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Aging, Taxes and Pensions in Switzerland

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Abstract

The gains in life expectancy are expected to double the dependency ratio and increase population by 10% in Switzerland until 2050. To quantify the effects on pensions, taxes and social contributions, we use an overlapping generations model with five margins of labor supply: labor market participation, hours worked, job search, retirement, and on-the-job training. A passive fiscal strategy would be very costly. A comprehensive reform, including an increase in the effective retirement age to 68 years, may limit the tax increases to 4 percentage points of value added tax and reduce the decline of per capita income to less than 6%.

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1 Introduction

Demographic change poses a challenge to the welfare state. With current levels of benefits and a much larger dependent population, contribution rates and social spending will grow to unprecedented levels. Already now, social spending is a main driver of public sector growth in Switzerland. Given the projected rise in the dependency ratio, this trend is bound to accelerate over several decades if current policies remain unreformed. The burden of labor taxes and social security contributions would have to grow substantially to sustain current levels of benefits, with negative consequences for labor market performance, or benefits would have to be cut to much smaller levels.

The financing of social security and labor market behavior are importantly interrelated. Aging necessitates higher taxes and contributions with negative effects on labor earnings and growth. Lower earnings, in turn, require further increases in contribution rates and taxes. The present paper focusses on the incentive effects on five margins of labor supply in general equilibrium. First, employees can adjust intensive labor supply, consisting of hours worked or effort on the job. This incentive is measured by the effective tax rate on wage income which includes not only the income tax but also contributions to social security as well as consumption taxes. In principle, the contributions to social security are a non-distortive price for individual insurance. However, insurance benefits are typically worth less than contribution payments. As was pointed out by Feldstein and Samwick (1992) long ago, part of the statutory contribution rate is an implicit tax which adds to tax distortions.

The size and quality of employment may depend rather more on other margins of labor supply. Second, employees may invest in education and life-time training. The government often subsidizes current training costs. On the other hand, a progressive income tax discourages training since the extra tax on higher future earnings is larger than the tax savings today when the individual gives up income to devote more time to training. In an aging society, postponed retirement is needed to balance pension systems by raising labor force participation among older workers. This obvious adjustment also strengthens incentives for training among younger employees as they can expect to consume the returns to training over a longer working period.

Third, taxes and benefits affect labor market participation among prime age workers. The

larger the net of tax earnings from a job is relative to social assistance benefits, the larger is the incentive to (re-)enter the labor market. Fiscal incentives are captured by 'participation tax rates' which are typically large since they consist of the sum of tax and contribution rates plus the replacement rate when out of the labor force. Fourth, incentives to search for jobs are diminished by taxes and contributions as well as forgone social benefits when leaving unemployment. Finally, an individual's retirement date reflects another participation decision. When continuing work instead of retiring, a person pays taxes and social security contributions over a longer period and, at the same time, may have to give up an eligible pension. Again, the participation tax on continued work tends to be very high since it consists of the sum of taxes and forgone benefits. However, incentives for early retirement can be much reduced if the system includes significant pension discounts/supplements when retiring earlier/later.

This paper aims to quantify the potential economic impact of aging in Switzerland. I use an overlapping generations model to replicate demographic projections and quantify fiscal and economic consequences. The model captures in detail the interactions between taxes, social security and the labor market. As a base case scenario, I simulate the consequences of a passive fiscal strategy which merely adjusts labor taxes and contribution rates to balance budgets. Economic consequences turn out rather discouraging, leading to an increase in the total labor tax burden by 21 percentage points and a reduction in per capita income of roughly 20 percent. I then turn to a comprehensive reform which implements six important policy measures, ranging from structural reform of the pay-as-you-go (PAYG) pillar to an increase in the statutory retirement age. Raising retirement age by effectively four years is by far the most important measure. Simulation results show that the reform can limit the increase of the tax burden to 4% of the value added tax (VAT) rate and the decline in per capita income to less than 6% in long-run. The key message of the paper is, thus, that a large part of the negative consequences of aging can be offset by a comprehensive reform package to boost the quantity and quality of aggregate labor supply and, thereby, the contribution base of social security.

