Why the increase in the retirement age will lead to more inequality and poverty? An ignored fairness problem

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Summary: In this study, we show with the help of a simple model that an increase of the retirement age has a negative impact on the distribution of pension benefits in the Bismarckian as well in the Beveridgean pension system. In both systems, the distribution of pension benefits will change in favour of high-income earners. Additionally, we show that the increasing gap in the life expectancies of low and high-income earners will increase inequality. Both results are a consequence of the positive relationship between the socio-economic status and life expectancy of a person. These important insights are often ignored by the promoters of pension reforms.

Keywords: Bismarckian pensions, Beveridgean pensions, life span, retirement age

JEL Classification: H55, D31

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1 Introduction

Most OECD countries and European countries apply a pay as you go (PAYG) pension for their national pension system. A key principle of a PAYG pension system is that the contributions of employees are directly paid out as pension benefits to retired contributors. Thus, the age dependency ratio (the ratio of people older than 64 to the working-age population (those ages 15-64)) is an important variable influencing the replacement rate (percentage of a worker's pre-retirement monthly income that is replaced by retirement benefits when they retire.). However, most developed countries are experiencing an unsustainable total fertility rate (number of children per female) of less than 2.1 children per female, and an increase of the life expectancy of retired persons. These two characteristics of the demographic change lead to a decline of the number of contributors, and to an increase of retired persons. Given these facts, pension reforms are necessary to keep the replacement ratio constant. The political consensus in many countries is to increase the retirement age (OECD 2017). The direct effect of an increase in the retirement age is that the number of retired persons will decline and that the workforce will increase.

If all humans would be equal regarding their life expectancy an increase in the retirement age may be justifiable and fair. Unfortunately, in reality the life expectancy of a person is strongly related to its socio-economic status. Therefore, it is the aim of this paper to show theoretically that an increase of the retirement age will affect (adversely) low-income earners more than high-income earners if a PAYG pension system or capital funded pension system is applied. On fairness, we address the question: what are the redistributional effects if the life spans of different social groups evolve at different speeds, that is, what can be expected from an increasing or decreasing gap of life spans of different socio-economic groups, and what can be expected if the retirement age will increase.

The paper is organized as follows. In the second section, we provide an overview of the literature which is related to the intragenerational fairness of PAYG pension systems. In the third section, we present the basic assumptions and introduce the model. Next, we analyze the distributional impact of increasing retirement age and increasing gap in the life spans of low- and high-income earners in a Bismarckian PAYG, Beveridgean PAYG and a public fully funded pension system. In section 4, we calibrate the model. In section 5, we discuss our results.

2 Literature review

The literature on the relation between life expectancy and socio-economic status (for example, Evelyn M. Kitagawa and Philip M. Hauser 1973, Michael G. Marmot, Martin J. Shipley and Geoffrey Rose 1984, Michael Wolfson, Geoff Rowe, Jane F. Gentleman and Monica Tomiak 1993, Pekka Martikainen, Pia Mäkelä, Seppo Koskinen and Tapani Valkonen 2001, Pekka Martikainen, Eero Lahelma, Michael Marmot, Michikazu Sekine, Nobuo Nishie and Sadanobu Kagamimori 2004, Yoshiharu Fukuda, Keiko Nakamura and Takehito Takano 2004, Mackenbach et al 2008, Crimmins at al 2011, Martin G. Marmot and George D. Smith 1989, Michael T. Molla, Jennifer H. Madans, Diane K. Wagener 2004, Majer 2010, Richard G. Wilkinson 1994, Richard G.

Wilkinson and Kate E. Pickett 2009, Kate E. Pickett and Richard G. Wilkinson 2015, Raj Chetty, Michael Stepner, Sarah Abraham, Shelby Lin, Benjamin Scuderi, Nicholas Turner, Augustin Bergeron and David Cutler 2016, Stephen Crystal, Dennis G. Shea, and Adriana M. Reyes 2017, Peter Haan, Daniel Kemptner and Holger Lüthen 2017, Pavel Grigoriev, Rembrandt Scholz and Vladimir M. Shkolnikov, 2019) indicates a causal positive relationship between income status and life expectancy. Peter Haan, Daniel Kemptner and Holger Lüthen (2017) using Germany as a case, calculate that the gap in life expectancy at age 65 of the top and bottom decile of the income earners was 50% or 7 years for the cohort born 1947-49, while it was only 30% or 4 years for the cohort born 1926-28. Chetty et al (2016), who consider US population data, conclude that the richest 1% (based on income level) males live 15 years longer than the poorest 1% males. Additionally, they state that the life span of the poorest 5% did not increase since 2001, while the life span of the richest 5% increased by 3 years. Studies like the latter highlight a significant gap in the life spans of individuals, which are largely dependent on the socio-economic status, and that this gap is increasing (Geoffrey T. Sanzenbacher, Anthony Webb, Candace M. Cosgrove and Natalia S. Orlova 2017).

