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Pensions, Education and Life Expectancy *

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Abstract

In a two-period model with agent heterogeneity we analyze a pension reform toward a stronger link between contributions and benefits (as recently observed in several countries) in a pension system with a Bismarckian and a Beveridgian component. We show that such a policy change reduces the educational level in an economy. The life expectancy differential between skilled and unskilled individuals drives this result. Furthermore, we investigate the consequences on the intragenerational redistribution characteristics of the pension system – in the sense of the number of net-recipients relative to net-payers – as well as welfare effects.

Keywords: social security, education, life expectancy, pension reform, redistribution
JEL classification: H55, I21, D39

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1 Introduction

This paper studies the effects of a pension reform toward a stronger link between individual contributions and benefits on the educational level of the economy. In particular, we are interested in the consequences of the interplay of different types of redistribution when a (public) pension system becomes more 'Bismarckian', a direction into which many countries headed since the 1990s. In a two-period model with agent heterogeneity we argue that a pension reform of the described type *discourages* human capital investment at the margin. Furthermore, we show that the reform will change the ratio of net-payers to net-recipients of the pension system. Governments considering a pension reform should therefore keep in mind that (exogenously) given life expectancy and productivity differences between skilled and unskilled individuals may induce an undesired outcome.

It is widely accepted that output is the key variable for solving the demographic challenge in the Western world (see Barr 2004, p. 207). According to standard growth theory human capital accumulation, i.e. education in a broader sense, leads to a higher growth path and thus to more output. When more output is available due to higher education-induced growth, shifting resources from young to old becomes easier in ageing societies, regardless of whether their pension systems are pay-as-you-go (PAYG) or funded. However, not only may education have an impact on pension systems but also the design of pension systems on human capital accumulation and therefore growth.

When individuals maximize their lifetime utility, they will take redistributive taxation via the pension system into account. PAYG pension systems introduce an implicit tax on income (see e.g. Sinn, 2000). While this tax inevitably follows from *inter*generational redistribution (from young to old), tax rates differ depending on the level of *intra*generational redistribution between individuals of the same generation (usually from rich to poor). Following the convention by Cremer and Pestieau (1998), a pension system with zero or little intragenerational redistribution may be called 'Bismarckian' while a system with flat-rate benefits is called 'Beverdigian', assuming that in both systems contributions are collected by means of a payroll tax. The more Beverdigian a pension system is, the higher is implicit taxation (Sinn, 2000). Hence, activities creating additional income will become less attractive under these circumstances. Since education is positively correlated with income, a pension system with a high level of Beveridgian redistribution may discourage human capital investment (see Lau and Poutvaara, 2000).

However, in our analysis – unlike most of the existing literature – we consider that there exist not only one, but two intragenerationally redistributive channels within a pension system which could influence the incentive to invest in human capital. The first channel is the previously mentioned, 'traditional' intragenerational rich-to-poor redistribution. It follows from the fact that rich persons contribute relatively more than poor persons, but receive (almost) the same benefit under a Beveridgian system. Only under a pure Bismarckian system no intragenerational redistribution takes place. As in Cremer and Pestieau (1998) we use the so called 'Bismarckian factor' to describe a mixture of Bismarckian and Beveridgian elements when pension benefits are calculated. The higher the Bismarckian factor, i.e. the tighter the link between one's contributions and one's own benefits, the more attractive is a pension system for a high income earner. However, this rich-to-poor redistribution is softened by a poor-to-rich redistributive effect when higher incomes correlate with higher life expectancy (Borck, 2005). If high income earners receive pension benefits for a longer time than low income earners, this potentially leads to redistribution from the poor to the rich when the effect is sufficiently strong to compensate for lower absolute contributions. This, however, is true only when at least some Beveridgian redistribution takes place.[1]

In the literature, the distinction between Beveridgian and Bismarckian pension systems has attracted some attention. Some of the literature asks whether there is a negative relation between the level of intragenerational redistribution and the size of PAYG pension systems (see, e.g. Casamatta, Cremer and Pestieau, 2000a; Köthenbürger, Poutvaara and Profeta, 2005). Other models explain why real world pension systems usually contain both Beveridgian and Bismarckian elements (Conde-Ruiz and Profeta, 2005; Casamatta, Cremer and Pestieau, 2000b; Cremer and Pestieau, 1998, 2003; Kolmar, 2005).[2]

A further strand of the literature which is closely connected to our analysis dis-

[1]Bommier, Leroux and Lozachmeur (2005a, 2005b) discuss a social planner's problem who would like to compensate individuals for different life expectancies, given the existence of a pension system.

[2]Further topics related to Beveridgian and Bismackian pension systems include migration issues (Krieger, 2003; Rossignol and Taugourdeau, 2006), retirement age (Hougaard Jensen, Lau and Poutvaara, 2004), unemployment insurance and labor unions (Goerke, 2000).

cusses the effect of the design of pension systems on the educational decisions of individuals. Individuals decide whether to invest in (costly) education when they expect a positive return on their investment. When redistributive taxation of high incomes via the pension system is sufficiently strong, individuals may prefer to invest less into their human capital. This argument can be found in Lau and Poutvaara (2000, 2001) and Poutvaara (2005). However, this literature ignores the life expectancy channel.

Finally, it is important to note that our analysis of the effects of a pension reform on an economy's educational level is based on the observation that recent pension reforms in European countries share two common characteristics: we observe a trend toward higher funding and toward a stronger link between individual contributions and pension benefits, as shown by Werding (2003) or Fenge et al. (2003) for OECD countries since the 1990s. More funding means less intergenerational redistribution in the first place, while a stronger link between individual contributions and pension benefits reduces intragenerational redistribution in the pension system. We do not consider policy changes toward more funded systems but focus on the second phenomenon and analyze how such a policy reform affects the level of education in an economy.

Based on the previous discussion, our model then analyzes the effect of a change in the pension system on the educational level in an economy and considers – thereby closing a gap in the literature – in particular a positive correlation between individual education and longevity. Intuitively, there are good reasons to believe that life expectancy depends on the educational background of an individual. The fact that skilled people usually face a more stable social situation, have higher incomes and have a way of living which more agrees with health compared to unskilled people,[3] justifies this. Furthermore, Bopp and Minder (2003) for example found substantial mortality gradients by education in German speaking Switzerland in the 1990s for ages between 25 and 90 in a longitudinal data set of the Swiss National Cohort.

