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A Microanalysis of Pension Reform: To Switch or Not to Switch in the Czech Republic?

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1. Introduction

Demographic changes throughout the world have led to the phenomenon of population ageing. The proportion of old people in the population is rising steeply – this process is already well under way in OECD countries and by 2050 only Africa will still be "young" (World Bank, 1994). While this result of improvements in medical care as well as the standard of living is impressive, it represents a substantial challenge for social security systems. In particular, increasing life expectancy and declining fertility lead to ever increasing dependency ratios[1] in developed countries, which renders their public pension schemes financially unsustainable.

Most public pension plans were set up or expanded on a massive scale in the post-war era of "baby-boom" and significantly lower life expectancies. These plans have been largely financed out of payroll taxes on a pay-as-you-go (PAYG) basis, i.e. today's workers pay the pensions of today's retirees and these workers expect to be supported in the same manner in the future. However, owing to the aforementioned demographic developments, current workers face the prospect of being supported by a relatively less numerous work force for a much longer period than it was at the time these plans were introduced.[2] These plans are, therefore, in need of reform because there is a looming possibility that they will encounter insurmountable difficulties in meeting their future liabilities.

An increasingly popular alternative to PAYG schemes are fully funded (FF) schemes in which individuals save for their own retirement through pension funds. Unlike PAYG plans which usually contain solidarity-based redistributive elements, these plans are actuarially fair and, ideally, every

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[1] Defined as the number of old-age pensioners in relation to the number of working persons.

[2] In the words of the French poet Paul Valery, the "future is not what it used to be".

participant is entitled to no more and no less than his/her accumulated contributions plus interest.

While the average rate of return of a FF scheme equals the rate of interest, the average rate of return of a PAYG scheme equals the growth rate of the underlying taxable wage base in the economy, which is equal to the rate of growth of the labor force plus the rate of growth of wages (Samuelson, 1958). Data from various countries indicate that if the investment period is sufficiently long, the rate of interest on a combination of bonds and equity generally exceeds the rate of wage growth by approximately 2 to 3 percentage points (World Bank, 1994). Hence, given a stationary or even declining labor force, FF schemes' performance is superior to that of mature PAYG schemes today.

By and large, both schemes have their pros and cons.[3] Most importantly, they are subject to different kinds of risk. Funded schemes are exposed to investment risk.[4] In contrast, public pension schemes are susceptible to political risk[5] and labor income risk. Since those risks are unlikely to be perfectly correlated, their combination leads to a reduction in the overall risk and this is an argument for introducing a pension scheme comprising both PAYG and FF plans. While the PAYG plan possesses a unique potential to redistribute income towards persons in need,[6] the FF plan limits the government's upper hand over the economy and rewards responsible behavior.[7] Countries throughout the world have contemplated at least a partial shift towards funded schemes,[8] but the cost of such a transition poses a barrier to any major reform. This is due to the fact that the government must continue to honor its obligations to pay pension benefits to current and some future pensioners long after part or all of the stream of PAYG contributions ceases, and the accumulated implicit debts of these pension plans are substantial.[9] Also, such a complex reform requires adequate supervision and regulation of the capital market, pension funds and insurance companies in order to mitigate the risks associated with investment-based pension plans. If, however, the transition is

[3] See e.g. the debate in (Holzmann – Stiglitz, 2001).

[4] Disney et al. (1999) add that "an additional risk arises from annuitization [...] if there is substantial uncertainty as to expected mortality improvement" (p. 22).

[5] "Not one public defined benefit scheme has held to the same benefit formula over lifetimes of a cohort of members." (World Bank, 1994, p.112)

[6] As implied earlier, a high performance of the PAYG scheme could theoretically be sustained through a continual growth in the population of contributors. In his often quoted Newsweek editorial, Paul Samuelson referred to this as "the greatest Ponzi game ever contrived" (Samuelson, 1967, p. 88). Once a baby boom is followed by a baby bust, however, traditional defined benefit PAYG schemes find themselves in trouble if their generous promises are to be kept. A well-designed notional defined contribution PAYG plan establishing a perfect link between contributions and benefits (i.e. generally neither intergenerational nor intragenerational redistribution) can cope with demographic shocks, but the political risk still remains.

[7] Unlike PAYG plans, FF plans do not hamper international labor mobility. See (Schneider, 1998).

[8] Most countries reforming their pension systems have opted for a combination of PAYG and FF schemes, albeit the extent of switching varies considerably from main reliance on the PAYG scheme (Hungary and Poland) to equal weight attached to both schemes (Switzerland) to almost full privatization of social security (Chile and Kazakhstan).

financed at least partially through taxes and is connected with restrictive fiscal measures, national saving increases. Also, the reform may deliver a positive externality of great importance – capital market development. In sum, a well-defined reform may ultimately lead to higher economic growth.[10]

Pension schemes must be adjusted to the demographic developments sooner or later and the Czech Republic will be no exception. Indeed, it is beginning to feel the mounting demographic pressures which threaten the stability of its public finance and a profound reform of its social security system is becoming a necessity. Much has been written on this ubiquitous topic and various reform scenarios have been suggested. Some economists oppose funded plans and believe that a parametric reform of the PAYG scheme suffices (Rusnok, 2001), some cautiously admit gradual introduction of a minor FF scheme while retaining reliance on the PAYG scheme (Laursen, 2000), some prefer a combination of both schemes (Bezděk, 2000) and some advocate a full switch towards a FF scheme (Schneider, 1998). I believe that the pros of funded schemes significantly outweigh their cons and a partial shift towards a funded scheme should be made soon. The objective of this paper is, therefore, to supplement the existing literature containing macroeconomic simulations of a pension scheme reform with the estimates of its elementary microeconomic implications for future retirees.

We shall attempt to demonstrate that if individuals are given the option to switch partially into a funded scheme, an overwhelming majority of them will do so voluntarily, thus not only increasing their own retirement income, but also alleviating the future burden which would hamper the PAYG scheme as currently structured. Most countries which have switched at least partially towards a FF scheme instituted mandatory switching for new labor force entrants and some have done so for current workers under a certain age limit as well. However, due to redistributive streams towards low-income workers in PAYG schemes, such a requirement may affect the standard of living of low-income individuals in retirement. Notably, workers with a low earning capacity are susceptible to periods of non-contribution to pension plans, which could result in a severe reduction in their future pension benefits should they be compelled to switch into an alternative pension plan. Therefore, we shall investigate the impact of mandatory switching on individuals with respect to their earning capacity in order to supply recommendations for policy makers.

The remainder of this paper is structured as follows. Section 2 models the income of the individual over his/her lifetime and presents a general description of the Czech public pension scheme as well as the alternative

[9] When most PAYG systems were established or expanded amidst the post-war euphoria, the generation which had previously contributed either very little or not at all reaped a windfall in the form of pension benefits. Analogously, if this scheme is ever to be abandoned, the "last" generation(s) must foot the bill. According to the accrued benefit obligation definition, if a PAYG system is discontinued (i.e. no future revenues), the implicit debt of the system is the present value of all benefit obligations accumulated until that moment minus accumulated pension reserves.

[10] For more in the context of the Czech Republic, see e.g. (Schneider, 1998).

funded scheme. Section 3 details the results of the simulations which sought to estimate the impact of the proposed reform on the incomes of future pensioners. Section 4 gives some recommendations and concluding remarks.

2. The Model

We construct a simple model in order to simulate the microeconomic dynamics of the proposed pension-scheme reform. We model the microeconomic foundations of the Czech PAYG scheme as well as the proposed FF scheme and focus on individual economic agents' decisions to join an alternative pension system.

2.1 The Individual

An individual enters the labor force at the biological age φ. To simplify our notation, let the term "age" denote the time that has elapsed since the individual's entry into the labor force, i.e. his/her biological age less φ. This terminology is adhered to from this point onwards throughout this section, but is dropped in the sections that follow. Thus, the individual's current age is t, he/she expects to die at age E and, therefore, retires at age $R \in \langle 0, E \rangle$.[11] While working, the individual receives a gross real wage $w(t)$ and after retirement, he/she is entitled to real pension benefits $b(t)$.

Notation:
g ... national nominal wage growth rate
$s(t)$ ... individual nominal wage growth rate due to the effect of human-capital accumulation as well as ageing;[12] $s(t)$ is continuous on $\langle 0, R \rangle$
π ... consumer price inflation rate

Hence,

$$\frac{dw(t)}{dt} = \left[\frac{(1+g)(1+s(t))}{1+\pi} - 1 \right] \cdot w(t), \quad t \in (0,R) \tag{1}$$

Using

$$\frac{(1+g)(1+s(t))}{1+\pi} - 1 \approx g + s(t) - \pi$$

[11] *Sensu stricto*, the worker aged R is just about to retire and does so only at the next moment (see *Figure 1*).