As plainly highlighted by Pierre Pestieau and Maria Racionero (2015, p.195), "[t]he public economics literature has not delved much into the relationship between occupation, longevity and retirement". However, one strand of literature provided by Marc Fleurbaey, Marie Louise Leroux, Pierre Pestieau and Gregory Ponthiere (2014, 2016), Pierre Pestieau and Gregory Ponthiere (2016), Pestieau and Racionero (2015) consider theoretically the question of fairness of a PAYG pension system in the presence of differing life expectancies. All these papers use a recently introduced utility function which is state dependent. The underlying idea is to take into account the criticism and considerations of Antoine Bommier (2006, 2007, 2010) and Antoine Bommier, Marie-Louise Leroux and Jean-Marie Lozachmeur. (2011a, 2011b). Based on their analyses and arguments, the authors link the retirement age to the occupation of contributors because life expectancy and occupation are empirically correlated. However, this literature is suffering from the assumed utility function which is derived simply from theoretical and ad hoc considerations, and it is difficult to validate it empirically.

Asghar Zaidi and Edward Whitehouse (2009) found in 18 OECD countries special treatments for groups of people working in hazardous jobs and having a lower life expectancy. The authors argue that nowadays these special pension treatments have been extended to whole industries and are no longer restricted to individuals working in hazardous jobs. Not surprisingly, they argue that it is not justified that white collar workers in the mining industry, with a higher than average life expectancy benefit from the low life expectancy of miners.

Another strand of literature (Gary Burtless and Henry J. Aaron 2013, Constantijn Panis, Michael Hurd, David Loughran, Julie Zissimopoulos, Steven Haider, and Patricia St. Clair. 2002, Michael V Leonesio, Denton R. Vaughn, and Bernard Wixon. 2003, Christian E. Weller 2005, Kelly Haverstick, Margarita Sapozhnikov, Robert K. Triest, and Natalia A. Zhivan. 2007, John A. Turner 2007, Alicia Munnell and Jerilyn Libby. 2007, David Cutler 2009, Courtney Monk, John A. Turner, and Natalia A. Zhivan 2010, David Cutler, Fabian Lange, Ellen Meara, Seth Richards-Shubik, and Christopher J.

Ruhm 2011) focuses on the empirics of ability to work longer. The underlying argument is that occupations requiring strong physical fitness cannot be executed beyond some age level. Thus, it makes not much sense and it is disproportionate to require from the respective workers to work longer, or to require that they change their occupations if they are close to their retirement age.

Although the positive impact on the replacement ratio induced by an increase in the retirement age may seem to be obvious, Peter J. Stauvermann and Jin Hu (2018) have shown that this is in general not a certain outcome. They show that the replacement ratio will decline with an inceasing retirement age, if the capital income share is relatively huge. It can be argued against this outcome that values for the capital income share exceeding or close to 0.5 are rare in reality (for example China).

Geoffrey T. Sanzenbacher, Anthony Webb, Candace M. Cosgrove, and Natalia S. Orlova (2015) take US data from 1979-2011 to investigate the relationship between retirement income and social economic status in the USA. The outcome of their study is that the retirement age of high-income earners should be more than the retirement age of low-income earners to guarantee the fairness of the pension system.

Examining the issue of fairness of the German Bismarckian pension system, Friederich Breyer and Stefan Hupfeld (2009, 2010) show that the German Bismarckian pension system has, in general, a regressive distributional impact. This is in contrast to the repeated statement of every German government that every Euro paid as contributions has exactly the same value in generating future retirement benefits.

In summary, few efforts have been made to investigate the intragenerational fairness of pension systems in the presence of differing life expectancies, which correlate to the socioeconomic status. Our analysis differs from the literature in so far that we consider the pure forms of the Bismarckian and Beveridgean pension systems and that we investigate theoretically the effects on fairness induced by an increasing retirement age and the effects induced by an increasing gap in the life expectancies of low- and high-income earners. Additionally, we briefly examine the fairness of a pure capital-funded system.

3 Basic assumptions

In the recent years, a number of countries have increased their mandatory retirement age. Particularly, for countries with ageing societies applying a pay as you go (PAYG) pension system the main argument is that the reforms are necessary to avoid an increase of the contribution rates to maintain an acceptable level of replacement rate. Table 1 represents the average life expectancy at the age of 65 of males in 1971 and in 2016:

Life expectancies of males in 1971 and in 2016 for selected countries

Country	1971 (years)	2016 (years)	Country	1971 (years)	2016 (years)
United States	13.2	18	Hungary	11.9	14.6
Poland	11.7	16	Latvia	12.3[1]	14

Netherlands	13.3	18.5	Slovak Republic	12.1	15.3
Denmark	13.7	18.2	Greece	15.1	18.9
Finland	11.4	18.2	France	13	19.4[4]
United Kingdom	12[3]	18.6[4]	Korea	10.3	18.4
Australia	12.5	19.6	Italy	13.3	19.4
Germany	12.1	18.1	Portugal	11.8	18
Czech Republic	11.1	16.2	Ireland	12.4[2]	18.6
Estonia	12.3	15.6			