The paper relates to a large existing literature on aging and social security reform.[1] The demographic effects on the financing of pensions and on the economy are discussed in Miles (1999) and Bovenberg and Knaap (2005), for example. Important survey articles include Feld-

[1] The empirical literature on the labor market impact of taxes and social security is surveyed in Section 3.1.

stein and Liebman (2002), Bovenberg (2003) and Lindbeck and Perrson (2003). A particular problem is the trend towards early retirement. Retirement incentives are extensively analyzed in the theoretical and empirical literature, e.g. in Gruber and Wise (2004) who summarize results for a wide range of industrial countries. Jaag et al. (2010) analyze aging and pension reform in Austria. Recently, the debate in the U.S. has focussed on either assigning a more important role to capital funding (Kotlikoff, 1997; Feldstein, 2005a,b) or reforming the existing PAYG system (Diamond, 2004; Diamond and Orszag, 2005). Holzmann (2013) offers a review of worldwide trends in pension reform while OECD (2014) provides an extensive analysis of aging and offers policy recommendations for Switzerland. Börsch-Supan et al. (2015) review the effects of aging and pension reform on savings. Recent work with state of the art quantitative models has focussed on aging and human capital formation (Kindermann, 2015; Vogel et al., 2015) and on fiscal costs under alternative reforms (Kitao, 2014, 2015).

The present analysis is one of the most detailed in assessing the potential labor market effects of aging and social security reform. Most of the literature does not institutionally model the coexistence of PAYG and capital funded pillars and limits attention to only one or two margins of labor supply. I believe, and quantitatively demonstrate, that indeed all five employment margins are important determinants of the economic response to aging and pension reform. Another novel contribution is the rigorous analysis of the differential labor market consequences of the PAYG and funded pension systems in a unified framework. Agents separately contribute to the PAYG and funded pillars and accumulate private savings to provide for old age consumption. Retirement income stems from private savings on top of separate PAYG and funded pensions. We explicitly show how the three pillars of the Swiss pension system together with labor taxation, unemployment insurance and social assistance add to the effective tax rates on labor supply. To compute these effective tax rates is in itself a novel contribution of the paper.

The paper proceeds as follows. Section 2 presents the model. Section 3 reviews existing empirical evidence on labor market behavior and model calibration. Section 4 presents quantitative results and Section 5 concludes.

2 A Model of Aging and the Labor Market

We use a dynamic general equilibrium model with overlapping generations, a rich institutional modeling of the public sector and social security, and five margins of employment L^D. For the sake of transparency, we present the main identities and behavioral equations to intuitively explain the key transmission channels for policy effects.[2] Maybe the most important channel for labor market effects is endogenous retirement which determines the physical labor force N^W via a participation decision of older persons. Prime age workers respond on four additional margins: a participation decision determining the participation rate $\bar{\delta}$ where the bar stands for an average among age groups; job search which, together with job creation by firms, results in an unemployment rate $\bar{u}$ of the active labor force; hours worked or effort on the job of employed workers, $\bar{l}$; and life-time training affecting the skill level $\bar{\theta}$. Aggregate employment is

$$L_t^D = \bar{\theta}_t \cdot \bar{l}_t \cdot (1 - \bar{u}_t) \cdot \bar{\delta}_t \cdot N_t^W. \tag{1}$$