[12] This also includes wage growth with seniority due to the fact that the employee pays for on-the-job training by receiving a wage lower than his/her potential marginal product (i.e. with no training) at the beginning of his/her career. According to (Becker, 1993), if the training is employer-specific, its costs are shared by the employer and the employee. Then, there is not only a strong incentive for the employee not to quit (and not to shirk duties for fear of dismissal) in order to be able to enjoy the fruits of his/her increased productivity later, but also a good incentive for the employer not to dismiss such a specifically-trained employee, thus reducing turnover costs. For empirical evidence of wage growth with seniority; see also (Topel, 1990).

for values of g, $s(t)$ and π near zero, we arrive at

$$\frac{dw(t)}{dt} = (g + s(t) - \pi) \,.\, w(t), \qquad t \in (0,R) \tag{2}$$

Solving this simple differential equation, we obtain:

$$w(t) = w(0) \cdot e^{(g-\pi)t + \int_0^t s(x)dx}, \qquad D_w = \langle 0, R\rangle^{13} \tag{3}$$

Let $w(t)$ be concave on $\langle t_0, R\rangle$, $t_0 \in \langle 0, R)$.[14] Then, it can be shown easily that $s(t)$ is decreasing on $\langle t_0, R\rangle$.[15]

Analogously, assume that the growth rate of the individual's pension benefits is equal to that of wages in the economy. Then:

$$b(t) = \rho \,.\, w(R) \,.\, e^{(g-\pi)(t-R)},^{16} \qquad D_b = (R, E\rangle \tag{4}$$

where ρ denotes the gross replacement ratio, i.e. the ratio of the worker's first benefits received upon retirement and the last pre-retirement gross wage.

2.2 Dynamics of Wages and Benefits in the Economy

Due to the increase in the productivity of work, the average nominal wage in the economy grows at the rate of g, as do the subsistence wage and minimum pension benefit. Formally,

$$wage_0(time) = wage_0(time_t) \cdot e^{(g-\pi)(time-time_t)} \tag{5}$$

$$wage_{MEAN}(time) = wage_{MEAN}(time_t) \cdot e^{(g-\pi)(time-time_t)} \tag{6}$$

$$benefit_0(time) = benefit_0(time_t) \cdot e^{(g-\pi)(time-time_t)} \tag{7}$$

denote the subsistence real wage, average real wage and minimum real pension benefit, respectively. Further notation:

time . . . calendar time
$time_t$ . . . calendar time at which the individual is aged t

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[13] $w'_+(0) = (g + s(t) - \pi) \,.\, w(0)$ and $w'_-(R) = (g + s(t) - \pi) \,.\, w(R)$

[14] This is to approximate empirical age-earnings profiles as shown by (Becker, 1993) or (Bosworth et al., 1996). The latter support the view that earnings rise with age until the mid-forties and then decline until retirement. However, Becker argues that this belief may be the result of an inappropriate use of cross-sectional data rather than time-series data (or from the failure to adjust the former by the increases in wages due to economic growth), and demonstrates that earnings rise until retirement and "there is no systematic tendency for time-series profiles to decline even though cross-section ones do" (p. 233).

[15] For our particular choice of the functional form of $s(t)$, see the *Appendix*.

[16] $\lim_{t \to R+} b(t) = \rho \,.\, w(R)$

FIGURE 1 System Dynamics and the Individual Gross-income Trajectory *T*

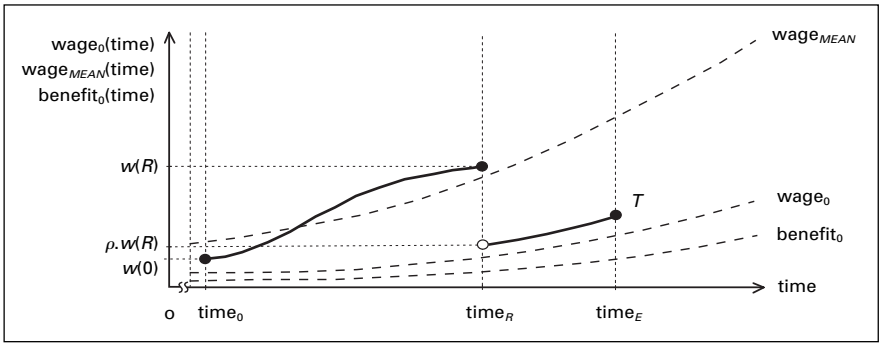

Figure 1 shows the system dynamics and the trajectory of the individual's gross income within the system.

2.3 The Czech Pay-As-You-Go Scheme

The individual's gross wage is taxed throughout his/her working life and this tax is called a mandatory social security contribution, part of which is paid by the employer and part by the employee. Denote the old-age pension contribution rate as τ and assume that the individual retires at age $R \in \langle P, E \rangle$, where P is the pensionable age defined by law.[17] Then:

$$\lim_{t \to R+} b_{PAYG}(t) = \rho_{PAYG} \,.\, w(R) = b_b(time_R) + 0.015 \,.\, R \,.\, B_c + 0.06 \,.\, (R - P) \,.\, B_c \quad [18] \tag{8}$$

where ρ_{PAYG} is the individual's gross[19] replacement ratio offered by the PAYG system and $b_b(time_R)$ is the real flat component of PAYG benefits to which every participant retiring at $time_R$ is entitled regardless of his/her earnings history.

$$\begin{aligned} &B_p && \text{for } B_p \in (0, p_1(time_R)\rangle \\ &0.7 \,.\, p_1(time_R) + 0.3 \,.\, B_p && \text{for } B_p \in (p_1(time_R), p_2(time_R)\rangle \\ &0.7 \,.\, p_1(time_R) + 0.2 \,.\, p_2(time_R) + 0.1 \,.\, B_p && \text{for } B_p \in (p_2(time_R), +\infty) \end{aligned} \tag{9}$$

is the calculation base, where

$$B_p = \frac{1}{\psi} \,.\, \int_{R-\psi}^{R} w(t) \,.\, \frac{wage_{MEAN}(time_R)}{wage_{MEAN}(time_R - R + t)}\, dt \tag{10}$$

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[17] Strictly speaking, the law defines the pensionable biological age $\varphi + P$. We ignore survivors and disability pensions, and focus exclusively on old-age pensions.

[18] As defined by law for $time_P \in \langle 2001.5, +\infty)$, where $benefit_0(time_R)$ is guaranteed to every participant. Assume that $b_{PAYG}(t)$ increases according to (4).

[19] Unlike wages, pension benefits are tax exempt.

denotes the personal base of assessment of the individual, ψ denotes the pre-retirement period over which wages are included in the calculation of the personal base of assessment,[20] and parameters $0 < p_1(time_R) < p_2(time_R)$ are the first and the second real reduction limits at $time_R$, respectively.

We obtain from (8) that

$$\rho_{PAYG} = \frac{b_b(time_R)}{w(R)} + \frac{0.075 \,.\, R - 0.06 \,.\, P}{w(R)} \,.\, B_c \tag{11}$$

and it follows from (3), (6) and (10) that

$$B_p = \frac{w(R)}{\psi} \,.\, \int_{R-\psi}^{R} e^{\int_R^t s(x)dx} dt \tag{12}$$

Assume that an individual aged h is able to estimate the development of his/her wages over the remaining working life. He/she expects no adjustments within the current PAYG scheme except for an increase in the pensionable age and the following development of PAYG parameters over time:

$$b_b(time) = b_b(time_h) \,.\, e^{(g-\pi)(time-time_h)} \tag{13}$$

$$p_j(time) = p_j(time_h) \,.\, e^{(g-\pi)(time-time_h)} \qquad j = 1,2 \tag{14}$$

Then, it follows from (3), (9), (11), (12), (13) and (14) that his/her estimate of the PAYG replacement ratio is given by the following formula:

$$\rho_{PAYG} = \begin{cases} \dfrac{b_b(time_h)}{w(h)} \cdot e^{\int_R^h s(x)dx} + \dfrac{7.5R-6P}{\psi.10^2} \,.\, \int_{R-\psi}^{R} e^{\int_R^t s(x)dx} dt \\ \text{for } w(h) \in \langle w_0(h),\, w_1(h)\rangle \text{ [21]} \\ \\ \dfrac{b_b(time_h) + (52.5R-42P) \,.\, p_1(time_h) \,.\, 10^{-3}}{w(h)} \cdot e^{\int_R^h s(x)dx} + \\ + \dfrac{22.5R-18P}{\psi.10^3} \,.\, \int_{R-\psi}^{R} e^{\int_R^t s(x)dx} dt \\ \text{for } w(h) \in (w_1(h),\, w_2(h)\rangle \\ \\ \dfrac{b_b(time_h) + (7.5R-6P) \,.\, (7p_1(time_h) + 2p_2(time_h)).\, 10^{-3}}{w(h)} \,. \\ \,.\, e^{\int_R^h s(x)dx} + \dfrac{7.5R-6P}{\psi.10^3} \,.\, \int_{R-\psi}^{R} e^{\int_R^t s(x)dx} dt \\ \text{for } w(h) \in (w_2(h)+\infty) \end{cases} \tag{15}$$

where

$$w_j(h) = \frac{p_j(time_h) \cdot \psi}{\int_{R-\psi}^{R} e^{\int_h^t s(x)dx} dt} \qquad j = 1,2 \tag{16}$$

It is obvious that $\rho_{PAYG}(w(h))$ is twice continuously differentiable with

$$\frac{d\rho_{PAYG}(w(h))}{dw(h)} < 0 \text{ and } \frac{d^2\,\rho_{PAYG}(w(h))}{d(w(h))^2} > 0 \tag{17}$$

on each of the open intervals $(w_0(h), w_1(h))$, $(w_1(h), w_2(h))$ and $(w_2(h), +\infty)$. Therefore, it is decreasing and strictly convex on those intervals. It can be shown easily that

$$\rho_{PAYG}(w_j(h)) = \lim_{w(h)\to w_j(h)+} \rho_{PAYG}(w(h))$$
$$j = 1,2 \tag{18}$$

Thus, we know that $\rho_{PAYG}(w(h))$ is continuous, decreasing and strictly quasiconvex on $(w_0(h), +\infty)$. However,

$$\lim_{w(h)\to w_j(h)+} \frac{d\rho_{PAYG}(w(h))}{dw(h)} < \lim_{w(h)\to w_j(h)-} \frac{d\rho_{PAYG}(w(h))}{dw(h)} < 0$$
$$j = 1,2 \tag{19}$$

Hence, $\rho_{PAYG}(w(h))$ is only piecewise smooth on $(w_0(h), +\infty)$ with kinks at $w_j(h), j = 1, 2$, i.e. the points of discontinuity of $\frac{d\rho_{PAYG}(w(h))}{dw(h)}$.

