC1}} = \gamma_f^{\text{share NDC1}} \cdot c_{x,g,f}^{av,\theta,\text{non-OA retired}} 
\]

\[
(54) \quad C_{x,g,f}^{\text{NDC2}} = (1 - \gamma_f^{\text{share NDC1}}) \cdot c_{x,g,f}^{av,\theta,\text{non-OA retired}} 
\]

The initial old-age pension benefit (per capita of the population) $b_{x,g,f}^{\text{new}}$ at age $x$ is estimated on the basis of the benefit formula below. The sum of NDC1 and NDC2 is divided by the expected unisex life expectancy $LE_{x,g,f}^{\text{unisex}}$ at age $x$ in a future year $f$.\(^{41}\)

\[
(55) \quad b_{x,g,f}^{\text{new}} = \frac{NDC1_{x,g,f}^{\text{av,pop}} + NDC2_{x,g,f}^{\text{av,pop}}}{LE_{x,g,f}^{\text{unisex}}} 
\]

As shown in Figure 15, a longer working period contributes significantly to a higher expected pension level upon retirement.

---

\(^{40}\) For more details on the share of contributions paid into NDC1 and NDC2 see section 2.2.

\(^{41}\) Unisex life expectancy tables are derived from the CSO base year data projection with Europop2010 mortality assumptions.
In the next step these initial pension benefits are weighted with the respective gender and age specific old-age retirement probabilities $i_{x,g,f}^{old}$ of a future year $f$.

\begin{equation}
    b_{x,g,f}^{new,retprob} = i_{x,g,f}^{old} \cdot b_{x,g,f}^{new}
\end{equation}

The starting point for the estimation of retirement probabilities $i_{x,g,b}^{old}$ is provided by the retirement behaviour observed in the base year $b$. It is measured by dividing the number of new retirees $R_{x,g,b}^{new}$ by the number of ZUS participants $P_{x,g,b}$.

\begin{equation}
    i_{x,g,b}^{old} = \frac{R_{x,g,b}^{new}}{P_{part \, ZUS} \cdot P_{x,g,b}}
\end{equation}

\begin{equation}
    i_{x,g,f}^{old,initial} = i_{x,g,b}^{old}
\end{equation}
But future retirement behaviour is also determined by the retirement history which is reflected in the age and gender specific retirement rates \( r \) – defined as the number of total old-age retirees \( R \) to the population \( P \) at age \( x \) and gender \( g \).

\[
(59) \quad r_{x,g,b} = \frac{R_{x,g,b}}{R_{x,g,b}}
\]

Each cohort being of age \( x \) and gender \( g \) in the base year is with a certain probability already retired or will retire in a future year \( f \) at age \( i \) (\( i > x \)). We assume that the accumulated life cycle retirement probabilities (LCRP) – shown in equation (60) – should sum up to one for each cohort. In other words, the sum of the retirement rate \( r_{x,g,b} \) in the base year \( b \) and the accumulated future old-age retirement probabilities \( \sum_{i=x+1}^{100} i_{x,g,f,i} \), i.e. the sum of probabilities of an \( x \) year old in the base year to retire at a future age \( i \), should amount to one.

\[
(60) \quad LCRP_{x,g,b} = r_{x,g,b} + \sum_{i=x+1}^{100} i_{x,g,f,i} = 1
\]

If we base our assumptions on future retirement behaviour solely on the retirement decisions observed in the base year \( (i_{x,g,b}) \), this condition does not necessarily have to be fulfilled and the parameter \( \theta_{x+(f-b),g,f} \) – shown in equation (61) below – may be other than one.

\[
(61) \quad \theta_{x+(f-b),g,f} = \frac{1-r_{x,g,b}}{\sum_{i=x+1}^{100} i_{x,g,f,i}}
\]

Therefore, we correct the derived retirement probabilities \( i_{x,g,f,i} \) with the cohort and gender specific parameter \( \theta_{x,g,b} \) – see equation (62) below – to ensure that the LCRP of each birth year is equal to one.

\[
(62) \quad i_{x+(f-b),g,f} = i_{x+(f-b),g,f} \theta_{x+(f-b),g,f}
\]

In our estimation we consider that all cohorts born after 1948 are obliged by the rules of the new system to retire not sooner than at the male (female) legal retirement age of 65 (60). Furthermore, we take into account that statutory retirement ages gradually increase for both genders to 67 (see section 2.3). There is an occupation group, which can retire earlier than the statutory retirement age, namely teachers. We keep their privilege to
retire early constant in the future. Of course, miners can retire earlier, but they are treated separately – see following chapters.

As a final outcome we derive cohort and gender specific retirement probabilities which reflect possible changes of retirement behaviour due to 1) legal changes and 2) cohort specific retirement histories (i.e., corrected by $\theta$). An example of these final retirement probabilities is provided in Figure 16 for male and female individuals in the base year and in the future year 2021. As can be seen, retirement probabilities are shifting – in line with the increase in statutory retirement ages – to higher age groups over the long-term. What is remarkable is the relatively low retirement probabilities in the base year. An explanation for this low pensioner inflow is provided by the retirement rate in 2010 which illustrates that the overwhelming majority of male (female) age groups 62+ (57+) have already retired before the base year. As a consequence, the shown retirement probabilities per scheme member are not adding up to 100%. In the future years retirement probabilities will gradually increase.

Figure 16: Probability to retire in the new system
Finally, these expected initial pension benefits $b_{x,g,f}^{new,retprob}$ are accumulated over the individual life cycle considering pension indexation rules $p_{x}^{pen}$, i.e. the increase in benefits after retirement with a 20% wage growth. On this basis we estimate the accumulated pension benefit of each cohort $b_{x,g,f}^{new,cohort}$.

$$b_{x,g,f}^{new,cohort} = b_{x-1,g,f-1}^{new,cohort} \times \left(1 + p_{x-1}^{pen}\right) + b_{x,g,f}^{new,retprob}$$

The reduction of old-age benefits per capita of the population over the coming decades is illustrated in Figure 17 below for males. Until 2050, average benefit levels from the public pay-as-you-go system are more than halved — ignoring the wage growth effects. The decline of NDC pension benefits is determined by the following factors: 1) younger cohorts participate to a higher degree in the mixed FDC/NDC system and therefore pay less contributions into NDC pensions, 2) younger cohorts experience longer periods of self-employment and therefore pay less into NDC accounts and 3) younger cohorts have higher expected life expectancy and therefore can expect lower pension benefits at a given age.

**Figure 17: Accumulated pension benefit of males: 2010 vs. future years**

![Figure 17: Accumulated pension benefit of males: 2010 vs. future years](image-url)
So far the focus of the description lied on the estimation of future new pension benefits. For our projection of future expenditures pension payments for current retirees are crucial. Therefore, we first calculate analogously age and gender specific benefit levels of current pensioners per capita of the population \( b_{x,g,b}^{old,cohort} \) in the base year \( b \). This figure can be simply measured by multiplying average actual benefits of current retirees \( AP \) by the respective number of pensioners \( R \). Thereafter, these aggregated age and gender specific expenditures are divided by the respective population sizes \( P \).

\[
\frac{AP_{x,g,b}R_{x,g,b}}{P_{x,g,b}}
\]

Also for current retirees of the base year we project their benefits into the future considering pension adjustment rules \( p_{x-1,g,f-1}^{pen} \).

\[
b_{x,g,f}^{old,cohort} = b_{x-1,g,f-1}^{old,cohort} \left( 1 + p_{x-1,g,f-1}^{pen} \right)
\]

Finally, we multiply the age and gender specific accumulated benefits of base year and future new retirees by cohort sizes \( P \) in future years to derive total expenditures \( (TE) \) in a respective future year \( f \). The cohort sizes \( P \) in future years \( f \) are derived from our population projection which is based on EUROPOP2010 assumptions.

\[
TE_f = (b_{x,g,f}^{old,cohort} + b_{x,g,f}^{new,cohort}) \times P_{x,g,f}
\]

In line with the assumptions taken in our previous paper, issued in 2011\(^{43}\), we differentiate between groups of future pensioners, who, despite being insured in one old-age pension fund, have a different legal status which affects their pension entitlements. Accordingly, we estimate the pension entitlements of miners separately. The computation approach for this groups is outlined in greater detail in the following sections.

**4.4 Miners**

A profession which profits from the early retirement privileges in an infinite time horizon is mining. Legal rules set for this group in 2005 petrify the old system rules, where a pension

\(^{42}\) The population projection bases on a program initially developed by Bonin (2001).

\(^{43}\) Jablonowski et al. (2011).
was based on contributory and non-contributory periods. Additionally, a significant factor contributing to miners’ pension levels is a relatively high average ‘pension calculation basis’, directly related to the so-called multiplier coefficient (every year of working career multiplies in principle by 1.8) and to some extent to high miners’ salaries.

Figure 18 shows the number of miners in the coming years, estimated with the use of the statistical trend observed in recent years in the number of miners in the public sector45.

![Figure 18: Actual number of miners in the public sector](image)

The probability to be a miner, expanded for the coming years on the basis of observed trend in years 2003-2011 \( (y = -12.56\ln(x) + 197, R^2 = 0.9) \) is applied for male cohorts aged from 20 to 45. As a result, the number of miners, from an initial level of 170,000 in a base year, would gradually fall to around 140,000 in 2045. After 2045 the number of active miners is kept constant under the assumption of a stable mining sector though smaller than in the base year. However, this figure was estimated on the basis of a statistical trend, which can make our assumptions debatable.

