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The Demographic Challenge of the Interconnected Education and Pension System in the Czech Republic

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1. Introduction

Some theoretical and empirical literature exists – see (Boldrin – Montes, 2005) – on the theory referred to as "return on human capital investment" (Mulligan – Sala-i-Martin, 2004). It mainly reads as research into the relationship between human capital investment (e.g. public education) and pension systems, and it considers the public pension to be a return on the investment in human capital of the next generation. The generation of current retirees made an investment when they were middle-aged by paying taxes which were partially used to educate their offspring. In turn, the debt incurred by the young for being educated through this system is repaid through their own social security contributions when they become middle-aged. In a pay-as-you-go pension system, these contributions would be transferred to the elderly as pensions. An interconnected pension and public education system can replicate the allocation achieved by complete markets, where the young can borrow against their future income. The two systems are connected through implicit rates of return on public schooling expenditures and education taxes. This scheme is equivalent to intergenerational transfers among three generations: the young, the old, and the middle aged.[1] The "return on human capital investment" theory could be thought of as generational accounting – see, e.g. (Auerbach – Kotlikoff – Leibfritz, 1999) – from individual perspective.

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[1] Alternative financing schemes proposed by Boldrin and Montes (2005) include a special proportional tax on capital or a special debt instrument. Without lump-sum taxation, the replication of the complete markets allocation becomes impossible, though it is still possible to approximate it even when the markets are incomplete and private borrowing to finance education is not available. The analysis is very promising because even in the developed countries the markets for financing accumulation of the human capital (education) through borrowing against future labor income are not very advanced; it sheds light on ways to complete important markets. See Patrinos (2002) for a survey of observed institutional arrangements around the world and Saint-Paul and Verdier (1993) for a theoretical analysis.

Boldrin and Montes (2005) further calibrate their model to the Spanish data. The normative prediction of the model is that the implicit rate of return i that equalizes the discounted values of education services received and social security contributions paid, equals the implicit rate of return π that equalizes the discounted values of education taxes paid and social security benefits received. Finally, both π and i equal the market interest rate. The authors show that this normative prediction approximately holds in the Spanish case if one assumes that the institutional structure of the public education and pension systems in the last 20 years are in effect for all living cohorts. They further extrapolate their model into the future, using demographic projections and various assumptions on the behavior of taxes and expenditures over time. The projections reach two conclusions: First, demographic evolution moves the two implicit rates of return apart – individuals receive a higher rate of interest through pensions than they pay through social security contributions, and second, rates of interest paid or received by different cohorts do not monotonically depend on the year of birth. The joint consideration of education and pension systems proposed by the authors does not lead to a systematic transfer of resources from the currently young and not-yet-born generations to the currently old, as the usual conclusion in the generational accounting methodology finds.

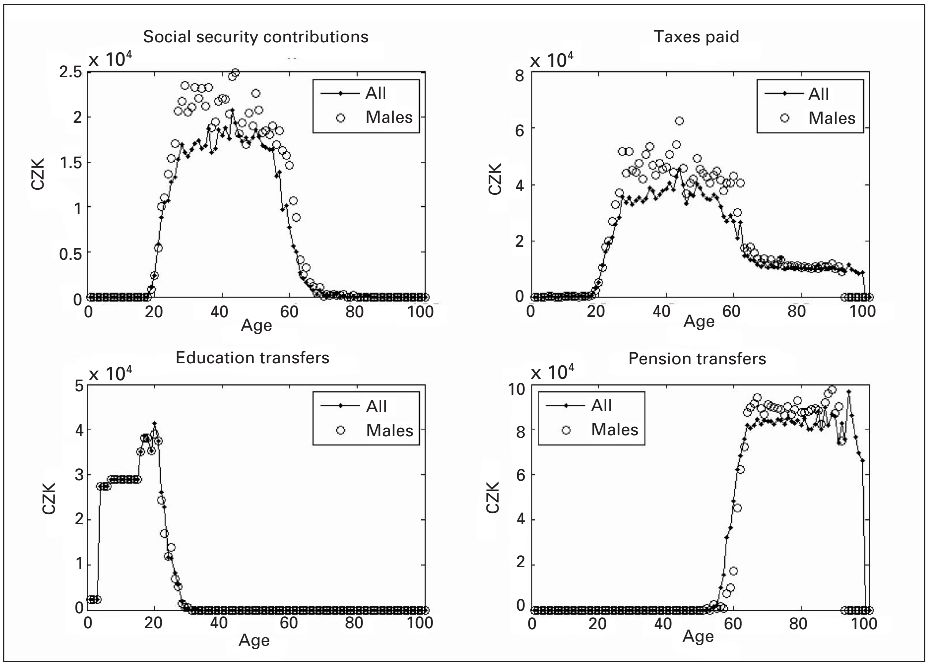
Guided by this theoretical framework, we apply it to calibrate an interconnected pension and education system in the Czech Republic under different scenarios of demographic and economic development. Both systems are undergoing extensive changes, and the study proposed here might prove to be useful in informing policymakers about the desirable direction for reforms in the two systems and estimating the magnitude of such reforms. In particular, it is important to understand the impact of any possible changes to the structure of funding in higher education and/or pension benefits. For instance, while higher education in the Czech Republic at present is mostly free, parts of the political spectrum propose to fund it privately to a larger extent. The latter could provide less costly transition to a system where education is not "free" but represents an explicit individual asset with corresponding liabilities (provided such a system is socially optimal and politically feasible). Another crucial qualitative exercise is to assess the impact of an increase in the retirement age, which is a key part of the pension system reform currently underway in the Czech Republic. We scrutinize these issues empirically by looking at the Czech Microcenses data of 1996 and 2002.