Figure 2 shows the replacement ratio the individual is offered by the PAYG scheme depending upon his/her last pre-retirement wage, i.e. $h = R$. This is regardless of gender since the PAYG formula does not discern between genders and as the wage level is varied, all other things are held equal, including wage growth rates.

2.4 A Fully Funded Scheme

The individual saves for retirement in a pension fund throughout his/her working life. Unable to foretell the exact moment of his/her death, a risk-averse individual can be expected to seek insurance against longevity.[22]

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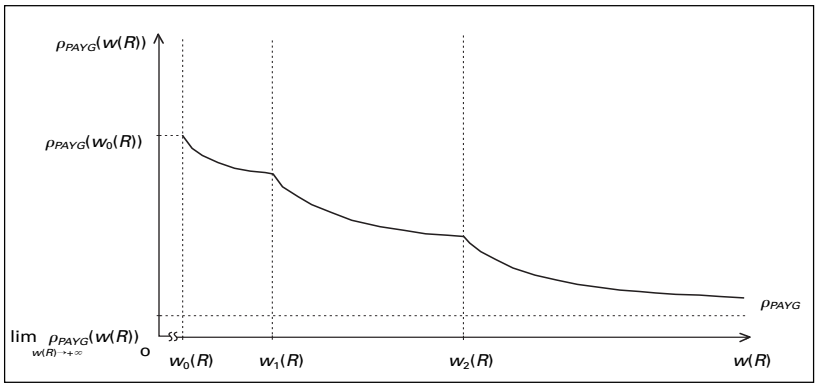
[20] $\psi = \min [\text{time}_R - 1986, 30]$, $\text{time}_R \in \langle 1996, +\infty)$ as defined by law.

[21] As noted earlier, a minimum benefit is guaranteed by law to every participant in the PAYG scheme. Thus, let the minimum wage the individual has to receive at h in order for the formula to apply be denoted by $w_0(h)$.

[22] The personal expected length of life differs among individuals based upon their health status, lifestyle, family-health history, etc. and the information about the remaining length of life rises as he/she ages. Naturally, the uncertainty of the time of death still remains.

FIGURE 2 PAYG Replacement Ratio Based on $w(R)$



Therefore, upon reaching retirement age, the individual converts his/her accumulation into an annuity, which is an insurance product paying specified amounts to its policyholder for as long as he/she is alive.

The contribution rate in the FF scheme equals that of the PAYG scheme (denoted by τ) and contributions are mandatory for every participant. Let i denote the nominal yield rate of personal pension accounts – we assume the value of i to be near zero just like g, $s(t)$ and π. From this point onwards, let E denote the life expectancy of the individual's birth cohort conditional on reaching age R. Suppose the individual has the choice to opt out of the PAYG scheme, divert the contributions into the FF scheme and annuitize his/her personal account accumulation upon retirement. The individual purchases an escalating annuity with escalation rate g, i.e. FF benefits rise at the same rate as PAYG benefits.[23] The present value of annuity payouts of a person who dies at age E is lower than the price of the annuity due to the cost of administration, marketing and also the phenomenon of adverse selection in the annuities market.[24] Let a certain share of the total accumulation covering this cost be denoted by c.

Thus, the benefit $b_{FF}(t)$ increases according to (4) and the real value of the individual's accumulation at the time of retirement less the annuitization cost equals the present value of FF benefits, i.e.

$$(1-c) \cdot \int_h^R \tau \cdot w(t) \cdot e^{(i-\pi).(R-t)} dt = \int_R^E b_{FF}(t) \cdot e^{(\pi-i).(t-R)} dt \qquad (20)$$

Then, it can be obtained from (3), (4) and (20) that

[23] Alternatively, the individual may buy a nominal annuity, which pays a constant nominal payout each period, or a real "inflation-indexed" annuity whose nominal payout is adjusted each period by the percentage change in the price level, etc. Since, however, none of the conclusions reached in this text would be affected by the choice of insurance product, an escalating annuity is used for convenience.

[24] The problem of adverse selection in the private annuities market means the empirical evidence that the annuitants' life expectancy is higher than in the population at large and insurance companies adjust the prices of annuities upwards accordingly. For more, see (Finkelstein – Poterba, 2002).

$$\rho_{FF} = (1 - c) \,.\, \tau \,.\, \frac{\int_h^R e^{(g-i).(t-R)} + \int_R^t s(x)dx dt}{\int_R^E e^{(g-i).(t-R)} dt} \tag{21}$$

is the FF replacement ratio. Note that $\rho_{FF}(w(h)) = const.$ owing to no redistribution within the system. This is congruent with our intuition that if the individual's lifetime wage (and contributions) *ceteris paribus* doubled, his/her savings in the personal pension account would double as well, which would eventually translate into doubling of his/her pension benefits.

2.5 Individual Choice of Pension Arrangement

The individual has the choice to switch an arbitrary portion of PAYG contributions to a pension fund at the expense of receiving proportionately reduced PAYG benefits in the future without any compensation for the past contributions, i.e. a proportionate part of the accumulated rights under the PAYG scheme is completely eliminated. Denote the combination of schemes in the individual pension arrangement as $\mu \in \langle 0, 1 \rangle$, i.e.

– – $\mu \,.\, \tau$ is the rate of contributions to the FF scheme,
– – $(1 - \mu)\ \tau$ is the rate of contributions to the PAYG scheme.

Using (15) and (21), we define the individual's resulting replacement ratio as

$$\rho = \mu \,.\, \rho_{FF} + (1 - \mu) \,.\, \rho_{PAYG} \tag{22}$$

The individual's wage is exogenous and his/her optimization problem is replacement ratio maximization. Therefore, on the condition that the risks associated with both schemes are identical,[25] the individual switches if and only if

$$\rho > \rho_{PAYG} \tag{23}$$

Alternatively, inserting (22) into (23) and rearranging yields

$$\rho_{FF} > \rho_{PAYG} \tag{24}$$

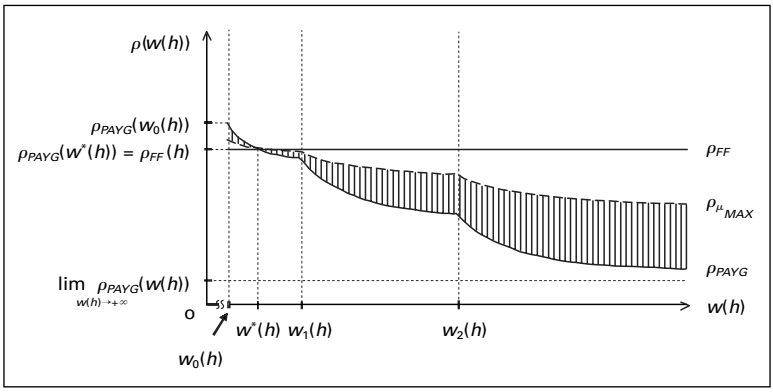
Suppose there is an upper limit on the extent of switching denoted as $\mu_{\mathrm{MAX}} \in \langle 0, 1 \rangle$. Then (22) and (24) imply

$$\frac{d\rho}{d\mu} = \rho_{FF} - \rho_{PAYG} > 0 \tag{25}$$

and ρ is maximized at $\mu = \mu_{\mathrm{MAX}}$ on $\langle 0, \mu_{\mathrm{MAX}} \rangle$. Therefore, given the opportunity to divert an arbitrary percentage of PAYG contributions into a FF scheme in exchange for the same percentage reduction in traditional public pension benefits, if the individual switches, he/she does so to the maximum possible extent.[26]

[25] This is a great simplification indeed – the risks associated with both pension plans have already been discussed.

FIGURE 3 Mixed-scheme Replacement Ratio for a Given h and $\mu_{MAX} \in (0, 1)$



This conclusion is obvious in *Figure 3*. ρ_{FF} is the same for all workers aged h regardless of their wages whereas ρ_{PAYG} declines with income due to redistribution within the PAYG scheme. After a switch into a mixed scheme, the resulting replacement ratio of those whose ρ_{PAYG} exceeds ρ_{FF} falls and the greater the extent of switching, the greater the drop. For those whose ρ_{PAYG} is lower than ρ_{FF}, the situation is reversed and the greater the extent of switching, the greater the resulting replacement ratio. Given an upper limit on the extent of switching, $\rho\mu_{\mathrm{MAX}}$ denotes the replacement ratio attainable by switching to the maximum possible extent and $w^*(h)$ denotes the switching wage in the cohort of workers aged h.

