Measuring Intra-generational Redistribution in PAYG Pension Schemes

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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 approx. 100,000 German individuals, who progressed into retirement in 2007-2015, to measure intra-generational redistribution in the German statutory pension scheme (GRV). We use a reform of childcare benefit provision, which became effective in 2014, to show that our index responds in the predicted direction.

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

JEL Classification: H55, D31, 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.[1] 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 in PAYG pension schemes 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*.[2] 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

[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 Bimarckian pension schemes (cf. Conde-Ruiz and Profeta 2007).

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

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 measure 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 (cf. Fredriksen and Stølen, 2017), making it an 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 follows broadly the construction of Lorenz curves and the Gini coefficient, but show resemblance to measures of inequality in tax systems, such as the Suits index (Suits, 1977).

Our paper is structured as follows. Chapter 2 discusses existing measures of intra-generational redistribution and derives our 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 β^{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:

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[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.

$$\beta^{INC} \equiv \frac{P_B/Y_B}{P_T/Y_T} = \frac{P_B}{P_T} \cdot \frac{Y_T}{Y_B}, \quad (1)$$

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 ith quintile of the income distribution. A pure Beveridgean pension system with equal benefits for all retirees implies $P_B/P_T = 1$ and hence, $\beta = Y_T/Y_B \geq 1$. 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 quintile and the bottom quintile of the income distribution, potentially one loses important information contained in the complete income distribution.[6] 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 γ^{IOP}, relates inequality in pension benefits to inequality in earnings:

$$\gamma^{IOP} \equiv 1 - \frac{G_P}{G_Y}, \quad (2)$$

where $G_P = 1/2\bar{P}n^2 \sum_{i=1}^{n} \sum_{j=1}^{n} (P_i - P_j)$ and $G_Y = 1/2\bar{Y}m^2 \sum_{k=1}^{m} \sum_{l=1}^{m} (Y_k - Y_l)$ 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 Beveridgean scheme $\gamma^{IOP} = 1$

[6] 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 $\beta_{2,4}^{INC} = 1$ since $P_2/P_4 = Y_2/Y_4$. Hence, since $\beta^{INC} > \beta_{2,4}^{INC} = 1$, the INC based on B and T only obviously lacks complete information.

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, $i = 1, \dots, N$, 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 $C = \{c_1, c_{2,}, \dots, c_n\}$ and a benefit vector $P = \{p_1, p_{2,}, \dots, p_n\}$ 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 Beveridgean 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.

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 $i \in \{1,2, \dots, n\}$, and K working-age contributors, indexed and ordered according to contributions paid by $j \in \{1,2, \dots, k\}$. Until her retirement, each individual i has personally paid an amount e_i into a country's pension scheme system. The contribution is defined as:

$$e_i = \sum_{l=1}^{m} h\left(Y_l^i \lambda_l\right)\ ,\ m \le t, \tag{3}$$

[7]

with m representing the time of retirement, Y representing personal income respectively the contribution assessment basis, and λ being the contribution rate that has to be paid in each period. Finally, function $h(.)$ adjusts the paid contributions of a period l over time.[8] 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:

$$\text{Beveridge:}\quad PE_i^{Bev} = \frac{\sum_{i=1}^{n} e_i}{N}\ \delta, \tag{4}$$

$$\text{Bismarck:}\quad PE_i^{Bis} = e_i \delta, \tag{5}$$

where PE_i represents the pension entitlement of individual i and δ 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 δ 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:

$$PE_i^{PS} = G(e_i, x_i)\delta \tag{6}$$

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

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 scheme represented by function $G(\cdot)$. Equation (7) is the budget constraint of the

[7] Note that $m \le t$ 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.

[8] In a simple saving scheme, $h(.)$ would represent paid contribution plus interest. Another possibility for function $h(.)$ is discussed below.