Table 1([1] in 2002, [2] in 1979, [3] in 1970, [4] in 2015)

Table 2 presents the mandatory retirement age in 2016 and the planned retirement age in the future for the same countries as in table 1:

Retirement age in 2016 and in the future

Country	2016	future	Country	2016	future
United States	66	67	Hungary	63	65
Poland	66	65	Latvia	63	65
Netherlands	66	71	Slovak Republic	62	68
Denmark	65	74	Greece	62	62
Finland	65	68	France	62	64
United Kingdom	65	68	Korea	61	65
Australia	65	67	Italy	67	71
Germany	65	67	Portugal	66	68
Czech Republic	63	65	Ireland	66	68
Estonia	63	65			

Table 2 (OECD, http://dx.doi.org/10.1787/888933633850)

The analysis presented in this paper should provide the reader with some basic insights on how an increase in the retirement age affects the fairness of pension systems. To do so, we have constructed a very simple model to highlight the outcomes. Different from Peter A. Diamond (1965), who considers two periods of life, consisting of a working and a retirement period, we assume that each individual lives three periods (childhood, working period, and retirement period). Interestingly, the difference in the assumptions has no effect on the outcomes. For simplicity, we consider two types of individuals – low-ability individuals and high-ability individuals – who are equipped with different stocks of human capital. The human capital shall reflect the productivity of the respective individual. The subscripts L and H indicate the type of individuals. The subscript L represents a low-ability worker and the subscript H represents a high-ability worker.

Based on the literature above, we derive the assumption that low-ability individuals usually perform physically demanding jobs associated with hazardous and difficult working conditions, which lead to a lower life expectancy than the high-ability workers' life expectancy, who generally (and relatively) benefit from convienient working conditions. The difference in the life expectancies is also influenced by the incomes of workers, because higher incomes make it possible to afford better healthcare, which in turn enhance the life expectancy. Usually, the incomes of high-ability individuals exceed the incomes of low-ability workers. Thus, the life expectancy is determined by the working conditions and income, and therefore a further difference between the two types of individuals is the life span in the third (retirement) period of life. For simplicity, we normalize the length of each period to one.Regarding the life span in the retirement period $\rho_i, i = H, L,$ $0 < \rho_L < \rho_H < 1$ holds. This reflects the fact that low-ability individuals have a shorter life (expectancy) than high-ability individuals.

In the first period of life, an individual is born, either as a low-ability individual with a human capital or productivity index of h_L or as high-ability individual with a human capital or productivity index of h_H. She enjoys her childhood and makes no decisions as a child. At this point, we highlight that the differences in abilities of individual denoted by h_H and h_L are not necessarily due to any innate characteristics of individuals, and can be related to the economic and social contexts of their origin household. In the second period of life she supplies her labor and earns a wage income of $wh_i, i = H, L$, where $h_H > h_L \geq 1$ and w is the wage rate per human capital unit. She has to contribute the share τ to a compulsory pension system and receives in exchange a pension benefit $P_{t+1,i}, i = H, L,$ in the third period of life. A part of the net income can be saved and she receives the principal and interest in the third period of life. In addition, she has to work $\theta \leq \rho_L$ time units in the third period of life until retirement. Again, she contributes the share τ of her wage income to the pension system. We can summarize these assumptions in two budget constraints:

$$c_{t,i}^1 = (1 - \tau)wh_i - s_{t,i}, \tag{1}$$

and

$$c_{t+1,i}^2 = s_{t,i}R + \theta(1 - \tau)wh_i + P_{t+1,i}. \tag{2}$$

where $c_{t,i}^1$ is the consumption in the second period of life including the consumption of children and $c_{t+1,i}^2$ the consumption in the third period of life. The market interest factor is assumed to be equal to *R*. However, this assumption has no further relevance. We ignore bequests or the like because they have no relevance for our analysis which is strictly restricted to the pension system.

3.1 Bismarckian PAYG Pension System

PAYG pension systems can be classified as Bismarckian PAYG pension system or as Beveridgean PAYG pension system. In reality, most countries apply a mix of both systems (Jairo Rivera-Rozo, Manuel E. García-Huitrón, Onno W. Steenbeek and

Fieke S.G. van der Lecq 2018). However, to keep the lines of arguments clear and simple we consider both systems in their pure form. In this section we consider a pure Bismarckian pension system, which relates the individual contributions to the individual pension benefits. The main goal of the Bismarckian pension systems is to smooth the income over the lifecycle. It is organized as earnings-related scheme and pension benefits have a close link with individuals' lifetime earnings.The underlying idea is that the labor income distribution should be maintained in retirement. The aggregate contributions in period $t+1$, P_{t+1}^{tot} become:

$$P_{t+1}^{tot} = \tau w N_t(\Psi_H h_H + \Psi_L h_L)(n+\theta), \tag{3}$$

where N_t is the population in *t* and *n* is the exogenous number of children per capita. Or in other words, *n* represents the growth factor of the population. The variables Ψ_H and Ψ_L represent the population shares of high and low ability individuals. By definition, $\Psi_H + \Psi_H = 1$. The average pension benefit per capita is then:

$$\bar{P}_{t+1} = \frac{P_{t+1}^{tot}}{N_t} = \tau w(\Psi_H h_H + \Psi_L h_L)(n+\theta). \tag{4}$$

