A New Measure of Intra-generational Redistribution within PAYG Pension Schemes and its Application to German Micro-data

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Abstract:
This paper proposes a new Index for measuring intra-generational redistribution in PAYG pension schemes. This index solely requires information on contributions and pension benefits of retirees, enabling us to measure intra-generational redistribution isolated from possible inter-generational redistribution. As an application, we use contribution records of individuals progressing into retirement to measure intra-generational redistribution in the German statutory pension scheme and the importance of certain additional benefits.

Keywords: PAYG pension systems; intra-generational redistribution; Beveridge vs. Bismarck; index; microdata; Germany

JEL Classification: H55, D81, C55

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1. Introduction

Demographic change and the ageing of societies have become major challenges to all industrialized countries. Pension reforms, especially in the first, pay-as-you-go (PAYG) financed pillar of public pension schemes, will therefore be unavoidable, but need to be backed by public acceptance and, ultimately, democratic support. Arguably, this support is stronger when pension reforms appear acceptable along two dimensions. First, the reforms need to balance the interests of the involved living, and possibly also yet unborn, generations, i.e., after the reform the pension system must still be seen as broadly inter-generationally fair. Second, public pension systems are usually considered as a part of the broader public tax-transfer mechanism. Although controversial, the public and many politicians expect public pension systems to also redistribute intra-generationally, i.e., between different types of households of the same generation. Interestingly, the academic discourse focuses more on the first dimension; there is only a small literature that systematically investigates the politically highly relevant issue of intra-generational redistribution. Our paper aims at providing new insights on the relevance of intra-generational redistribution and the effects that even minor parametric reforms might have on it. We do so by introducing a new measure for intra-generational redistribution and apply it to micro-data from the German public pension system.

Public pension schemes differ according to the relationship between contributions and benefits. One polar case, sometimes called Bismarckian pension system (cf. Cremer and Pestieau 2003; Casamatta, Cremer and Pestieau 2000a,b), provides earnings-related benefits, where there is proportionality between earnings (and thus earnings-related contributions) during work-life and paid-out pension benefits after retirement. The other polar case assumes that there is no link at all between earnings and benefits, which is typically achieved by having flat benefits for every member of the pension scheme, regardless of one’s personal level of contributions (or income-tax rates, given that these pension schemes are often tax-financed). Pension schemes of this type may be labeled Beveridgean. Most real-world pension schemes are somewhere in-between these extremes, as Krieger and Traub (2011, 2013) show. This is because of the – above mentioned – fact that the majority of voters prefers some elements of redistribution even in traditionally Bismarckian pension schemes. Table 1 gives an overview of non-earnings related benefits in the German public pension system, to which we will refer in the remainder of the paper. A striking example, highlighting how intra-generational redistribution may enter a pension scheme, are benefits based on child-raising times, where mothers receive benefits as if they were working, although they did not.

| Benefits due to Early Retirement |
| Benefits without contributions due to education, unemployment, illness and other work-related circumstances |
| Benefits due to Child Raising |
| Benefits payable to Repatriates / Foreigners resident in Germany under Special Conditions |
| Higher evaluation of Vocational Periods |
| Health / Long-Term Care Insurance for Pensioners |
| Minimum Pension |
| Invalidity Pension |
| Part-Time Work for Older Workers |

Table 1: Non-earning related benefits in the German Pension System

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1 While potential “generational conflict” is a topic in public debate and academic discourse, the existing empirical evidence in its favor is not overly robust (for a summary of evidence cf., e.g., Krieger and Ruhose 2013).
2 Due to the larger degree of redistribution, Beveridgean pension schemes are typically smaller (less generous) in absolute terms than Bismarckian pension schemes (cf. Conde-Ruiz and Profeta 2007).
Apparently, one approach to measure intra-generational redistribution in a public pension scheme is thus to identify benefit payments which are not backed by contribution payments (such as the ones in Table 1), add them up and relate them to total benefits (as, e.g., in Börsch-Supan and Reil-Held 2001). However, not all benefits can be clearly identified as non-contribution backed. In order to overcome this problem, broader measures of intra-generational redistribution have been proposed. These measures include the “index of non-contributiveness” by Lefèbre and Pestieau (2006) and Lefèbre (2007), the “index of progressivity” by the OECD (2013), correlation analyses between individual contributions and individual pension entitlements as suggested by Stöwhase (2016), and the “Bismarckian factor” proposed by Krieger and Traub (2008, 2011, 2013). While all of these measures work in theory, they are difficult to employ empirically unless rather strong assumptions are applied. For instance, if it is assumed that the income distribution does not change over time, this would allow to compare different generations (i.e., workers and pensions) at the same point of time. In Krieger and Traub’s works this makes it possible to use data on distributions of incomes and retirement benefits as provided by the Luxembourg Income Study (LIS).\(^3\) Let us delegate a closer inspection of the existing measures to the next section of this paper.