2.1 Demographic Change

We apply an overlapping generations model with a period length of one year. We assume a limited number of age states, $a \in \{1, \ldots, A\}$, each associated with life-cycle characteristics such as earnings, employment risk and mortality etc. The calibrated model distinguishes five active and three retired groups with size N_t^a as in Table 2 below. At each date, an individual faces three possible events: (i) she dies with probability $1-\gamma^a$; (ii) she survives without aging, i.e. keeps all life-cycle characteristics, and remains in the same age state with probability $\gamma^a\omega^a$; and (iii) she survives, ages and belongs to group $a+1$ next period with probability $\gamma^a\left(1-\omega^a\right)$. Individuals in the last state have exhausted the aging process ($\omega^A = 1$) and either survive with probability γ^A or die with probability $1-\gamma^A$, as in Blanchard's (1985) model of perpetual youth. After aggregation, the demographic system is

$$N_{t+1}^1 = \gamma^1\omega^1 \cdot N_t^1 + n_{t+1}^0, \quad N_{t+1}^a = \gamma^a\omega^a \cdot N_t^a + \gamma^{a-1}\left(1-\omega^{a-1}\right) \cdot N_t^{a-1}. \tag{2}$$

The total population remains constant only when the inflow of newborns n^0 equals the outflow due to mortality in all age groups.

[2] I refer to Keuschnigg et al. (2011) for a detailed formal presentation of the model.

Retirement choice occurs in an intermediate state, corresponding to people aged 60 to 69 years old. Retirement leads to an endogenous fraction $0 < x^m < 1$ of still active workers in the 'mixed' group while a share $1 - x^m$ is retired and collects pension benefits. Noting $x^a = 1$ for prime age workers, $a < m$, and $x^a = 0$ for fully retired people, the physical labor force N^W as stated in (1) is $N^W = \sum_{a \leq m} x^a N^a$ while the number of retirees is $N^R = \sum_{a \geq m} (1 - x^a) N^a$. The economic dependency ratio N^R/N^W depends on retirement choice in group m.

2.2 Life-Cycle Labor Supply and Consumption

Earnings: Prime age workers are equipped with skill units of labor θ^a so that work per unit of time pays a gross wage $w^a\theta^a$. Training shifts life-cycle earnings profiles. Active agents can be in three different labor market states: non-participating; participating and unemployed; and participating and working. Denoting the participation rate by δ^a and the unemployment rate by u^a, average wage related income per unit of skill amounts to

$$\bar{y}_t^a = \delta_t^a \cdot y_t^a + (1 - \delta_t^a) \cdot s_t^a, \quad y_t^a = (1 - u_t^a) \cdot l_t^a w_t^{n,a} + u_t^a \cdot b_t^a. \tag{3}$$

When non-participating, agents obtain social assistance and other benefits equal to s^a. If participating but unemployed, they are entitled to unemployment benefits $b^a = b^U \cdot l^a w^{n,a}$ which are indexed to net wage earnings with a replacement rate b^U. The net wage is reduced by employee contribution rates t^E and t^F to the PAYG and funded pillars, and by wage tax rates $t^{w,a}$. While contributions are proportional, the wage tax is progressive and implies varying tax rates over the life-cycle, reflecting the typical hump-shaped pattern of life-cycle earnings. Since social security contributions are tax deductible, net wages amount to $w^{n,a} = (1 - t^{w,a}) \left(1 - t^E - t^F\right) w^a$.

Participation incentives reflect the income gap between replacement income s^a and expected income y^a when joining the labor force. If participating, an agent either finds employment with probability $1 - u^a$ and earns net wages, or she ends up unemployed with probability u^a and collects benefits. The employment probability itself is determined by incentives for job search which are often undermined by the welfare system. The unemployment rate $u^a = 1 - \zeta^a \cdot f$ in life-cycle group a depends on search effort ζ^a and on the state of the market given by the matching probability f. High taxes and benefits reduce the income gap between work and unemployment, discourage job search ζ^a and result in larger unemployment which, in turn, reduces expected income y^a and feeds back negatively on labor market participation.