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 δ 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 if we are solely interested in calculating the existing intra-generational redistribution in a pension scheme. 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). Legislators using the presented framework to plan an adjustment of the rate of intra-generational redistribution via $G(\cdot)$ will of course have to take the budget constraint of equation (7) into account. However, for the purpose of this index, this can be neglected.

Using this result, we can calculate the required pension benefits in the pension system, as well as the corresponding benchmark 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 δ. This yields the following equations that measure the distribution of pension benefits:

$$\text{Beveridge:} \quad F_E^{Bev}(e) = \int_0^1 f_E^{Bev}(e)de := Bev(e) \tag{8}$$

$$\text{Bismarck:} \quad F_E^{Bis}(e) = \int_0^1 f_E^{Bis}(e)de := Bis(e) \tag{9}$$

[9] See e.g. Krieger and Stöwhase (2009) for the effects of discrete policy interventions on the generosity of the German pension scheme.

$$\text{Actual pension system:} \quad F_E^{PS}(e) = \int_0^1 f_E^{PS}(e)de := PS(e) \tag{10}$$

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

$$R = \frac{PS(e) - Bis(e)}{Bev(e) - Bis(e)} \tag{11}$$

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.

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 Beveridgean 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 Beveridgean 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 index R. Using normalized values for a given sample population of retirees, quadrant I relates own contributions to pension entitlements. In this depiction, the bisector of quadrant I represents the first benchmark, an idealized Bismarck system as defined in equation (9). In this benchmark system, pension entitlements depend only on own contributions and strictly adhere to the principle of equivalence. Equation (8), the Beveridgean benchmark, is derived via quadrants 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, consequently the income distribution and the contribution scheme prior to retirement. If contributions are determined by 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 Beveridgian 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 bisection 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 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:

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

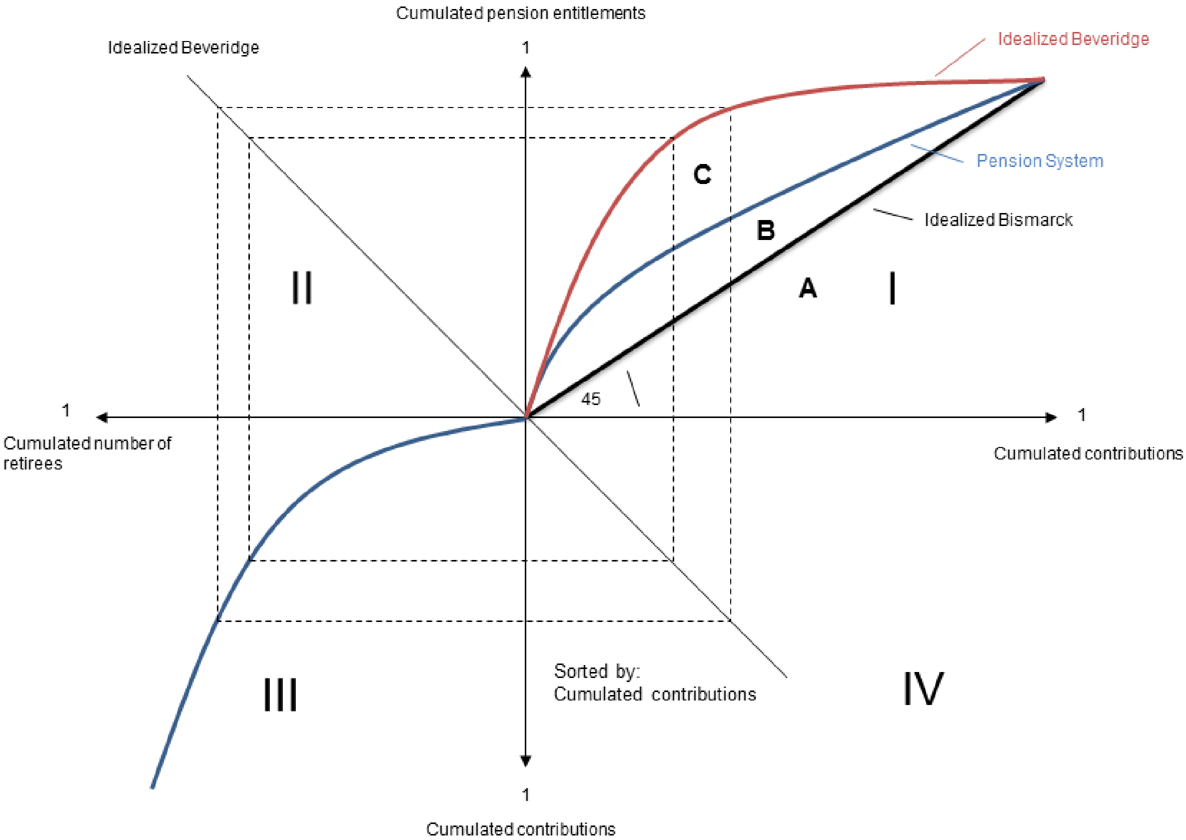

Figure 1: Graphical derivation of index R

3. Empirical application on German contribution records.

3.1 The German old-age pension system

The German statutory pension plan (Federal Pension Insurance GRV) is designed as an earnings-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 earnings points. Paying exactly the contribution of an average earner (relative to all contributors in a certain year) yields a full earnings point. Contributions by earners above and below the average yield the corresponding fraction or multiple of an earnings point; e.g., earning, and contributing, half the average will result in 0.5 points. The sum of earnings points forms the basis for determining pension claims at the time of retirement. This design could be characterized as purely Bismarckian when claims would indeed depend exclusively on own contributions. However, additional non-earnings related pension points can be awarded. These are primarily the ones listed in Table 1.

Furthermore, earnings points can also be deducted in case of a settlement of pension entitlements following a divorce or because pension claims exists against other countries' pension systems ("Vertragsrenten"). The extent of those additional benefits (and deductions) determines the level of intra-generational redistribution of the German statutory pension plan. At retirement, earnings points are multiplied with the so-called pension value resulting in the final pension entitlement (in Euro).[10] The pension value is the same for all pensioners and is adjusted on a yearly basis according to the growth rate of gross wages and some demographics-related parameters.[11]

3.2 Data

We use data on new entries into the pension system (Versichertenrentenzugang) in 2007 to 2015 provided by the Research Data Centre of the German Pension Insurance. 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

[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 e.g. applies to widows' pensions. In case of a regular old-age pension ("Regelaltersrente") this factor is 1.

[11] For a more detailed information about the German pension system see, e.g., Boersch-Supan and Wilke (2004).

pension specific information. In 2015, this data compromises about 130 variables on approximately 105,000 individuals.[12]

3.3 Measuring intra-generational redistribution for new German pensioners

In the following section, we will apply index R to data of pensioners that entered retirement in a certain year. We focus on new retirees, because changes of pension system parameters are usually phased in and therefore the effect is most pronounced for new retirees. This is especially true for changes in intra-generational redistribution, as they are usually not introduced in a backdated way and thus start to affect only the newest cohort. Technically, by looking only at new entries into retirement we reduce the risk that our measure accidentally includes inter-generational redistribution. Furthermore, we focus on those new retirees that claim a regular old-age pension, which is the standard pension claim in the German Federal Pension Insurance, to avoid distortions which may result from mixing regular, early retirement or invalidity pensions.[13]

Following the rules that apply in the GRV, we will use two primary reference values of the earnings points system. Our measure of paid contributions is the sum of own earnings points (OEP) that an individual accumulates during its contribution period. Own earnings points can only be obtained by being employed and paying contributions; therefore, they are a direct and proportional proxy of contributions paid e_i. As described above, one year of employment yields a certain number of earnings points, which result from a comparison of one's own wage and the average gross income. Therefore, the resulting number of OEPs when entering retirement in t is given by

$$OEP = \sum_{l=1}^{t} \frac{Y_l}{\bar{Y}_l},$$

with Y being personal income in year l and $\bar{Y}$ being the mean income of all contributors.[14] Note, that this way of calculating earning points reflects the idea of function $h(.)$ in equation (3). In a pure Bismarckian pension system, these points would be the relevant basis for pension benefits.