Our own measures of intra-generational redistribution in pension systems takes a different avenue, as we are able to make use of a rich data-set on individual earnings histories from the German public pension system.\(^4\) Comparable data on individual earnings histories as required for our measure may be available in a number of cases, including e.g. the Nordic countries.\(^5\) Moreover, even in cases where such real-world data is unavailable, our index could be applied on simulated data,\(^6\) making it a potentially important tool for further research. In a first step, we propose theoretically a new index measure of intra-generational redistribution. This measure relates work-life contributions to the pension scheme and the resulting benefit entitlements to a benchmark, which rests on the ratio of two hypothetical benefit distributions resulting from idealized Beveridgean and Bismarckian pension systems. The construction of our measure resembles broadly the construction of Lorenz curves and the Gini coefficient, however we also take concepts for measuring inequality in tax systems like the SUITS index (Suits, 1977) into account.

Our paper is structured as follows. Chapter 2 discusses existing measures of Intra-Generational Redistribution and derives the proposed index. Chapter 3 presents an empirical application of the index on micro-data of German retirees and Chapter 4 concludes.

2. Measuring Intra-Generational Redistribution

2.1 Existing Measures of Intra-Generational Redistribution

As stated above, there exist only a limited number of measures that allow for a comparison of intra-generational redistribution over time, between countries, or even between specific subgroups of a population. One of these measures is the “index of non-contributiveness” (INC) introduced by Lefèbre and Pestieau (2006) and Lefèbre (2007). INC, denoted by \(\beta_{\text{INC}}\), is defined as the ratio of the income share of public pensions in the bottom quintile, \(B\), to the same share in the top quintile, \(T\):

\[^3\] LIS is not a panel but rather a collection of independently sampled waves. This implies that one cannot resort to individual earnings histories.

\[^4\] Note that the downside of our approach is that we are not able to compare pension schemes of different countries, as, e.g., those papers can which employ LIS data.

\[^5\] See Edin and Fredriksson (2000) for information on Swedish pension register data or Hjollund et al. (2007) on Danish register-based data.

\[^6\] Fredriksen and Stolen (2017).
\[
\beta^{INC} = \frac{P_B/Y_B}{P_T/Y_T} = \frac{\bar{Y}_B}{\bar{Y}_T},
\]

where \(Y_i\) and \(P_i\), \(i \in \{B,2,3,4,T\}\), are the mean income and the mean pension benefit, respectively, of the \(i\)th quintile of the income distribution. A pure Beveridge pension system with equal benefits for all retirees implies \(P_B/P_T = 1\) and hence \(\beta = 1/(Y_B/Y_T) > 1\). A purely Bismarckian system which relates benefits solely on previous earnings would yield \(P_B/Y_B = P_T/Y_T\) and therefore \(\beta = 1\). Although it is possible to normalize this measure to fit into the [0,1] interval (cf. Krieger and Traub, 2013), there are some obvious disadvantages for the measurement of intra-generational redistribution.

First, considering only the ratio between the top quintil and the bottom quintil of the income distribution, potentially one loses important information contained in the complete income distribution.\(^7\) Second, the INC compares two entirely different generations with each other, the working population and the pensioners, thereby implicitly assuming that the income distribution does not change from generation to generation. The same needs to be assumed for any redistributive measures introduced by governments at different times. Clearly, neither can be taken for granted. A suitable measure should rather compare the benefits of current retirees with their previous contributions, which then includes intra-generationally redistributive measures during work-life. As a consequence, it is preferable to consider individual contributions and benefits at the micro level.