Savings: We distinguish four ways to provide for the future: (i) private savings and asset accumulation A^a; (ii) contributions to earnings linked pensions, accumulating (implicit) future pension claims $A^{E,a}$; (iii) contributions to the funded pillar, accumulating assets $A^{F,a}$ in an individual account; and (iv) skill accumulation by devoting time to training. Skills become obsolete with rate $1-\delta^h$. Agents must thus engage in training to prevent a depreciation of skills. New skills are acquired with technology $F(\cdot)$ using teaching resources I^a and training time as inputs. When people are employed, they allocate time to training e^a and hours of work l^a, adding up to $e^a + l^a$. Training is on the job. Effective training rises with higher participation and employment rates while non-participation and unemployment lead to a loss of skills:

$$\begin{aligned}
\gamma^a G A^a_{t+1} &= R_{t+1}\left[A^a_t + \text{net earnings} - (1+t^c_t)\, C^a_t\right], \\
\gamma^a G A^{F,a}_{t+1} &= R^F_{t+1}\Big[A^{F,a}_t + \text{contributions} - \text{pensions}\Big], \\
G A^{E,a}_{t+1} &= R^E_{t+1}\Big[A^{E,a}_t + m^a \cdot (\text{earnings})\Big], \\
G\theta^a_{t+1} &= F\left(\text{training}, I^a_t\right)\theta^a_t + \delta^h \theta^a_t.
\end{aligned} \tag{4}$$

The factor G is one plus the growth rate and reflects exogenous productivity growth while γ^a enters by the assumption of reverse life-insurance as in Blanchard (1985) for financial assets, applied to each group separately. When accidental bequests are distributed among surviving agents via this implicit insurance contract, the individuals' effective return on savings is augmented by the factor $1/\gamma^a$. In the first equation above, new savings consist of net of tax earnings minus consumption spending $(1+t^c)\, C^a$ including tax at rate t^c. In a small open economy, the interest factor $R = 1 + r$ is fixed on world markets.

The second equation shows the accumulation of financial assets $A^{F,a}$ in the individual account of the mandatory funded pillar. In any period, contributions by workers and firms at rates t^F and $t^{F,F}$, respectively, add to existing assets and build up a person's financial wealth until retirement when it is converted into a pension annuity. The contribution rates apply to gross wage earnings of employed workers. Unemployment and non-participation result in lower contributions and reduce pensions after retirement. We assume that the funded system generates a return on assets possibly below the market return, $R^F \leqslant R$. The return differential captures costly investment regulations and high administrative costs, making savings via the funded system only an imperfect substitute for private savings.

The third equation models the accumulation of implicit pension claims $A^{E,a}$ in the earnings linked PAYG pillar. At any date, new pension claims are added which are equal to the fraction m^a of the pension assessment base which normally would consist of earnings of an employed worker. In Switzerland, unemployment benefits received during periods of joblessness fully raise the assessment base.[3] Other countries often apply similar rules. The factor m^a captures the tax benefit link. If it were zero, future benefits would be independent of current earnings, making the contribution rate a full tax. If it is positive, agents anticipate that higher earnings today will translate into higher benefits in the retirement period so that contributions are perceived less as a tax. At the date of retirement, the starting pension is equal to accumulated claims.

Life-time utility: Anticipating consequences later in life, agents optimally choose consumption and work related activities $C_t^a, l_t^a, e_t^a, \zeta_t^a, \delta_t^a$ and x_t^m to maximize expected life-time utility. Preferences in recursive form (see Weil, 1990; and Gertler, 1999) are

$$V_t^a = \max \left[(Q_t^a)^\rho + \gamma^a \beta \left(G \bar{V}_{t+1}^a \right)^\rho \right]^{1/\rho}, \tag{5}$$

where β is a discount factor and $\sigma = 1/(1-\rho)$ is the intertemporal elasticity of substitution. Instantaneous utility $Q_t^a \equiv C_t^a - \bar{\varphi}_t^a$ is assumed separable in consumption C_t^a and effort costs $\bar{\varphi}_t^a$ which are convex increasing in job related activities. Separability excludes income effects of labor supply. Expected utility next period, $\bar{V}_{t+1}^a = \omega^a V_{t+1}^a + (1-\omega^a) V_{t+1}^{a+1}$ takes account of the fact that, with probability $1-\omega^a$, the agent may switch to the next age state $a+1$.