The number of beneficiaries is calculated on the basis of a trend observed in recent years: around 60% of miners retire after 25 years of work (at age of 47 to 50), and another 35% after 30 years of work (at age of 50-55), and the remaining 5% retire at various ages. With

44 PLN 4026.65 for miners, and PLN 2127.99 for average ZUS member in 2008.
45 According to Employment in national economy (NSI) there are around 170 thousand miners. Available data cover the 2004-2011 period.
a constant retirement probability \( i_{\text{miner}}^{\text{old}} \), today’s number of 200,000 retired miners\(^{46}\) decreases in our simplified model to 150,000 around 2060.

![Figure 19: Projected number of miners (active contributors and pensioners)](image)

Source: own calculations based on ZUS and NSI

Miners’ contributions increase the overall sum of ZUS pension contributions, but are not registered on the NDC accounts.\(^{47}\) In consequence, the sum of contributions collected on the NDC accounts is lower than the actual overall amount of pension contributions in the base year recorded in the Social Insurance Fund. The estimation of miner’s pension contributions is based in our model on the average miner’s gross salary\(^{48}\) treated with the time-invariant nominal pension contribution rate 19.52%, and the (AWG) wage growth \( w_{f}^{\text{AWG}} \) – applied also for the NDC system.

The computation of miners’ pensions is based on old rules,\(^{49}\) so in our model the miners’ pension system are computed separately from the NDC pensions. The benefits are based on modified \( b_{\text{miner}}^{\text{old},\text{coh.ort}} \), with the already observed probabilities to retire \( i_{x}^{\text{old}} \). To

\(^{46}\) http://www.zus.pl/files/gornicze2008.pdf The miners’ profile was updated only for 2008 and 2009 due to discontinuation of the publication of the figures for this profession by the ZUS.

\(^{47}\) In fact miners have a right to collect their contributions on the NDC&FDC accounts, though this seems a rather theoretical possibility since upon retirement at a relatively young age (below 50) the small collected amounts divided by long life expectancy would result in very low replacement rate – the choice of such option seems irrational. In cases when a miner has an NDC/FDC account, FDC contributions are transferred to the state budget upon retirement.

\(^{48}\) PLN 5.717 in 2009 according to the ‘Structure of wages and salaries by the occupation’ (CSO).

\(^{49}\) See equations (1)-(3).
ensure that our applied micro data match the aggregate data of miners’ pension expenditures we rescale benefits (with a miners’ specific \( \theta_{miner_{x,b}} \) parameter) to equal total expenditures.

\[
(67) \quad b_{miner_{x,f}}^{new,retprob} = i_{miner_{x,f}}^{old} \times b_{miner_{x,f}}^{old,cohort}
\]

The cash balance of the miners’ subsystem, in a scenario of full wage growth indexation (AWG scenario) is depicted in Figure 20 below:

**Figure 20: Cash balance of the miners’ pension system, in % of GDP**

![Cash balance of the miners’ pension system](image)

*Source: own calculations*
5 Results

Following a decade of no major pension reforms in Poland, two profound changes of the public pension system were adopted in the last two years:

a. a cut of contributions paid in the mandatory funded pension pillar (FDC) introduced in 2011 and
b. a gradual increase in the statutory retirement age to 67 for both men and women, adopted in May 2012.50

The aim of the following section is to outline the quantitative impact of these reform measures on:

1) Long-term fiscal stability (section 5.1),
2) Intergenerational redistribution of the ZUS old-age pension fund (section 5.2) and
3) Adequacy of public pension benefits in future decades (section 5.3).

5.1 Long-term fiscal stability51

5.1.1 Starting point – large deficit in 2010

In 2010 the ZUS old-age pension fund was running a deficit of 3.6% of GDP. This gap between expenditures and revenues in 2010 can be explained to a large degree by the change to a two pillar FDC/NDC system. In the current transition process relatively generous pensions from the pre-1999, pure PAYG system need to be financed by decreasing contributions to the current NDC system. Additionally, the actuarially unbalanced miners’ pension scheme adds to the ZUS deficit – as will be outlined in further detail below. The overall resulting current deficit is financed by taxpayers.52

In the following sections, we assess the future development of annual cash balances under the legal status in place before the shift of FDC contributions to the NDC pillar (FDC cut),

50 For a detailed description of these reform acts see chapter 2.
51 The following illustration of cash balances covers all the NDC as well as miners’ pension contributions and revenues. Bridge pensions and contributions – which account for only 0.1% of total expenditures – are not taken into account.
52 One can assume that it is mostly the working age population that is financing the current deficit as they pay the highest taxes per capita. Additionally, these young cohorts need to save for their old-age as future NDC pension levels will be less generous. Therefore, one often refers to a double burden for younger cohorts who finance the transition from a PAYG to a (partially) funded pension system.
followed by an evaluation of the FDC cut and of the increase in retirement ages to 67 (RA67).

5.1.2 Evaluation of pre-reform cash balances (before FDC cut)

Under the pre-reform scenario the deficit is expected to shrink until 2014 to roughly 2.3% of GDP. The main reason for this deficit reduction is the low inflow of new retirees. Most cohorts born around 1950 have to retire significantly later than their previous counterparts as early retirement rules have been mostly abolished for cohorts born after 1948.

After 2014 the deficit will again start to rise reaching 2.7% of GDP in 2025. This deficit increase is caused by the comeback to the normal inflow into retirement. Cohorts born around 1950 now reach the statutory retirement ages of 60/65 and enter into retirement. Additionally, the increase in the deficit until 2025 is driven by the so called baby boomer generations. These sizeable age groups born between 1955 and 1960 retire in the period 2015 till 2025. As a consequence, overall pension expenditures will increase significantly in these years (which can be observed in the bump in Figure 21).

After 2025 the fiscal situation of the ZUS pension system is easing. Pension expenditures are expected to shrink significantly as NDC benefit levels are decreasing and as less sizeable cohorts are entering into retirement. From 2025 to 2075, the old-age ZUS deficit will gradually shrink. Under our assumptions the ZUS pension fund can expect almost a match of revenues and expenditures from 2075 onwards. In the year 2075 the transition process from the pre-1999 single pillar to the mixed NDC/FDC pillar system is almost fully finalized as most scheme member benefiting from the old pre-1999 retirement rules have died.
5.1.3 Evaluation of the shift in FDC contributions (FDC cut) on cash balances

The shift of FDC contributions to the PAYG system legislated in 2011 shows an immediate impact on the revenue side. Total contributions increase in our estimations from 3.6% of GDP in 2010 to 4.6% of GDP in 2012. Also in the long-term revenues are nearly 1 percentage point of GDP higher after the shift of FDC contributions than under the pre-reform, ‘no FDC cut’ scenario. Expenditures are (almost) unaffected by the shift of FDC contributions until the year 2025. This can be explained by the fact that only a small share of cohorts retiring before 2025 is participating in the FDC system.\footnote{The birth year specific participation rates in the FDC system are illustrated in Figure 9.} Therefore, the shift of FDC contributions affects their pension levels only to a low extent. Younger cohorts, on the contrary, participate to a higher degree in the FDC system. For them the shift of FDC contributions to the NDC system translates into an increase in NDC pension entitlements. As a consequence, the legislated shift of FDC contributions leads to a gradual increase in pension expenditures after 2025 – compared to the “no FDC cut” scenario. In the long-
term the FDC cut will lead to an extension of the NDC system and to an increase in overall expenditures by almost 1% of GDP.

Policy makers will find it relevant that the shift of FDC contributions to the NDC system will trim the deficit of ZUS considerably in the coming decades (see also Figure 23). Already in 2012 the deficit is cut, according to our calculations, by 1% of GDP from 2.8 to 1.8% of GDP. Also over the next three decades the deficit will be lower compared to the legal status of 2010. On average the deficit is reduced by about 35% or about 0.8 pp. of GDP in the period 2012-2040. In conclusion, on the one hand the FDC cut adopted in 2011 will significantly reduce future deficits of the ZUS old-age pension fund. On the other hand, the overall level of revenues and expenditures of the NDC scheme will increase, so the public sector shifted a large burden of the PAYG system onto the shoulders of future contribution and tax payers: the overall expenditures will rise by 1% of GDP. Consequently, if the revenue side is affected by a crisis, the negative impact on public finances will be higher than in the no-FDC-cut scenario.

5.1.4 Evaluation of the increase in retirement ages (RA67) on cash balances

The gradual increase in legal retirement ages to 67 for both men and women additionally stabilizes the long-term finances of the ZUS old-age pension fund. Pension expenditures shrink in particular in the period 2015 till 2025. From a fiscal point of view the relatively rapid increase in retirement ages is well chosen. The years from 2015 till 2025 are exactly the years in which the fiscal pressure is relatively high due to the large retirement inflow of baby boomer generations.

In the first years of the increase in retirement ages (2015-2021) the impact on total expenditures is the highest as both men and women are affected by this reform. Thereafter, until the year 2045 the impact of the 2012 reform on the expenditure side is less visible. In this period (2022-2045) one can identify two factors with opposite effect on the level of expenditures. On the one hand, women postpone their retirement in line with the increase in retirement ages until 2041. This postponement effect leads to a decrease in total expenditures. On the other hand, both men and women are retiring later and are therefore entitled to higher pension benefits than under the 2011 legal status. This entitlement effect increases total expenditures. Until the year 2041 the postponement
effect outweighs the entitlement effect and expenditures are slightly lower than under the legal rules of 2011. After the year 2042, however, the entitlement effect determines the rise of expenditures as more and more pensioners with higher benefits than under the 2011 legal status enter the retiree population. In the long-term an increase in retirement ages leads to a considerable rise of total expenditures by about 0.5% of GDP – compared to the “without RA67” scenario.