While – at a first glance – it may seem a little far-reaching to assume, for instance, a 20-years old person seriously considering educational effects on retirement income, there are at least two arguments in support of this. First, according to Sinn (2005),

[3]See for example the German Health Report 2006 of the Robert Koch Institute or Schneider and Schneider (2006) who find empirical evidence for Germany that "education is a central determinant of health relevant behavior".

behavioral changes take place as a reaction to changes in social systems, however, they often take a long time to become widely anticipated. For instance, by the way of observation and imitation, generation after generation adapted to the new institutional circumstances after the first introduction of public pension systems, until finally, fertility rates slumped to today's historically low levels. Therefore, when a pension reform takes place today people will not immediately start to invest more or less into their human capital. Some years or decades from now, however, it may be a common wisdom that 'you have to go to university in order to be able to finance retirement'. A second argument follows from the observation that changes of *subjective* variables may suffice to induce certain behavioral changes. In our model, we argue that life expectancy differences play an important role when it comes to educational decisions. Psychologists find that each additional year of education increases subjective life expectancy (Mirowsky and Ross, 2000). If individuals also (ex ante) believe in higher life expectancy due to education and if life expectancy increases lifetime utility via the pension system, investing into human capital may appear to be a reasonable strategy, even if – at the end of the day – life expectancy turns out to be falsely predicted.

The main result of our analysis is that a pension reform toward a more Bismarckian pension system reduces the educational level in an economy if individuals differ in life expectancy at retirement age. Furthermore, we show that the reform not only changes individual benefits and welfare but may also change the composition of net-recipients and net-payers in the system, together probably leading to political consequences in a democracy.

The paper is structured as follows. After introducing the model in Section 2, we analyze the effects of a pension reform and present our results in Section 3 before Section 4 briefly discusses the results and concludes.

2 The model

Each individual in our model lives for two periods. While the individual's time endowment in the first period ('working life') can be used for *either* higher education and supply of skilled labor *or* exclusively for unskilled work, the second period ('retirement') represents the evening of life where individuals no longer work but receive pension benefits. The individual time endowment in both periods is normalized to one.

Whether an individual goes for education or not, to a large extent depends on his or her ability. We assume heterogenous agents who differ in their ability to acquire skills in the sense that a more able individual needs less time to do so than a less able one. $h \in [0,1]$ denotes the time fraction in period one needed to acquire skills (e.g. in form of a university degree) and reflects an individual's ability. While an h close to zero indicates very high abilities, an h close to one means very low abilities. Abilities are distributed among individuals according to a cumulative distribution function $F(h)$ with $f(h)$ representing the corresponding density function.

Each worker's totally inelastic labor supply is normalized to one. A skilled worker earns net labor income $(1-t)(1-h)w$, where w is the wage rate per unit of effective labor and $t \in [0,1]$ is the labor income tax rate or contribution rate to the pension system. $(1-h)$ reflects working time, i.e. time endowment net of time spent on education. An unskilled worker is assumed to provide less units of effective labor per unit of working time compared to a skilled worker. His net income amounts to $qw(1-t)$, where $q \in]0,1[$ reflects the difference in productivity across worker types.

The pension payout for a retiree consists of a flat-rate benefit b and a first-period labor income contingent component $\alpha(1-h)w$ for skilled and αqw for unskilled workers, where $\alpha \in [0,1]$ is the 'Bismarckian factor' (Cremer and Pestieau, 1998). Individuals receive pension benefits for the time they are alive in the second period. We assume that skilled pensioners have a life expectancy of one (i.e. they live for the entire retirement period) while the life expectancy of an unskilled pensioner is only a fraction $(1-\sigma)$ of period two with $\sigma \in [0,1]$, i.e. life expectancy is modeled as the fraction of time in period two before the individual dies. Although we use the term life *expectancy* here, there is no uncertainty in our model. Figure 1 summarizes the time structure of the model. The pension benefits for some skilled individual with ability h, denoted by P_h, and an unskilled pensioner, denoted by P_q, then can be written as

$$P_h = b + \alpha(1-h)w \tag{1}$$

$$P_q = (1-\sigma)[b + \alpha qw] \tag{2}$$

Two extremes of the pension system would be the pure Beveridgian system ($b > 0$, $\alpha = 0$) and the pure Bismarckian system ($b = 0$, $\alpha > 0$).

Note that, as our focus is on intragenerational redistribution, we use a simplified

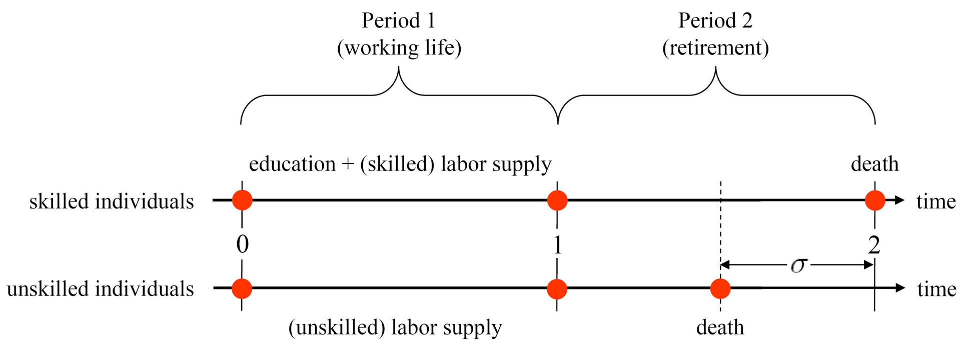

Figure 1: Time structure

framework which in principle considers overlapping generations. We assume, however, that each generation reproduces itself exactly. The pension benefits should in fact be denoted by $(1+n)P_h$ and $(1+n)P_q$, where n reflects the return on contributions to the PAYG system.[4] For simplicity, we assume $n = 0$ which will, however, not change our results qualitatively. Another standard assumption is that ability is inherited. Furthermore, contribution rates are fixed and decision making lasts for individual lifetime. This allows us to consider only one generation at each point in time. This is because all generations are identical with respect to size and skill distribution.