If the rate of return *i ceteris paribus* increases, the graph of ρ_{FF} shifts parallelly upwards, thus decreasing the switching wage. If women's retirement period $E - R$ is longer than that of men due to women's higher life expectancy, then the change of sex from male to female *ceteris paribus* shifts the graph of ρ_{FF} parallelly downwards, thus increasing the switching wage. If age h is *ceteris paribus* increased, then the graph of ρ_{FF} shifts parallelly downwards. However, albeit the range of attainable values of ρ_{PAYG} remains unaffected, the graph of ρ_{PAYG} generally changes too as h varies. In this case, the resulting change in the switching wage is not clear without the specification of wage growth rates.[27]

3. Simulations

3.1 Assumptions

We consider 2005 to be the year of a pension-scheme reform.[28] In our calculations, we use this values of parameters – see *Table 1*:[29]

[26] It is worth repeating that the difference in the nature of risk in both schemes is ignored.

[27] In this general descriptive model, concrete wage growth rates are not specified. This is only done in Section 3 where computer simulations are conducted (for instance, see the dependence of the switching wage on age in *Table 8* and *Table 9*).

TABLE 1 Values of Parameters Used in the Simulations

g	π	τ	c	ψ	$b_b(2005)$	$p_1(2005)$	$p_2(2005)$
0.05	0.02	0.2	0.1	30	1,500	8,500	20,000

TABLE 2 Differences between Individual and National Wage Growth Rates

Age	23	27	30	35	40	45	47.5	50	55	60	65
$s(t)$ in %	4.5	3.3	2.6	1.6	0.9	0.3	0	–0.2	–0.7	–1.0	–1.3

Thus, the national growth of real wages is 3 % p.a. in the whole projected period (which spans about 60 years in the case of new entrants), the old--age pension contributions to the PAYG scheme are 20 % of gross wages[30] and the cost of annuitization is 10 % of the accumulation.[31]

The individual enters the labor force at 23 if male and at 27 if female, and retires at the pensionable age of 65.[32] The life expectancy conditional on reaching age 65 is 78.72 for men and 82.09 for women using the 2000 mortality rates (ČSÚ, 2002). These can be expected to increase. However, the extent of this increase is fairly difficult to estimate with any degree of precision as it means estimating the average age of dying in several decades from now. Therefore, alternative scenarios are considered. It is not easy to estimate $s(t)$ either.[33] This function serves as an approximation of the rate of the individual's wage growth over time cleared of the general wage growth in the economy and we set $s(t)$ so that this rate decreases over the individual's career – see *Table 2*.

[28] This is due to the fact that the preparation of such a complex reform requires some time. As a consequence, 2005 is a base year for the calculation of all real values. Moreover, all those who choose to switch are likely to retire after the Czech Republic's entry into the Economic and Monetary Union, i.e. they will receive pension benefits in euros rather than Czech crowns. However, the results of our simulations are unaffected by the choice of currency units.

[29] Strictly speaking, a gradual increase in the period ψ from 2005 to 2016 is considered.

[30] The total contribution rate is currently 26 % (19.5 % is paid by the employer) and the scheme already runs deficits. We assume this rate to be increased to 30 % by 2005 in an attempt for a fiscally sustainable PAYG scheme. Since, however, almost 30 % of total PAYG expenditures cover non-old-age (disability and survivors) pensions, we assume that 10 percentage points of the total contribution rate go towards non-old-age pensions (with the 'surplus' being reallocated towards old-age pensions) and only 20 percentage points are earmarked for old-age pensions. Bezděk (2000) demonstrates that if there is to be full wage indexation of pension benefits, the current PAYG scheme may be fiscally sustainable with a contribution rate of 30 %, the statutory retirement age of 65 irrespective of gender, a reduction in early retirements by 50 %, a reduction in disability and survivors pensions by 10 % and the gross replacement ratio for the economy (i.e. the ratio of the average pension benefit and the average gross national wage) reduced from the current 44 % to 38 %. As the initial reduction in this replacement ratio is not assumed in the simulations, the expected performance of the PAYG system is still *overestimated*.

[31] Mitchell and McCarthy (2002) compare the present values of expected annuity payouts with the prices of annuities in a range of developed countries, using the population mortality tables. They conclude that "a typical member of the population could anticipate receiving at least 90 percent of his premium from the single life annuity. The results also imply that adverse selection as well as loadings and administrative charges must be below ten percent of the purchase price." (p. 14)

For the sake of simplicity, we apply these rates uniformly to all workers in our simulations regardless of gender and level of earnings.

It is worth reiterating that we assume no reform to the current PAYG scheme and a complete elimination of a proportionate part of the acquired rights under this scheme for those who switch. One of the main objectives of this paper is to compare the replacement ratios attainable in the FF scheme with those attained in the PAYG scheme as currently structured, thus illustrating the relatively poor performance of the latter scheme. I believe that after reform, the PAYG scheme should remain a redistributive defined benefit scheme, although the current weak link between contributions and benefits should be strengthened while a minimum pension income would continue to be ensured. In such a case, the switching outcomes would differ from those presented in the following text and generally more lower-income workers would tend to switch. However, introducing some arbitrarily redefined PAYG formulae would probably add to confusion rather than make a stronger case for reform and, therefore, current formulae are used as described in Section 2. Thus, we can proceed further and investigate the microeconomic pros and cons of the alternative pension schemes.[34]

3.2 What Are the Alternatives?

One possible way of measuring the performance of pension schemes is comparing the amount of contributions an individual makes during his/her working life with the amount of benefits the very same individual can expect to receive after he/she has retired. Assume a five-year increase in current life expectancies, a real discount rate of 5 % p.a.,[35] and a 20% rate of contribution towards old-age pensions as used throughout our simulations.

By definition, the present value of contributions to the FF scheme equals the present value of benefits received after retirement. However, unlike public PAYG schemes, this scheme by itself may not provide insurance against longevity if, for instance, lump-sum withdrawals are an option. Therefore,

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[32] Of course, some persons enter the work force at an earlier age, some later. The reasons for not setting the age of new entrants at 20 (implying 45 years to be spent in the labor force) are manifold – higher level education, maternity (or paternity) leave, unemployment, travel before starting a job, etc. As a compromise, there are 42 years of work ahead of new male entrants ($R = P = 42$) and 38 years of work ahead of new female entrants ($R = P = 38$). Since, however, non-contribution periods such as unemployment, higher level education or child rearing are added to the contribution years in the PAYG scheme, we use 45 years of participation in the PAYG benefit formulae. Strictly speaking, the above values implying the pensionable age of 65 are used only for workers aged 50 or less in 2005. Currently, the pensionable age is being raised gradually from 60 for men and 53–57 for women (depending on the number of children reared) in 1995 to 62 and 57–61 in 2007. We assume a further phased increase until it reaches 65 for both men and women in 2020, and we use the statutory retirement age for a woman with 2 children in the simulations.

[33] For a discussion of this and our concrete choice of $s(t)$, see the *Appendix*.

[34] The mathematical software package Maple was used for the simulations.

[35] Reasons for these assumptions are given later in Scenario 3 where they are used as well.

TABLE 3 Present Values of Contributions and Benefits in 2005 (CZK) – Men

	Monthly wage upon entry into labor force in 2005:			
	CZK 7,000	CZK 10,000	CZK 20,000	CZK 50,000
PVC	667,000	953,000	1,907,000	4,767,000
PVB_{FF}	601,000	858,000	1,716,000	4,290,000
PVB_{PAYG}	626,000	701,000	839,000	1,088,000

TABLE 4 Present Values of Contributions and Benefits in 2005 (CZK) – Women

	Monthly wage upon entry into labor force in 2005:			
	CZK 7,000	CZK 10,000	CZK 20,000	CZK 50,000
PVC	554,000	791,000	1,582,000	3,956,000
PVB_{FF}	498,000	712,000	1,424,000	3,561,000
PVB_{PAYG}	733,000	811,000	994,000	1,254,000

if the performance of these schemes is to be compared, the cost of this insurance in the FF scheme has to be considered. As noted earlier, the present value of expected annuity payouts in the population at large may be up to ten percent lower than the price of the annuity. Therefore, the average FF scheme participant can expect to receive at least 90 % of his/her contributions with accrued interest back in the form of annuity payouts. This, however, is not the case of the PAYG scheme and if we compare the present values of individuals' benefits in the alternative pension plans, we find that they differ substantially. These differences can be seen in *Table 3* and *Table 4*.[36,37]

Thus, it is clear after comparing these present values that while participants in the FF scheme can expect to receive approximately 10 % less than they will have contributed, the expectations of most PAYG-scheme participants cannot be so high. A man entering the work force with the national average wage (CZK 20,000 in 2005) can expect to receive 2.3 times less in pension benefits than he will have contributed during his working life and a woman with that wage can expect 1.6 times less. If a man earns a wage two and a half times higher than the national average wage (CZK 50,000 in 2005), he can expect to receive 4.4 times less than his past contributions and a woman earning that wage can expect to receive 3.2 times less. Note that while the latter workers contribute over seven times more than subsistence-wage earners, they receive less than twice higher benefits. This is due to justified redistribution towards individuals who are not able to con-

[36] *PVC* denotes the present value of contributions, PVB_{FF} = 0.9PVC denotes the present value of FF benefits, and PVB_{PAYG} denotes the present value of PAYG benefits. While PVB_{FF} may well be higher than 0.9 *PVC*, PVB_{PAYG} is likely to be slightly lower than presented due to our overly optimistic assumptions about the financial sustainability of the PAYG scheme.