Given four ways to provide for future consumption, five margins of labor market activity, and a multitude of policy instruments, the solution of the household decisions is necessarily complicated.[4] However, behavior reflects the same intuition known from stylized models. Households smooth consumption over income states and life-cycle periods. The level of the consumption profile exhausts life-time resources so that, at any date, consumption net of effort costs is a fraction of life-time wealth, consisting of financial assets, discounted future earnings (human wealth), pension wealth, and a present value of transfers. The marginal propensity to consume, as listed in Table 2 below, rises with higher mortality rates in later stages of life.

Work and training: Fiscal incentives are captured by effective tax rates. The effective tax on intensive labor supply is reduced by the deductibility of social security contributions, reflecting

[3] In the funded pillar, in contrast, benefits only depend on actual contributions paid.

[4] Details are in Keuschnigg et al. (2011) and separate appendices are available upon request.

the consumption tax treatment of pension savings. It is further reduced by wage indexation of unemployment benefits. When employed, working more hours not only raises earnings but also raises benefits when the worker becomes unemployed. Hence, benefit indexation reduces the effective wage tax on work effort. Intensive labor supply is also discouraged by the effective pension contribution tax. This implicit tax is much reduced if there is a strong tax benefit link m^a. Higher earnings today add to the pension assessment base and raise benefits after retirement. The present value of these extra benefits reduces the tax character of the statutory contribution rate. Strengthening the tax benefit link thereby boosts intensive labor supply. Finally, the implicit contribution tax to the funded pillar is very low and even zero under ideal conditions. When an individual pays into her individual account at the statutory rate t^F, the contribution will earn an interest much like private savings. When retiring, the individual gets a pension annuity with a present value equal to accumulated assets. All this would just replicate private savings if $R^F = R$. The contribution would be a perfect substitute to private savings and would not at all be perceived as a tax, giving an implicit tax rate of zero. If $R^F < R$, pension fund savings yields a lower return and contains a tax component.

The general principle is that an effective tax rate rises when higher earnings lead to paying more tax or giving up social benefits (e.g., unemployment and social assistance), but declines with a stronger tax benefit link, i.e. when higher earnings today contribute to higher retirement income. The choice of intensive labor supply on the job (equivalently, hours worked or work effort) balances the marginal increase in earnings net of effective tax rates and the marginal utility cost of work. When employed, agents allocate time $l^a + e^a$ on training and work, creating an effort cost. More training comes at the expense of working time but the acquired skills shift up future earnings. Training is optimal when the marginal return is equal to the common opportunity cost of productive time. Importantly, postponed retirement boosts training incentives since the additional earnings accrue over a longer working life. The effect should be more important for persons close to retirement where an increase in retirement age means a disproportionately large extension of the remaining working life.

Job search: Job search is conditional on labor market participation. A person's probability of employment, $1 - u^a = \zeta^a \cdot f$, depends on search intensity ζ^a and market tightness as reflected by the matching rate f. More search effort raises employment prospects. The gains to search

consist of the increase in life-time welfare when a person switches from unemployment into a job. Equating this to marginal effort cost yields optimal search. The effective tax on job search summarizes fiscal incentives. When an unemployed switches into a job, she incurs a double cost, paying wage taxes (reduced by the deductibility of social security contributions) and forfeiting benefits. Given tax rates and a replacement rate around 50%, the effective tax is substantial. Search incentives are also undermined by the implicit contribution taxes for pensions. Switzerland allows periods of unemployment to add to pension claims, by crediting the replacement income towards the assessment base. This rule weakens the negative consequences of unemployment for future pension income. By allowing unemployment benefits to add to the pension assessment base, the system significantly raises the effective tax on job search.