The individual when deciding on education – the education decision is a 0-1-decision – considers his abilities, the net pension benefit (accounting for life expectancy) and the cost of education. Comparing net lifetime incomes, i.e. labor income and pension benefits net of pension contributions and education costs, an individual only goes for education if his ability exceeds a certain cutoff level $(1-h^*)$ which is implicitly given by[5]

$$(1-t)(1-h^*)w - h^*g + \frac{1}{1+r}P_{h^*} = (1-t)qw + \frac{1}{1+r}P_q \tag{3}$$

with $P_{h^*} = b + \alpha(1-h^*)w$ and P_q from (2). With r as the exogenously given interest rate, $\frac{1}{1+r}P_j$ $(j \in \{h^*, q\})$ represents the present value of the pension payment. An individual of ability h^* is exactly indifferent between acquiring skills and working as an unskilled worker. Remember that low values of h indicate high abilities, i.e. only

[4]This return is equal to the growth rate of the total sum of wages. Without productivity growth this corresponds to Samuelson's biological interest rate, i.e. the population growth rate.

[5]The modeling of agents' heterogeneity with respect to ability and the formulation of the cutoff level is inspired by Razin and Sadka (1999).

individuals with $h \leq h^*$ go for education. We assume two kinds of education costs: direct costs hg, where g is some per unit cost of education, and opportunity costs in the sense of foregone earnings from unskilled labor supply in period one while going for education. In what follows we assume

$$(1 - h^*) = q \tag{4}$$

which means that the individual who is indifferent between going for education or not, earns the same working life labor income whatever education decision he makes[6]. Note that we choose g such that (4) holds. From (3) we can infer that $h^* g = \frac{1}{1+r}\sigma(b+\alpha q w)$ ensures $(1-h^*)$ to equal q. Furthermore, with the distribution function $F(h)$, h^* determines the number of educated workers or rather the educational level in the economy.

The role of the government in our model is confined to collecting the payroll income tax and distributing pension benefits. We assume that this governmental task is costless, i.e. we ignore administrative costs. The budget constraint in a PAYG pension system then reads

$$Ntw\left[\int_0^{h_i^*}(1-h)f(h)dh + q\int_{h_i^*}^1 f(h)dh\right] = N\left[\int_0^{h_{-i}^*} P_h f(h)dh + P_q \int_{h_{-i}^*}^1 f(h)dh\right] \tag{5}$$

i.e. the aggregate pension benefits of generation $-i$ are financed by the contributions of the currently working generation i. The size of a generation is denoted by N. With our assumption of a non-growing population, N is the same across all generations.

Since we assume a pension system with a fixed contribution rate t, any change of the structure of benefits, i.e. higher or lower Beveridgian/Bismarckian benefits, needs to be compensated within the benefits sphere as total contributions are given. We use the following Lemma to describe the life-expectancy adjusted relationship between contributions and benefits in a PAYG pension system in a given period.

Lemma 1 *If and only if there is no life-expectancy differential ($\sigma = 1$), the average-income individual contributes to the pension system exactly the amount necessary to cover the retirement benefit of a retiree who was an average-income individual himself.*

[6]This is in line with Razin and Sadka's (1999) definition (2).

This can be seen when we reformulate budget constraint (5) – as shown in Appendix A – as

$$t\tilde{w} = b + \alpha\hat{w} \tag{6}$$

or rather

$$b = b(\alpha) = t\tilde{w} - \alpha\hat{w}, \tag{7}$$

where

$$\tilde{w} := \frac{Nw\left[\int_0^{h_i^*}(1-h)f(h)dh + q\int_{h_i^*}^1 f(h)dh\right]}{N\left[\int_0^{h_{-i}^*} f(h)dh + (1-\sigma)\int_{h_{-i}^*}^1 f(h)dh\right]} \tag{8}$$

is the ratio of the aggregate wage income of the currently young generation relative to the life expectancy weighted size of the currently old generation. Furthermore,

$$\hat{w} := \frac{Nw\left[\int_0^{h_{-i}^*}(1-h)f(h)dh + (1-\sigma)q\int_{h_{-i}^*}^1 f(h)dh\right]}{N\left[\int_0^{h_{-i}^*} f(h)dh + (1-\sigma)\int_{h_{-i}^*}^1 f(h)dh\right]} \tag{9}$$

is the life expectancy weighted average wage income level of the currently old generation.[7] See that only for $\sigma = 0$, i.e. in case of no life expectancy differential, $\tilde{w} = \hat{w} = \bar{w}$, with $\bar{w}$ as the average labor income level and

$$t\bar{w} = b + \alpha\bar{w},$$

i.e. the contribution of an average income individual exactly supplies the retirement benefit of a retiree who was an average income individual himself. As stated in Lemma 1 and displayed in equation (6) this equality does no longer hold if retirees differ in life expectancy.

3 The effects of a pension reform

This section analyzes the effects of a pension reform on the educational level, on intragenerational redistribution via the pension system and on welfare. As already

[7]Note that due to our assumption of identical generations, $h_i^* = h_{-i}^*$ holds in every period, except for one: the period in which the reform takes place, since then we expect the educational level to differ between the pre- and the post-reform generation. However, most of the time we can omit the generation superscript and simply write h^*.

argued before, our simplifying assumptions regarding reproduction behavior guarantee that individual decision making will not change over time. If a generation decides on the educational level and, thus, implicitly retirement income, this income – although received in the subsequent period and covered from next period's workers' contributions – will be just as expected today.

3.1 Adjustment in the benefits sphere

As already argued, a change of the Bismarckian parameter requires an adjustment of the flat-rate benefit in a fixed contribution rate system in order to keep the system's budget balanced. Let us look at this adjustment in more detail before going for our 'main' analysis in the following Sections 3.2 to 3.4. We state the following Lemma.

Lemma 2 *In a fixed contribution rate system, a change in the Bismarckian parameter α requires an adjustment of the flat-rate benefit b. This adjustment consists of a direct budget effect and an indirect effect due to the reform's effect on the economy's educational level which has to be considered if there is a life expectancy differential between skilled and unskilled individuals.*

Remember the relationship between contributions and benefits in the pension system as captured by (7)

$$b = t\tilde{w} - \alpha\hat{w}.$$

A change in the educational level in the economy influences b via $\tilde{w}$ and $\hat{w}$:

$$\frac{\partial b}{\partial h^*} = t\frac{\partial \tilde{w}}{\partial h^*} - \alpha\frac{\partial \hat{w}}{\partial h^*}. \tag{10}$$

Deriving $\frac{\partial \tilde{w}}{\partial h^*}$ and $\frac{\partial \hat{w}}{\partial h^*}$ from (8) or rather (9) and using this in (10) yields after some manipulations

$$\frac{\partial b}{\partial h^*} = \frac{n(h^*)}{\tilde{n}}\left\{tw\Big[(1-h^*) - q\Big] - \alpha w\Big[(1-h^*) - (1-\sigma)q\Big] - \sigma b\right\}$$

which with (4) reduces to

$$\frac{\partial b}{\partial h^*} = -\frac{n(h^*)}{\tilde{n}}\sigma(b + \alpha q w), \tag{11}$$

where $n(h^*)$ denotes the number of individuals of ability type h^* and $\tilde{n}$ the life expectancy weighted size of a generation. The sign of $\frac{\partial b}{\partial h^*}$ is clearly negative. The intuition here is as follows: the portion of individuals with a higher life expectancy is smaller in a generation with a lower educational level; due to our assumption of life annuity pension benefits and for given contributions, ceteris paribus, this allows for a higher flat-rate benefit.