The paper is organized as follows: Section 2 provides a description of the data and a discussion of empirical methodology applied in our analysis. Section 3 presents the simulation results. Finally, Section 4 concludes with the summary of findings and a discussion on policy tools that could be used to achieve efficiency and fairness in intergenerational transfers.

2. Empirical Framework

We first attempt to estimate the net present value of transfers that were paid and received by every currently-living cohort in the Czech Republic.

FIGURE 1 Age Profile of Tax Paid and Transfers Received, Microcensus 2002



Note, however, that such an estimate involves a stationarity assumption that might have been justified in the Spanish case studied by Boldrin and Montes (2005) where both the public school and the social security systems were relatively stable within the last 20 years. However, this could be somewhat unrealistic for transition countries where the real values of both education and pension expenditures have been varying greatly since 1989.[2,3] Therefore, this calculation will serve mainly as a crude benchmark for forward-looking projections.

Given the share in taxes/pensions/education transfers for each cohort, one could determine the net present value (NPV) of publicly provided education, social security taxes and the taxes used to pay for educating the future cohorts, and social security pensions (see *Figure 1* for age profile of taxes paid and transfers received, computed from Microcensus 2002). These age profiles are assumed to be invariant in further simulations. The calcu-

[2] For instance, the Czech Republic implemented its first pension reform in 1990; since then, the Czech pension system has undergone other changes, e.g., an increase in the retirement age, implementation of early retirement schemes, indexation mechanism adjustments; another transformation of the pension system is currently being discussed by the Czech government; the Czech education system experienced a shift of resources in the state budget towards secondary vocational schools after 1995/96, etc.

[3] Without detailed information on the evolution of pension and education transfers per capita as well as the past demographic structure, it is impossible to say how the stationary assumption biases our results for the currently living cohorts. Therefore, all the results for these generations should be treated as purely illustrative.

lation of these net present values requires knowledge of period-to-period survival probabilities (available from standard mortality tables) and of the interest rates. The forward-looking projections also require some assumptions regarding future fiscal policy (in particular, social security contributions and payments, and public expenditures on education).

A forward-looking prognosis provides an evaluation of the NPV of contributions to and services from the public education and the pension systems. An implicit rate of return along the life cycle that is paid on the debt incurred by going to school is the interest rate that equalizes NPV of education services and of social security contributions, while the implicit rate received as pensions is the one at which the NPV of education taxes[4] equals the NPV of pensions received. The results of the forward projection would then be cast in terms of a spread between the market interest rate and the two implicit rates of return.

In Boldrin and Montes (2005), these rates of return are defined implicitly by

$$\sum_{a=1}^{A}\Big(\prod_{j=1}^{a} p_j \cdot \prod_{j=a}^{A}(1 + i_j)\Big)\Big[E_a - T_a^p\Big] = 0$$

$$\sum_{a=1}^{A}\Big(\prod_{j=1}^{a} p_j \cdot \prod_{j=a}^{A}(1 + \pi_j)\Big)\Big[T_a^e - P_a\Big] = 0$$

where A is the maximum lifespan of an individual, p_j the probability of survival between age a and age a+1, T_a^p and T_a^e pension and education taxes, E_a and P_a education and pension transfers, respectively.[5]

In our research, to compute these implicit rates, we use the Czech Microcenses 1996 and 2002 as a primary source. The size of Microcensus 1996 is 72,245 (including 34,937 males), while the Microcensus 2002 is significantly smaller and covers 19,002 individuals, out of which 9,031 are males. For each individual in the sample we compute the amount and value of public education received, the amount of taxes and pension contributions paid, and the amount of public pensions received.

Pension is defined as the sum of old-age pension and (if any) widow(er) pension received by an individual (orphan pensions, disability pensions, etc., are not included). We assume that all pensions come from the state pension fund (i.e. private pension funds can be neglected; this assumption was fully legitimate under socialism and is still applicable, by and large, in the Czech Republic).

To evaluate transfers made by an individual to the budget in the year of the Microcensus, we use the difference between gross income and net income reported by the individual in the Microcensus, combined with the VAT payment projected as a fraction of an individual's gross total money income

[4] Since it is not feasible to disentangle taxes used to finance education transfers, we employ VAT and PIT as proxies.

[5] A detailed procedure can be found in the working-paper version of Boldrin and Montes (2005) that was published as Research Report 336 of the Federal Reserve Bank of Minneapolis (May 2004).