According to the Bismarckian pension scheme, the individual pension benefit becomes:

$$P_{t+1,i} = \frac{h_i(\rho_i - \theta)\bar{P}_{t+1}}{\left(\Psi_H h_H(\rho_H - \theta) + \Psi_L h_L(\rho_L - \theta)\right)}. \tag{5}$$

The term $\rho_i - \theta$ represents the time span of retirement in the third period of life. Thus, the pension benefit per unit of time is given by:

$$\frac{P_{t+1,i}}{(\rho_i - \theta)} = \frac{h_i \bar{P}_{t+1}}{\left(\Psi_H h_H(\rho_H - \theta) + \Psi_L h_L(\rho_L - \theta)\right)}. \tag{6}$$

If we relate the pension benefit per unit of time of high and low ability individuals, we get:

$$\frac{\frac{P_{t+1,H}}{(\rho_H - \theta)}}{\frac{P_{t+1,L}}{(\rho_L - \theta)}} = \frac{\frac{h_H \bar{P}_{t+1}}{\left(\Psi_H h_H(\rho_H - \theta) + \Psi_L h_L(\rho_L - \theta)\right)}}{\frac{h_L \bar{P}_{t+1}}{\left(\Psi_H h_H(\rho_H - \theta) + \Psi_L h_L(\rho_L - \theta)\right)}} = \frac{h_H}{h_L}. \tag{7}$$

Equation (7) provides us with the information that the relation between the pension benefit of a high-ability worker and the pension benefit of low-ability worker is equal to the relation between the wage income of a low-ability worker and the wage income of a high-ability worker. This equality is the characteristic which manifests the Bismarckian pension system. At the first look, this equality seems to show that the Bismarckian pension system is fair. In fact, if both groups would have the same life expectancy it would be fair. However, this equality ignores the differing life expectancies. For this reason, we propose to consider the internal factor of return I of the pension system for both groups as a reference criterion. This is given by the ratio of the individual pension benefit and individual contributions:

$$I_i = \frac{P_{t+1,i}}{(\tau w h_i(1+\theta/R))}, \text{ for } i = H, L. \tag{8}$$

We should note that we use the discount factor R for the contributions in the third period of life. In the presence of a perfectly competitive insurance market with full information the individually fair discount factor would be $\frac{R}{\rho_i}$. However, our results will not change qualitatively if we consider $\frac{R}{\rho_i}$ as a discount factor. Here we assume that such a perfectly competitive insurance market does not exist.
Further, we propose that the fairness of the pension system is measured by the ratio of the internal factor of return of high-ability workers to the internal factor of return of low-ability workers:

$$\Omega = \frac{I_H}{I_L}. \tag{9}$$

If the value of the fairness indicator Ω exceeds (is less than) one, the pension system can be called regressive (progressive) because the internal factor of return of high-ability workers exceeds (is less than) the internal factor of return of low-ability workers. If the value of Ω equals one, $I_H = I_L$ and the pension system is fair.
Calculating the fairness indicator for a pure Bismarckian pension system we get:

$$\Omega^{BIS} = \frac{\left(\frac{h_H(\rho_H-\theta)\bar{P}_{t+1}}{(\Psi_H h_H(\rho_H-\theta)+\Psi_L h_L(\rho_L-\theta))}\right)/(\tau w h_H(1+\theta/R))}{\left(\frac{h_L(\rho_L-\theta)\bar{P}_{t+1}}{(\Psi_H h_H(\rho_H-\theta)+\Psi_L h_L(\rho_L-\theta))}\right)/(\tau w h_L(1+\theta/R))} = \left(\frac{\rho_H-\theta}{\rho_L-\theta}\right) > 1. \tag{10}$$

Equation (10) indicates that a high-ability individual receives a higher rate of return on her contributions than a low-ability individual. Thus, the high-ability and rich individuals receive (unfairly) a huge share of the current aggregate pension contributions and the low-ability and poor individuals receive accordingly (unfairly) a small share of the aggregate current pension contributions. This outcome results from the fact that high-income contributors enjoy a longer time of retirement than low-income contributors.

Proposition 1: A pure Bismarckian PAYG pension system is inherently regressive in the sense that low-income contributors receive a lower rate on return on their contributions than high-income contributors.