[12] For more detailed information on the scope of the data see Himmelreicher (2005).

[13] Early retirement generally results in a reduced pension entitlement depending on the years left to statutory retirement age. Invalidity pensions are paid depending on the level of reduced earnings capacity in the years before statutory retirement age.

[14] Additionally, contributable income Y and therefore OEP per year are capped by a contribution ceiling.

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:

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

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 have already been corrected during the contribution period.[15]

Figure 2 presents the results for new pensioners in 2015. The actual pension system (PS) as defined in equation (10) is represented by the GRV curve:

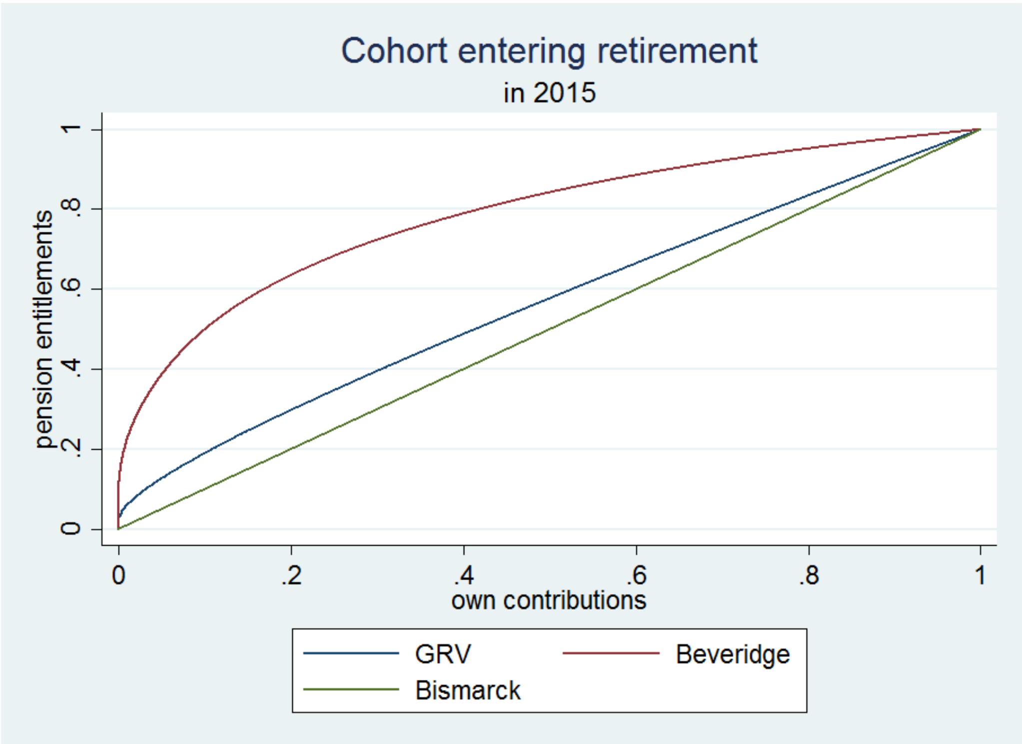

Figure 2: New retirees in 2015

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 earnings points. In terms of personal entitlements, the GRV curve indicates redistribution that is especially pronounced in the lower half of the distribution of own contributions. The corresponding values for equations (8) - (10) are:

[15] Contributions paid in the former German Democratic Republic are adjusted by a weighting factor to compensate for differences in average gross incomes.

$$Bev(e) = 0.7857$$

$$Bis(e) = 0.5000$$

$$PS(e) = 0.5647$$

Inserting these values into equation (11) yields

$$R = \frac{0.5647 - 0.5000}{0.7857 - 0.5000} = 0.23$$

Figure 3 shows the underlying curves for male and female new entries into retirement. It is striking to see that the GRV 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 much more evenly distributed.