TABLE 1 Education Transfers per Student by Type of Education in the Czech Republic in 1996 and 2002

Type of school	Educational transfers per student in CZK	
	1996	2002
Nursery, age 0–2 years	951	2 285
Nursery, age 3–5 years	19 456	27 391
Basic, age 6–15 years	19 604	28 939
Secondary, with or without maturita, age 15+	29 711	38 772
University	69 221	75 930

(according to the Czech Statistical Office, the percentage of income paid as VAT varies from 9.8 percent for the highest gross income decile to 12.2 percent for the lowest decile).[6] While computing per-capita social security and tax payments, and education and pension transfers, we follow the methodology of Boldrin and Montes (2005). As the best available source of information, we employ Microcenses data that may be biased in the sense that, statistically, certain age cohorts are under-represented (e.g., students) and some are over-represented (e.g., retirees) as compared to the demographic pyramids. However, by normalizing the above per-capita values for each cohort to the Microcenses shares of this cohort, we correctly measure the "participation rate" of each cohort in tax and social security contributions and in education and pension transfers.

Figures on income taxes, pensions and social security payments are taken directly from the Microcenses. Education transfer is a constructed variable: The Ministry of Education, Youth, and Sport of the Czech Republic provides information on expenditures per student by type of school – nursery, basic, gymnasium (humanitarian high school in the Czech Republic), secondary vocational, secondary professional, and university. Further, from the same source we compute that in 1996 (2002 in brackets), 4.4 % (7.3 %) of children aged 0–2 years attended nursery schools,[7] while among children aged 3–6 years this proportion reached 90.0 % (87.5 %); also, out of a pool of students enrolled in secondary education, 42.5 % (36.2 %) studied in secondary vocational schools, 19.5 % (25.2 %) in gymnasia, and 38.0 % (38.6 %) in secondary professional schools (SOŠ in Czech). Combined with information on education type coded in the Microcensus as 'no education or incomplete elementary', 'elementary', 'incomplete secondary or secondary without leaving diploma (maturita)', 'complete secondary with leaving diploma (maturita)', and 'university (including Bachelor, Masters or Doctoral degree)', these figures enable us to compute education transfers to an individual in the sample as presented in *Table 1*.

The methodology described above allows us to estimate the "age profiles" of taxes paid and transfers received. For instance, we know that in 1996

[6] We do not include corporate and excise taxes because the former is irrelevant to our model, and the lack of reliable data makes it very difficult if not impossible to derive age profile of the latter. However, under certain uniformity assumptions, excise taxes can be incorporated in the model by scaling up the VAT payment, but this should not affect simulation conclusions.

[7] The nearly two-fold increase in nursery school attendance in 2002 could be attributed to a political decision to substantially increase per-student expenditures in this type of school.

a typical 10-year-old received 20 times as large an education transfer as a typical one-year-old, and a typical 35-year-old male paid approximately twice as much in taxes as a typical 24-year-old male, etc. These age profiles are then kept fixed in all projections and used in simulations that are discussed in detail in the next section.

3. Simulation Results

3.1 Benchmark Case

Unless otherwise noted, all the results are presented for Microcensus 2002. We consider separately the total population and males only.

Our basic assumption about demographic scenarios and fiscal rules is as follows: Prior to the year 2005, we fix the age structure and contributions or benefits which a typical representative of a cohort pays or receives. This counterfactual assumption allows us to derive implicit interest rates which are "implied" by the current structure. After 2005, the age structure and the pattern of contributions and benefits change according to the scenarios described below. We again freeze the age structure and the population size from 2100 onward.

As a benchmark we take the demographic scenario which is labeled "current": it assumes that the fertility rate (that is, the average number of children born to a female over her life span) will stay constant at the current level (1.19 in the year 2004). As explained in Boldrin and Montes (2005), one needs to assume a fiscal rule in order to calculate implicit interest rates when the population is not constant. For the benchmark we use the "demand-driven" fiscal rule, where the expenditures on education and pensions are fixed at the current level (per capita), and taxes are adjusted so that the government budget is balanced at all times (this fiscal rule corresponds to the concept of a "defined benefit" system). Time profiles of the implicit interest rates for different cohorts for the total population and males only are presented in *Figure 2*.

Notably, the results are significantly different because of two factors. First, women with children could retire earlier, depending on the number of children – see *Figure 3*, which plots the distribution of retirees by age and gender in Microcensus 2002. For instance, in the age group 50–60 the share of retired females is dramatically larger as compared to males. The latter hints that the implicit return π should be higher for females (and thus for the total population) than for males, which is consistent with what we observe in Figure 2.