[37] $wage_0$ = CZK 7,000 and $wage_{MEAN}$ = CZK 20,000 are assumed to be the monthly subsistence wage and national average wage in 2005, respectively. In 2000, approximately 65 % of workers earned less than the national average wage (ČSÚ, 2001b).

TABLE 5 Comparison of Alternative Replacement Ratios

Age	ρ_{FF} (in %)		ρ_{PAYG} (in %) for those earning in 2005:			
	men	women	CZK 7,000	CZK 10,000	CZK 20,000	CZK 50,000
23	114.7	–	79.6	62.3	37.3	19.4
27	100.6	89.0	89.2	69.1	42.4	21.4
30	89.7	79.5	93.7	73.5	45.6	22.7
35	72.1	63.8	88.9	79.2	49.8	24.4
40	55.6	49.2	88.9	82.8	52.5	25.5
45	40.7	36.1	88.9	84.6	53.4	26.0
50	27.8	24.6	88.9	84.6	53.4	26.0

tribute sufficiently for their own retirement. Surprising as it may seem, however, a man earning the subsistence wage (CZK 7,000 in 2005) upon entry into the labor force can expect to receive almost 10 % less than his past contributions and a woman with that wage can expect to receive (only) about 30 % more. The calculations reveal that only women earning 60 % of the national average wage (i.e. about CZK 12,000 in 2005) or less when entering the work force are net recipients in the PAYG scheme and in the population of men, this scheme is actuarially fair only to subsistence-wage earners. Given the mounting demographic pressures, it is unthinkable that this situation should improve.[38]

This indicates that the PAYG scheme is challenged by the FF scheme even at the microeconomic level and it seems that a partial transition to the FF system would make most labor force entrants and young workers better off. However, it might be argued that the actual yield rate of personal accounts may be lower than the assumed 5 % p.a. in real terms or that a contribution period of 42 years if male and 38 years if female is not feasible for some workers. These objections have to be taken into account and an analysis including comparisons of various scenarios is needed.

3.3 Alternative Scenarios

3.3.1 Scenario 1

The yield rate of personal accounts is 6 % p.a. in real terms. The life expectancy conditional on reaching age 65 is 82 and 85 years for men and women, respectively, i.e. only a three-year increase in the current values is assumed. With such expectations, workers estimate their retirement income in alternative schemes. Utilizing replacement ratios, *Table 5* shows the alternatives of individuals based on age, gender and earnings level.[39,40]

Under these assumptions, the PAYG scheme as currently structured

[38] Unless redistribution towards certain groups of workers is strengthened even further.

[39] ρ_{FF} denotes the replacement ratio in the FF scheme in the event of a full switch at a given age. ρ_{PAYG} denotes the replacement ratio based on the income level at a given age offered by the PAYG scheme to those who remain "faithful".

seems to be actuarially fair only to female subsistence-wage earners. Thus, should switching be mandatory, no labor force entrant would experience a drop in his/her expected retirement income and all men up to the age of 29 would benefit from switching regardless of their earnings.[41] By entering a 50–50 mixed scheme[42] instead of entering the PAYG scheme solely, new male labor force entrants earning the subsistence wage would achieve a 22% increase in their pension benefits relative to the benefits they can expect now. The pension benefits of middle- and upper-income groups would rise dramatically. By entering a 50–50 mixed scheme, a male labor force entrant earning the average wage would achieve twice higher pension benefits and a woman in the same situation would increase her benefits by 55 %. By switching into this scheme, a 30-year-old man earning the average wage would achieve a 48% increase in pension income and a woman of the same age and wage would increase her pension income by 37 %. If the performance of pension funds were as strong as it is in this scenario with a modest increase in life expectancies only, the transition towards an alternative scheme would be smooth and it seems that an overwhelming majority of young persons would enjoy increased financial security later in old age.

3.3.2 Scenario 2

The yield rate of personal accounts is 4 % p.a. in real terms. The life expectancy conditional on reaching age 65 is 86 and 89 years for men and women, respectively, i.e. an approximately seven-year increase in current life expectancies is assumed.[43] In comparison with the previous scenario, the replacement ratios attainable in the FF scheme fall and because the replacement ratios in the PAYG scheme do not change, the lowest income levels for individual age cohorts necessary to achieve higher pension benefits in a mixed scheme rise. Replacement ratios for this scenario are summarized in *Table 6*.

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[40] If, for the sake of consistency, we stuck to our universal values of $s(t)$ even in the case of workers aged more than 33 earning the subsistence wage, we would allow their wages to fall slightly below the subsistence level later in their working lives. To avoid this, we let the wages of these workers follow the development of the subsistence wage until retirement. Consequently, the actual FF replacement ratios of these workers are lower than presented in the table by approximately 5 percentage points. Thus, the highest gross replacement ratio "attainable" in the PAYG scheme by workers whose wages grow at the same rate as the national average wage is approximately 90 %, i.e. the net replacement ratio (the ratio of the first benefit received after retirement and the last pre-retirement net wage) can exceed 100 %. Clearly, as shown in the table, workers with wages growing faster early in their career and more slowly later, thus approaching the subsistence wage, can "attain" even higher replacement ratios, but that information is of little relevance when measuring the performance of a pension scheme.

[41] These results were obtained by comparing replacement ratios ρ_{FF} and ρ_{PAYG} for individual age cohorts. *Table 5* summarizes replacement ratios for selected cohorts and PAYG ratios are shown only for selected wage levels.

[42] A scheme in which 50 percent of the total old-age pension contributions flow to the PAYG plan and 50 percent flow to the FF plan. According to (22), the replacement ratio in this scheme is the arithmetic mean of ρ_{PAYG} and ρ_{FF} for a given age and income level.

[43] While such longevity might be good for individuals, it would be less so for the ailing PAYG scheme.

TABLE 6 Comparison of Alternative Replacement Ratios

Age	ρ_{FF} (in %)		ρ_{PAYG} (in %) for those earning in 2005:			
	men	women	CZK 7,000	CZK 10,000	CZK 20,000	CZK 50,000
23	51.0	–	79.6	62.3	37.3	19.4
27	46.5	41.3	89.2	69.1	42.4	21.4
30	42.9	38.1	93.7	73.5	45.6	22.7
35	36.4	32.3	88.9	79.2	49.8	24.4
40	29.7	26.4	88.9	82.8	52.5	25.5
45	23.0	20.5	88.9	84.6	53.4	26.0
50	16.6	14.8	88.9	84.6	53.4	26.0

Under these assumptions, female average-wage earners entering the labor force would still be rather indifferent between the two alternative schemes, but male average-wage earners aged up to 28 would be better off switching. For instance, a male labor force entrant earning the average wage would increase his pension benefits by 18 % if he entered a 50-50 mixed scheme. Most importantly, however, the FF scheme is not attractive for the lowest--earning persons and should entry into a mixed scheme be compulsory for some age cohorts of workers, the socially weakest would be hurt. By entering a 50–50 mixed scheme, a male worker earning the subsistence wage upon entry into labor force would experience a relative drop in pension income of 18 % and this drop would be 27 % for a woman in the same situation. A 30-year-old man earning the subsistence wage switching into this scheme would see his pension income fall by 27 % and this drop would be 30 % for a woman of the same age with the same wage. Moreover, longer periods of non-contribution could significantly exacerbate the situation of these persons. Thus, if pension funds underperformed, the lowest earning individuals would be the first to feel the consequences and this is an argument for not forcing these individuals to switch and retaining a limited PAYG scheme in which redistribution based on solidarity secures a decent retirement income for the poorest.

3.3.3 Scenario 3 – A Conservative Forecast

In order to evaluate the impact of the proposed reform on the retirement income of current or future workers and estimate the responses of current workers to the opportunity to switch into an alternative scheme, it is important to use conservative assumptions about the yield of personal accounts and life expectancies of future retirees.