The “index of progressivity” (IOP) as applied by the OECD in its publications on pension politics (OECD 2013) resolves the first, but not the second disadvantage. IOP, denoted by \(\gamma^{IOP}\), relates inequality in pension benefits to inequality in earnings:

\[
\gamma^{IOP} \equiv 1 - \frac{G_P}{G_Y},
\]

where \(G_P = 1/2 \bar{P} n^2 \sum_{i=1}^n (P_i - \bar{P})\) and \(G_Y = 1/2 \bar{Y} m^2 \sum_{i=1}^m \sum_{i=1}^n (Y_i - \bar{Y})\) are the Gini coefficients of pensions and earnings, respectively, \(\bar{P}\) and \(\bar{Y}\) are mean pensions and mean earnings, \(n\) the number of pensioners, and \(m\) the number of employees. In a pure Bismarckian pension scheme, \(\gamma^{IOP} = 0\) since \(G_P = G_Y\). In contrast, in a Beveridge scheme \(\gamma^{IOP} = 1\) because \(G_P = 0\). Compared to INC, the IOP makes use of the complete distribution of both pension benefits and earnings. However, this measure still relates current pensions to current earnings without linking individuals’ contributions and pension entitlements.

If information on both contributions \(c_i\) and pension entitlements \(p_i\) for all individuals \(i, i = 1, ..., N\), is available, a simple alternative to the above measures could be a correlation analysis. Stöwhase (2016) calculates the coefficient of correlation of a contribution vector \(C = \{c_1, c_2, ..., c_n\}\) and a benefit vector \(P = \{p_1, p_2, ..., p_N\}\) for all \(N\) pensioners. While it is straightforward that a pure Bismarckian system implies \(corr(C, P) = 1\), a measure that is exclusively based on this correlation suffers from the problem that it cannot be normalized. This is because in a Beveridge pension scheme its value would depend on the distribution of pension benefits \(P\), which is not accounted for. Hence, any \(corr(C, P) \neq 1\) is hard to interpret. However, the measure of correlation could be a good starting point for developing a new measure of intra-generational redistribution if a normalization will be possible.

\(^7\) For instance, if pension benefits are calculated differently at different income levels, INC will be biased. Consider a Bismarckian pension scheme that covers the middle class only, i.e., there is a tight link between earnings and benefits in the second, third and fourth quintile, while at the bottom and the top of the distribution only a flat minimum benefit is received. Then, \(\beta^{INC} > 1\) since \(P_B/P_T > 1\). For the middle-class members of the scheme (ignoring the third quintil for simplicity), we have \(\beta^{INC}_4 = 1\) since \(P_2/P_4 = Y_2/Y_4\). Hence, since \(\beta^{INC} > \beta^{INC}_4 = 1\), the INC based on \(B\) and \(T\) only obviously lacks complete information.
2.2 Introducing a New Measure of Intra-Generational Redistribution

Our new index measures intra-generational redistribution by relating paid contributions to resulting benefits. Similar principles can be found in the literature on inequality and progressiveness in tax systems. Lambert and Ramos (1997) present a global index of horizontal inequity in income taxes that measures the inequality in post-tax incomes for pre-tax equals. Suits (1977) proposes the so called SUITS-Index for the measurement of tax progressivity by relating accumulated incomes to accumulated tax burdens, similar to the Gini ratio. Our proposed index provides a standardized measure of intra-generational redistribution by relating contributions and the resulting entitlements to a benchmark, which rests on the ratio of the two hypothetical distributions of the idealized Bismarckian and Beveridgean pension schemes.

In order to introduce our new measure of intra-generational redistribution, we assume a population consisting of two groups at time $t$: $N$ retirees, indexed and ordered by $i \in \{1,2,\ldots,n\}$, and $K$ working-age contributors, indexed and ordered according to contributions paid by $j \in \{1,2,\ldots,k\}$. Until her retirement, each individual $i$ has personally paid a certain amount of $e_i$ into a country’s pension scheme system. The contribution is defined as:

$$e_i = \sum_{l=1}^{m} Y^i_l \lambda_l \quad m \leq t,$$

with $m$ representing the time of retirement, $Y$ representing personal income respectively the contribution assessment basis, and $\lambda$ being the contribution rate that has to be paid in each period. This sum of own contributions is used to calculate the personal pension entitlement $PE_i$. Using (3), we can define entitlements for either the Beveridgean or the Bismarckian pension system at time $t$:

Beveridge: $PE_{i}^{Bev} = \frac{\sum_{l=1}^{m} e_l}{N} \delta$,

Bismarck: $PE_{i}^{Bis} = e_i \delta$, $\quad (4)$

where $PE_i$ represents the pension entitlement of individual $i$ and $\delta$ is a measure of generosity, which indicates how contributions $e_i$ are valued. More generally speaking, the generosity measure indicates the level of redistribution between generations (Krieger and Traub 2013). It depends on the development of societal key indicators like income or demography in the long run, while it is often decided upon by legislators in the short run (thereby ignoring – in a non-sustainable manner – their decision’s long-run implications). For the sake of convenience, we assume that $\delta$ is not varying over time. Eq. (4) represents an idealized Beveridgean pension scheme, in which the total sum of contributions is evenly distributed and each individual is awarded the same entitlement. Equation (5) is designed as an idealized Bismarckian system, where each individual’s pension entitlement is solely depending on her own past contributions.

Next, we define the actual pension system:

$$PE_{i}^{PS} = G(e_i, x_i) \delta \quad (6)$$

$$\sum_{i=1}^{N} G_t(e_i, x_i) \delta = \sum_{j=1}^{K} Y^j_t \lambda_t + SG_t \quad (7)$$

Eq. (6) represents how personal entitlements are calculated in the actual pension scheme. The individual pension entitlement depends on own contributions $e_i$ as well as other individual factors $x_i$. How these factors are valued depends on the actual (redistributive) design of the pension system.

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* Note that $m \leq t$ ensures that the individual has retired in the past or in the most recent period $t$. That is, we consider current pensioners only at this stage.
pension scheme represented by function \( G(\cdot) \). Equation (7) is the budget constraint of the pension scheme. The sum of pension entitlements is funded by the sum of contribution payments of all contributors and a state grant \( SG \) that may subsidize the pension scheme.

Equations (6) and (7) indicate legislators’ various options for modifications, or reforms, of the pension scheme: the state grant and the contribution rate could be adjusted; the contribution assessment basis could be changed; the group of contributors could be adjusted; or the generosity \( \delta \) could be changed.\(^9\) However, these options only affect inter-generational redistribution. Regarding intra-generational redistribution, legislators only have the option to modify the redistribution function \( G(\cdot) \). For instance, the importance of own contributions \( e \) in determining pension entitlements could be shifted relative to the influence of individual factors \( x \). This will change the degree of intra-generational redistribution for the current group of retirees. Note that the fact that intra-generational redistribution is affected only through \( G(\cdot) \) allows us to drop Eq. (7) in the following. More specifically, in order to measure intra-generational redistribution, only information regarding contributions and individual factors as well as the functional form of \( G(\cdot) \) are required to calculate equations (4)-(6).

Using this result, we can calculate the required pension benefits in the pension system, as well as the corresponding benchmarks claims for every retiree in our sample. Similar to the methodology of the SUITS index and related measures, we can now order and normalize the distribution of \( e \) to the interval \([0,1]\), such that it measures the accumulated share of paid contributions. Furthermore, we can now define \( F_E(e) \) as the cumulative distribution function of \( PE \) depending on \( e \) with corresponding density function \( f_E(e) \). Therefore, at point \( e \), \( F_E(e) \) measures the accumulated amount of pension benefits in the sample population. Since we are only interested in the distribution of \( e \) in equations (4)-(6), we can also drop the constant generosity measure \( \delta \). This yields the following equations that measure the distribution of pension benefits:

\[
\begin{align*}
\text{Beveridge: } & F_{E}^{\text{Bev}}(e) = \int_{0}^{1} f_{E}^{\text{Bev}}(e) \, de = \text{Bev}(e) \\ \text{Bismarck: } & F_{E}^{\text{Bis}}(e) = \int_{0}^{1} f_{E}^{\text{Bis}}(e) \, de = \text{Bis}(e) \\
\text{Actual pension system: } & F_{E}^{\text{PS}}(e) = \int_{0}^{1} f_{E}^{\text{PS}}(e) \, de = \text{PS}(e)
\end{align*}
\]

Using Equations (8)-(10), we can define our index of intra-generational redistribution as follows:

\[
R = \frac{F_{E}^{\text{PS}}(e) - \text{Bis}(e)}{F_{E}^{\text{Bev}}(e) - \text{Bis}(e)}
\]

Equation (11) measures intra-generational redistribution by calculating, how strong the underlying pension system is trending towards one of the two benchmark distributions. Since these benchmarks are constructed by using the contributions of the underlying sample population, this trending is measured relative to the difference between the two benchmarks, as expressed by the denominator of \( R \), providing a standardization.