Second, males pay about two-thirds of taxes while getting about 50 % of pension and education transfers. For males, even counterfactual cohorts, which "lived" under the frozen age structure and fiscal rule, received less in pension benefits than they paid in taxes, with the gap between the implicit interest rates of 0.2 % (for cohorts born before the Second World War). This gap increases dramatically for the cohorts born on the eve of the 21st century and reaches its maximum of 3.9 % for the cohort of 2019. In the long run, males are facing a gap of 2.7 %. For the whole population, counterfactual cohorts received more than they paid: the gap was –1.6 %. This imbalance starts to reduce and eventually changes sign for the later-born cohorts, reaching a maximum of about 1.3 % for the cohort of 2017,

FIGURE 2 Implicit Interest Rates for the Whole Population and Males Only, Microcensus 2002 Data, Current Demographic Scenario, “Demand-Driven” Fiscal Rule

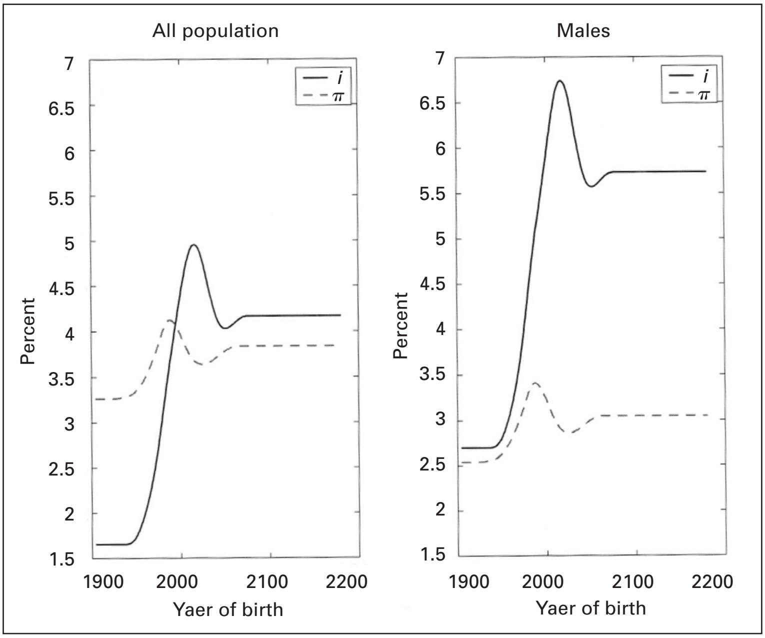


FIGURE 2a Implicit Interest Rates for the Whole Population and Males Only, Microcensus 2002 Data, Baseline Demographic Scenario, “Demand-Driven” Fiscal Rule

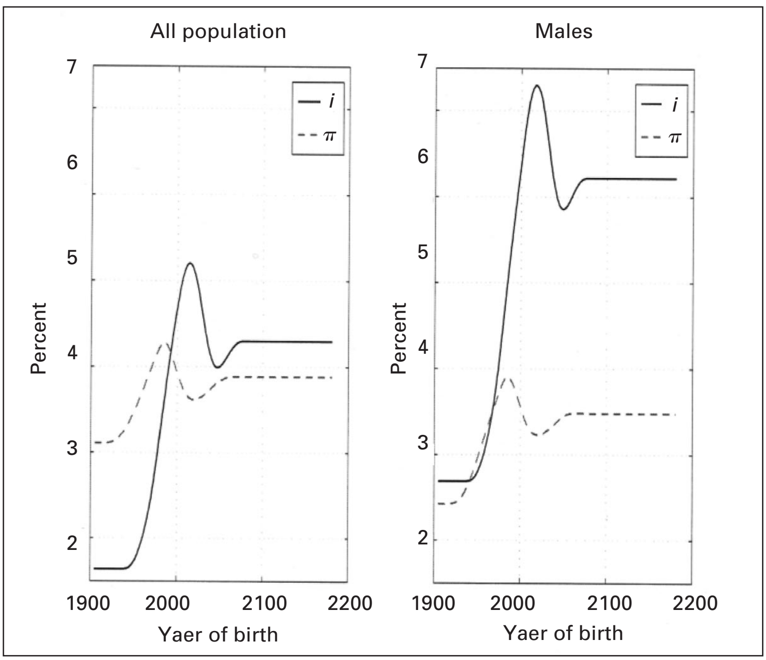
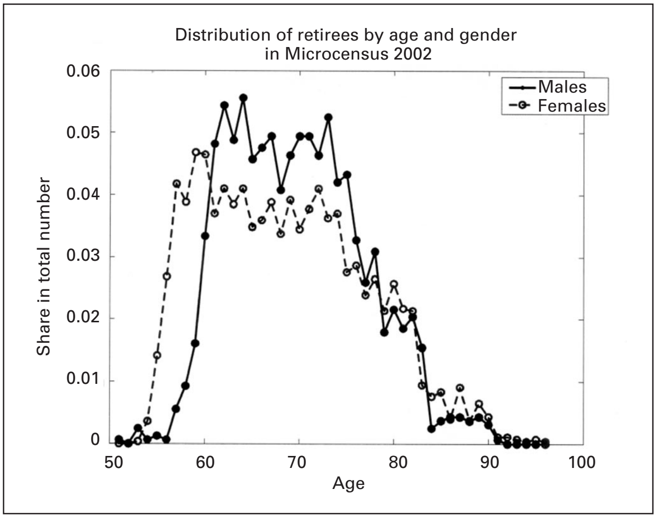


FIGURE 3 Shares of Retirees in Microcensus 2002 by Age and Gender



and falling to 0.3 % in the long run. Overall, the Czech system of public education and pensions seems to be approximately "fair" to the total population, and it was overly generous in the past. Considered from the point of view of a newly born male, the system is going to be highly unfair, but was about fair in the past.