The adjustment of the flat-rate benefit b if the Bismarckian factor α changes, consists of two effects. Using (7) and (10) yields

$$\frac{db}{d\alpha} = -\hat{w} + \left[t\frac{\partial \tilde{w}}{\partial h^*} - \alpha \frac{\partial \hat{w}}{\partial h^*} \right] \frac{dh^*}{d\alpha}. \tag{12}$$

See that from the budget constrain we can also derive

$$\left(\frac{\partial b}{\partial \alpha}\bigg|_{h^*=const.} \right) = -\frac{w\left[\int_0^{h^*} (1-h)f(h)dh + (1-\sigma)q\int_{h^*}^1 f(h)dh \right]}{\int_0^{h^*} f(h)dh + (1-\sigma)\int_{h^*}^1 f(h)dh} = -\hat{w}. \tag{13}$$

and therefore rewrite (12) as

$$\frac{db}{d\alpha} = \left(\frac{\partial b}{\partial \alpha}\bigg|_{h^*=const.} \right) + \frac{\partial b}{\partial h^*}\frac{dh^*}{d\alpha} \tag{14}$$

with the first term as the (negative) direct budget effect in a fixed contribution rate system and the indirect one via the induced change in the educational level. The sign of the latter is determined by the sign of $\frac{dh^*}{d\alpha}$ which will be shown to be negative in the following section. Hence, if this indirect effect which is positive (since $\frac{\partial b}{\partial h^*}$ is also negative) dominates the direct budget effect, the flat-rate benefit might even also have to increase in case of an increase of the Bismarckian parameter, despite the assumed fixed contribution rate system. The adjustment in the benefits sphere in case of a reform as represented by (14) illustrates Lemma 2.

3.2 Level of education

We are interested in the effect of a reform toward a more Bismarckian system (i.e. a marginal increase of α) on the ability cutoff level h^* in the education decision. The pension reform is assumed to be a one-time event. Let us analyze $\frac{dh^*}{d\alpha}$ considering the public budget constraint.

Proposition 1 *A marginal increase of the Bismarckian parameter α (in a fixed contribution rate system) reduces the educational level in the economy. This is due to a positive life expectancy differential between skilled and unskilled individuals.*

Implicit differentiation of indifference condition (3) yields

$$\frac{dh^*}{d\alpha} = -\frac{Z_\alpha}{D}$$

where

$$D := -w(1-t) - g - \frac{1}{1+r}\alpha w + \frac{\sigma}{1+r}\frac{\partial b}{\partial h^*} < 0$$

and

$$\begin{aligned} Z_\alpha &:= \frac{1}{1+r}\Big[(1-h^*)w - (1-\sigma)qw\Big] + \frac{1}{1+r}\Big[1-(1-\sigma)\Big]\left(\frac{\partial b}{\partial \alpha}\bigg|_{h^*=const.}\right) \\ &= \frac{1}{1+r}w\Big[(1-h^*) - q\Big] + \frac{1}{1+r}\sigma\left[qw + \left(\frac{\partial b}{\partial \alpha}\bigg|_{h^*=const.}\right)\right]. \end{aligned}$$

With (4) this reduces to

$$Z_\alpha = \frac{1}{1+r}\sigma\left[qw + \left(\frac{\partial b}{\partial \alpha}\bigg|_{h^*=const.}\right)\right]. \tag{15}$$

Z_α consists of a positive and a negative component. The first one, $\frac{1}{1+r}\sigma qw$, captures the positive effect of an increase in α on the Bismarckian part of an h^*-type individual's pension benefit. Due to the positive life expectancy differential, a skilled individual benefits more from this effect compared to an unskilled individual. On the other hand, skilled individuals also lose more from the reduction in the flat-rate benefit b. The reason is, that due to the higher life expectancy of skilled individuals, their flat-rate pension benefit is higher in present value terms than for unskilled individuals. This effect is captured by $\frac{1}{1+r}\sigma(\frac{\partial b}{\partial \alpha}|_{h^*=const.})$ The overall sign of (15) can be shown to be unambiguously negative, meaning that around the ability cutoff level, less individuals prefer to become educated when α increases.

Z_α is negative if

$$qw + \left(\frac{\partial b}{\partial \alpha}\bigg|_{h^*=const.}\right) < 0 \quad \Leftrightarrow \quad qw < \hat{w} \tag{16}$$

which should always hold if there is at least one (educated) higher income individual in the economy.[8] Appendix B provides a more formal proof. Hence, for $\sigma \neq 0$,

$$\frac{dh^*}{d\alpha} < 0$$

unambiguously holds, which implies that the reform reduces the educational level in the economy. This proves Proposition 1.

Although we do not model other generations explicitly, the effects on those can easily be derived. Note first that any generation following the generation of workers who are affected by the one-time pension reform will perfectly replicate this 'initial' generation, i.e. it will not change its educational decisions. Hence, there is only one generation left which may be affected by the reform: the retirees in the period of the reform. In Section 3.4 dealing with welfare effects we will come back to this.

3.3 Redistribution

The previous section took a view from a broader ('macro') perspective, arguing that a pension reform toward a higher Bismarckian factor reduces educational effort in the economy. However, a pension reform not only changes the level of education in our model economy but also the redistributive characteristics of the pension system. A priori it is not clear how the reform affects different (skill) groups in society such that – at the end of the day – h^* falls. It may turn out that a pension reform which leads to a lower educational level and should therefore be undesired by the population as a whole becomes attractive for an increasing subgroup of citizens because they gain from redistribution via the pension system.

In order to analyze the distributional effects, we look at the individual who represents the transition from net-recipients to net-payers in the system. We are interested in seeing whether individuals who were indifferent in terms of redistribution before the reform will gain or lose from the reform. Only in the next section we will turn to a more thorough welfare analysis.