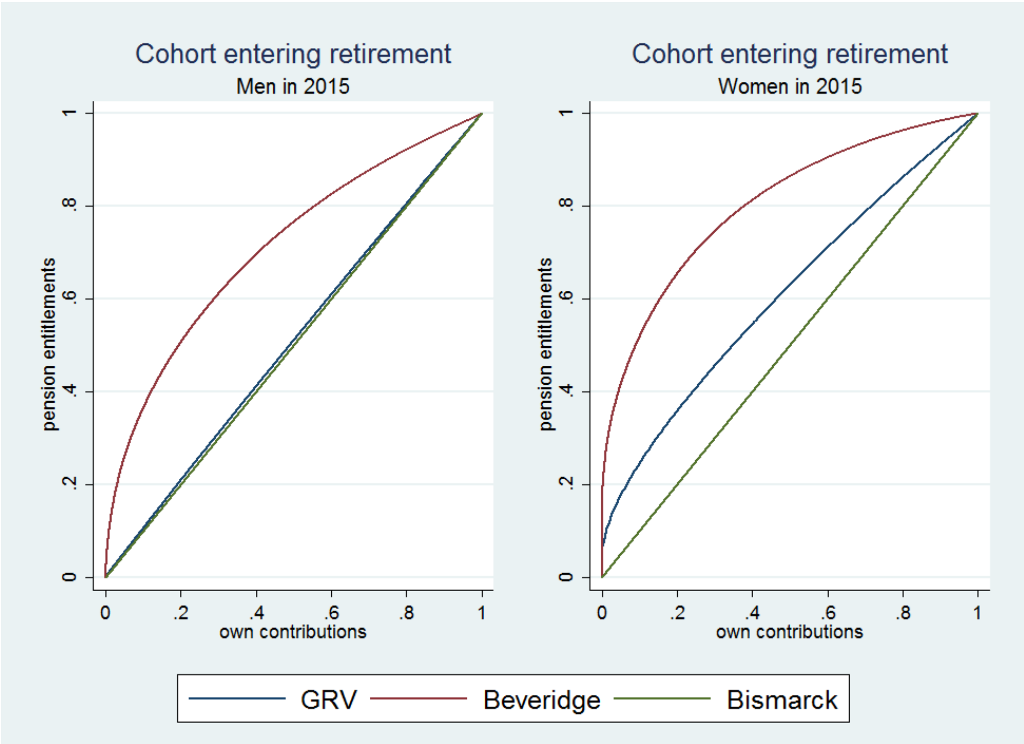

Figure 3: New retirees in 2015 by sex

Table 2 presents the respective values of index R. Index R is much smaller for men than for women, which shows that, measured in terms of own contributions, men receive significantly fewer additional entitlements (beyond the Bismarckian line of own contributions in Figure 3) than women. This is not surprising because women are more likely to gain additional earnings points that are detached from own contributions (e.g. for raising children). In addition, they are – on average – more likely to receive bonus points in case of divorces.

Note that the total value for R measures the effect of the whole population with both males and females being part of the distribution of own earnings points and pension entitlements. Therefore the total value of R should not be interpreted as a function of the values for men and women.

Total	0.23
Men	0.04
Women	0.36

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.

Figure 4: Index Values over Time.

For the total populations, index R shows a slightly increasing trend between 2010 and 2013 with a significant increase in 2014. For men, the index remains nearly constant over time. In contrast, the index decreased slightly for women prior to 2014, which was primarily driven by a significant reduction of redistributional entitlements, i.e. $PS(e)$. From 2007 to 2013, received entitlements, which represents the nominator of R, dropped from 0.092 to 0.0693, a decrease of approx. 25 percent. At the same time, own female contributions, measured by $Bev(e)$, increased from 0.7662 to 0.7746, i.e. by approx. 1 percent. Taken together, 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 this general downward trend will persist.