The system of 1996 was even more unfair to "hypothetical" males: the initial gap was 0.9 %. Its maximum and long-run values are also projected to be slightly higher (up to 0.2 %) under the 1996 aggregate education and pension expenditures. This is not surprising because the total amount of money spent in the Czech Republic on pensions increased from 1996 to 2002 by more than that on education (66 % increase *versus* 28 %, not adjusted for inflation; however, education transfers per capita increased by over 28 % as small post-1989 cohorts entered the school system)[8]. Thus, the unfairness of the system was expected to be even greater for currently young and not-yet-born males under 1996 conditions. For the whole population, we observe that all gaps are lower in the absolute value: "hypothetical" cohorts enjoyed a "free lunch" of only –1.1 %, the maximum gap is achieved for the same cohort of 2017 and equals 1.1 %, and the long-run gap is merely 0.15 %. The system of 1996 was less generous, and, projected into the future, was expected to hurt future cohorts less.

A common feature of the 1996 system for both males and the total population is that all implicit rates are higher by up to 0.5 percentage point, and the interest rate i shifts more than π. We will discuss efficiency issues related to this shift below.

[8] Based on Microcenses data, we find that in nominal prices, the increase in education transfers in 2002 against 1996 for the total population was 42 % (40 % for males only), while pensions increased by 64 % (62 % for males), and gross income became larger by a mere 16 % (12 % for males, respectively).

TABLE 2 Long-Run and Largest Gaps between the Implicit Interest Rates under Different Demographic Scenarios

	All population		Males	
	Largest gap i-π (Year of max)	**Long-run gap**	**Largest gap i-π (Year of max)**	**Long-run gap**
Current	1.29 (2017)	0.33	3.86 (2019)	2.68
Pessimistic	1.75 (2019)	0.33	4.33 (2021)	2.69
Baseline	1.58 (2015)	0.42	4.07 (2018)	2.74
Optimistic	1.58 (2010)	0.46	3.95 (2013)	2.72

Very distinct gender patterns, uniformly observed in different scenarios and both Microcensuses, can be explained by biological (longer life expectancy) and behavioral (different labor-force participation rates, largely caused by childbearing) differences along with policy choices (allowing earlier a retirement age for women with children). The impact of policy choices will be discussed below.

3.2 Impact of Different Demographic Scenarios

Until now we have operated under the assumption of an unchanged fertility rate. However, projected population dynamics play an important role in evaluating the implicit interest rates for currently living and unborn cohorts. To exemplify this role, we repeat the above exercise under three alternative scenarios of demographic development. In these scenarios, fertility rates are taken from the official demographic forecasts provided by EUROSTAT.[9] The baseline scenario with no migration assumes a monotonic increase in the fertility rate from 1.15 in 2004 to 1.5 in 2030; after 2030, the fertility rate stays constant. In the pessimistic scenario, the fertility rate changes from 1.06 in 2004 to 1.3 in 2030 and stabilizes at this level afterwards. In the optimistic scenario, the fertility rate monotonically grows from 1.24 in 2004 to 1.9 in 2030 and does not change further. We also employ the EUROSTAT forecast of monotonically increasing life expectancy to calculate non-stationary survival probabilities.

Qualitatively, the results do not change: *Figure 2a* and *Figure 4a*, recalculated for the 'baseline' scenario, illustrate the statement. Quantitative changes are presented in *Table 2*. As the demography improves, the maximum gap decreases for both males and the population as a whole, and it decreases in relation to earlier cohorts. The long-run gap slightly increases for the total population, and remains essentially unchanged for males.

3.3 Impact of Different Fiscal Rules

Up to this point, we have considered only the "demand-driven" fiscal rule. Boldrin and Montes (2005) proposed three other rules. All of them are characterized by a balanced budget of the combined pension/education system

[9] See http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1996,45323734&_dad=portal&_schema=PORTAL&screen=welcomeref&open=/&product=EU _MASTER_population&depth=2

FIGURE 4 The Behavior of Implicit Interest Rates π and i for Different Fiscal Rules under the Current Demographic Scenario. Microcensus 2002 Data, Males Only