This systematic unfairness results from the fact that the pension benefits are calculated based on the average life span and not based on the actual life span of low- and high-income earners. This outcome coincides fully with considerations of Breyer and Hupfeld (2009, 2010).
In the next step, we analyze what will happen with the ratio of the rate of returns if policymakers increase the working time θ and postpone the retirement age. For this purpose we differentiate Ω^{BIS} with respect to the working time in the third period of life:

$$\frac{\partial \Omega^{BIS}}{\partial \theta} = \frac{\rho_H - \rho_L}{(\rho_L - \theta)^2} > 0. \qquad (11)$$

Equation (11) shows that an increase in the retirement age leads to an increase of the regressivity of the pension system. It should be noted that the increase of the retirement age will decrease the rate of return of a unit of pension contribution for all income groups. The reason is simple, the employees have to contribute more because of the longer working life and get less because of the reduced span of retirement. This means that the reduction of the rate of return is stronger for low-income contributors than for high-income contributors. In other words, the low-income contributors will have to bear an over-proportional share of the burden of the most recent pension reforms in countries in which a Bismarckian pension system is applied.

Proposition 2: An increase of the retirement age in pure Bismarckian PAYG pension system leads to the outcome that the gap between the rates of return on the contributions of the low- and high-income earners increase.

A further effect intensifying the unfairness is induced by the empirical observation that the gap in the life spans of low- and high-income earners is increasing. To emphasize this, we differentiate equation (10) with respect to ρ_H:

$$\frac{\partial \Omega^{BIS}}{\partial \rho_H} = \frac{1}{(\rho_L - \theta)} > 0. \qquad (12)$$

Hence, it follows that the distribution of pension benefits in a Bismarckian pension system becomes more unequal (unfair) if the gap between the life span of low- and high-income earners increase.

Proposition 3: An increase of the gap between life spans of low- and high-income earners leads in pure Bismarckian PAYG pension system to the outcome that the gap between the rates of return on the contributions of the low- and high-income earners rise.

3.2 Beveridgean PAYG Pension System

Next, we consider the Beveridgean pension system which is characterized by the fact that the pension benefit per time unit is equal for all retirees, while the contributions are still dependent on wage income. The main goal of the Beveridgean pension system is to guarantee a minimum pension income for all individuals, irrespective of their earnings history. As such the Beveridgean pension system guarantees that low-income individuals obtain higher replacement rates.These characteristics lead to the general belief that a Beveridgean pension system leads to a redistribution of income from rich to poor retirees. The total pension benefit of an individual becomes:

$$P_{t+1,i} = \frac{(\rho_i - \theta)\bar{P}_{t+1}}{(\rho_L - \theta)\Psi_L + (\rho_H - \theta)\Psi_H}. \tag{13}$$

In a pure Beveridgean system, the pension benefit per time unit is equal for all retirees. Thus, the main characteristic of the Beveridgean pension system is:

$$\frac{P_{t+1,L}}{\rho_L - \theta} = \frac{P_{t+1,H}}{\rho_H - \theta} = \frac{\bar{P}_{t+1}}{(\rho_L - \theta)\Psi_L + (\rho_H - \theta)\Psi_H}. \tag{14}$$

If we calculate the ratio of the internal factors of return of high- to low-income earners Ω^{BEV} for the Beveridgean system, we get:

$$\Omega^{BEV} = \left(\frac{h_L}{h_H}\right)\frac{(\rho_H - \theta)}{(\rho_L - \theta)} \gtreqless 1. \tag{15}$$

Against the general belief that a Beveridgean PAYG pension system changes the income distribution in favour of the low-income earners, equation (15) shows that this is not necessarily the case. In general, without knowing the income gap between low- and high-income earners and without knowing the gap between the life spans of low- and high-income earners, the redistribution effect induced by a Beveridgean system is ambiguous. A reason is that the fairness indicator of the Beveridgean system depends on the ratio between the abilities or human capital stocks and on the ratio of individuals' durations of retirement. If the differences in the human capital stocks are relatively small compared to the difference between the duration of retirement, the system can lead to an unfair outcome, in the sense that the rate of return of a unit of the contribution of high-income contributors exceeds the respective rate of return of low-income contributors. Usually, the relative differences in the life spans are much smaller than the relative differences in the labor productivities or incomes, and therefore, the Beveridgean system smooths out the income distribution.

Proposition 4: The redistributive effects caused by a pure Beveridgean PAYG pension system are in general ambiguous.

To derive the impact caused by an increase in the retirement age, we differentiate (15) with respect to the time the individuals have to work in their third period of life:

$$\frac{\partial \Omega^{BEV}}{\partial \theta} = \left(\frac{h_L}{h_H}\right)\frac{(\rho_H - \rho_L)}{(\rho_L - \theta)^2} > 0. \qquad (16)$$

From equation (16), we gain the insight that an increase of the retirement age results in a change of the distribution of pension benefits in favour of high-income contributors. Thus the recent pension reform reduces the progressivity of the Beveridgean pension system, given that it was progressive before the reform took place.

Proposition 5: An increase of the retirement age in pure Beveridgean PAYG pension system leads to the outcome that rate of return for a unit of the contribution of a low-income contributor is more reduced than the respective rate of return of a high-income earner.