Independent of this general trend, we observe a significant upward shift in the value of R in 2014, indicating a massive change of the degree of intra-generational redistribution toward women in the GRV. This shift can be explained by a recent reform that doubled the number of obtainable earnings points resulting from childcare.[16] More specifically, the GRV awards non-earnings related pension points for raising children. Before the reform, mothers received one earnings point per child born before 1992 and three earnings points for children born after 1992. One pension point means that a mother is awarded the equivalent of having been employed for one year, thereby earning the average income.

The ruling grand coalition in Germany considered this unfair for mothers with older children and therefore increased earnings points to two for any child born before 1992. The reform was designed in a way that even mothers close to retirement could benefit from the more generous benefits, which means that our analysis ought to capture the reform by driving up index R for women, but not for men.[17] In fact, most women entering retirement in recent years received earnings points for childcare periods before 1992, since it is extremely unlikely that they had a child born after 1992. In order to measure the importance of the reform, we take the difference between R including all pension entitlements and R without the additional benefits for childcare periods in question.

[16] “Gesetz über Leistungsverbesserungen in der gesetzlichen Rentenversicherung“; June 2014

[17] 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.

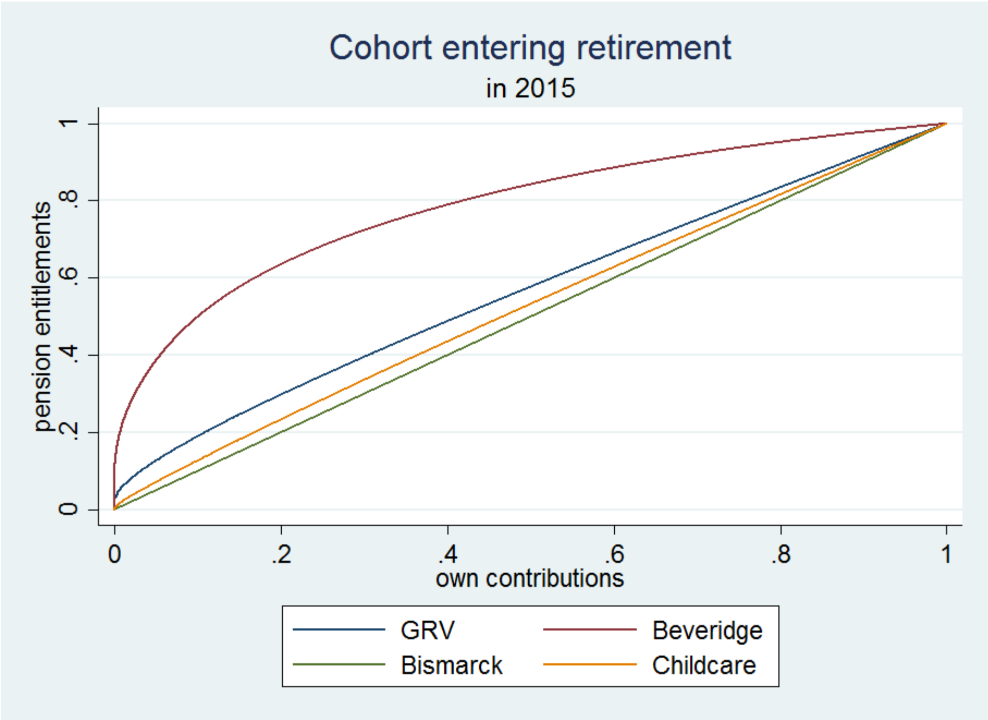

Figure 5: Results with and without childcare

Figure 5 shows that childcare contributes substantially to the level of intra-generational redistribution in the GRV. 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 increased 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.