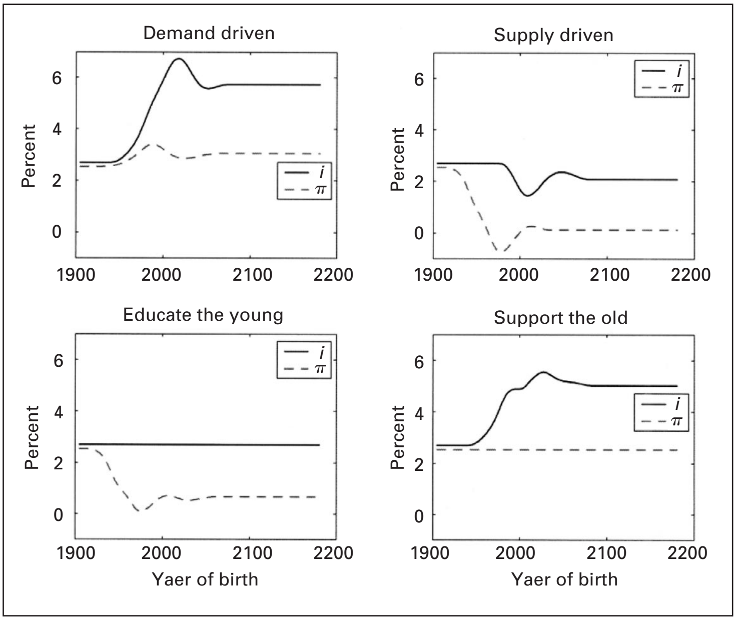
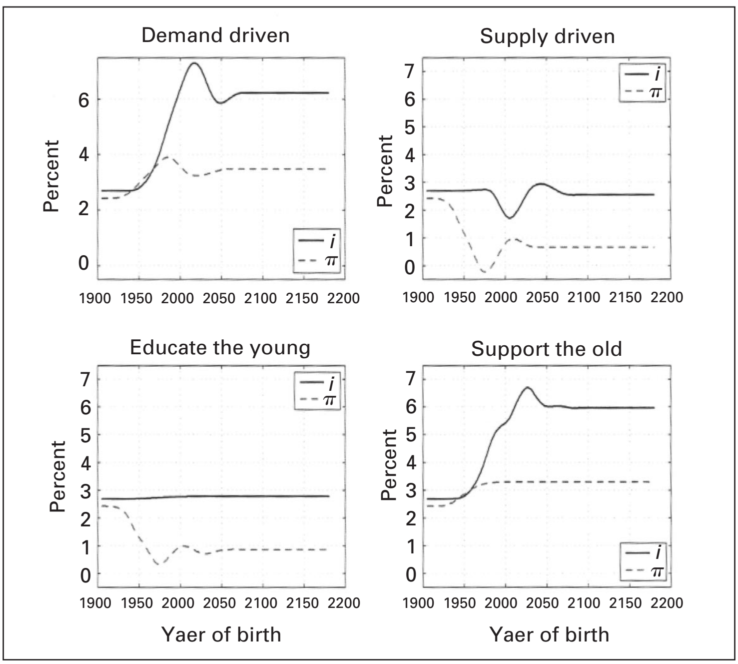


FIGURE 4a The Behavior of Implicit Interest Rates π and i for Different Fiscal Rules under the Baseline Demographic Scenario. Microcensus 2002 Data, Males Only



at all times. The "supply-driven" rule fixes the amounts of taxes (per capita) paid by currently living workers and adjusts the pension and education transfers as the population structure changes in the future (this fiscal rule corresponds to the concept of a "defined contribution" system). The "educate the young" rule keeps unchanged education transfers and social security contributions, thus fixing the implicit interest rate determining how costly the "education loan" is. In contrast, the "compensate the old" rule fixes taxes directed toward the education system and pension benefits, thus keeping unchanged the implicit interest rate determining how generous the pension system is. *Figure 4* presents the results for males, using the Microcensus 2002 and "current" demographic scenario.

All the fiscal rules result in large gaps, both at the maximum point for a cohort born around 2020 and in the long run. The maximum gap fluctuates between 2.2 % and 3.9 %, while the long-run difference varies from 2.0 % to 2.7 %. For all fiscal rules, the public pension/public education system is projected to remain unfair. As the "supply-driven" and "educate the young" fiscal rules result in generally low values for the interest rates, they might be considered especially inefficient, as discussed below. It is interesting to note how demographic scenarios interact with different fiscal rules. While a falling fertility rate leads to an increase in both implicit rates if the "demand-driven" fiscal rule is used, the outcome is reversed for the "supply-driven" rule. Under the "demand-driven" rule, relatively few workers pay a lot of taxes to support larger retiree cohorts. As a result, a faster rate of population decline leads to very large demands on social security contributions, and thus higher i. On the other hand, current workers have to educate an even smaller generation of their children and get guaranteed pensions, which results in higher π. The causality is reversed when the "supply-driven" rule is used. With population rapidly declining, retirees pay fixed education transfers but have to live off social security contributions paid by smaller cohorts, leading to lower π. The same logic applies to the "educate the young" and "support the old" rules.

For the total population different fiscal rules result in qualitatively similar results, with the interest rates being the lowest in "supply-driven" and "educate the young" budgeting. The system is projected to be about "fair" in the long run for "supply-driven" and "educate the young" rules under baseline or optimistic demographic scenarios, and for "demand-driven" and "support the old" rules under current/pessimistic scenario.

In the long run the fairness of the system could be further improved if the two interest rates are equalized by means of unbalancing the education or pension budget.[10] For instance, for the whole population at current fertility rates with "demand-driven" budgeting and with a 10.3 % increment in pensions from their 2002 levels (without a corresponding increase in social security contributions), the two interest rates will be equalized at 4.2 percent, completely closing the gap of 0.33 percentage points. In the Boldrin and Montes (2005) framework, efficiency requires not only pair-

[10] We do not focus on the sustainability of such policies and aggregate budget consequences; such issues could be addressed using the standard generational accounting approach.