Figure 22: Annual cash balances – with and without RA67

Revenues will likewise increase with the RA67 reform. In line with the increase in retirement ages to 67 also the potential contribution periods are prolonged and more pension entitlements can be accrued. In the long-term the rise of statutory retirement ages leads to an additional rise of total contributions by roughly 0.5% of GDP.

The impact of the increase in retirement ages on the ZUS deficit is clear cut. This recent reform measure will further reduce the mismatch of contributions and expenditures of the next decades. In particular, in the period 2015-2025 the ZUS deficit can be lowered by an average of 0.5% of GDP – compared to the scenario without the RA67 reform. In the
longer time horizon of 2010-2060 the deficit is on average reduced by 0.4% of GDP. The following Figure 23 summarizes the impact of the reforms on the ZUS deficit.

**Figure 23: ZUS deficit under different reform scenarios**

Our estimations of future cash balances do not take into account the changing proportions of minimum pension beneficiaries. As outlined in section 5.3, a large number of future beneficiaries may expect pension levels below the threshold of the minimum pension. This is especially the case in a reform scenario without the increase in retirement ages to 67. In our aggregate projections we do not consider that this cut of future pension benefits may be limited in the case of an increasing share of scheme members by the minimum pension threshold. Consequently, we may overestimate the decline of future pension expenditures.

### 5.1.5 The sustainability gap of the ZUS old-age pension fund

Annual cash balances, shown above, provide valuable information about the timing effect of reforms. Moreover, these flow figures have the advantage to be easily understandable.
by the public. Annual cash balances can provide an indication of the mid- and long-term stability of a fiscal system. An indicator which is more often applied in academic circles is the sustainability gap. It reflects not only the fiscal situation in one year (like flow figures) but sums up (in one stock figure) the stability of a fiscal system over an infinite horizon. In our computation, the sustainability gap reflects the accumulated and discounted future deficits in terms of the GDP of 2010. It can be interpreted as the PLN amount which needs to be set aside today in order to finance all future deficits of the ZUS old-age pension fund. The sustainability gap is shown to outline the overall impact of recent reforms and to illustrate the relative gap caused by the general old age pension system and by the miners’ pension system. In fact this gap will be most likely bridged by tax inflows, as observed in recent years – and by an increase in the general government debt.

Before the FDC cut the sustainability gap of the ZUS pension fund amounted to 86.3% of GDP. This figure includes the sustainability gap of the general old-age pension system (66.4 % of GDP) and of the miners’ pension system (19.9 % of GDP). The sustainability gap has been significantly reduced by 27.6 pp. with the partial shift of FDC contributions to the NDC system. A slightly lower, but still considerable, decrease in the sustainability gap of 17.4% of GDP has been achieved with the increase in statutory retirement age to 67. After this reform the sum of all future deficits in ZUS pension fund amounts to 41.2% of GDP in 2010. In conclusion, the sustainability gap of the ZUS pension fund has been more than halved with the two recent reforms. Roughly half of the current sustainability gap (19.9% of GDP) is caused by the miners’ pension system.
5.2 Intergenerational redistribution effects of past reforms

The aim of the following section is to assess the intergenerational redistribution effects of the Polish public pension system after the two recent reforms, the FDC cut and the RA67. For this analysis we will rely on the method of generational accounting, a method widely used in the public finance literature and initially developed by Auerbach, Gokhale and Kotlikoff (1991, 1992 and 1994).

5.2.1 Intergenerational redistribution effects of the FDC cut and RA67

Generational accounts (GAs) can answer the question which cohorts bear the highest burden and are the most affected by fiscal reforms. They are set up in a purely forward-looking manner and reflect the discounted sum of contributions paid minus transfers received in or after the base-year. As a consequence, GAs cannot, generally, be compared across living generations as they incorporate effects of differential lifetime. While for younger cohorts born in or after the base year the entire lifecycle is reflected in GAs, this is not the case for older age groups which can look back on a number of past years not considered in GAs. One may, however, compare GAs for different reform scenarios to
outline to which extent different cohorts are affected by legal changes over their remaining lifecycle.

The intergenerational redistribution impact of the two recent pension reforms is illustrated in Figure 25. It can be observed by comparing the GAs of a given age for the three legal statuses (i.e. comparing the orange, red and green bar). A glance at Figure 25 reveals that the level of GAs is almost unchanged in all three legal frameworks. Cohorts older than 60 are not affected at all by the two reforms. The net-lifecycle payments, i.e. GAs, of younger age groups are slightly increased by the cut of FDC contributions and the RA67. This implies that both reforms, the shift of contribution rates (FDC cut) and the increase in retirement ages (RA67) do not lead to significant intergenerational redistribution effects. In other words, the net-lifecycle payments of each cohort remain constant in both reform scenarios.54

One may ask why the recent pension reforms did not have considerable intergenerational redistribution effects? An answer is provided by the notion of equivalence which is strongly embedded in the NDC pension system. Any rise of contributions to the NDC system, whether caused by the shift of FDC contributions or by the increase in retirement ages, is translated proportionally via the benefit formula into higher pension benefits. As a consequence, the net-lifecycle payments, i.e. GAs, are unaffected by reforms leading to an increase in contributions.

54 A slight increase in GAs can be observed for younger cohorts aged 30 and younger. This rise is mainly caused by higher discounts of pension benefits received later.
5.2.2 **Intergenerational redistribution effects for the miners pensions scheme**

At last, but not least, we present the generational accounts for the miners’ sub-system, as depicted on Figure 26. As might be expected all cohorts of miners are regarded from this perspective as net beneficiaries. In other words, all presently living cohorts will receive more benefits than they pay contributions over their remaining lifecycle.
5.3 Adequacy of future pension benefits

The third perspective used in this study analyses the adequacy between pension levels and salaries. As stated in chapter 3, the adequacy ratio (AR) in this study compares the gross pension level in relation to the average gross salary in the economy. For the purposes of the analyses we apply the forecasts based on the 1% sample data, which is much more detailed than average per cohort data. Further to the assumptions taken in the chapter devoted to the input data, the adequacy will be analysed for employees and self-employed persons who participate in the FDC system.55

The profound reforms introduced in years 2011-2012 have had an influence on the gender specific adequacy, but also on particular relations in the adequacy ratios between cohorts – since the forecast covers a period of phase-out of the old system and the gradual changeover into the new one. The picture turns to be even more complex if we add the division into employment type: self-employed or hired. To introduce some predictable order we will proceed with the description of the results as follows:

1. Status quo scenario (and FDC reform)

55 Non-FDC employees and self-employed are analyzed separately in Annex 1.
a. gender specific outlook (by employees and the self-employed).

b. comparison of employees and self-employed adequacies (by gender).

2. Increased retirement age scenario.

a. gender specific outlook (breakdown into employees and the self-employed).

b. comparison of employees and self-employed adequacies (by gender).

3. reference to the minimum pension levels

a. gender specific outlook (breakdown into employees, the self-employed and miners).

The figures and related explanation will refer to the statistical measures introduced in the computation chapter, i.e. for the contributors who paid in 2010 a median (50% of the sample) and the third quartile (75% of the sample) contributions.

5.3.1 The status quo scenario

5.3.1.1 Gender specific outlook, for employees and the self-employed

Figure 27 shows a comparison between the adequacy ratios for employees, participating in the FDC scheme by gender under the legal framework of years 1999-2011 (before the FDC cut). A significant spread between gender specific adequacy ratios of the initial pension level upon retirement is explained by the difference in the legal retirement age: 60 for women and 65 for men. 5 more years of work translates into significantly higher adequacy ratios for men. On average, they are higher by over one third.\(^\text{56}\) Both analysed statistical measures: median (current minimum salary contributors) and the 3rd quartile (current average salary contributors) drop significantly with time, but their percentage relation stays stable. Nevertheless, the divergence between the average salary and the initial old-age pension in the future may be disappointing for many individuals who pay the median contributions: adequacy ratios amount to approx. 60% for men and 40% for women around 2015, dropping steadily over time to 17% for men and 13% for women in 2045. The cushioning effect of the minimum pension is not considered here – but addressed later (section 5.3.4).

\(^{56}\) Male higher adequacy ratios can be mainly explained by a higher retirement age but also by longer contribution careers.
Our contribution analyses show that the median contribution path across birth years, for men as well as for women, moved between two ‘levels of resistance’\(^{57}\); the minimum salary (lower bound) and the 60% of the average salary in the economy. These salary levels are currently highly representative for the baby-boomers born after 1980. Despite the fact that these cohorts follow the promotion path observed in the base year 2010, their initial pension would correspond to 15% adequacy levels upon retirement around 2045. The adequacy rates are visibly higher for older cohorts, who retire around 2030. The explanation consists of mainly three impact factors: relatively generous estimation of initial capital of older cohorts, decreasing real wage growth and extending life expectancy. For more analysis, see the chapter devoted to sensitivity analyses.

The adequacy ratio for the 3rd quartile (average salary level in the base year) shows a very deep decrease: the initial level of around 85% for men and 63% for women in 2015 decreasing with years to 35% and 25% respectively in 2045.

An FDC member, employee, who was paid salaries around statistical outliers (97.5% of the sample and over) in the base year, may expect a pension of 100% of the average salary in case of men and over 70% in the case of women (not presented on the charts). Concurrently, contributors who reach the upper salary ceilings (250% of monthly average salary) are very rare, so they appear around the statistical error margin. Therefore a 100% adequacy ratio for this group may be regarded as a potential maximum achievable in the new system in the status quo scenario (no FDC cut & without increase in retirement age).