Further, by differentiating equation (15) with respect to ρ_H, we show that an increase in the gap of life spans leads to a similar effect as that of an increase in the retirement age.

$$\frac{\partial \Omega^{BEV}}{\partial \rho_H} = \left(\frac{h_L}{h_H}\right)\frac{1}{(\rho_L - \theta)} > 0. \qquad (17)$$

Proposition 6: An increase of the gap in the life spans of low- and high-income contributors in a Beveridgean PAYG pension system results in a stronger reduction of the rate of return per unit of the contribution of low-income contributors than of high-income earners.

Thus, regarding both prototypes of pure PAYG pension systems, we conclude that by increasing the retirement age, there is a distributional effect, that advantages the high-income earners and disadvantages the low-income earners. The same outcome is noted regarding the increase of the gap in the life spans. This means that low-income earners will experience negative effects. At first, the increasing gap in the life spans indicates that the average increase in life expectancy is caused by high-income earners, and this lowers the rate of return of low-income earners over-proportionally. The induced increase in the retirement age again disadvantages the low-income earners. Both effects have the potential to drive low-income earners into poverty when a Bismarckian pension system is applied. The situation differs in a Beveridgean pension system where only the progressive character of the pension system slowly vanishes in time. The simple reason is that the pension per unit of retirement time is constant for all retirees. Nevertheless, the low-income earners bear an over-proportional share of the burden of these developments.

3.3 A public capital funded system

In this section, we consider a public pension system with mandatory contributions and in which the pension benefits are financed through a capital fund. In such a system like it is applied in South Korea in the private sector, the contributions are collected by a pension fund and invested on the capital market. According to the system the pension benefits are calculated based on the capital market rate of return and the average life expectancy of the contributors. The average life expectancy $\bar{\rho}$ is given by:

$$\bar{\rho} = \rho_L \Psi_L + \rho_H \Psi_H. \quad (18)$$

To calculate the individual pension benefit, we note that the public pension fund assumes that on average the individuals will receive the pension benefits for a period of $\bar{\rho} - \theta$ time units. However, in fact, a low-income contributor receives benefits only for a period of $\rho_L - \theta$ time units and a high-income contributor for $\rho_H - \theta$ time units. Therefore, the individual pension benefit can be calculated by:

$$P_{t+1,i} = \frac{\left(\frac{R\tau w h_i}{\bar{\rho}} + \theta \tau w h_i\right)}{\bar{\rho} - \theta} (\rho_i - \theta) = \frac{\tau w h_i \left(\frac{R}{\bar{\rho}} + \theta\right)}{\bar{\rho} - \theta} (\rho_i - \theta),\ i = H, L. \quad (19)$$

The internal factor of return of a capital funded pension system becomes:

$$I_i^{CF} = \frac{\left(\frac{R}{\bar{\rho}} + \theta\right)(\rho_i - \theta)}{1 + \frac{\theta}{R}},\ i = H, L. \quad (20)$$

The respective fairness indicator Ω^{CF} becomes to:

$$\Omega^{CF} = \frac{(\rho_H - \theta)}{(\rho_L - \theta)} > 1. \quad (21)$$

Clearly, a public pension fund has a regressive distributional effect, that is, the low-income contributors subsidize implicitly the high-income contributors.

Proposition 7: A capital funded pension system is inherently regressive in the sense that low-income contributors receive a lower rate of return on their contributions than high-income contributors.

To analyze the effect of an increase of the retirement age we differentiate equation (21) with respect to the retirement age:

$$\frac{\partial \Omega^{CF}}{\partial \theta} = \frac{(\rho_H - \rho_L)}{(\rho_L - \theta)^2} > 0. \quad (22)$$

As in the case of the Bismarckian pension system, an increase of the retirement age will increase the unfairness of the pension system. The reason is simply that the duration of retirement is shorter for low-income earners than for high-income earners.

Proposition 8: In a capital funded pension system an increase of the retirement age increases the unfairness of the pension system in the sense that the internal rate of return of low-income earners declines relatively stronger than the decline of the internal rate of return of high-income earners.

Next, we analyze an increasing gap in life spans. Now we differentiate equation (21) with respect to the life expectancy of high-income earners:

$$\frac{\partial \Omega^{CF}}{\partial \rho_H} = \frac{1}{(\rho_L - \theta)} > 0. \qquad (23)$$

The fairness indicator of the capital-funded pension system is negatively impacted by an increasing gap in the life spans.

Proposition 9: In a capital funded pension system an increase of gap of life expectancies lead to an increase of the unfairness of the pension system in the sense that the internal rate of return of low-income earners declines relatively stronger than the internal rate of return of high-income earners.

In the case of the capital funded pension system, an increase of the life expectancy of the high-income earners increases the average life expectancy with the result that the pension per time unit declines and this lowers over-proportionally the internal rate of return of low-income earners.

4 A Calibration

In this section we calibrate the development of the fairness indicator Ω depending on the retirement age. It is a rough calibration, nevertheless it emphasizes the consequences of an increasing retirement age. However, to set up a more realistic calibration, we will require much more (quality) data which is not available for any country at this point. For example, we would need the profiles of the individual lifetime incomes, and unfortunately this data is not available. The empirical study of Haan, Kemptner and Lüthen (2017) consider only two cohorts, one from the period 1935-37 and the other from 1947-49, and the data is partly estimated.