-wise equality of the two implicit interest rates, but also their simultaneous equality to the market interest rate. If both are above the market rate, education is too costly and human capital is not accumulated in a sufficient amount. If, on the contrary, both are below the market rate, there is too much human capital while the physical capital is under-accumulated. For the Czech Republic, we estimate the marker interest rate to be close to 3 percent.[11] Usage of unbalanced pension or education transfer adjustments, while equalizing i and π in the long run, leads to different efficiency outcomes. Additionally, different unbalanced schemes might not necessarily be equally politically feasible. For instance, in the above example increasing education spending is more efficient than raising pensions in the long run (the difference from the market rate is smaller), but the voting block of retirees and the middle-aged might make this policy unrealistic.

3.4 Impact of an Increase in the Retirement Age

The last numerical exercise that we perform is to increase the retirement age. An upward shift in the retirement age is a part of the pension reform which has been implemented since 1996. For males, in 2002 it was 61 years, and it is expected to reach 63 by 2016.[12] We therefore increase the retirement age by two years in our simulations. In addition, in some European countries the retirement age for males reaches as high as 67 years, and one cannot exclude the same option for the Czech Republic as well. Thus another round of simulations is performed with the retirement age increased by six years. In both rounds we assume that the money "saved" by such a reform is removed from the pensions/education system, and the amount of social security contributions is reduced correspondingly.[13]

The three major features of our simulations are as follows. First, the retirement-age reform uniformly decreases both implicit interest rates across all demographic scenarios and fiscal rules. The change in i is larger than that in π for the "demand-driven" rule, but this relationship is reversed for "supply-driven" fiscal arrangement. The logic behind this is relatively simple. With demand-driven budgeting, the effect of increased retirement age is similar to that of improved demography, as there are more workers and fewer retirees. Therefore, one could say that pension reform (increasing the retirement age) is necessitated by falling fertility rates, if reducing the living standards of retirees is not politically feasible (this is what the "demand-driven" fiscal rule amounts to).

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[11] Bond markets in the Czech Republic are very weak and illiquid, and even yield to maturity of the long-term state bonds may not serve the purpose of estimation of the market interest rate. As a measure of real interest rate, we take the average midpoint between long-term deposit and loan rates minus 12-months CPI inflation. We average the years 1999 through 2003 in order to exclude extreme volatility in 1998, possibly related to the Czech banking crisis of 1997.

[12] See http://www.cssz.cz/duchodove/davky_duch_pojisteni.asp#starobni for detailed design of retirement age reform.

[13] In our simulations, the retirement age increase is instantaneous while in reality it will be spread over several decades. The latter does not affect the long-run gap estimates. However, in our setup changes in the maximum gap values (which we do not report) could be slightly overstated.

TABLE 3 Effect of a Two- (Six-) Year Increase in the Retirement Age on Long-Run Implicit Interest Rates

	All population		Males	
	Long-run i	**Long-run π**	**Long-run i**	**Long-run π**
"Demand-driven" fiscal rule				
Current	3.33 (2.00)	3.17 (1.83)	4.64 (2.93)	2.25 (0.39)
Pessimistic	3.71 (2.35)	3.63 (2.41)	5.37 (3.57)	3.15 (1.55)
Baseline	3.46 (2.13)	3.25 (2.01)	5.10 (3.35)	2.79 (1.16)
Optimistic	2.95 (1.71)	2.63 (1.33)	4.57 (2.91)	2.19 (0.52)
"Supply-driven" fiscal rule				
Current	0.45 (–0.43)	0.37 (–1.19)	1.37 (0.20)	–0.78 (–2.96)
Pessimistic	0.52 (–0.35)	0.58 (–0.90)	1.42 (0.29)	–0.37 (–2.34)
Baseline	0.91 (–0.01)	0.82 (–0.63)	1.82 (0.62)	–0.14 (–2.07)
Optimistic	1.56 (0.54)	1.30 (–0.11)	2.48 (1.18)	0.34 (–1.54)

For "supply-driven" budgeting, the mechanics are somewhat different: Workers now pay a very similar amount in education taxes, as their working life is increased by less than 5 %, but receive pensions later in life for a shorter period of time, which results in much lower NPV of the pension. This drives down π. On the other hand, the value of education transfers remains the same, and it is "repaid" in a smaller amount by social security contributions which are transferred to the retirees. As this reduction is spread over a long working life, the decrease in NPV of social security contributions is less than that of pensions, which leads to smaller downward movement of i relative to π. For males, the effects are similar in nature but larger in magnitude, as they pay relatively more taxes. With the "supply--driven" fiscal rule, their π even becomes negative.

Second, the sizes of maximum gaps are reduced relative to the "no-reform" environment.