\(^{57}\) For details see Figure 5
Figure 27: Adequacy ratio (AR) for female & male employee, FDC member; RA: 60f/65m, \( r_{FDC} = 3\% \), \( W_G = AWG \)

Figure 28 depicts the adequacy ratio for median (currently below 60% of the average salary) and the 3rd quartile contributions (currently 60% of the average salary) paid by the self-employed FDC members. The initial adequacy rate for the self-employed is, not surprisingly, far smaller than in the case of employees, and drops far lower: a median female contributor may expect only 23% of the future average salary – steadily dropping to 3% in 2035. In the case of men, an initial level of 47% steadily shrinks to reach 13% around 2045. Women, with shorter career paths and lower median than men, are severely worse off in terms of the initial level of pension upon retirement. Median (as well as 3rd quartile) contributions paid by men followed exactly the minimum contribution level calculated on the basis of the 60% of the average salary in the economy, while female contributions were below this value. The low values for older cohorts may be explained also by much lower stock of the initial capital, compared with that of employees. We may thus draw the preliminary conclusion that contributions paid on the basis of the minimum declared gross income, equal to 60% of the average salary, will transform into 10-15% adequacy ratio for baby-boomers born after 1980. Interestingly, the comparable income

\[58\] Again, the minimum pension is not (yet) considered here. Its compensation effect will be discussed in section 5.3.4.
level recorded in 1999-2010 for employees (the above-mentioned median for cohorts of 1955-1975) translates into higher adequacy ratios: this might be due to twice as high stock of the initial capital recorded for employees in comparison with the self-employed.\textsuperscript{59}

**Figure 28: Adequacy ratio (AR) for female & male self-employed, FDC member; RA:** 60f/65m, \( r_{\text{FDC}} = 3\% \), \( w_{\text{G}} = \text{AWG} \)

\[ \text{Source: own calculations.} \]

5.3.1.2 **Comparison between employees and the self-employed for each gender**

The next two figures: Figure 29 and Figure 30 may serve as a visualization of the already described interrelations between adequacy ratios of the employed and self-employed men and, respectively, women, both FDC members. The retirement age is comparable on each of the charts: 65 for men and 60 for women. Figure 29 shows a difference between minimum salary earners (median male employees) and those self-employed who declare 60\% of the average salary: the initial level of the benefit is lower by 10 pp for the self-employed, which may be explained by the lower initial capital in the case of older cohorts, and a discontinuous career path in the case of younger self-employed, observed in the data for 1999-2010. Since the self-employed seem to maximize their disposable income,

\textsuperscript{59} Our grouping method, based on predominant type of labor activity (employee or self-employed) in 1999-2010 shows comparable IC/contributions ratio.
the difference between employees (current average salary in the economy) and the self-employed (mainly 60% of this value, i.e. 40 pp. less) stays stable over time at 20 pp.

Figure 29: Adequacy ratio (AR) for male self-employed & employee, FDC member; RA: 65m, \( r_{FDC} = 3\% \), \( wg = AWG \)

![Graph showing AR for male self-employed and employee over time.]

Source: own calculations.

Figure 30: Adequacy ratio (AR) for female self-employed & employee, FDC member; RA: 60f, \( r_{FDC} = 3\% \), \( wg = AWG \)

![Graph showing AR for female self-employed and employee over time.]

Source: own calculations.
5.3.1.3 The main drivers for the drop of adequacy ratios

In the previous sections we observed that adequacy ratios can be expected to drop significantly in the period from 2015-2060 for all groups assessed. Generally, we can expect a shrinking of adequacy ratios by about 50-75%. For the lower income quartiles and the group of self-employed the reduction is more considerable than for higher earnings groups and employees. An important question is thus which factors determine this drop of adequacy ratios in future decades?

We can identify three main drivers of the reduction of adequacy levels, namely:

1) the increase in life expectancy,
2) the low future indexation of pension entitlements,
3) changing contribution histories.

The first two factors are directly related to the benefit formula. An increase in the unisex life expectancy at the age of retirement directly translates into a decrease in the initial pension levels. In our estimations the unisex life expectancy at retirement is assumed to increase by about 4 years until 2060. This first factor alone will lead to a drop of pension benefits by about 20%. For illustration we show in the appendix a scenario of the adequacy ratios with a constant unisex life expectancy of the base year over time.

The second factor represents the low future indexation of pension entitlements. According to the benefit formula pension rights accrued on NDC accounts are indexed each year in line with the wage bill growth. The latter indexation factor sums up the wage and the employment growth. As the Polish working population will shrink in future decades (see section 4.1 Population projection), the employment growth is expected to turn negative from 2015 onwards. Consequently, the wage bill growth will be lower than the wage growth (see also Figure 7). This growth differential has a clear cut impact on future adequacy ratios: The level of pension entitlements accrued on NDC accounts will grow slower (only with wage bill growth) than the average earnings in the economy (which grow with wage growth). According to our calculations this comparably low indexation of pension entitlements will lead to a reduction of adequacy ratios up to 10%\(^{60}\) over time. To

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\(^{60}\) 3rd quartile male employees (average salary in the economy in 2010).
outline this impact we show a scenario with an indexation of NDC pension rights with the wage growth, instead of the wage bill growth, in the appendix.

The third factor represents changing contribution histories. During the communist era Poland experienced almost full officially registered employment. After the fall of the iron curtain, however, unemployment was rising considerably, especially among the younger cohorts. As a consequence older cohorts, who accrued pension rights during the communist era, have fewer breaks in their contribution history than younger age groups. They accrued relatively high pension entitlements until 1990 (reflected in the initial capital) which was indexed with high internal rates of return (see valorisation factor in Table 3). Younger cohorts, on the contrary, show more breaks in their contribution history which are only partially or not at all credited for in the new NDC pension benefit formula. Besides more frequent career breaks younger cohorts also declare rather low earnings as a contribution basis. As outlined in section 4.1.1.2 about 50% of contributors (of the group of employees) declare only between zero and the minimum salary as contribution basis. Consequently, their future pension levels will be rather low. All together these changing contribution careers translate into significantly lower pension levels for younger cohorts. We assume that about half of the future drop of adequacy ratios is driven by the factor of changing contribution careers. For self-employed and lower earnings groups the contribution history explains even more than 50% of their reduction of adequacy levels until 2060 as their declared income for the contribution calculation is extremely low. In other words, we assume that the drop of adequacy ratio which cannot be explained by the former two factors (increasing life expectancy and low indexation of pension rights) is attributed to changes of the contribution history.

In conclusion, three factors determine the future drop of adequacy ratios until 2060. Half of the reduction can be explained by the automatic adjustment of the NDC benefit formula to demographic changes. Namely 1) the expected increase in the life expectancy and 2) the shrinking of the working population will lead via the benefit formula to pension benefit reductions. The other half of the drop of future pension benefits can be traced back to 3) changes of the contribution history. Increasing unemployed periods and very low declared earnings translate into rather low pension levels in the future. This result is rather

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important upon discussion on the measures to increase future adequacy ratios. A focus should lie on initiatives, which increase the employment rate and the declared contribution basis.

5.3.2 The FDC cut reform

The FDC cut reform has not changed the pension contribution overall rate of 19.52% - it changed only the ratios between the NDC and the FDC part. The FDC cut reform shows a relatively small effect on adequacy ratios, compared to the increase in retirement ages. The difference between the status quo and FDC cut scenarios become more visible in adequacy ratios after 2040. According to our findings, the FDC cut results roughly in a 10% decrease in pension benefit for employees retiring after 2050, as depicted in Figure 31 and Figure 32. This observation may be explained by several factors:

- The rate of return on FDC accounts is higher for most of the projection horizon. It is fixed at a 3% level in real terms until the end of the forecast. In the projection period 2010-2060 it is roughly twice as high as the NDC rate of return.
- Younger cohorts retiring after 2030 are more affected by the FDC cut, as a longer stretch of their contribution career is affected by this cut. Older cohorts retiring in the coming 10 years are almost unaffected by the FDC cut. The age specific impact can be explained as follows: First, older cohorts often do not participate in the FDC system. Second, if they participate in FDC, they spent only a small part of their contribution career in the FDC system (only periods after 1998). Third, the differential between FDC and NDC rates of return is not very considerable for 1999-2015. Only after 2015 both rates of return will diverge as the NDC rates of return shrink considerably via the link to the ageing population.
- In general the impact of FDC cut is relatively small since FDC contributions represent 37% of the entire old-age pension contributions. With the FDC cut this proportion is halved to a level of 18% (after 2017).

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63 Sensitivity analysis for different macroeconomic assumptions will be tackled in the chapter devoted to sensitivity analyses.

64 See also Table 3 and Figure 7.
Figure 31: Adequacy ratio (AR) without FDC cut, for male employee, FDC member; RA: 65m, $r_{FDC} = 3\%$, $wg = AWG$

Source: own calculations.

Figure 32: Adequacy ratio (AR) without FDC cut, for female employee, FDC member; RA: 60f, $r_{FDC} = 3\%$, $wg = AWG$

Source: own calculations.
5.3.3 The 67 retirement age reform

In 2012 a new reform was introduced, which raises gradually the retirement age for both men and women. For men the extension period of the shift from the retirement age of 65 to 67 will be spread between 2016 and 2020, while for women the increase in retirement ages from 60 to 67 will be carried out between 2016 and 2040, 1 full year of extra work for every 4 years in time. We will inspect the change in adequacy ratios for each gender, broken down into employees and the self-employed.