The US President's Commission to Strengthen Social Security (2001) assumes that individuals in the United States opting for personal accounts hold a portfolio which consists of 50 percent equities, 30 percent corporate bonds, and 20 percent government bonds. They utilize the rates of return on those assets as recommended by the Office of the Actuary of the Social Security Administration: "Equities are assumed to provide an ultimate expected real rate of return of 6.5 percent. Corporate and Treasury bonds are assumed to provide a real rate of return of 3.5 percent and 3.0 percent re-

TABLE 7 Comparison of Alternative Replacement Ratios

Age	ρ_{FF} (in %)		ρ_{PAYG} (in %) for those earning in 2005:			
	men	women	CZK 7,000	CZK 10,000	CZK 20,000	CZK 50,000
23	76.4	–	79.6	62.3	37.3	19.4
27	68.3	60.7	89.2	69.1	42.4	21.4
30	62.0	55.1	93.7	73.5	45.6	22.7
35	51.3	45.5	88.9	79.2	49.8	24.4
40	40.7	36.2	88.9	82.8	52.5	25.5
45	30.7	27.3	88.9	84.6	53.4	26.0
50	21.6	19.2	88.9	84.6	53.4	26.0

spectively. Administrative costs are assumed to be [...] 0.3 percent of the account balance. [...] The overall expected real return for this [...] portfolio, net of expenses, is therefore a conservative 4.6 percent. This portfolio return is much lower than that used in many academic studies of personal accounts." (p. 97) They add that actual administrative costs could be lower than assumed. Similarly, Acuña and Iglesias (2001, p. 25) state that "[...] in Chile's case, 5 % (real) return is a lower limit for forecasting the yield of the pension funds in the long term". The rates of return of pension funds as well as the administrative costs differ in various countries and are influenced by the stringency of the government regulation of pension funds and the overall institutional arrangement of the FF scheme. However, with an expected real rate of return of government bonds of 3 % p.a., pension funds in the Czech Republic should be able to attain a real rate of return exceeding 5 % annually through portfolio diversification without a substantial risk increase. Therefore, we assume that the rate of return of personal pension accounts, after deduction of administrative costs, is 5 % p.a. in real terms.[44]

The increase in life expectancies is difficult to predict. We assume a five-year increase in current values, i.e. the life expectancy conditional on reaching age 65 is 84 and 87 years for men and women, respectively. It is possible that the actual increase turns out to be greater, but that would bring additional strains on the PAYG scheme and full wage indexation of benefits would be even less likely in the long run.[45] Therefore, I believe that by using these values we do not overestimate the expected benefits in the FF scheme relative to those in the PAYG scheme.

Under these assumptions, the resulting replacement ratios are as shown in *Table 7*.

There seem to be few, if any, male labor force entrants who would prefer the old scheme to a new mixed one, and by entering a 50-50 mixed scheme, a large number of young male workers with a relatively low earning capa-

[44] Results obtained with alternative returns are presented in the *Appendix*.

[45] A sharp unexpected rise in life expectancies would, *ceteris paribus*, undoubtedly put paid to the government's efforts to maintain pension benefits wage-indexed and, therefore, further austerity measures in the form of parameter adjustments would be needed (for instance the pensionable age could be increased to 67).

TABLE 8 Switching Wages (CZK per month) – Men

Age	w^*	Age	w^*	Age	w^*	Age	w^*
23	7,500	32	15,200	41	29,200	50	65,600
24	8,100	33	16,500	42	31,400	51	80,800
25	8,700	34	18,000	43	33,900	52	98,600
26	9,500	35	19,400	44	36,700	53	125,100
27	10,200	36	20,700	45	39,900	54	183,800
28	11,000	37	22,100	46	43,500	55	291,200
29	11,900	38	23,700	47	47,700	56	673,900
30	12,900	39	25,300	48	52,600	57+	n/a
31	14,000	40	27,200	49	58,500		

TABLE 9 Switching Wages (CZK per month) – Women

Age	w^*	Age	w^*	Age	w^*	Age	w^*
27	12,200	35	22,300	43	39,500	51	117,800
28	13,300	36	23,800	44	42,900	52	160,700
29	14,400	37	25,500	45	46,700	53	303,800
30	15,600	38	27,300	46	51,200	54	1.883,200
31	17,000	39	29,300	47	56,400	55+	n/a
32	18,300	40	31,400	48	62,500		
33	19,600	41	33,800	49	69,900		
34	20,900	42	36,500	50	79,100		

city could achieve a non-negligible increase in the standard of their living in old age. For instance, in the case of new male labor force entrants earning a wage equal to one half of the national average wage (CZK 10,000 in 2005), the increase would be 11 %. For middle-income groups, switching into a 50–50 mixed scheme could result in a substantial increase in future pension benefits. For illustration, it would be 52 % and 22 % for male and female labor force entrants earning the average wage, respectively. However, if the current high level of redistribution were to be maintained in the PAYG scheme, the lowest-earning young women would be better off remaining in this scheme rather than switching into a mixed one. For instance, female workers earning the subsistence wage upon entry into the work force would experience a 16% drop in pension income after entering a 50–50 mixed scheme. Nevertheless, it is obvious that a large number of female labor force entrants would benefit from entering a mixed scheme.[46] Estimates of the lowest wage levels at which switching would make individuals better off are presented in *Table 8* and *Table 9*.[47]

[46] Because the average gross wage of women is lower than that of men (the difference was 26.7 % in 2000 – (ČSÚ, 2001a)), PAYG benefits of women are, on average, lower than those of men despite the fact that the PAYG formulae do not discern between genders. However, due to the fact that the life expectancy in the population of women is higher than in the population of men (and also because women's contribution periods are generally shorter due to child rearing, which the PAYG scheme treats like a contribution period), the introduction of a FF scheme would widen the gap between the average pension benefits of men and women.

Since workers earning the lowest wages tend to be unskilled and likely to start working earlier than we assume, a 42-year contribution period for such men and 38-year contribution period for such women may not be infeasible even if we allow for short non-contribution spells. However, very long periods of unemployment that some of these workers may experience could curtail the period over which they are able to contribute and caution should be exercised in the interpretation of the results presented.[48]

Let us finally consider hypothetical mandatory switching into a 50-50 mixed scheme for all persons up to the age of 30 years and estimate its impact on the lowest-earning workers – for simplicity those earning the subsistence wage. In addition, suppose that there is no experience-related wage increase at the beginning of the career of these workers and they earn the subsistence wage until retirement.[49] Then the retirement income of male labor force entrants would fall by 8 % and female entrants would experience a drop of 18 %. For 30-year-old workers, mandatory switching would mean a slightly more pronounced forced decrease in expected pension benefits – it would be 18 % in the case of men and 21 % in the case of women. Again, although these differences may not seem very large considering the fact that the real value of those "decreased" benefits would, in the distant future, be much higher than that of benefits received by pensioners today, the relative fall in the standard of living of these persons after retirement could be deepened by substantial non-contribution periods.

4. Policy Implications and Conclusion

It is worth bearing in mind that the results presented apply to workers with a particular wage development over their careers. We assumed a smooth uninterrupted stream of contributions from the time of switching until retirement and allowed for no "jumps" in the individual age-earnings profiles caused by changes of jobs or "gaps" in these profiles due to unemployment, child rearing or health problems. In fact, wage trajectories are subject to risk just like capital returns, demographic development or political management of public pension schemes. It is also important to realize that the rate of return on capital is a crucial factor determining retirement income in the FF scheme[50] and expectations about returns may vary across

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[47] "n/a" means not applicable at this age level because

$$\rho_{FF} < \inf_{w(h)\in\langle w_0(h),\,+\infty)} \rho_{PAYG}(w(h)) = \lim_{w(h)\to+\infty} \rho_{PAYG}(w(h))$$

To see this, the reader may find *Figure 3* illustrative.

[48] Consider an individual aged h who, for various reasons, is unable to contribute to his/her personal account for n years between the time of switching and retirement. Then, the switching wage in the cohort of workers aged $h + n$ can serve as a rough approximation of the individual's actual switching wage.

[49] Formally: $s(t) \equiv 0$, $t \in \langle 0, R\rangle$. The data in *Table 10* in the *Appendix* indicate that this results in a better approximation of the wage development of e.g. unskilled female workers. For detailed estimates of replacement ratios under this assumption, see *Table 13* in the *Appendix*.

[50] See *Table 11* and *Table 12* in the *Appendix*.

individuals, thus affecting their switching decision. Therefore, we explored three scenarios in which we covered a reasonable range of likely returns as well as life expectancies. The simulations suggested that an overwhelming majority of new labor force entrants would increase their standard of living in old age by entering an alternative pension plan, and they can be expected to do so once they are given the opportunity. Furthermore, a large number of current workers would be better off switching without any compensation for their past contributions to the public pension scheme, thus decreasing its implicit debt.

We considered scenarios in which workers were given the opportunity to divert a percentage of PAYG contributions into the FF scheme in exchange for the same percentage reduction in PAYG benefits. In addition, incentives in the form of "tax relief" for these workers or allowing reverse switching within a certain "guarantee" period might be considered – this is open to further discussion. I believe that after reform, the PAYG scheme should remain a defined benefit scheme, although a reduction in the current relatively high level of redistribution may be considered so that subsistence benefits continue to be guaranteed, but otherwise benefits are more earnings--related, thus in all likelihood reducing labor market distortions. Nevertheless, to avoid any arbitrary adjustments to the current benefit formulae, these formulae were conserved and the simulations illustrated that despite its strong redistribution towards low-income workers, the relative performance of the PAYG plan is so poor that a large number of young persons with low earnings would be better off in a funded scheme.