Third, a six-year increase leads to a proportional increase of all the effects observed in the case of two-year increase. Nevertheless, even such a dramatic reduction in retirees' living standards does not mean significant unfairness of the pensions/education system for the total population: the long-run gap is below one percentage point in all scenarios and for all fiscal rules. For males only, though, the system could become far less fair. The effect is most dramatic when the "supply-driven" rule is used: The long--run gap increases from 1.8–2.2 % to 2.6–3.2 %, and π now drops to anywhere between –1.5 % and –3 %, depending on the demographic scenario. Conversely, with the "demand-driven" fiscal rule, the increased retirement age of males does not affect the fairness of the pension/education system, and in the case of "pessimistic" and "baseline" demographic scenarios, it even marginally improves faireness.

Numerically, the effect of two- and six-year increases in the retirement age is presented in *Table 3* for the two fiscal rules, all demographic scenarios, and both the total population and males only.

4. Conclusion and Policy Recommendations

Using the framework developed by Boldrin and Montes, our empirical results, estimated from the Microcenses of the Czech Republic 1996 and 2002, indicate that if current budget rules are combined with an artificially frozen current age structure, paying for educating the next generation provides a significantly higher return (in the form of pensions) than the interest "paid" on education loans (for males only, the two rates are almost equal). Demographic change, however, is bound to affect the gap between the two implicit interest rates. The direction of movement of these interest rates and the size of this gap over time depends on an assumed scenario of demographic development, and on the type of budgeting rules chosen (i.e. "supply-driven", "demand-driven", or "partially driven").

As the population structure eventually freezes at different levels determined by assumed demographic projections, various fiscal tools can be applied to eliminate the gap between the two implicit rates of return i and π and make equal i, which equalizes the discounted values of education services received and social security contributions paid, with π, which equalizes the discounted values of education taxes paid and social security contributions received.

The choice and efficiency of the applied fiscal tools is conditional on projected demographic changes and existing budgeting rules. Even if different tools – e.g. pension adjustments or education transfer adjustments – result in the equalization of the two implicit interest rates, the level of the common interest rate may vary. Thus, the relative efficiency of these tools would be different as well, because along with pair-wise equality of the implicit interest rates, efficiency also requires their simultaneous equality to the market interest rate.

The most dramatic outcome of our analysis is the gender difference in the fairness of the pension/education system.[14] This imbalance in addition to biological and behavioral causes, is influenced by the fact that the Czech pension law allows earlier retirement for women with children, which makes the study more difficult than those performed for other European countries so far, e.g., Spain. Such an option does not exist in most pension systems across the globe and represents a policy variable.

We cannot speculate on the effectiveness of this scheme in encouraging fertility, which sounds plausible but is beyond the scope of the current research. What is clear, however, is that the scheme affects female labor-force participation to a large extent. One of the outcomes of our study is that better demography improves the fairness of the system. On the other hand, more children might mean fewer working women who retire earlier, which leaves males with a larger tax burden and decreases the system's fairness for them.

A shortcoming of our study is that we are unable to model labor-supply decisions of females (i.e., to which extent females are to decrease their re-

[14] We do not report results for females for reasons discussed next. Significant difference in fairness between males only and the total population reflects an even larger difference between genders.

tirement age by means of having a larger number of children) as a function of the pension system. To estimate the influence of our ignorance, we ran simulations assuming the tax/benefit ratio for males relative to the whole population between 1.25 and 1.35 (Microcensus 2002 gives an estimate of 1.30, which was used in all previous simulations). The long-run gap is seen to monotonically increase in the pessimistic (optimistic) demographic scenario from 2.38 (2.41) to 2.99 (3.02) percentage points for the "demand-driven" fiscal rule, and from 1.37 (1.86) to 1.96 (2.46) for the "supply-driven" rule.

Thus, if reducing the gender difference in fairness is deemed to be an important goal, collecting relatively more taxes from females (either by encouraging them to increase their labor-force participation with potentially negative effects on fertility, or by reducing gender-based wage inequality) will be more effective if the "supply-driven" fiscal rule is chosen. One has to keep in mind, however, that in the case of unfavorable demographic development, such a rule might lead to rapidly falling standards of living for the elderly and deteriorating quality of education. Finally, if one is prepared to use unbalanced fiscal adjustments to improve the fairness of the system, our results suggest that an increase in education expenditures is likely to be more efficient than a raise in pensions.

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SUMMARY

JEL classification: H52, H55, I22, I28, J11, J26
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The Demographic Challenge of the Interconnected Education and Pension System in the Czech Republic

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In their recent paper, Boldrin and Montes (2005) analyzed the "return on human capital investment" theory and showed that if borrowing for education is not possible, then a combined public education and pension system that uses lump-sum revenue from taxes and income transfers can replicate the first-best decentralized allocation achieved in an economy without taxes, where borrowing for human-capital accumulation (education) is permitted. Taking into account that such borrowing is either absent or inefficient in many countries, a combined public education/public pension scheme might prove to be welfare enhancing.

Guided by this theoretical framework, we calibrate the parameters of an interconnected pension and education system for the Czech Republic under different demographic scenarios and fiscal rules. We also model the impact of increases in the retirement age and of a hypothetical unbalancing of pensions or educational transfers.