5.3.3.1 Gender specific outlook for employees and the self-employed.

Extended retirement age for female employees participating in the FDC system is clearly the furthest reaching consequence of the recent reform: as depicted in Figure 33, the median female contributor born after 1980 who currently earns a minimum salary would have the adequacy ratio of her pension raised from around 13% to 20%. A third quartile employed FDC female being currently paid approximately the average salary in the economy, at the new retirement age reaches around 37% adequacy, compared with 25% if she retired at the age of 60. Interestingly, it seems that the raised retirement age for employed women does not guarantee stable relation of the initial pension to the average salary: a drop from the current 50% to 37%, with the career extended by 7 years may be somewhat disappointing.
Figure 33: Adequacy ratio (AR) for female employee, FDC member; RA: 60f/67f, r_{FDC} = 3%, wg = AWG

Source: own calculations.

Self-employed women with extra 7 years added to their careers would have adequacy raised by around 5 pp. for all cohorts, if the current declared income amounts to 60% of the average salary – see Figure 34. The modest adequacy before (around 20%) and after the reform (15%) should be a point for consideration. These women who declare median values (either 60% or less, due to long non-contributory periods, see Figure 6) are actually left with almost ‘starvation’ adequacy ratios, which are below any minimum pension measure we consider (see Figure 40).
Increased retirement age for men from the age of 65 to 67 has a surprisingly high impact on adequacy: male employees participating in the FDC system may count on a rise of around 5 pp if they currently pay contributions near the average salary in the economy (3rd quartile). Yet, earnings around minimum salary increase adequacy from 17% to 20% in a long term perspective (median value).
The analysis of the self-employed men participating in the FDC system shows significantly weaker impact of the 2 additional years on the labour market: those who declare 60% of the average salary raise the initial adequacy ratio by barely 2pp to 15% in the case of cohorts born after 1980. The cohorts born earlier may count on 45-55% of the average salary in the economy of their initial pension. This can be explained by the fact that they cumulate relatively small earnings during their contribution life-cycle (which are subsequently added to the substantial initial capital level). As a consequence, the extension of the contribution time-span does not add considerably to future pension levels.
5.3.3.2 Comparison between men and women

Cross-gender comparison reveals apparent differences in the adequacy ratios in the transition period, visible especially between 2020 and 2030, when men may retire at age 67 and women at 62 to 64. Although the distance between retirement ages is equal to the status quo, the remaining retirement period for men is smaller – the NDC and FDC accounts at retirement are therefore divided by a smaller number of expected years until death. As a consequence, Figure 37 (FDC members), which compare male and female employees, show an adequacy gender gap of 20 to even 25 pp. in 2020. As might have been expected, after the unification of the retirement ages, the pension levels for both genders show no difference for the median (minimum salary paid in the base year). In the case of earnings around average salary in the economy (3rd quartile), the gap between men and women adequacy ratios can be explained by higher men’s initial capital and salaries, and continuous career path.
Figure 37: Adequacy ratio (AR) for male & female employee, FDC member; RA: 67m/67f, $r_{FDC} = 3\%$, wg = AWG

Source: own calculations.

The difference between genders is not that apparent in the case of self-employed FDC members, as shown in Figure 38 below. The gap between gender specific adequacy peaking around year 2020 is visible for the 3rd quartile, where women may count on 30% and men on a 50% adequacy ratio, though after the unification of retirement ages after 2040, the initial level of the pension drops to 15% of the then average salary. We may conclude that despite the introduction of higher retirement ages for both genders, adequacy benefits are not obvious, especially in the case of self-employed women who pay the lowest possible contributions allowed (currently 60% of the average salary). They may merely count on a pension reaching approx. 15% of this amount upon retirement, which is far below the safety net purpose.
5.3.4 The impact of minimum pensions

The issue of the minimum pension as a sub-issue of adequacy is complex and deserves a separate sub-chapter. The complexity of the minimum pension is related to the rules of indexation, which are often prone to externalities: social tensions or the political context, e.g. an approaching election campaign. The legal rule which assumes that the indexation of the social benefits amounts to 20% of the average salary growth observed in the economy (in our model 20% of the wage growth) was replaced in 2012 by the rule of a lump sum indexation, equal for all ZUS pensioners, irrespectively of amounts received. The new rule results in higher percentage growth of the lowest pensions than of the highest ones. However, the lump sum is not precisely set in relation to any predictable or quantifiable variable, like GDP growth, long-term government bond interest or the inflation rate. To cope somehow with this difficulty, we make the assumption that the indexation of future minimum pensions will be limited by two extremes: the current rule of 20% indexation and full (100%) indexation in relation to the real wage growth (wg).
5.3.4.1 Comparison between men and women

Figure 39 and Figure 40 again show adequacy ratios (similarly to Figure 37 and Figure 38), comparing males and females, both employed and participating in the FDC scheme, in a scenario of extended retirement ages and the FDC cut. What is new is the dotted lines representing minimum pension brackets: the lower dotted line marks a 20% indexation and the upper dotted line - full indexation. A third quartile employee & FDC contributor (paid currently at the average salary level) is clearly above the minimum threshold line (20% indexation). However, the compensating payment made by the state and capped at the minimum level is minimised if the full indexation of the pension were to be introduced right after the base year.

Figure 39: Adequacy ratio (AR) for male & female employee, FDC member; RA: 67m/67f, \( r_{\text{FDC}} = 3\% \), in relation to minimum pension (idx = 20%w\(_{\text{AWG}}\), idx = w\(_{\text{AWG}}\))

In the case of the self-employed, only a male contributor who declares 60% of the average salary in the base year would not receive anything above the minimum pension. Interestingly, the level of compensation for women and median contributors of both genders is higher than the comparable margin for employees. Yet again, this might be
explained by higher initial capital stocks and more consistent contribution history of employees.

Figure 40: Adequacy ratio (AR) for male & female self-employed, FDC member; RA: 67m/67f, r_{FDC} = 3%, in relation to minimum pension (\text{id}x = 20\%g_{AWG}, \text{id}x = w_{AWG})

In both analysed cases it seems that women, who are paid currently the lowest possible salary, being employees or self-employed, may not have a motivation to pursue the longer required working period. In the context of the partial old-age pension (POAP\textsuperscript{65}) they might be more motivated to apply for this form of early retirement compensation, since upon statutory retirement age they would be compensated to the level of the minimum pension. The possibility to get POAP+TCOAP is conditioned by the documented working experience (sufficient number of contributory and non-contributory years) but not by the amount of collected notional capital. Therefore, the lower the notional capital and the FDC stock would be, the stronger the motivation might be to apply for the POAP&TCOAP without reduction of the final old-age pension, compensated by the state to the minimum level.

\textsuperscript{65}See Legal framework
The full wage growth indexation of pensions would keep the minimum guaranteed pension at the same adequacy ratio level of around 22% (upon and after retirement). However, a full wage indexation of the minimum pension may act in a quite demotivating way on certain groups due to the generosity trap effect. For instance, if the minimum possible income level declared by self-employed or employees is insufficient to guarantee a pension level above the minimum pension level, then the motivation to declare any extra income shrinks. According to our findings, the compensation to the minimum level range from 20% (minimum salary employees)\(^{66}\) to even 40% (self-employed, who declare 60% of the average salary). Such scenario would move the equilibrium point closer to the individual pensioner perspective, but may put some pressure on public finances.\(^{67}\) The perspective of public finance managers would be to minimize the compensation to the minimum pension level. Preferably, the stock of the NDC and FDC accounts upon retirement should be exactly sufficient for the minimum pension level. So far, our study may conclude that such condition is not met by the legal rules for the self-employed contributors, if the indexation of 100% is applied.

### 5.3.4.2 Comparison with the adequacy of the miners’ pension scheme

Finally, we follow with Figure 41 which depicts a relation of the employees adequacy ratio in reference to the minimum pension levels, but additionally enriched by the reference to the expected miners’ adequacy ratio assuming a full wage growth indexation of their pensions. The over 90% adequacy ratio, observed currently would be responsible for the significant sustainability gap of 19%, showed in Figure 24. This is not a surprise, since in our scenario we prolong the existing rules for miners, and continue to project their current retirement behaviours: retirement at age of 45-50 and - compared with employees - very high adequacy ratio. An ordinary employee, who retires at the age of 67 earning the average salary may count on 35% of this amount, while a miner would be entitled to over 90% of this amount, but paid upon retirement at the age of e.g. 47 (median). There are employees who work in relatively comparable harsh conditions, but if they aim at 90% adequacy...
adequacy ratio they should economize through other forms of savings, carrying the risk of default by themselves.

Figure 41: Adequacy ratio (AR) for male & female self-employed, FDC member; RA: 67m/67f, \( r_{\text{FDC}} = 3\% \), in relation to miners’ pension (idx = \( wg_{\text{AWG}} \)) and minimum pension (idx = 20\%wg_{\text{AWG}}, idx = wg_{\text{AWG}})

![Graph](source: own estimation)
6 Conclusions and outlook

Until 2060 Poland faces one of the most rapid population ageing process in the entire EU. In light of this development the Polish government adopted a profound reform of the public pension landscape and introduced a new two pillar system in 1999: a mandatory funded pension pillar (FDC) and an unfunded pension pillar (NDC), both based on a (notional) defined contribution formula. After a decade of only minor pension reforms, two significant changes of the public pension system were adopted in the last two years: 1) a cut of contributions paid to FDC, called here the FDC cut reform and 2) a gradual increase in the statutory retirement age to 67 for both men and women, referred here briefly as 67RA. The aim of this paper was to evaluate these recent changes of the Polish public pension system from three perspectives: 1) fiscal long-term stability, 2) intergenerational redistribution and 3) adequacy of future pension benefits. The main conclusions are as follows:

Fiscal long-term stability: In 2010 the ZUS old-age fund runs a deficit of about 3.6% of GDP. Without the consideration of the FDC cut and the increase in retirement ages this mismatch would have remained considerable over the next decades.