As stated above, this index is closely related to measures of inequality and progressiveness in tax systems that themselves are related to more standard measures of inequality, in particular Lorenz curves and the Gini coefficient. Those measures should generally satisfy four main criteria, namely scale or mean independence, symmetry, transfer sensitivity, and decomposability. We therefore discuss briefly below how these criteria apply to the presented index.

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\(^9\) See e.g. Krieger and Stöwhe (2009) for the effects of discrete policy interventions on the generosity of the German pension scheme.
$R$ satisfies the condition of scale or mean independence. If all own contributions and pension entitlements were doubled, $R$ remains unchanged. The applied normalization ensures that $R$ is not dependent on the size of the retiree population, meaning that $N$ has no direct effect on $R$. The order of individuals depends solely on contributions, which satisfies the criterion of symmetry. The transfer of pension entitlements from retirees with high contributions to those with lower contributions increases the index, meaning that $R$ moves towards the Beveridge benchmark of entirely equalized benefits. Therefore, the index also satisfies the criterion of the Pigou-Dalton transfer sensitivity.

Another desirable feature of an inequality measure is decomposability, meaning that the index can be calculated for different subgroups. The index also satisfies this criterion, since pension entitlements are always measured depending on any subgroup’s own contributions. Note, however, that even though the index allows for decompositions, the sum of index values for different subgroups does not yield the index value of the entire population.

Our index yields 0 for the Bismarckian or 1 for the Beveridge benchmark, but it is not confined to this range. For example, pension systems that are more restrictive than an idealized Bismarck system (e.g., if they redistribute regressively) would yield a negative index value. It is also possible, that $PS(e)$ intersects $Bis(e)$ (possibly, even more than once). In this case, it might be, that the calculation results in $PS(e) = Bis(e)$ and the index would yield a value of 0, although redistribution occurs. In this case, a possible solution would be to subdivide the sample population at the intersections and calculate index values for these subsamples. Values greater than 1 are feasible, if the underlying pension system is extremely generous, such that $PS(e)$ intersects or lies above $Bev(e)$. This is also possible, if all retirees have very small own contributions such that $Bev(e)$ is not sufficient to provide basic welfare. Another special case would be a perfectly equal distribution of paid contributions. This could occur if the underlying pension scheme would not utilize a proportional contribution rate but a flat and equal contribution. In this case we would receive $Bev(e) = Bis(e)$ and the index would not be defined, since the denominator would be 0. Nevertheless, those special cases are relatively unlikely, since those cases would systematically violate the principle of equivalence, which is not likely if we apply the index to real world pension systems.

For a better understanding, Figure 1 presents a graphical approach to derive the Index $R$. Using normalized values for a given sample population of retirees, Quadrant I relates own contributions to pension entitlements. In this depiction, the first benchmark, an idealized Bismarck system as defined in equation (9), is represented by the bisector of Quadrant I. In this benchmark system pension entitlements are solely depending on own contributions, thereby strictly adhering to the principle of equivalence. Equation (8), the Beverdigian benchmark, is derived via Quandrants II-IV. Quadrant III represents the distribution of own contributions with the horizontal axis depicting the number of retirees, ordered and normalized by contributions. The resulting curve represents the composition of the underlying sample population and consequently the income distribution and the contribution scheme prior to retirement. If contributions are determined via proportional contribution rates, a curve with a very sharp increase in the upper parts of the retiree distribution would therefore be a representation of unevenly distributed incomes. The distribution of Quadrant III, which is the sole determinant for the Beverdigian benchmark, has now to be converted to Quadrant I to receive the desired second benchmark. This is achieved via Quadrants II and IV. Contributions are mirrored to Quadrant I via Quadrant IV, while the required pension entitlements are determined and transferred via Quadrant II. The second quadrant relates the cumulated number of retirees to cumulated pension entitlements. Therefore, the bisecion of this quadrant represents the idealized Beveridge system of Equation (8) because every sample member receives exactly the same pension entitlements. After constructing the two benchmarks, the actual pension entitlements of the retirees can be calculated to construct the
curve that represents the pension system in Quadrant I. The purpose of the index $R$ is to measure how much the curve of the pension system is trending towards one of the two benchmarks. Using Figure 1 equations (8)-(10) can be represented as the areas of Quadrant I:

- **Beveridge**: $A + B + C$
- **Bismarck**: $A$
- **Pension System**: $A + B$

Therefore, equation (11) can be interpreted as:

$$\frac{A + B - A}{A + B + C - A} = \frac{B}{B + C}$$

Figure 1: Graphical derivation of the Index R
3. Empirical application on German contribution records.