A critical question for reformers is the extent of switching. The World Bank (1994, p. 23) states: "The right mix of [schemes] is not the same at all times and places. It depends on a country's objectives, history, and current circumstances, particularly its emphasis on redistribution versus saving, its financial markets, and its taxing and regulatory capability. The kind of reform needed and the pace [...] will also vary [...]." Both schemes are subject to different kinds of risk – the FF scheme is associated with investment risks whereas participants in the PAYG scheme are exposed to political risks. Disney et al. (1999, p. 22) point out that "it should not be assumed that [political] risk is *a priori* lower than the investment risk associated with funded plans". Browning (1975) shows that it is rational for a politician in a democracy to overpromise pensions since the cost is to be borne by future generations when the respected politician is already out of office. The two schemes should be viewed as two portfolios with very imperfectly correlated returns. In order to diversify the risks, a combination of both schemes seems optimal for individuals although people with different degrees of risk aversion may favor different combinations. Because the transition to a mixed scheme is, however, associated with substantial costs, the extent to which individuals are allowed to opt out of the PAYG scheme is likely to depend on the political climate.[51] For this reason, the results of

[51] The greater the switch, the higher the transition costs. For instance, Hungary has so far allowed workers to divert 1/5 of mandatory contributions to a FF scheme and Polish workers may switch over 1/3 of old-age pension contributions to private pension funds.

the simulations were presented in a form enabling a simple computation of replacement ratios for any mix of schemes. These results suggest that even a relatively low extent of switching could mean substantially higher pension benefits for a large number of future retirees.

The ultimate impact of the reform fundamentally depends on how the transition to a mixed scheme is financed. For instance, national savings will not be increased if the transition is financed 100 percent by debt with no other changes. An increase in savings requires a cut in consumption – either public or private. If the government raises taxes or cuts other expenditures in order to finance the transition out of current general tax revenues, the possibility of increased national savings and enhanced economic growth emerges. Therefore, the reform should be at least partially tax-financed. The financing strategy critically determines the generational distribution of the costs and benefits of reform. In the case of a debt-financed transition, some cohorts might win as pensioners but heavily lose as taxpayers in order to serve the implicit-turned-explicit debt in the future. In the case of a tax-financed transition, if taxes are raised, the current generation bears the brunt of reform because it has to pay taxes to cover the transitional public pension deficits while also saving for their own retirement. Similarly, a reduction in other government expenditures hurts groups that would otherwise benefit from the programs that are restricted (the current generation if current spending is reduced, future generations if government investment is reduced). In order to spread the costs of transition over current and future cohorts in a possibly fair and socially acceptable manner, a mixed financing strategy would probably have to be adopted, i.e. a combination of tax and debt.[52] The benefits would then be realized at a corresponding speed. The choice of the right financing strategy is, however, a complex issue which goes beyond the scope of this paper. The possible welfare consequences for different generations (including the question whether a Pareto-improving transition could be achieved) are outlined in (Kotlikoff, 1995). The World Bank (1994, p. 272) states: "The biggest winners are likely to be the generations following the transition, who will reap the economic gains of increased efficiency and growth."

Another question is whether participation in the new mixed system should be voluntary or mandatory, and in the latter case, for whom it should be so. It has been shown that the lowest-earning workers would be the first to be hurt if pension funds underperformed and given the fact that low-earning individuals are the most likely to have their career histories interrupted by longer non-contribution periods, I believe that workers should be given the opportunity to remain in the PAYG scheme and this should be so even for new labor force entrants.[53] However, all workers up to a certain age limit should freely choose which alternative they prefer. This limit could well be 50 years of age as our estimates show that high-earning individuals would still be better off switching even in their late 40s.[54] One of the distinct advantages of a voluntary switching approach is the fact that workers voluntarily renounce part of their accumulated rights under the old scheme

[52] Some countries also used privatization revenues to significantly reduce the implicit debt, but the Czech Republic missed this opportunity in the 1990's.

and its implicit debt is reduced. If an individual decides to switch, he/she *voluntarily* runs the risk of not being able to save sufficiently for retirement and cannot claim any additional benefits from the government if it so occurs.[55] The government would only provide guarantees in case of bankruptcy of pension funds or insurance companies.[56] Even though no single worker would be compelled to enter an alternative pension scheme, a well-designed awareness-raising campaign run by the government should ensure that within a generation or two, only a small number of the lowest-earning individuals would participate in the PAYG scheme fully, the rest of the work force having freely opted for a mixed scheme.

So far, we have assumed that workers annuitize all their accumulation. There are, however, more possibilities. Retirees might, for instance, opt for scheduled withdrawals of their savings over the whole retirement period or, in the most extreme case, they might withdraw all their accumulation as a lump sum upon retirement. Obviously, this would not only eliminate annuitization costs, but also maintain the longevity risk. Experience suggests that most workers seek to insure themselves against this risk – for instance in Chile, workers may choose between scheduled withdrawals and life annuities, but the percentage of workers opting for the latter is increasing constantly.[57] It is generally recognized that one of the main purposes of mandatory pension plans is the protection of individuals against ending

[53] It can be argued that new entrants should be forced to a mixed scheme because experience shows that young people tend to switch massively and such a mandatory entry would incur a minimum welfare loss (the population affected would be minimal) while enhancing administrative simplicity. Also, the real value of PAYG benefits "promised" to current labor force entrants significantly exceeds the real value of benefits received by pensioners today, and the current high level of redistribution which aims to protect some persons from a very low standard of living in old age may not be needed in the future. In such a case, the PAYG replacement ratios of individuals with a low earning capacity would fall and the FF scheme would be relatively more attractive for these persons. Even in that case, however, the relative drop in the pension incomes of the lowest-earning workers due to long non-contribution periods might be substantial in comparison with the pension incomes which these persons would receive in the still (albeit less) redistributing PAYG scheme. In the UK, low-income workers were one of the arguments for not requiring mandatory switching and retaining an unfunded scheme (the so-called SERPS) at the time of the introduction of a funded scheme (Disney et al., 1999). Also, in September 2000, 28 % of Chilean workers were self-employed. According to (Acuña – Iglesias, 2001), over 95 % of them did not contribute to the mandatory FF system at that time, "many of [them] hav[ing] low wages" (p. 21). Due to government guarantees of minimum pension benefits, this poses a future fiscal burden which is by no means negligible. Rusnok (2001) uses implicit government guarantees as a major argument against the introduction of a funded scheme.

[54] In the case of Poland, switching was mandatory for all workers under the age of 30 and voluntary for those between 30 and 50. In Hungary, switching was compulsory for new labor force entrants and an implicit age limit for voluntary switching was 35–40 years as entry into the new scheme was unlikely to be attractive for older workers (Laursen, 2000).

[55] In the case of a large extent of switching, it would be socially and politically unacceptable not to declare guarantees of the subsistence benefits. However, the problem of moral hazard would have to be addressed in the process of setting the eligibility criteria.

[56] For instance in Chile, apart from the guarantee of the minimum pension benefits for those who meet certain basic eligibility criteria, the government guarantees 100 % of the life annuity payments up to the amount of the minimum pension benefit and 75 % of the amount above that level.

[57] Acuña and Iglesias (2001) discuss possible reasons for this trend.

up resourceless after retirement.[58] Especially in the event of a large extent of switching, compulsory annuitization would, to the same degree as compulsory contributions to a pension plan, prevent myopic behavior. Moreover, Finkelstein and Poterba (2002) found that the amount of adverse selection in compulsory annuities markets is only half of that in voluntary markets and conclude that "even a relatively flexible mandatory annuitization system can substantially reduce this cost" (p. 48). Therefore, I believe that annuitization should be mandatory up to a certain amount[59] of the accumulation, which would make a mixed scheme more attractive for low-income risk-averse individuals.[60]

Schneider (1998) provides the estimates of the macroeconomic implications of a full switch to a FF scheme in the Czech Republic. We have conducted simple simulations of the microeconomic impact of reform in order to demonstrate its merits at the level of individuals. Although it is infeasible to estimate the exact impact on every person due to idiosyncrasies in individual wage developments over their careers, simple approximations of the lowest wage levels at which male and female workers would benefit from switching will be instrumental in the process of reform preparation. Disney et al. (1999) demonstrate that individuals' responses to the switching process are fairly predictable in a variety of countries and we have presented estimates upon which the prediction of the dynamics of voluntary switching can be based. Due to unfavorable demographic conditions, the Czech PAYG scheme would be outperformed by a FF scheme and it can be expected to be so for as far down the road as the eye can see. Indeed, we have demonstrated under certain conservative assumptions about rates of return, life expectancies and wage development that among workers with uninterrupted career histories, only women earning about 60 % of the national average wage or less upon entering the work force are net recipients in the currently structured PAYG scheme and in the population of men, this redistributive scheme is actuarially fair only to subsistence wage earners. Workers should not be denied the right to increase their standard of living in old age via a combination of a public PAYG scheme and a private FF scheme, and we have shown that this increase could be non-negligible even for future pensioners with a history of relatively low earnings. The sooner the reform, the better.

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[58] Myles (1995) notes that this might happen due to myopia, mistakes made in the process of planning, lack of information or irrationality.

[59] Low-earning individuals who have accumulated less than this amount would be required to annuitize all their accumulation, but high-earners could withdraw the difference between their total accumulation and this amount as a lump sum. Thus, myopic individuals would be prevented from becoming a future burden to the public social security system while inefficiencies resulting from constraining individual choice would be lower than in the case of universal mandatory annuitization.