Thus, our approach differs in that we use their data to compare the fairness of the different pension systems. We assume that the length of one period is 30 years, so the maximum age is 90 years. Further, one year in reality, coincides with 0.033 in the model. According to Haan, Kemptner and Lüthen (2017), top decile (male) individuals live 18 years after retirement on average and the bottom decile (male) individuals live 14 years after retirement on average, given that they were born between 1935-37. Male individuals born between 1947-49 have a life expectancy at age of 65 of 22 years (top decile) and 15 years (bottom decile). Regarding the different incomes, we assume that the ratio between the incomes of high-skilled individuals and low-skilled individuals lies between 2-3, which is our own calculations based on German Panel of household Finances 2010/2011, Piopiunik et al 2017, and Schmillen and Stueber 2014). Regarding figure 1, we assume that the ratio $\frac{h_L}{h_H} = \frac{1}{2}$.

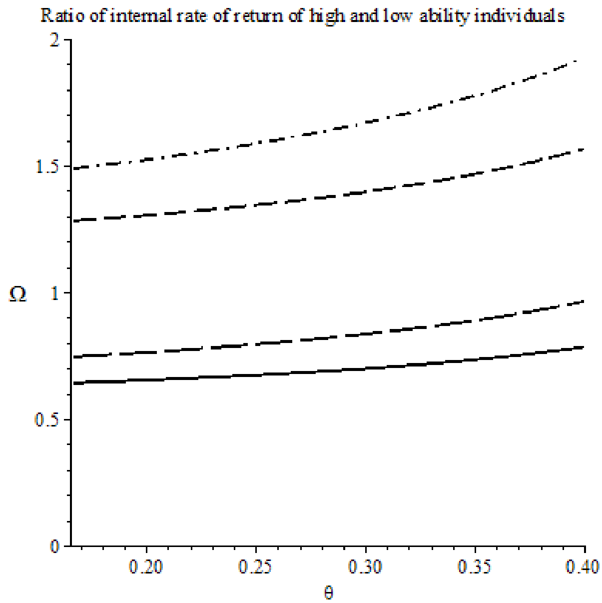

Figure 1

Figure 1 represents 4 scenarios. Two scenarios represent the fairness indicator for a Bismarckian system, the upper one (dot dash line) is relevant for a gap in the life expectancy of 7 years at the age of 65, the second one (dash line) represents the same but with gap in the life expectancy of 4 years at the age of 65. The two scenarios are then repeated for a Beveridgean pension system. The solid line represents the fairness indicator for gap in the life expectancy of 4 years at the age of 65, and the second (long dash line) for a gap in the life expectancy of 7 years at the age of 65.

Next, we repeat the whole calibration in figure 2 with the assumption that $\frac{h_L}{h_H} = \frac{1}{3}$.

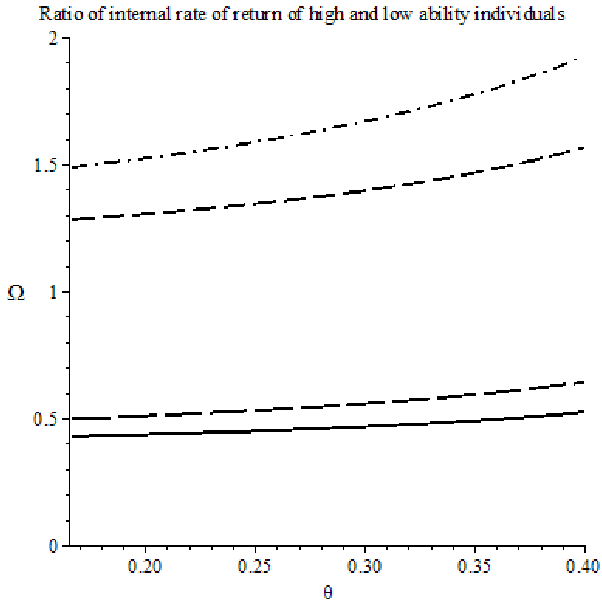

Figure 2

If we compare both figures, then the ratio of productivity $\frac{h_L}{h_H}$ matters only for the Beveridgean pension system. The fairness indicator Ω is the ratio between the internal rate of return of high-ability individuals receive and the internal rate of return of low-ability individuals receive. It is clear that the smaller the ratio is the more progressive is the pension system. However, what we see is that the Beveridgean system has a progressive effect in all scenarios, because the value of Ω is always below one. However, in all scenarios the value increases with an increasing retirement age, and regarding the Beveridgean system, it is clear that the progressivity declines with an increasing retirement age.