Net-recipients in our model are individuals whose pension benefits (in present value terms and considering life expectancy) exceed their contributions. Since all uneducated individuals are equal with respect to labor income and life expectancy,

[8] Remember that qw is the lowest possible labor income in the economy.

they are either all net-recipients or net-payers. The latter case (from which we will abstain in what follows) can occur if the life expectancy differential is such that the poor-to-rich redistributional effect of the pension system exceeds the rich-to-poor redistributional effect. Within the group of educated individuals there might be net-recipients and net-payers.

We now analyze the effect of a reform on the ability level $\tilde{h}$ characterizing the individual at the transition between net-recipients and net-payers. The implicit definition of $\tilde{h}$ is given by

$$(1-\tilde{h})tw - \frac{1}{1+r}\left[b + \alpha(1-\tilde{h})w\right] = 0. \tag{17}$$

The present value of pension benefits for an $\tilde{h}$-type individual exactly equals his pension contributions. Individuals with abilities greater than the threshold ability, i.e. individuals with $h < \tilde{h}$, are net-payers while all other individuals with lower abilities are net-recipients.

Let us first of all check for the existence and uniqueness of $\tilde{h}$.

Lemma 3 *A contribution rate $t > \frac{1}{1+r}\alpha$ ensures the existence of an ability level $\tilde{h} < h^*$, which is unique.*

This result follows from Figure 2, presenting the individual tax bills or rather pension contributions and the individual retirement benefits for the different ability types. It illustrates the definition of $\tilde{h}$ for a given pension system with $\alpha, b > 0$. With the distribution function $F(h)$, $\tilde{h}$ determines the size of the group of net-recipients or rather net-payers in the system.

The tax bill curve in Figure 2 being steeper than the retirement benefits curve (for skilled individuals, i.e. to the right of $(1-h^*)$) ensures the tax bill and retirement benefits curve to intersect. Therefore

$$t > \frac{1}{1+r}\alpha \tag{18}$$

is a sufficient condition for $\tilde{h}$ to exist.

The fact that both the tax bill and the retirement benefits curve are linear (and therefore intersect only once) and the governmental budget constraint ensure that $\tilde{h}$ is unique and $\tilde{h} < 0$ (i.e. there are net-payers in the pension system). This proves Lemma 3.

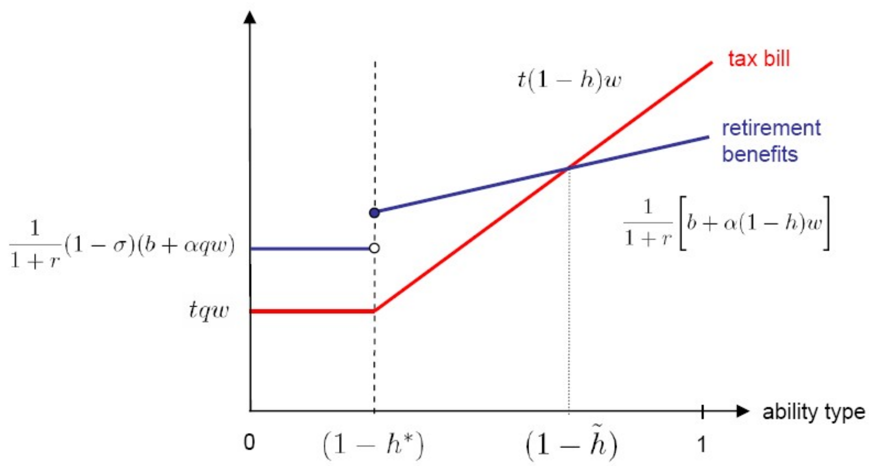

Figure 2: Ability cutoff level h^* and threshold $\tilde{h}$

After having checked for the existence and uniqueness of $\tilde{h}$ we can now turn to comparative statics and analyze the effect of a policy change on $\tilde{h} \neq h^*$. Again, we consider a policy change toward a more Bismarckian system, i.e. a marginal increase of α.

Proposition 2 *A marginal increase of the Bismarckian factor increases the number of net-recipients relative to net-payers in the pension system if and only if the flat-rate benefit either also increases or if at least a potential reduction does not exceed the increase of an $\tilde{h}$-type individual's Bismarckian benefit due to the reform.*

Hence, whether the number of net-recipients relative to the number of net-payers in the pension system increases or decreases as a consequence of the reform is a priori unclear. Implicit differentiation of (17) yields:

$$\frac{d\tilde{h}}{d\alpha} = -\frac{A_\alpha}{B} \tag{19}$$

where

$$\begin{aligned} A_\alpha &:= -\frac{1}{1+r}\left[(1-\tilde{h})w + \frac{db}{d\alpha}\right] \\ &= -\frac{1}{1+r}\left[(1-\tilde{h})w - \hat{w} + \frac{\partial b}{\partial h^*}\frac{dh^*}{d\alpha}\right], \end{aligned} \tag{20}$$

$$B := -tw + \frac{1}{1+r}\alpha w. \tag{21}$$

Condition (18) ensures that $B < 0$. Therefore, the sign of $\frac{d\tilde{h}}{d\alpha}$ solely depends on the ambiguous sign of A_α:

$$\frac{d\tilde{h}}{d\alpha} \begin{cases} \leq 0, & (1-\tilde{h})w + \frac{db}{d\alpha} \geq 0 \\ > 0, & (1-\tilde{h})w + \frac{db}{d\alpha} < 0. \end{cases} \tag{22}$$

As long as the adjustment of the flat-rate benefit due to the increased Bismarckian factor is positive, i.e. $\frac{db}{d\alpha} > 0$, or at least no too large in case it is negative, $\tilde{h}$ decreases (i.e. the ability threshold $(1-\tilde{h})$ in Figure 2 shifts to the right) implying an increasing number of net-recipients relative to net-payers in the pension system. The individual whose pension benefits (in present value terms) exactly equal his contributions would now become a net-recipient if the reform was implemented. Lemma 2, i.e. the fact that the adjustment of the flat-rate benefit does not only consist of a direct (negative) budget effect but also of an indirect (positive) effect due the change in the educational level and therefore the average life expectancy of retirees – which might even induce an *increase* in b – explains this result.

3.4 Welfare effects

Beside an analysis of a pension reform's effect on the redistributive characteristics of the system as presented above, a further important step in evaluating the reform is to ask about welfare implications. Who gains and who loses from the reform and does the economy or rather society as a whole gain or lose?