[60] Due to a "negative relationship between socio-economic status and mortality" (Finkelstein – Poterba, 2002, p. 31), i.e. low-earning persons are shorter-lived than higher-earning ones, if compulsory annuitization reduces the life expectancies in the population of annuitants, annuitization based on these life expectancies is "fairer" towards individuals with a low earning capacity. Still, if low- and high-income workers are in the same annuity pool, the former end up paying more than their expected benefits while the latter pay less, and, therefore, equity concerns remain.

5. Appendix

5.1 The Definition of the Function $s(t)$

It follows from (3) that $\forall t \in (0, R)$:

$$\frac{dw(t)}{dt} = w(0) \,.\, (g + s(t) - \pi) \,.\, e^{(g-\pi)t + \int_0^t s(x)dx} \tag{26}$$

and

$$\frac{d^2w(t)}{dt^2} = w(0) \,.\, \left[(g + s(t) - \pi)^2 + \frac{ds(t)}{dt} \right] \,.\, e^{(g-\pi)t + \int_0^t s(x)dx} \tag{27}$$

Hence, if $\exists\, t_0 \in \langle 0, R) \; \forall t \in (t_0, R)$: $\dfrac{d^2w(t)}{dt^2} < 0$, then

$\forall t \in (t_0, R)$: $\dfrac{ds(t)}{dt} < 0$ [61]

We attempt to approximate the development of wages over the working life and assume that they tend to grow at a decreasing rate. Without the possibility to use mathematical computer software for the numerical evaluation of Riemann integrals, the choice of a particular functional form of $s(t)$ would be constrained by the necessity to express $\int e^{\int_R^t s(x)dx} dt$ explicitly in order to compute for instance (15) or (21). A decreasing function satisfying this condition is e.g.

$$s(t) = \frac{\sigma_1}{\sigma_2 + t} + \sigma_3,\; \sigma_1 \in \aleph,\; \sigma_2 > 0 \tag{28}$$

Although this choice may seem somewhat artificial and computer software gives us much greater freedom in choosing $s(t)$, we stick to this function as it enables us to obtain values which can be realistic approximations of wage-growth rates due to human-capital accumulation and ageing. We assume that the rate of growth is greatest at the beginning of one's career because the worker's increase in productivity is greatest upon entering the labor force and then decreases. Moreover, we assume that this slowdown of growth is most "noticeable" at the beginning of one's career, i.e. $s(t)$ is convex.

A basic distinction should be made between skilled and unskilled workers. According to (Becker, 1993), skilled workers receive more on-the-job training and returns to the training are reflected in steeper age-earnings profiles at the beginning of the career (empirical age-earnings profiles for skilled and unskilled workers are presented on p. 233; for more on the effects of on-the-job training on earnings, see (Becker, 1993, pp. 29–51). Becker states that "cross-sectional education profiles [...] [can] be converted into time series profiles only by adjusting very simply for the secular growth in incomes" (p. 232). *Table 10* shows cross-sectional data about earnings in the Czech Republic in 2000 classified by age and education.

Hence, we might be able to extract the approximate values of our function $s(t)$. This, however, may be complicated by the fact that workers older than roughly 35 in 2000 had received education (or training) in socialism and they are likely to have experienced a different wage development from those educated and trained in a market economy. Nevertheless, the data support Becker's findings about relatively steeper age-earnings profiles at the beginning of the career of skilled workers. Also, Becker presents (p. 230) similar data for the US in 1939 and 1949 and concludes that "[...] incomes tend to be relatively low at the beginning of labor force participation,

[61] Naturally, $w(0) > 0$.

TABLE 10 Average Gross Wages in the Czech Republic in 2000 (CZK per month for workers employed full time) Based on Gender, Age and Education Attained

Age	men		women	
	elementary	college	elementary	college
under 19	9,380	–	8,278	–
20–24	11,641	14,752	9,159	11,933
25–29	12,765	22,874	9,130	17,482
30–34	13,351	31,142	8,759	18,091
35–39	12,872	31,560	8,860	17,666
40–44	12,720	30,957	9,264	19,822
45–49	12,801	31,813	9,414	20,993
50–54	12,492	32,306	9,464	20,742
55–59	12,163	30,456	9,340	19,550
60–64	10,769	30,630	7,481	20,224
over 65	7,391	22,066	6,939	19,272

Source: (Czech Statistical Office, 2001a)

rise throughout later ages until a common peak is reached in the 45 to 54 age class, and decline in the last class" (p. 231). This, though not perfectly, can be observed in *Table 10* as well. Becker adds that e.g. secular trends towards higher education can render this use of data less precise.

Although it may, for instance, be argued that Becker's conclusions drawn from data from the middle of the 20th century do not necessarily have to hold in the 21st century, the data in *Table 10* indicate that a decreasing function $s(t)$ should enable us to finally obtain better estimates of switching-wage levels than if we used a constant wage growth rate over one's career.[62] To simplify the analysis, we use a uniform functional form of $s(t)$ for all workers regardless of the type of their job. Specifically, we set $\sigma_1 = 3$ and $\sigma_3 = -0.055$ irrespective of gender, $\sigma_2 = 30$ for men and $\sigma_2 = 34$ for women.[63] The worker's resulting age-wage trajectory is increasing and convex from the age of entry into the labor force to the age of 44, and then concave, but still increasing, until retirement.

5.2 Scenario 3 – Alternative Returns

The estimates are obtained under the same assumptions about life expectancies as in Scenario 3 (84 and 87 conditional on reaching 65 for men and women, respectively), but the real yield rates of personal accounts are varied (originally 5 % p.a.). Apparently, FF replacement ratios are very sensitive to changes in the yield rate. (PAYG replacement ratios are not affected by these changes and are identical to those in *Table 7*.)

[62] In the latter case, older workers would slightly overestimate their future incomes, i.e. their ability to save sufficiently for retirement.

[63] The national real wage growth rate $g - \pi = 3$ % is smaller than the average real wage growth rate over the worker's career

$$\frac{1}{R} \int_0^R [s(t) + g - \pi] dt$$

which equals 3.8 % for men and 3.4 % for women. This is to be attributed to the ageing of the labor force, i.e. there are more older workers (whose wages rise more slowly) in the economy.

TABLE 11 FF Replacement Ratios for Different Returns – Men

Age	Rate of return:						
	2 %	3 %	4 %	5 %	6 %	7 %	8 %
23	30.8	41.3	55.8	76.4	105.5	147.3	207.5
27	29.0	38.3	50.9	68.3	92.5	126.0	173.2
30	27.4	35.7	46.9	62.0	82.5	110.5	148.8
35	24.3	31.1	39.8	51.3	66.3	86.0	112.1
40	20.9	26.0	32.5	40.7	51.1	64.3	81.0
45	17.0	20.7	25.2	30.7	37.5	45.7	55.7
50	12.9	15.3	18.2	21.6	25.5	30.2	35.7

TABLE 12 FF Replacement Ratios for Different Returns – Women

Age	Rate of return:						
	2 %	3 %	4 %	5 %	6 %	7 %	8 %
27	24.7	33.1	44.6	60.7	83.1	114.7	159.2
30	23.3	30.9	41.1	55.1	74.2	100.5	136.8
35	20.7	26.8	34.9	45.5	59.6	78.3	103.0
40	17.7	22.5	28.5	36.2	46.0	58.5	74.5
45	14.5	17.9	22.1	27.3	33.7	41.5	51.2
50	11.0	13.2	15.9	19.2	23.0	27.5	32.8

TABLE 13 Comparison of Alternative Replacement Ratios

Age	ρ_{FF} (in %)		ρ_{PAYG} (in %) for those earning in 2005:			
	men	women	CZK 7,000	CZK 10,000	CZK 20,000	CZK 50,000
23	75.0	–	88.9	75.4	47.8	23.2
27	64.8	57.6	88.9	75.4	47.8	23.2
30	57.7	51.3	88.9	75.4	47.8	23.2
35	46.8	41.6	88.9	75.4	47.8	23.2
40	36.9	32.8	88.9	75.4	47.8	23.2
45	28.0	24.9	88.9	75.4	47.8	23.2
50	19.9	17.7	88.9	75.4	47.8	23.2

5.3 Scenario 3 – Exponential Wage Growth

The estimates are obtained under the assumptions of Scenario 3 with the exception of a modified wage growth over the working life: $s(t) \equiv 0$ on $\langle 0, R\rangle$. The individual's average real wage growth rate in this alternative scenario is $\frac{1}{R}\int_0^R [s(t) + g - \pi]\, dt = g - \pi = 3$ % (*cf.* 3.8 % for men and 3.4 % for women in the original scenario).

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SUMMARY

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A Microanalysis of Pension Reform: To Switch or Not to Switch in the Czech Republic?

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This paper examines the microeconomic impact of a reform of the Czech pension system in which the program is partially shifted from a public, unfunded basis to a private, funded basis. It considers three different scenarios in which individuals have the choice to switch some of their mandatory contributions into a funded scheme in exchange for a proportionate reduction in their traditional public pension benefits. It attempts to discern, based on gender, age and income, which workers would be better off switching, and offers some recommendations for policy makers. In particular, the impact of mandatory switching on individuals with low earning capacities is examined and discussed.