Participation: When more individuals join the labor force, the participation rate δ^a rises. The gains from participation consist of expected earnings y^a arising from wages and unemployment benefits as a result of job search. Another benefit is the increase in future income arising from job related training. These gains are partly offset by utility costs which consist of the forgone utility from household production of a non-participating person and the effort costs of job search, training and effort on the job. Optimal participation equates the marginal utility cost of participation, reflecting a general preference for leisure and non-market activities, with the increase in expected income net of utility costs of job related activities and net of the participation tax. This effective tax consists of the sum of the wage tax plus the replacement rate in forgone social assistance (see Immervoll et al., 2007). Furthermore, a higher replacement rate of wage indexed unemployment insurance reduces the participation tax. More generous unemployment benefits encourage participation by strengthening income in the event of unsuccessful job search. The implicit pension contribution taxes also discourage participation, but less so if there is a tight tax benefit link. Finally, the consumption tax discourages participation by reducing real earnings but not utility benefits from non-participation.

Retirement: In an aging society, retirement is arguably the most important dimension of labor supply.[5] The retirement date in the time span of ages 60 to 69 can be mapped one to one into a participation rate $x \in [0, 1]$ in the cross-section of people aged 60 to 69. In the next group, representing people aged 70+, this ratio is zero as all people are retired. Agents in the mixed

[5] Fisher and Keuschnigg (2010) show how retirement interacts with labor supply in younger age.

group split time between work and retirement where the shares determine average income,

$$Y_t^a = x_t \cdot \bar{y}_t^a \theta_t^a + (1 - x_t) \cdot (1 - t_t^{w,a}) \sum_j P_t^{j,a}. \tag{6}$$

Agents collect three types of pensions, $j \in \{E, F, L\}$, i.e. earnings linked PAYG, funded and lump-sum pensions. The flat pension is not linked to past earnings and contributions.[6] Postponing retirement leads to an income gain of $dY^a/dx = \bar{y}^a \theta^a - (1 - t^{w,a}) \sum_j P^{j,a}$. However, for physical and psychological reasons, individuals find it increasingly burdensome and costly to postpone retirement which is captured by a progressively rising disutility $\varphi_R(x)$. We thus expand instantaneous utility noted in (5) to $C^a - x \cdot \bar{\varphi}^a - \varphi_R(x)$ in the mixed group.

In the earnings linked and funded pillars, the starting levels of pensions depend on three factors: accumulated entitlements; expected remaining life-time; and supplements/discounts for late/early retirement. Fiscal disincentives for continued work are summarized by an effective tax rate τ^R. For intuition, take first the simplest case with full participation of workers, no unemployment, no training and no other public program beyond PAYG system. The retirement choice then reduces to $\varphi_R'(x) = \left[\left(1 - \tau^R\right) l^a w^a - \varphi_L^a\right] \theta^a$ where the effective old age participation tax $\tau^R = t^{E,a} + \frac{P^a}{w^a \theta^a l^a} - \frac{1-x}{\theta w l} \frac{\partial P}{\partial x}$ is the sum of contribution and replacement rates minus the pension supplement $\frac{\partial P}{\partial x}$.[7] Retiring at the statutory age $x = x^R$ yields a normal PAYG pension while retiring later $x > x^R$ entitles to a higher pension. In general, the effective tax τ^R measures the total fiscal cost of remaining active. A higher replacement rate in unemployment insurance and better protection of an active worker with social assistance encourages prolonged work since it strengthens expected income of staying active. The flat basic pension with fixed benefits ($\frac{\partial P}{\partial x} = 0$) raises the effective tax and discourages late retirement. The tax is greatly reduced, however, if the system includes incentives for late retirement, $\frac{\partial P}{\partial x} > 0$. The entire benefit stream until the end of life shifts up but is paid over a shorter remaining time period.

The funded pillar rewards postponed retirement in a forward looking way to satisfy the intertemporal budget constraint of the individual account, independent of the actual retirement

[6] In part, the flat pension reflects social policy to prevent old age poverty among low income persons. It also captures the fact that, in Switzerland, earnings in excess of an income ceiling do not create pension entitlements.