3.4.1 Individual welfare

After making the education decision according to indifference condition (3), the individual optimization problem is to maximize lifetime utility U from consumption in both periods subject to the intertemporal budget constraint.[9] The corresponding Lagrangians read

$$\Phi^q = U(c_1^q, c_2^q) + \eta\left\{(1-t)qw + \frac{1}{1+r}(1-\sigma)(b+\alpha qw) - c_1^q - (1-\sigma)\frac{c_2^q}{1+r}\right\}$$

[9]The value of consumption in both periods (we assume goods prices to be normalized to one) does not exceed the present value of net income from labor supply and the pension system. Skilled individuals also consider education expenditures in addition to the value of goods consumption.

which are identical for all unskilled individuals and

$$\Phi^h = U(c_1^h, c_2^h) + \eta\Big\{(1-t)(1-h)w - hg + \frac{1}{1+r}\Big[b + \alpha(1-h)w\Big] - c_1^h - \frac{c_2^h}{1+r}\Big\}$$

for skilled individuals with $h \leq h^*$. η is the Lagrangian multiplier.

The demand functions are $c_j^q = c_j^q(w,t,r,\alpha,b,\sigma)$ for unskilled and $c_j^h = c_j^h(w,t,r,\alpha,b,h,g)$ for skilled individuals, where $j \in \{1,2\}$ and $h \in [0,h^*]$. The corresponding indirect utility functions are $v^q = v^q(w,t,r,\alpha,b,\sigma)$ and $v^h = v^h(w,t,r,\alpha,b,h,g)$.

Proposition 3 *The individuals of the post-reform generations only gain from the reform if either the flat-rate benefit increases or if at least a potential reduction does not exceed the increase of their Bismarckian benefit due to the reform.*

Using the Envelope Theorem we can determine the effect of a policy change on individual utility.

$$\frac{\partial v^q(\cdot)}{\partial \alpha} = \frac{\partial \Phi^q}{\partial \alpha} = \eta \frac{1}{1+r}(1-\sigma)\left(qw + \frac{db}{d\alpha}\right), \tag{23}$$

$$\frac{\partial v^h(\cdot)}{\partial \alpha} = \frac{\partial \Phi^h}{\partial \alpha} = \eta \frac{1}{1+r}\left[(1-h)w + \frac{db}{d\alpha}\right]. \tag{24}$$

Whether an individual gains or loses depends on the direction and the size of the change in the flat-rate benefit as a consequence of the reform. If the flat-rate benefit b increases, or if at least a potential reduction of the flat-rate benefit does not exceed the increase in the Bismarckian component of an unskilled individual, both skilled and unskilled individuals unambiguously gain from the reform. However, beyond this threshold, only those (skilled) individuals with a high enough labor income, i.e. those who gain more from the higher Bismarckian benefit than they lose from the reduction in the flat-rate, gain from the reform.

Hence, knowing the size of the adjustment of the flat-rate benefit b not only allows us to determine the group of individuals who benefit from the reform, but by means of the ability distribution $F(h)$ we could also analyze the size of 'interest groups' in favor or against the reform. Furthermore, (22) then provides additional information on its redistributive consequences. Both aspects would be of special interest in a political economy framework analyzing the political support for the reform.

So far, we ignored the retirees in the period of the reform (generation $-i$) whose benefits depend on their own contributions but, in a PAYG system, also on the contributions of the subsequent generation (i) which now has a lower educational level due to the reform. Let us analyze the change in the pension benefits of these post-reform retirees, assuming that the new Bismarckian factor also applies to their pension scheme.

Proposition 4 *While the unskilled retirees in the period of the reform unambiguously lose from the reform, skilled retirees only gain if they have an above average labor income. Only in case of a right of continuance with respect to the Bismarckian factor, the retirees' welfare is not affected by the reform.*

First, consider the change in the pension benefit of an unskilled retiree.

$$\begin{aligned}
\frac{\partial}{\partial \alpha}\left[t\tilde{w}_{i,-i} - \alpha\hat{w}_{-i} + \alpha q w_{-i}\right] &= t\frac{\partial \tilde{w}_{i,-i}}{\partial h_i^*}\frac{\partial h_i^*}{\partial \alpha} - \hat{w}_{-i} + q w_{-i} \\
&= t\frac{n(h_i^*)}{\tilde{n}_{-i}} w\left[(1-h_i^*) - q\right]\frac{\partial h_i^*}{\partial \alpha} - \hat{w}_{-i} + q w_{-i} \\
&= -\hat{w}_{-i} + q w_{-i} < 0, \qquad (25)
\end{aligned}$$

where $n(h^*)$ denotes the number of individuals with an ability level h^* and $\tilde{n}$ the life expectancy weighted size of a generation. The unskilled retirees clearly lose from the reform. Whether a skilled retiree gains or loses depends on whether his labor income exceeds the weighted average income:

$$\frac{\partial}{\partial \alpha}\left[t\tilde{w}_{i,-i} - \alpha\hat{w}_{-i} + \alpha(1-h_{-i})w_{-i}\right] = -\hat{w}_{-i} + (1-h_{-i})w_{-i}. \qquad (26)$$

Only if there exists a right of continuance with respect to the Bismarckian parameter for the retirees in the period of the reform, their pension benefits remain unchanged, since

$$\frac{\partial t\tilde{w}_{i,-i}}{\partial \alpha} = t\frac{n(h_i^*)}{\tilde{n}_{-i}} w\left[(1-h_i^*) - q\right]\frac{\partial h_i^*}{\partial \alpha} = 0. \qquad (27)$$

Assumption (4) which ensures the aggregate wage income and therefore the sum of contributions to remain constant (at the margin), drives this result.

3.4.2 Social welfare

Whether the 'society' as a whole gains or loses from the reform is not a priori obvious. We now analyze the overall welfare change of skilled and unskilled individuals of a generation i by means of two exemplary social welfare functions. We assume the before mentioned right of continuance and therefore ignore the generation $-i$ retirees. First, take a Rawlsian welfare function:

$$W^R = \min[v^q, v^{h=h^*}, ..., v^{h=0}] = v^q$$

Therefore

$$\frac{\partial W^R}{\partial \alpha} = \frac{\partial v^q}{\partial \alpha} \begin{cases} \leq 0, & qw + \frac{db}{d\alpha} \leq 0 \\ > 0, & qw + \frac{db}{d\alpha} > 0. \end{cases} \tag{28}$$

The reform unambiguously reduces social welfare described by a Rawlsian welfare function if the individuals with the lowest utility level, i.e. the unskilled individuals, lose from the reform.