Both the cut in FDC contributions as well as the increase in retirement ages considerably reduce the deficit of the ZUS old-age fund in the next decades. The most considerable impact on cash balances can be observed in the period from 2012 to 2040. In these years the deficit will be on average 1.3% of GDP lower than in a scenario without these two reforms. From a fiscal perspective, the timing of the reforms is well chosen. They take effect in a period with relatively high fiscal pressure as large cohorts born around 1960 will enter into retirement.

Besides cash balance figures also the indicator of the sustainability gap shows an improvement of the fiscal long-term stability of the ZUS pension fund via the two recent pension reforms. The sustainability gap, representing the discounted sum of future deficits, shrinks considerably from a level of 86.3 to 41.2% of GDP. About half of the remaining sustainability gap is caused by the relatively generous design of the miners’ pension system – which has been so far untouched by recent reforms.
Conclusions and outlook

Intergenerational redistribution: The cut of FDC contributions as well as the increase in retirement ages show no major intergenerational redistribution effects. In other words, the burden of the recently legislated reforms is shared equally across generations. The NDC pension system is based on the notion of equivalence. Accordingly, a rise of contributions to the NDC system, whether caused by the shift of FDC contributions or by the increase in retirement ages, is translated proportionally into higher pension benefits. As a consequence, the net-lifecycle payments (i.e. generational accounts), are almost unaffected by the two recently adopted reforms.

Adequacy: For the analysis of adequacy we applied the so called adequacy ratios which reflect the initial pension level relative to the average wage in the economy. We showed that adequacy ratio will considerably drop in future decades. Without the two recent reforms an employee earning the average salary in the economy may count on an adequacy ratio of around 85% for men and 63% for women in 2015. This ratio would gradually decrease to a level of 35% and 25% respectively in 2040. Employees, who declare a minimum salary can expect an adequacy ratio of around 60% for men and 40% for women in 2015, dropping steadily to 13% for women and 17% for men until 2040. Nearly 75% of self-employed persons declare currently an income amounting up to 60% of the average salary (the lowest allowed by law for the self-employed). This rather low contribution basis translates into adequacy ratios of 10-13% for baby-boomers born after 1980 (retiring around 2040).

Three factors determine the future drop of adequacy ratios over the next decades. Half of the reduction can be explained by the automatic adjustment of the NDC benefit formula to demographic changes. Namely 1) the expected increase in the life expectancy and 2) the shrinking of the working population will lead via the benefit formula to pension reductions. The other half of the drop of future pension benefits can be traced back to 3) changes of the contribution history. Increasing unemployment periods and very low declared earnings translate into rather low pension levels in the future. This result is important than discussing measures to increase future adequacy ratios.

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68 3rd quartile of contributions paid by employees, see Figure 5.
The shift of contributions from the FDC to the NDC does not affect individuals who participate only in the NDC system. Participants of the FDC systems can, however, expect a slight decrease in the adequacy ratios. The reason lies in the internal rate of return, which will most likely be lower in the NDC than in the FDC system since the NDC rate of return will decrease in line with the ageing population.

The increase in retirement ages to 67 for both men and women considerably raises adequacy ratios. Male employees, participating in the FDC system and retiring in 2040 e.g. may count on an increase from 35% to 40% if they currently pay contributions based on the average salary in the economy. Male minimum salary earners can expect an increase in adequacy ratios from 17% to 20%. For women the retirement age will be increased from 60 to 67. Consequently, the rise of adequacy ratios is more considerable than for men. Average salary female earners may count on an increase from 25% to around 37% of the future average salary in 2040. Self-employed men, who declared the lowest possible income may count on extra 2 pp (from 13 to 15%) after having worked longer by 2 years (from 65 to 67). Self-employed women, with extra 7 years added to their careers, would have the adequacy raised by around 5 pp. to 15 % for all cohorts, if they declare an income of around 60% of the average salary in the base year. The modest adequacy ratio of self-employed – even after the increase of retirement ages should be a point for consideration for decision makers, pensioners and academics.

In 2010 1% of new old-age ZUS pensioners fell below the minimum pension threshold. If the current distribution of contributions (salaries) continues, between 25% and 50% of all future pensioners will receive only a minimum pension in 2060. The increase in retirement ages to 67 is reflected in this calculation. The proportion of future minimum pensioners depends greatly on the indexation of the minimum pension. In this study we took two margins for indexation: 20% and 100% of the average salary growth. With the latter indexation the minimum pension would remain at the level of around 22% of average wages in the economy. By contrast, an indexation of 20% would lead to a steady decrease in the minimum pension level from 22% to 9% of the average wage until 2060. According to our findings, all individuals, who declare less than 60% of the average salary in the economy will be paid a minimum pension, if it is indexed with full wage growth. Additionally, in this high-end scenario, the bill incurred by the public sector paying out
compensation up to the level of the minimum pension will be relatively high: almost all the self-employed and all minimum-salary employees would be entitled to get the compensation. If the lowest possible indexation was applied (20% of the real wage growth), 75% of the self-employed would be entitled only to the minimum pension, without a significant compensation.

Our study showed that the main challenge ahead lies in the adequacy of future pension benefits. In particular, the group of the self-employed can expect very low benefits in the future. Different key issues can be identified in order to mitigate the rise of old age poverty without triggering a major negative effect on our three perspectives:

- We identified that about half of the future drop of benefit levels is due to changed contribution/employment histories. Against this background, policy makers should focus on labour market and education measures to decrease long-term unemployment and enhance employment, in particular at younger and older ages. Such measures can considerably increase future pension benefit levels.

- The lowest possible income declared by self-employed (60% of average salary) should be raised for higher earning groups. For example, self-employed who earn above 100% of the average monthly salary should declare higher earnings as the contribution basis. This measure would reduce future minimum pension compensations.

- A continuation of the 20% indexation of the minimum old-age pension until 2060 seems unrealistic. This would lead to a steady decrease in the minimum pension level from 22% to 9% of the average wage until 2060. Policy makers should therefore consider a change of the indexation rules and evaluate possible consequences (higher compensations, lower contribution incentives, etc.).

- Current contributors should be broadly informed about their future expected pension benefit levels. Similar to the German statutory pension system such pension information should be provided on a regular basis. Individuals may then accumulate early enough additional private savings to finance adequate retirement.

Finally, we draw attention to the gap in adequacy ratios between the miners’ pension scheme and the NDC/FDC pension system. An ordinary employee, who retires at the age of 67, and has been earning an average salary in the economy may count on 35% of this amount, while a miner would be entitled to 90% of this amount, but paid upon retirement.
at the age of e.g. 47 (median). Whether miners’ harsh working conditions provide a sufficient argument for this large pension gap is questionable.

**Sensitivity Analysis**

In Figure 42 and Figure 43 a constant interest rate for NDC1 and NDC2 is applied, amounting to its initial value from the base year. Comparing to Figure 33 and Figure 35 the AR steadily grows, which, not surprising, may serve as evidence for the positive effect of a longer career path on the AR, if the high interest rate was applied. Growing AR at the end of the forecast can be explained by the significant difference between the growth rate at that time and much higher interest rate from the base year.

**Figure 42: Adequacy ratio (AR) for female employee, FDC member; RA: 60f/67f, r_{ROC} = 3\%, w_{G} = AWG (constant overtime from a base year)**

Source: own estimation
Figure 43: Adequacy ratio (AR) for male employee, FDC member; RA: 65m/67m, $r_{FDC} = 3\%$, $w_g = \text{AWG}$ (constant overtime from a base year)

Consequently, we follow with sensitivity analysis for life expectancy (LE), which, in Figure 44 and Figure 45, show a scenario of constant LE taken from the base year. Especially in the case of women such a scenario, coupled with the 67RA condition would guarantee an almost unchanged AR for female employees who declare average salaries in the economy (3rd quartile).
Figure 44: Adequacy ratio (AR) for female employee, FDC member; RA: 60f/67f, r_{FDC} = 3%, wg = AWG (LE constant overtime from a base year)

Source: own estimation

Figure 45: Adequacy ratio (AR) for male employee, FDC member; RA: 65m/67m, r_{FDC} = 3%, wg = AWG (LE constant overtime from a base year)

Source: own estimation
References


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Annex 1

This part is devoted to the remaining two groups of persons insured in ZUS, also divided by gender and by type of job contract: but not participating in the FDC system. As stated in the chapter on legal framework persons born between 1949 and 1969 could make a choice whether to keep their all pension contributions in the NDC system (or to have them split between NDC and FDC schemes). Further to the order set in the main part of the description devoted to FDC members, we bring here first the analyses of the adequacy of employees and the self-employed in gender specific division. Then we compare employees and the self-employed for the same gender. Next we follow with a similar breakdown of results in the scenario of the retirement age raised gradually to 67 years.

Adequacy for non-FDC members: status quo

Employees

Since non-FDC members, employed or self-employed, were born between 1949 and 1969, so the forecast is limited to year 2035, when the last 65 year old male, born in 1969, retires. The median non-FDC employed woman may count on around 20% while a respective male representative on 25% of the then average gross salary in the economy, gradually dropping to 4% in 2027 (women) and 6% in 2030 (men). This is clearly 5 pp. less than for an FDC member. Also 3rd quartile figures are slightly lower: 40% for men and 32% for women. The spread of adequacy between genders is smaller than in the case of FDC members, which may be explained by higher initial capital figures and higher contributions paid by women than by men among non-FDC employees.

69 The far right values might be misleading due to the fact that the sample for 1964-1969 birth year cohorts for non-FDC members was very small and had a high share of unemployed persons.
Figure 46: Adequacy ratio (AR) for female & male employee, non FDC member; RA:
60f/65m, r_{FDC} = 3%, wg = AWG

Source: own calculations.