In contrast, the Bismarckian pension system is regressive, because in all scenarios the value of Ω is above one. Additionally, we see that the regressivity of the Bismarckian pension system increases with an increasing retirement age. Without an increase of the retirement age the value of Ω is 1.3 if the gap of life expectancy is 4 years and 1.5 if the gap in the life expectancy is 7 years. This means the internal rate of return received by high-ability individuals which depends on the birth age, is 30% to 50% higher than the internal rate of return by low-ability individuals. These outcomes coincide with the outcomes of Haan, Kemptner and Lüthen (2017). If the retirement age increases, the ratio of the internal rates of return will increase over-proportionally. If a Beveridgean pension system is applied, the internal rate of return of low-ability individuals exceeds the internal rate of return received of high-ability individuals. If the retirement age increases the ratio of the rate of returns will also increase. Note, the value of Ω does not state anything about the level of the internal rate of returns. From this calibration it clear that an increase of the retirement age will increase the inequality of the economy.

5 Discussion and conclusions

Most developed countries suffering from an ageing population have either reformed their pension systems in the recent decade or have to do so. A major change uniquely proposed by the OECD, EU commission, national policymakers and many researchers was to increase the retirement age to counter the increasing life expectancy of retirees.

In this paper, we investigated the distributional consequences of an increase of the retirement age for the two PAYG pension systems; the Beveridgean and the Bismarckian PAYG pension system, and a public capital funded pension system. With this approach, we can directly derive that the Bismarckian system is not neutral in the sense that it maintains the income distribution which arose in the working period, and that the Beveridgean system does not necessarily smooth out the income distribution. Additionally, a public capital funded pension system is not fair in the sense of insurance theory because it works like a pooling contract with the consequence that low-income individuals subsidize high-income individuals.

Further, we have shown that the distributional impact of an increase of the retirement age is similar in all systems – the high-ability individuals, who are simultaneously the rich individuals will receive an over-proportionally huge share of the aggregate pension contributions. The underlying reasoning is that in general, richer or more productive individuals have on average a longer life span than the poorer and lesser productive individuals. However, the postponing of the retirement age has the same effect for all contributors in absolute terms, and this leads to the outcome that the reduction of the time of retirement in relative terms is much stronger for short-living retirees than for long-living retirees. In the extreme, the policy measure to postpone the retirement age can lead to the effect that low-ability and very short-living individuals have only to contribute and that they are unable to enjoy their retirement benefits. The problem is aggravated by the increasing gap in life expectancies because then this amplifies the distributional impact of an increase in the retirement age. However, the inequality effects caused by different life spans are not only restricted to the old age security systems. Similar effects can be expected in public health care systems because the highest costs are caused by old people and in general it can be said the older the citizens, the over-proportionally higher the healthcare costs per capita. This means the healthcare costs of poor short-living individuals are relatively lower than the healthcare costs of rich long-living individuals.

Because of decreasing replacement rates, particularly in countries applying a Bismarckian system like Germany, old age poverty (measured in relative terms) will become an increasingly serious problem and therefore postponing the retirement age further intensifies the problem of old age poverty. Peter Haan, Holger Stichnoth, Maximilian Blömer, Hermann Buslei, Johannes Geyer, Carla Krolage and Kai-Uwe Müller (2017) estimate that the share of old persons living in poverty will increase by 25-27% until 2035. Regarding the definition of poverty, they use the concept of the

European Union, which means that someone is poor if she has a household income less than 60% of the median household income.
To link the pension benefits or retirement age to the socio-economic status or occupation as proposed by Pestieau and Racionero (2015) it seems to be theoretically a solution, but it may be difficult to realize in reality. Thus, policymakers of countries applying a Bismarckian system should note that in this system the poor contributors subsidize rich contributors. To the best of our knowledge, such distributional effects caused by the increase of the retirement age were previously not discussed in the political and scientific sphere and it is time to consider these implications, to avoid an increase of old age poverty. It is surprising that for example, the OECD (2017) promotes strictly the idea to adjust the retirement age to the increasing life expectancy, but also criticizes the increasing old age poverty. In this paper, we did not consider that it could be impossible for some people to work longer because of a harsh working environment. This was done elsewhere as noted above. Also, the argument that a capital funded system could be a solution of the problem has to be rejected, because the effects caused by an increase of the gap of the life span and increasing retirement age are similar to what we observe in PAYG pension systems. Regarding the fairness, a Beveridgean system is superior compared to Bismarckian and capital-funded pensions systems. However, even if a Beveridgean pension system is applied, it is not solution to link retirement age to the increasing life expectancy. Probably more radical pension reforms are necessary to avoid the extension of old age poverty. For example, it could be considered to require contributions from the capital and firm owners like it is done in Switzerland. We are fully aware that our model structure is very simple, but we are convinced that it is appropriate to consider important and relevant issues.
It can be recommended that countries applying a Bismarckian pension system should consider transforming the system to a Beveridgean pension system, because at minimum the old age poverty problem will be avoided. However, to derive concrete policy proposals it is necessary to consider more and quality data on the lifetime incomes – such data is useful for the issues discussed in this paper as well as the data can also be used to examine whther richer individuals have a higher savings rate than poorer indiviuals over the lifetime.

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