Now, let us assume a Utilitarian social welfare function:

$$W^U = N\left[\int_0^{h^*} \theta_h v^h f(h)dh + \theta_q v^q \int_{h^*}^1 f(h)dh\right] \tag{29}$$

with θ_q as the welfare weight of unskilled and θ_h, $h \in [0, h^*]$, as the weights for skilled individuals.

$$\begin{aligned} \frac{dW^U}{d\alpha} &= \theta_{h^*} v^{h^*} n(h^*)\frac{dh^*}{d\alpha} + N\int_0^{h^*} \theta_h \frac{\partial v^h}{\partial \alpha} f(h)dh \\ &\quad - \theta_q v^q n(h^*)\frac{dh^*}{d\alpha} + N\theta_q \frac{\partial v^q}{\partial \alpha}\int_{h^*}^1 f(h)dh \end{aligned} \tag{30}$$

$$\begin{aligned} &= \left[\theta_{h^*} v^{h^*} - \theta_q v^q\right] n(h^*)\frac{dh^*}{d\alpha} \\ &\quad + N\left[\int_0^{h^*} \theta_h \frac{\partial v^h}{\partial \alpha} f(h)dh + \theta_q \frac{\partial v^q}{\partial \alpha}\int_{h^*}^1 f(h)dh\right]. \end{aligned} \tag{31}$$

Assuming identical welfare weights for all individuals and $v^{h^*} = v^q$ (which holds for example in a setting with $U^q = u^q(c_1^q) + (1-\sigma)\frac{c_2^q}{1+r}$, $U^h = u^h(c_1^h) + \frac{c_2^h}{1+r}$ and $u^j = u^j(c_1^j)$ for $j \in \{q, h\}$) the first term of (31) vanishes and the overall sign of $\frac{dW^U}{d\alpha}$, i.e. the direction of the welfare change due to the pension reform, depends on the size and direction of the adjustment of the flat-rate benefit relative to the change in the individual Bismarckian benefits, on the educational level in the economy and the distribution of abilities among individuals.[10] A priori, it is by no means clear

[10] In this very limited partial equilibrium welfare analysis we ignored potential effects of a change in the educational level on wages or on macroeconomic variables such as for example economic growth.

that the beneficiaries' gains from the reform would suffice to compensate potential losses. On the other hand, however, with an increase in the flat-rate benefit, i.e. $\frac{db}{d\alpha} > 0$, or at least a reduction which is not too large, a marginal reform could also be Pareto-improving.

4 Conclusion

In many countries, pension reforms since the 1990s aimed at a reduction of intragenerational redistribution by strengthening the link between individual contributions and benefits. Usually, these reforms are slowly phased in and still need to be fully anticipated by the population. Our results show that it is not clear whether the reforms will be successful in the long run. While we expect that a reduction of work disincentives from (distortive) redistributive taxation will be welfare-enhancing, the reduction of educational effort due to a pension reform could dilute economic growth. In an aging society, however, growth is the key to stabilizing social security systems. Policy-makers should keep these possible effects in mind. The life expectancy differential between skilled and unskilled individuals, for which there is empirical evidence, causes the education disincentive effect. Furthermore we demonstrated that, in a fixed contribution rate system, the reform requires an adjustment of the flat-rate benefit consisting not only of a direct budget effect but also an indirect one due to the decreased educational level. The direction and the size of this adjustment is the key to the reform's effect on the (intragenerational) redistributive characteristics as well as on welfare.

To our knowledge especially the possibility of a (higher) education *dis*couraging effect of a pension reform reducing the progression of the system as well as the redistributive consequences of the reform in the sense of a change in the number of net-payers and net-recipients has been ignored in the literature and the policy discussion so far.

Note that our assumption of a fixed contribution rate regime is not entirely innocuous in the context of our results and that there exist only few public pension systems which are considered to be of the DC (defined contributions) type.[11] If we

[11] 'DC system' is the more commonly used term for what technically has to be interpreted as a pension system with fixed contribution rates.

assumed the more common DB (defined benefits) or fixed pension benefits system, it would easily be possible to raise α without lowering the flat-rate benefit b. Obviously, this leads to higher total spending and requires higher contributions to keep the budget balanced. In the real world, this additional tax burden may be shifted to younger cohorts or yet unborn generations.[12] However, although several countries are still considered to have DB systems, many of them have started to introduce policy measures to keep contribution rates constant in the long run. The reason is that, due to demographic change, contribution rates would increase substantially in the future, inducing strong work disincentives for the young. With increasing factor mobility in a globalized world, hardly any country can afford this development. It is therefore justified to argue based on a fixed contribution rate pension system.

We saw that various economic parameters determine the consequences of a pension reform, like the one analyzed above, with respect to educational level, intragenerational redistribution and welfare. The life expectancy differential between skilled and unskilled individuals, the distribution of abilities or rather productivities among individuals and the return to education in terms of labor income were shown to play a role here. Therefore, one and the same reform of a pension system's benefits scheme in different countries may have completely different consequences, depending on parameter differentials. This insight might serve as a starting point for an empirical testing of our Propositions 1 and 2.

Finally, we want to note that our results are not only relevant for countries with a mainly Beveridgian pension system thinking about relating benefits more closely to individual contributions. Take the German system which is of the Bismarckian type as an example. By gradually reducing the individual recognition of time spent on (higher) education in the German pension benefits scheme since the 1990s and finally abolishing it in 2005, the system effectively became even more Bismarckian or rather less progressive with respect to intragenerational redistribution. On the one hand this should remove work disincentives. On the other hand, due to increased indirect (opportunity) costs of education, we would expect these measures to have an additional disincentive effect on education beside the one we examined in this paper. This tradeoff represents a very interesting opportunity for further theoretical as well as empirical research.

[12] The seminal contribution in this context is Browning (1975); see also Haupt and Peters (1998) or Krieger (2003) for further discussion.