3.1 The German old-age pension system

The German statutory pension plan is designed as an earning related PAYG scheme based on the principle of equivalence. Regular old-age pensions can be claimed at the statutory retirement age which is as of now gradually increasing from 65 to 67 for individuals born after 1964. Furthermore, a minimum of five years with paid contributions is required to be entitled for an old-age pension.

Equivalence is achieved by income related earning points. Contributing at the average earnings of all contributors in a certain year yields one earning point. Contributions above and below the average yield the corresponding fraction of an earning point - e.g. earning half the average will result in 0.5 points. The sum of earning points forms the basis for determining pension claims at retirement. This design is of strong Bismarckian character, because these derived claims are solely depending on own contributions. Furthermore, additional non-earning related pension points can be awarded. These are primarily those listed in Table 1.

Additionally, earning points can be deducted due to a settlement of pension entitlements in case of a divorce or due to pension claims in another country ("Vertragsrenten"). Due to the non-contribution relation, the extent of those additional benefits determines the intra-generational redistribution of the German statutory pension plan. At retirement, earning points are evaluated with a pension value resulting in the final pension entitlement.¹⁰ This pension value is valid for all pensioners and is adjusted yearly regarding the development of gross wage growth and demographics.¹¹

3.2 Data

We use data on new retirees (Versichertenrentenzugang) provided by the Research Data Centre of the German Pension Insurance from 2007 to 2015. The Research Data Centre offers cross-sectional and longitudinal datasets on individuals who are insured in the Federal Pension Insurance on an annual basis. Our data on new retirees is a 10 percent sample of individuals that enter retirement in a certain year and provides sociodemographic and pension specific information. In 2015 this data compromises about 190 variables on approximately 105,000 individuals.¹²

3.3 Measuring Intra-Generational redistribution for new German pensioners

In the following section we will apply our measure $R$ on data of pensioners that entered retirement in a certain year. We focus on new retirees, because developments and differences across several years of new retirees are more pronounced in contrast to looking at all pensions in payment. Moreover, since we are interested in measuring intra-generational redistribution, it seems to be more valid to look at a certain cohort of new retirees. Doing otherwise would yield the risk that our measure potentially also includes some kind of inter-generational redistribution. Furthermore, we focus on those new retirees that claim a regular old-age

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¹⁰ The so called “pension formula” adjusts earning points also with an access factor, that measures early/ late retirement and with a pension type factor, that for example is applied for a widow’s pension. In case of a regular old-age pension (“Regelaltersrente”) these factors have the value 1.

¹¹ For a more detailed information about the German pension system see, for example, Boersch-Supan and Wilke (2004).

¹² For more detailed information on the scope of the data see Himmelreicher (2005).
pension, which is the standard pension claim in the German Statutory Pension Insurance (GRV), to avoid distortions due to early retirement or invalidity.\(^{13}\)

Since we are using data of the German Statutory Pension Insurance, we will use two primary reference values of the earning points system. Our measure for paid contributions is the sum of own earning points (OEP) that an individual accumulated during its contribution period. Own earning points can only be obtained by being employed and paying contributions, therefore, they are a direct and proportional proxy of contributions paid \(\varepsilon_i\). As described above one year of employment yields a certain number of earning points depending on the average gross income. The resulting amount of OEP at retirement at year \(t\) is therefore \(OEP = \sum_{l=1}^{t} \frac{Y_l}{\bar{Y}_l}\), with \(Y\) being personal income in year \(l\) and \(\bar{Y}\) being the mean income of all contributors.\(^{14}\) In a pure Bismarckian pension system, these points would be the only relevant basis for pension benefits.