Self-employed

To get an almost complete picture we will check the already presented observations and references for the projection regarding self-employed non-FDC contributors – highly biased by unemployed persons. Figure 47 shows that the median is almost unobserved, and the 3rd quartile contributors may look forward to adequacy ratios of around 12%, comparable to those of self-employed FDC members who declared 60% of the average salary. The level of pension adequacy for this group drops sharply, which stems from the high pollution of this group by individuals with short careers abounding with long registered unemployment periods.
Figure 47: Adequacy ratio (AR) for female & male self-employed, non FDC member; RA: 60f/65m, \( r_{\text{FDC}} = 3\% \), \( w_g = \text{AWG} \)

Source: own calculations.

Adequacy for non-FDC members: 67RA

Non-FDC employees, women

The rise in the retirement age influences to a slightly lesser extent non-FDC female employees. However, the impact is still positive for the third quartile (earnings between 60 and 100% of the average salary), as shown in the Figure 48 below. The highest values (around 35%) seem more representative, as cohorts born between 1966 and 1968 were less representative and abounding in short employment paths and unemployed individuals.
Figure 48: Adequacy ratio (AR) for female employee, non FDC member; RA: 60f/67f, r_{FDC} = 3%, wg = AWG

Source: own calculations.

Non-FDC employees, men Figure 49, for non-FDC male employees confirms even more visibly the above-mentioned findings: both analysed measures increase by 5 pp.

Figure 49: Adequacy ratio (AR) for male employee, non FDC member; RA: 65m/67m, r_{FDC} = 3%, wg = AWG

Source: own calculations.
Figure 50: Adequacy ratio (AR) for male & female employee, non FDC member; RA: 67m/67f, $r_{FDC} = 3\%$, in relation to minimum pension ($idx = 20\% g_{AWG}, idx = g_{AWG}$)

Source: own calculations
Annex 2

Input data
Annex 2 provides further insight into the input data used in the study to compute results for all three perspectives. In this study we analyse the forecasts based on two datasets provided by the ZUS:

1) The cohort covered averages (e.g. pension contributions or benefits) for single year cohorts, age and gender specific for average contributions or benefits.
2) The raw 1% sample from the ZUS database, dated January 2011 consisting of 250 thousand men and women who are registered in the ZUS database. The original dataset provides a full description of the records reported to the ZUS, including the age, gender, full monthly career paths from 1999 until 2011, the initial capital, gross declared incomes, NDC and FDC contributions, code of the professional occupation, regional coordinates, NACE category of the employer and also information on e.g. benefits paid by the ZUS to a given individual.

The most detailed description refers to the data used for the first time: the 1% ‘raw’ sample from the ZUS database. It was used mainly in the part devoted to adequacy measures. We believe that good source data description may be valuable to better understand the outcomes presented in the Results chapter.

Filter for the 1% sample: removing empty accounts
The original database covered monthly figures of pension contributions’ history in years 1999-2011, but also net income and healthcare contributions data – and for both types of data unidentifiable IDs were earmarked. In Poland actually all citizens are insured in the healthcare system, so the number of IDs significantly exceeded the number of non-zero pension accounts. Obviously, the IDs used in the 1% sample were created also for the purposes of pension contribution collection and for healthcare system registration (ZUS intermediates in the transfer of healthcare contributions from the tax payers to the National Healthcare Fund). In consequence, the list of IDs provided in the 1% sample covered also IDs of persons who do not contribute to the ZUS pension fund, because they are e.g. farmers insured in another pension system. For such persons the only variable
available in the sample was their ID. Therefore, the inclusion of these empty IDs would have heavily increased the error margin. In certain cohorts these empty IDs amount to 40%, with almost 70% in very young and very old cohorts. In these extreme cases there might have been many other causes of the high number of empty IDs: the period of studies, emigration, death and retirement. The actual input data was therefore selected from the available original data source using a filter whose aim was to eliminate empty IDs that corresponded to records with no positive entries throughout entire professional career paths between 1999 and 2011 and registered no initial capital.

Division of the micro data into 4 groups

The 1% filtered sample was divided into 4 groups:

- Employees, members of the FDC,
- Self-employed, members of the FDC,
- Employees, not participating in the FDC,
- Self-employed, not participating in the FDC,

The division between the employees and the self-employed was based on the predominant type of job contract (‘code of the insurance entitlement’), observed through the entire career path between 1999 and 2011. This approach varies from the approach taken in the Labour Force Survey (LFS), where the predominant source of income in the last year prevails. In consequence, the gradual migration from employment towards self-employment, aiming at the reduction of the individual tax & contribution burden, observed in recent years, **may not be apparent in the distribution of our input data.**
Figure 51: Female relative group sizes

Source: own calculations based on 1% sample

Figure 52: Male relative group sizes

Source: own calculations based on 1% sample

Figure 51 and Figure 52 show the relative age and gender specific distribution of our applied four groups, namely of: 1) Employees and members of the FDC (empl FDC), 2) Self-
employed and members of the FDC (non empl non FDC), 3) Employees not participating in the FDC (empl non FDC) and 4) the self-employed not participating in the FDC (non empl non FDC). The following 4 graphs below show the number of representatives in each group type, after filtering away the empty IDs. As expected, the most numerous group are employees participating in the FDC system. The second largest group represents the employed not participating in the FDC scheme, followed by groups of the self-employed participating in the FDC and self-employed persons who decided not to participate in the FDC scheme.

Figure 53: employees FDC

Figure 54: self-employees FDC

Figure 55: employees non FDC

Figure 56: self-employees non FDC

Source: own calculations based on 1% sample

Statistical distribution of the initial capital and pension contributions

Figure 57 below shows a very typical distribution of the initial capital for all individuals in the base year 2010, in this case male employees born in 1961. The skyscraper bar on the
left represents those individuals, who have not had their IC computed, though they registered some income within the 1999 - 2011 period. For older cohorts the zeros might represent cases of death or retirement. For younger cohorts, born after 1980, the large proportion of persons yet inactive on the labour market, e.g. students, may explain some of the zeros. The graph shows a very good fit of the distribution of the initial capital to the normal distribution, when the empty accounts from the base year are removed. The explanation may lie in the initial capital computation formula (see (7)), very similar to the 'old' formula of the pension benefit. Not surprisingly, the older the analysed cohort is, the better the fit becomes. There are a few factors that explain that fit: 1) the IC formula, which limits the p (6) factor to 100% and takes into account the BCR based on the unified BA (1999); 2) work experience time span, which is limited by the starting point (18 by default), the actual age (persons born from 1949 to 1969) and the retirement age (60/65); 3) individual BCR, strongly dependent on the average salary in the economy, and finally 4) one-for-all interest rate applied after 1999 (see Table 3).

Figure 57: Distribution of the initial capital of employed males born in 1961, fit to normal distribution in case if empty records are removed, stock for January 2011

The 35% filter for the initial capital

The initial capital was filled in with empty records but actual data will certainly be filled in when the missing individuals apply for the calculation of that value e.g. upon retirement. Data provided by ZUS show that 8.7mln persons applied so far for initial capital
computation. When we compare this value with potential\textsuperscript{70} overall number of ZUS contributors born between 1949 and 1982, i.e. 11mln, we potentially get 34.5% of missing data. **For the purpose of this study we removed the lower 35% of initial capital for all cohorts.** In consequence, the filtered data show positive values for all analyzed quartiles in older cohorts and some empty records in younger cohorts. As depicted in Figure 3 (initial capital for employees), the values of the initial capital remaining in the filtered sample are very similar for the 1st, 2nd and 3rd quartile. The consequences of application of the 35% filter are described in details in chapter devoted to adequacy ratios.

The statistical distribution of the 1% sample data for pension contributions paid in the base year 2010, after being filtered for empty accounts in all years as described above, fit poorly the normal distribution, showing a very significant skewness (see Figure 58), caused by a still very high number of zeros recorded in the gross income, pension contributions or initial capital in 2010.

**Figure 58: Distribution of the pension contributions of employed females born in 1971, fitting to normal and lognormal distribution in case if empty records are removed, 2010**

![Graph of pension contributions distribution](source: own calculations)

If the zero entries for pension contributions in the base year are removed (a ‘no zeros’ filter), the skewness is still apparent, especially for self-employed persons (see Figure 59), for whom the median often represents the minimum amount of monthly contributions

\textsuperscript{70} Yet another method might have been applied to deal with the missing initial capital applicants, e.g. removal of all empty values. However, in this case the initial capital would have been by 20% higher for women than for men, and additionally, we would have assumed the same probability to work before 1999 for cohorts born in 1950 and in 1980, which seemed far too risky.
allowed by legal regulations (for details see chapter 4.2.1.2 on pension contributions). The
distribution of pension contributions (NDC/FDC) and the gross income is quite similar for
all the remaining groups, irrespective of age, gender or the type of the job contract. A
larger number of zeros is visible in these cases, when the individuals entered the labour
market apparently late and at the same time have chosen self-employment – in these
cases, very typical for high-end ID numbers, in many cases the given persons was
unemployed during the entire span of his or her career in 1999-2011 without obtaining
entitlement to the unemployment benefit. The data selection filter, based on the above
described code of insurance entitlement, was the only criterion for data division. Analyses
revealed that the last of the four analysed groups (self-employed, non-FDC participants)
displays the highest share of structurally unemployed persons. For instance, compared
with the other three analysed groups, the share of persons who have less than two years
of working experience recorded in the 1999-2010 period reached 50% in some cohorts.