Appendix

A The public budget constraint

Equation (5) from the text:

$$tw\left[\int_0^{h_i^*}(1-h)f(h)dh + q\int_{h_i^*}^1 f(h)dh\right] \;=\; \int_0^{h_{-i}^*} P_h f(h)dh + P_q\int_{h_{-i}^*}^1 f(h)dh.$$

The RHS can be written as

$$b\int_0^{h_{-i}^*} f(h)dh + \alpha w\int_0^{h_{-i}^*}(1-h)f(h)dh + (1-\sigma)\left[b\int_{h_{-i}^*}^1 f(h)dh + \alpha qw\int_{h_{-i}^*}^1 f(h)dh\right]$$

or

$$b\underbrace{\left[\int_0^{h_{-i}^*} f(h)dh + (1-\sigma)\int_{h_{-i}^*}^1 f(h)dh\right]}_{z} + \alpha w\left[\int_0^{h_{-i}^*}(1-h)f(h)dh + (1-\sigma)q\int_{h_{-i}^*}^1 f(h)dh\right].$$

Dividing both sides of the budget constraint (5) by z then yields

$$t\tilde{w} = b + \alpha\hat{w}.$$

B The sign of Z_α

The sign of Z_α is negative if

$$qw + \left(\left.\frac{\partial b}{\partial\alpha}\right|_{h^*=const.}\right) < 0.$$

With (13)

$$qw \;<\; \frac{w\left[\int_0^{h^*}(1-h)f(h)dh + (1-\sigma)q\int_{h^*}^1 f(h)dh\right]}{\int_0^{h^*} f(h)dh + (1-\sigma)\int_{h^*}^1 f(h)dh}.$$

Rearranging and simplifying yields

$$q\int_0^{h^*} f(h)dh \;<\; \int_0^{h^*}(1-h)f(h)dh. \tag{32}$$

This inequality strictly holds if $h^* > 0$, i.e. if there is at least one individual with some ability h who prefers education to remaining unskilled, since $(1-h^*) = q$.

References

[1] Barr, N. (2004). "Economics of the Welfare State," *4th ed., Oxford and New York: Oxford University Press.*

[2] Bommier, A., Leroux, M.-L. and Lozachmeur, J.-M. (2005a). "Social Security and Uncertain Lifetime," *Working Paper.*

[3] Bommier, A., Leroux, M.-L. and Lozachmeur, J.-M. (2005b). "Varying Life Expectancy and Social Security," *Working Paper.*

[4] Bopp, M. and Minder, C.E. (2003). "Mortality by education in German speaking Switzerland, 1990-1997: results from the Swiss National Cohort," *International Journal of Epidemiology* 32, 346-354

[5] Borck, R. (2005). "On the Choice of Public Pensions When Income and Life Expectancy are Correlated," *Journal of Public Economic Theory* (forthcoming).

[6] Browning, E. K. (1975). "Why the Social Insurance Budget is Too Large in a Democracy," *Economic Inquiry* 13, 373-388.

[7] Casamatta, G., Cremer, H. and Pestieau, P. (2000a). "The Political Economy of Social Security," *Scandinavian Journal of Economics* 102, 503-522.

[8] Casamatta, G., Cremer, H. and Pestieau, P. (2000b). "Political Sustainability and the Design of Social Insurance," *Journal of Public Economics* 75, 341-364.

[9] Conde-Ruiz, I. and Profeta, P. (2005). "The Redistributive Design of Social Security Systems," *Working Paper, Universitat Pompeu Fabra, FEDEA and The Pension Institute.*

[10] Cremer, H. and Pestieau, P. (1998). "Social Insurance, Majority Voting and Labor Mobility," *Journal of Public Economics* 68, 397-420.

[11] Cremer, H. and Pestieau, P.(2003). "Social Insurance Competition Between Bismarck and Beveridge," *Journal of Urban Economics* 54, 181-196.

[12] Fenge, R., Gebauer, A., Holzner, Ch., Meier, V. and Werding, M. (2003). "Alterssicherungssysteme im internationalen Vergleich: Finanzierung, Leistungen, Besteuerung," vol. 10, *ifo Beiträge zur Wirtschaftsforschung, Munich: Ifo Institute.*

[13] Goerke, L. (2000). “Beveridge versus Bismarck: Flat-Rate and Earnings-Related Unemployment Insurance in a General Efficiency Wage Framework,” *FinanzArchiv* 57, 243-260.

[14] Haupt, A. and Peters, W. (1998). “Public Pensions and Voting on Immigration,” *Public Choice* 95, 403-413.

[15] Hougaard Jensen, S., Lau, M. and Poutvaara, P. (2003). “Efficiency and Equity Aspects of Alternative Social Security Rules,” *FinanzArchiv* 60, 325-358.

[16] Kolmar, M. (2005). “Beveridge Versus Bismarck Public-Pension Systems in Integrated Markets,” *Regional Science and Urban Economics* (forthcoming).

[17] Köthenbürger, M., Poutvaara, P. and Profeta, P. (2005). “Why are Redistributive Social Security Systems Smaller? A Median Voter Approach,” *CESifo Working Paper* No. 1397.

[18] Krieger, T. (2003). “Voting on Unskilled Immigration under Different Pension Regimes,” *Public Choice* 117, 51-78.

[19] Lau, M. and Poutvaara, P. (2000). “Social Security Incentives and Human Capital Investment,” *CEBR Discussion Paper* No. 2000-18.

[20] Lau, M. and Poutvaara, P. (2001). “Social Security Rules, Labor Supply and Human Capital Formation,” *CEBR Discussion Paper* No. 2001-10.

[21] Mirowsky, J. and Ross, C.E. (2000). “Socioeconomic Status and Subjective Life Expectancy,” *Social Psychology Quarterly* 63, 133-151.

[22] Poutvaara, P. (2005). “Social Security Incentives, Human Capital Investment and Mobility of Labor,” *IZA Discussion Paper* No. 1729.

[23] Razin, A. and Sadka, E. (1999). “Migration and Pension with International Capital Mobility,” *Journal of Public Economics* 74, 141-150.

[24] Robert Koch Institut (ed.) (2006). “Gesundheit in Deutschland. Gesundheitsberichterstattung des Bundes (Health in Germany. Federal Health Report),” *Robert Koch Institut, Berlin.*

[25] Rossignol, S. and Taugourdeau, E. (2006). “Asymmetric Social Protection Systems with Migration,” *Journal of Population Economics* 19, 481-505.

[26] Schneider, U. and Schneider, B. (2006) "The effects of education and working hours on health: A multivariate probit approach," *University of Bayreuth Discussion Paper 05-06*.

[27] Sinn, H.-W. (2000). "Why a Funded Pension System is Useful and Why It is Not Useful," *International Tax and Public Finance* 7, 389-410.

[28] Sinn, H.-W. (2005). "Europe's Demographic Deficit – a Plea for a Child Pension System," *De Economist* 153, 1-45.

[29] Werding, M. (2003). "After Another Decade of Reform: Do Pension Systems in Europe Converge?" *CESifo DICE Report* 1, 11-16.

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