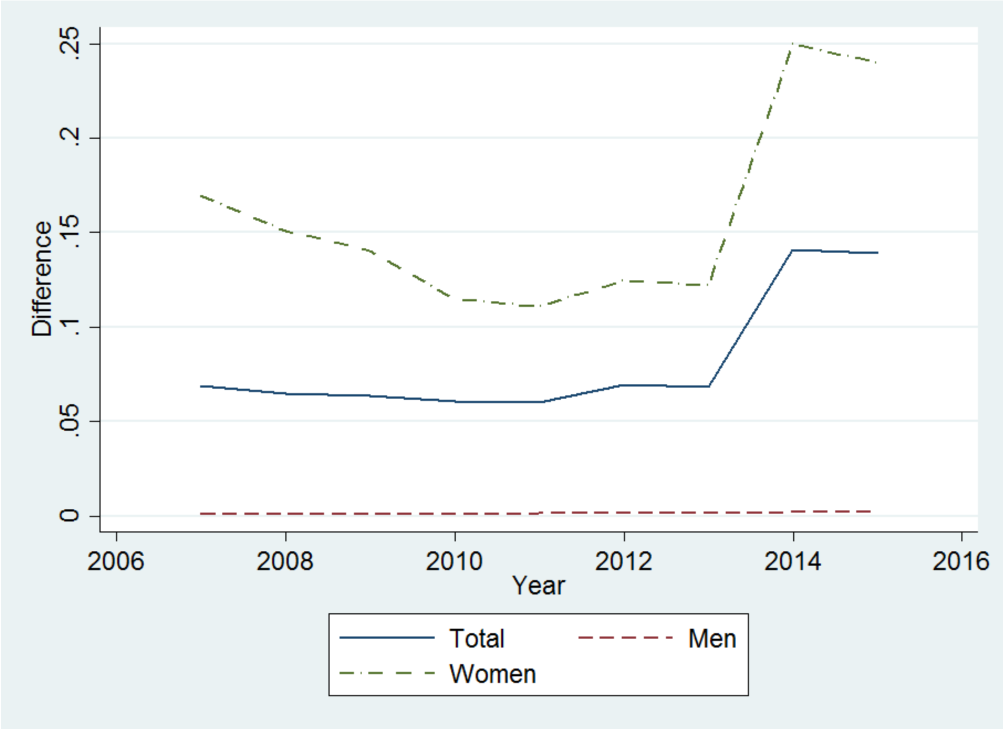

Figure 6: Differences in the redistributional effects of childcare over time

4. Conclusion

Due to recent and future demographic change, 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 for the feasibility of reforms of established pension schemes, 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 us to measure 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 existing concepts for measuring inequality and progressiveness in tax systems, we derive 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 does not depend on information on younger contributors. It utilizes the complete distribution of pension claims and own contributions rather than relying only on certain quintiles or moments. Our 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 are able to measure the development of intra-generational redistribution across different cohorts. We can also show that the index is able to measure the effects of legislative changes of intra-generational redistribution. We find that the index stays nearly constant before the year of 2014 except for a slow reduction over time for women. In 2015, the index scores a value of intra-generational redistribution of 0.23. In 2014, the index increases significantly, which can mainly be attributed to a regulatory change in the German public pension system: the extension of claimable childcare periods for children born prior to 1992. This is of specific 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: The level of intra-generational redistribution for male retirees resembles closely the Bismarckian principle of equivalence, while women's benefits are considerably less Bismarckian in nature.

Regarding further research, it would be of interest to apply our index to other countries to investigate how intra-generational redistribution varies in these 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 German reform of claimable childcare periods, the legislative importance of intra-generational redistribution in other countries' policy changes can be considered. As noted above, comparable data on individual earnings histories may be available in several countries, including e.g. the Nordic countries. If it is not available, the use of simulated data could be considered.

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