Figure 59: Distribution of the pension contributions of self-employed females born in
1967, fitting to normal and lognormal distributions, in case if empty records are
removed, 2010

Source: own calculations based on the 1% sample provided by ZUS

71 It seems like the high end IDs were created if an individual entered a labour market (or rather became
officially insured) at a relatively old age, e.g. when 40+ years old.
At this point the question arose around which variables does concentrate the majority of contributions. The answer was quite simple, but it requires some initial background explanation. In Poland the self-employed persons are allowed by law to declare only a part of their actual income to pension contribution purposes. In principle, the lower monthly bound (floor) is set at the level of 60% of the average salary in the economy, while employees declare all their income for contribution purposes. The upper ceiling is common for both groups and amounts to 250% (monthly) of the average monthly salary in the economy. In other words, once a contributor reaches a gross annual income of 30 average salaries, the contributions are not collected from the remaining income.

In the group of employees special interest is shown in those employees who are paid the administratively set lowest possible salary presented in the table below:

Table 4: development of the minimum salary levels

<table>
<thead>
<tr>
<th>Year</th>
<th>Min salary</th>
<th>Minimum salary pension contributions</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>800</td>
<td>156</td>
</tr>
<tr>
<td>2004</td>
<td>824</td>
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<td>849</td>
<td>166</td>
</tr>
<tr>
<td>2006</td>
<td>899</td>
<td>176</td>
</tr>
<tr>
<td>2007</td>
<td>936</td>
<td>183</td>
</tr>
<tr>
<td>2008</td>
<td>1,126</td>
<td>220</td>
</tr>
<tr>
<td>2009</td>
<td>1,276</td>
<td>249</td>
</tr>
<tr>
<td>2010</td>
<td>1,317</td>
<td>257</td>
</tr>
<tr>
<td>2011</td>
<td>1,386</td>
<td>271</td>
</tr>
<tr>
<td>2012</td>
<td>1,500</td>
<td>293</td>
</tr>
</tbody>
</table>

Source: ZUS website and own calculations

In the group of the self-employed, special focus is given to those earning 60% of the average salary in the economy. For detailed exact amounts in a given particular year see Table 5 below:
Table 5: Development of the contribution ceiling and a minimum possible basis for the pension contribution purposes for self-employed

<table>
<thead>
<tr>
<th>year</th>
<th>30 times average salary in the economy: the amount of the annual limit of the basis for the pension contribution calculation in PLN</th>
<th>average salary in the economy</th>
<th>60% of the average salary in the economy</th>
<th>self-employed monthly pension contribution limit, floor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>50 375</td>
<td>1 679</td>
<td>1 008</td>
<td>197</td>
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<tr>
<td>2000</td>
<td>54 780</td>
<td>1 826</td>
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<tr>
<td>2001</td>
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<td>2 098</td>
<td>1 259</td>
<td>246</td>
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<tr>
<td>2002</td>
<td>64 620</td>
<td>2 154</td>
<td>1 292</td>
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</tr>
<tr>
<td>2003</td>
<td>65 850</td>
<td>2 195</td>
<td>1 317</td>
<td>257</td>
</tr>
<tr>
<td>2004</td>
<td>68 700</td>
<td>2 290</td>
<td>1 374</td>
<td>268</td>
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<tr>
<td>2005</td>
<td>72 690</td>
<td>2 423</td>
<td>1 454</td>
<td>284</td>
</tr>
<tr>
<td>2006</td>
<td>73 560</td>
<td>2 452</td>
<td>1 471</td>
<td>287</td>
</tr>
<tr>
<td>2007</td>
<td>78 480</td>
<td>2 616</td>
<td>1 570</td>
<td>306</td>
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<tr>
<td>2008</td>
<td>85 290</td>
<td>2 843</td>
<td>1 706</td>
<td>333</td>
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<tr>
<td>2009</td>
<td>95 790</td>
<td>3 193</td>
<td>1 916</td>
<td>374</td>
</tr>
<tr>
<td>2010</td>
<td>94 380</td>
<td>3 146</td>
<td>1 888</td>
<td>368</td>
</tr>
<tr>
<td>2011</td>
<td>100 770</td>
<td>3 359</td>
<td>2 015</td>
<td>393</td>
</tr>
<tr>
<td>2012</td>
<td>105 780</td>
<td>3 526</td>
<td>2 116</td>
<td>413</td>
</tr>
</tbody>
</table>

Source: ZUS website and own calculations

If employees, especially the young ones, born after 1980, pay PLN 257 of monthly contributions, it means that they are hired for the minimum salary. Consequently, if the self-employed individuals declare the lowest possible income for pension contribution purposes, then the amount of PLN 368 will be very prominent in the data for self-employed persons. Indeed, both amounts are highly representative in the 1% sample data, as depicted in Figure 5 and Figure 6.

* * *

We may conclude this part as follows:

1. The IC computation formula (7) relies partly on individualised variables, and partly on administratively fixed parameters. With comparable input data inserted into the IC
formula regarding individual career paths (in terms of length and salary level), women get higher theoretical IC values until \( p \) reaches the 100% margin. This is due to a lower denominator in the \textit{social part} of the \( p \) coefficient, resulting from administratively fixed indicators that are less demanding for women: lower \textit{pens age} (60w/65m), and smaller required number of contributory and non-contributory periods \( \chi_{CP,NCP}^{req,g} \) (20w/25m). And last, but not least, actual higher women’s LE is lowered by the unisex life expectancy.

2. The IC formula, in terms of individual career path variables, is more fragile to the number of (especially) contributory and non-contributory periods rather than the relation of annual salaries to the average salary in the economy (IBCR). The comparable percentage increase/decrease in these input variables, checked separately, results in higher changes of the IC due to the number of contributory periods.

3. The actual IC data suggest that the privileged formula does not eliminate the difference between genders in terms of labour activity before the 1999 reform. As depicted in e.g. Figure 3, men’s ICs are higher than those of women, for all cohorts born up to 1970. Our findings confirm the observation present in the literature that at these times men earned more than women or stayed longer on the labour market.

4. After the gradual liberalisation of the economic activity implemented after 1999, much larger variety of possibilities to limit the declared income was put in place. It allowed to lower the direct fiscal burden imposed by the state on the gross income. Apparently, with time, more and more individuals declare the lowest allowed declared income to increase the disposable one.

5. It is uncertain if a large number of individuals who did not declare any income in the base year but paid some contributions in the previous years (see high number of zeros in Figure 58 & Figure 59), is due to the fact that the source data may be of poor quality or these persons were actually inactive on the labour market or were insured through other types of insurance (e.g. farmers, uniformed services).

\textit{Computation data for non-FDC members (employees and the self-employed)}

In this part we take a look at non-FDC members, employed and self-employed. The representatives of these groups were born between 1949 and 1969 and had the choice to
have their old-age contributions split between NDC and FDC or recorded entirely only on the NDC account. In principle, both analysed groups as well as both genders who decided to stay outside the FDC scheme registered comparable, though slightly lower, amounts of the initial capital and pension contributions when compared with the respective FDC members.

**Figure 60: non FDC employees initial capital, January 2011, PLN**

![Graph showing initial capital by birth year and gender](image)

*Source: 1% sample provided by the ZUS*

As depicted in the Figure 3 & Figure 5 compared with Figure 60 and Figure 62, there is no significant difference in the career paths between employees being FDC or non-FDC members before 1999. Regarding gender analyses, the 3rd quartile shows higher values than FDC participants throughout the entire analysed age span for women. Also the outliers (2 standard deviations distance from the average) are higher for women than for men. Additionally, women born after 1961 who do not participate in the FDC system record increasingly higher average initial capital values than men. The presented figures for the initial capital were trimmed by a filter which removed the lower 35% of (empty) data. Nevertheless, one must also bear in mind that there is a some significant number of individuals who have not had their IC computed yet.
The initial capital value for self-employed persons, who are or are not members of the FDC, represent around half of that recorded for employees, as depicted in Figure 61. Irrespective of the fact that there is a very small number of self-employed individuals for whom the IC was available in the 1% sample, the figures suggest that also before 1999 the labour activity of these individuals was fairly weak on the officially registered labour force. Yet, the predominant amount of paid contributions in the base year concentrates around the minimum possible declared amount, as in the case of FDC self-employed members (Figure 63). Interestingly, in this group the number of empty or nearly empty accounts was the highest of all analysed groups, reaching 50-70% in cohorts born after 1970, which resulted in a very low average value (see Figure 53 to Figure 55).
Figure 62: employees non FDC members, pension contributions in 2010, PLN

Source: own calculations based on 1% sample provided by the ZUS

Figure 63: non employees non FDC members, pension contributions (NDC only), 2010, PLN

Source: own calculations based on 1% sample provided by the ZUS
### Annex 3

#### Table 6: Birth date, age required to retire, and expected earliest date of retirement

<table>
<thead>
<tr>
<th>birthdate from</th>
<th>to</th>
<th>age in years/months</th>
<th>retirement date from</th>
<th>To</th>
</tr>
</thead>
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<td></td>
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<td>60</td>
<td>0</td>
</tr>
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<td>31-03-1953</td>
<td>60</td>
<td>1</td>
<td>01-02-2013</td>
</tr>
<tr>
<td>01-04-1953</td>
<td>30-06-1953</td>
<td>60</td>
<td>2</td>
<td>01-06-2013</td>
</tr>
<tr>
<td>01-07-1953</td>
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<td>60</td>
<td>3</td>
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72 Dark grey cells refer to female cohorts which may apply for the partial old-age pension (POAP)
<table>
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<tr>
<th>Date From</th>
<th>Date To</th>
<th>Year</th>
<th>Week</th>
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<th>Date To</th>
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Source: own calculations based on official legal act
Table 7: Birth date, age required to retire, and expected earliest date of the retirement for men (all male cohorts are entitled to POAP)

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Source: own calculations based on official legal act