Regarding pension entitlements, we use the sum of personal earning points PEP which is the final sum of earning points after adjustments. Personal earning points are defined as:

\[
PEP = \underbrace{OEP}_{\text{own contributions}} + \underbrace{\text{additional EP} - \text{deducted EP}}_{\text{not depending on own contributions}} \tag{12}
\]

Since we are looking at regular old-age pensions, personal earning points are the main determining factor of an individual’s pension entitlement. There are regional differences due to German reunification, but these differences do only affect how the sum of personal earning points is valued or they are already corrected during the contribution phase.

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\(^{13}\) Early retirement generally results in a reduced pension entitlement depending on the years left to the statutory retirement age. Invalidity pensions are paid depending on a reduction in earning capacity before the statutory retirement age.

\(^{14}\) Additionally, contributable income \(Y\) and therefore OEP per year are capped at a contribution ceiling.
Figure 2 presents the results for new pensioners in 2015. The actual pension system as defined in equation (10) is represented by the PS curve:

![Cohort entering retirement in 2015](image)

Figure 2: New retirees in 2015

As can be seen from the shape of the Beveridge curve, the majority of contributions are located in the lower 40 percent of the distribution of own earing points. Regarding the PS curve, we find existing redistribution in terms of personal entitlements, that is especially pronounced in the lower half of the distribution of own contributions. The corresponding values for equations (8) - (10) are:

\[
Bev(e) = 0.7857 \\
Bis(e) = 0.5000 \\
PS(e) = 0.5647
\]

Using these Values in equation (11), we receive a value of:

\[
R = \frac{0.5647 - 0.5000}{0.7857 - 0.5000} = 0.23
\]

Figure 3 shows the underlying curves depending on the sex of a new retiree. First of all, it can be seen, that the PS curve is much closer to a Bismarckian system for men than for women. Furthermore, we find differences in the underlying distribution of own contributions. The Beveridge curve for women concentrates more mass in the lower quantiles of the distribution of own contributions, while male contributions are more evenly distributed.
In terms of our measure $R$, we receive values that show clear differences in the amount of redistribution by gender (see Table 2). Reflecting Figure 3, the $R$ for men is much smaller than for women, which shows that, measured in terms of own contributions, men receive significant less additional entitlements above the Bismarckian line of own contributions than women. This is not surprising, because women are more likely to gain additional earning points that are detached from own contributions (e.g. raising children), and are on average more likely to receive bonus points in case of divorces. It is important to note, that the total value for $R$ is measuring the effects of the whole population with both genders being part of the distribution of own earning points and pension entitlements. Therefore the total value of $R$ should not be interpreted as a function of the values for men and women.

<table>
<thead>
<tr>
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<tr>
<td>Total</td>
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</tr>
<tr>
<td>Men</td>
<td>0.04</td>
</tr>
<tr>
<td>Women</td>
<td>0.36</td>
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</tbody>
</table>

Table 2: Index Values - 2015
Since we have data on new retirees from 2007 to 2015, we can also calculate $R$ for several cohorts. Figure 4 depicts the development over time for the overall population as well as gender specific developments.

![Index Values over Time](image)

**Figure 4: Index Values over Time.**

The $R$ calculations for the total populations show a slight increasing trend between 2010 and 2013 with a significant increase in 2014. The $R$ for men remains nearly constant across the years. Prior to 2014, women showed a trend of reduced redistribution. This reduction was primarily caused by a significant reduction of redistributional entitlements which we measure by $PS(e)$. From 2007 to 2013, received entitlements above the Bismarck line, which represents the nominator of $R$, dropped from 0.092 to 0.0693, a decrease of around 25 percent. Own female contributions, measured by $Bev(e)$, did in fact increase in this time period from 0.7662 to 0.7746, but this amounts only to about 1 percent. Therefore we can conclude that women showed a tendency for reduced dependency on redistributional pension claims and an increased dependency on own contributions prior to 2014. This tendency might still be valid after 2014. Data on future retirees will show if a downward trend is still persisting.

Using $R$, we can show that the intra-generational redistribution shifted significantly in 2014. This shift can be attributed to a recent reform that doubled the number of obtainable earning points due to childcare for children born before 1992. Therefore, it is not surprising that we see an increase in the $R$ for women but not for men. To show that this effect is indeed caused by changes in claimable childcare periods, we will take a closer look at how the importance of childcare has an influence on the development of $R$ over time. The German statutory pension system awards non-earning related pension points for raising children. Generally, each year of childcare yields one pension point, which means that a mother is

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15 “Gesetz über Leistungsverbesserungen in der gesetzlichen Rentenversicherung”; June 2014

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awarded the equivalent of having been employed with an average income. Currently, it is possible to claim up to 3 years as child care periods, if the child was born after the year of 1992. More importantly, for children born before 1992 it was possible to claim a child care period of one year. In 2014, as stated above this additional benefit was doubled to two points. So most women entering retirement in the last years received earning points for child care periods before 1992, since it is extremely unlikely that they had a child born after 1992. As a measure of importance, we will use the difference between the $R$ with all pension entitlements and the resulting $R$ if we omit the additional benefits for childcare periods in question.

![Figure 5: Results with and without childcare](image)

Figure 5 clearly shows that the importance of childcare is quite substantial. If we remove childcare related pension entitlements, retirees in 2015 are significantly closer to the Bismarck line. Not surprisingly, this type of additional benefit is of much greater importance for women. The difference for male pension claims is nearly nonexistent (in 2015, the difference for men is 0.002). Looking at the development over time, the reform of claimable childcare periods is clearly visible in Figure 6. It depicts the differences in $R$ due to childcare periods. The difference for women increases significantly in 2014, while changes for men are marginal. The difference in the female $R$ increases by 13 percentage points (from around 0.12 in 2013 to 0.25 in 2014). If we take into account, that the overall female $R$ in these years increases by only 11 percentage points (from 0.25 to 0.36), we can conclude that without the reform, female intra-generational redistribution would have followed the decreasing trend of previous years. These findings demonstrate, that $R$ is not only able to quantify changes in intra-generational due to reformed legislation, but also how different subgroups contribute to these shifts in redistribution.

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16 It has to be noted that child care periods are awarded to the mother by default. Fathers can apply to receive these periods instead, but in practice this rarely happens.
4. Conclusion

Due to recent and future demographic changes, caused by low fertility and rising longevity, societies with PAYG pension schemes face an increasing need for reform, especially in their public social insurance systems. Reforming a pension scheme might require to deviate from the current level of intra-generational redistribution, which has – up to that point in time – also represented an accepted social consensus. This deviation will be of crucial importance regarding the feasibility of reforming an established pension scheme, as the new level of redistribution must also be accepted widely in society.

The purpose of this paper was to introduce a new index that enables the measurement of intra-generational redistribution in a PAYG pension system. Existing measures, like the index of non-contributiveness or the index of progressivity are limited by setting different generations into relation, while information on own contributions and resulting pension claims are not taken into account. Extending on concepts of measuring inequality and progressiveness in tax systems, we derived an index that relates paid contributions and resulting pension entitlements to a benchmark, which rests on a ratio of two hypothetical distributions, an idealized Beveridge system and an idealized Bismarck system. Therefore, this index is not depending on information of the younger generation of contributors and utilizes the complete distribution of pension claims and own contributions rather than relying only on certain quintiles or moments. This specification also allows to compare intra-generational redistribution across different cohorts, as well as for different subgroups within a generation.

Applying our index on contribution records of new German retirees, we were able to measure the development of intra-generational redistribution across different cohorts and
show that the index is in fact able to measure the effects of legislative change on intra-generational redistribution. We found that the index stays nearly constant before the year of 2014 even though it shows a slow reduction over time for women. In 2015, the index measures intra-generational redistribution at a value of 0.23. In 2014 the index increases significantly, which can be primarily attributed to a specific change of regulation in the German pension system, the extension of claimable childcare periods for children born prior to 1992. This is especially of interest, since the main argument for this legislative reform was in favor of inter-rather than intra-generational redistribution. Moreover, decomposition reveals significant differences between men and women: Men are close to the Bismarckian principle of equivalence, while women benefits are considerably less Bismarckian in nature.

Regarding further research, it would be of interest to apply our index on other countries to investigate how intra-generational redistribution is varying across their pension systems. This may also include an analysis of recent trends in intra-generational redistribution in these countries and an investigation to which degree these trends have been the result of policy changes. Similar to the doubling of claimable child care periods, the legislative importance of intra-generational redistribution in these policy changes can be considered. As noted above, comparable data on individual earnings histories may be available in a number of cases, including e.g. the Nordic countries, or the application on simulated data could be considered.
**Bibliography**