[7] Similar to Cremer and Pestieau (2003), the problem $\max_x \left[\left(1 - t^E\right) wl - \varphi_L\right] \theta \cdot x + P(x) \cdot (1 - x) - \varphi_R(x)$ yields the optimality condition $\varphi_R'(x) = \left[\left(1 - t^E\right) wl - \varphi_L\right] \theta - P(x) + (1 - x) \frac{\partial P}{\partial x}$, leading to the definition of τ^R. The term $1 - x$ stands for the 'remaining retirement period' which is reduced by a higher retirement age x.

date. Postponing retirement means more contributions and savings in pension payments. The resulting surplus to the system is fully returned to the individual by raising the starting level of the pension until the account is balanded again. Under ideal conditions, funded pensions are fully neutral with respect to retirement choice and other margins of labor supply. If the pension fund offers exactly the same interest as is available to private households, $R^F = R$, savings via contributions to the pension fund are perfect substitutes to private savings, without any implicit tax. In this case, the capital funded system does not distort retirement behavior nor any other dimension of labor supply. A deviation from these conditions, however, such as high administration costs leading to $R^F < R$ or presence of wage taxes etc. make the capital funded pillar also distortive in a minor way.

2.3 General Equilibrium

Production and the labor market: Unemployment results from search frictions in a matching labor market where workers searching for a job meet firms wanting to fill vacancies. Using the notation in (3) and (6), we have $x^a N^a$ active households in age group a, who participate at rate δ^a and spend time ζ^a per person on job search. These activities add up to a total supply of $L^M = \sum_a \zeta^a \delta^a x^a N^a$ effective job searchers. Firms post v vacancies in total. Market frictions result in $f \cdot L^M = q \cdot v$ matches. Only a fraction f of search units and a fraction q of vacancies are matched. These matching rates are taken as given by individual agents.[8]

A firm with a vacancy finds a suitable worker with probability q who belongs to age group a with probality ϕ^a, has skills θ^a and supplies work effort l^a. Hiring thus results in an effective labor force $L_t^D = \sum_a l_t^a \theta_t^a \cdot \phi_t^a q_t v_t$. Firms produce output $F\left(K, L^D\right)$ using capital K and labor. They maximize firm value equal to the present value of dividends by choosing job vacancies and the rate of investment to accumulate the capital stock. Value maximization results in a simple condition for long-run capital demand, $F_K - \delta^K = r/\left(1 - t^k\right)$ where t^k is a source tax on corporate profits and δ^K is the depreciation rate. In a small open economy, the capital labor ratio is thus entirely determined by the world interest rate.[9] Posting a vacancy costs κ units

[8] We use the most common matching function $M = M_0 \cdot \left(L^M\right)^\eta v^{1-\eta}$ and get matching rates $f = M_0 \Theta^{1-\eta}$, $q = M_0/\Theta^\eta$ and $f = \Theta \cdot q$ where $\Theta = v/L^M$ measures labor market tightness.

[9] Adjustment costs lead to slow transitional investment dynamics in the small open economy.

of output, leading to recruitment costs κv. Firms post vacancies until marginal cost is equal to the expected return on hiring, $\kappa = (\text{job rent}) \cdot q_t$. The firm's job rent per efficiency unit is proportional to the gap $F_L - \left(1 + t^{E,F} + t^{F,F}\right) w^a$ between the marginal product and the gross wage cost where $t^{E,F}$ and $t^{F,F}$ are employer contributions to the PAYG and funded pillars.

When a firm and a worker are matched, they bargain over a wage to divide the total job rent relative to their outside options which define reservation wages. The worker's reservation wage is the minimum gross wage $w^a_{R,t}$ per hour that makes her indifferent between accepting or rejecting the offer. A gross wage in excess of this leaves a strictly positive rent. However, a higher wage reduces the firm's surplus. The firm's reservation wage is the maximum wage that leads to a non-negative firm rent, $F_L / \left(1 + t^{E,F} + t^{F,F}\right) \geqslant w^a$. If the wage were higher, the firm would make a loss. The wage per hour resulting from bargaining over the joint surplus is

$$w^a_t = \xi \cdot F_L / \left(1 + t^{E,F}_t + t^{F,F}_t\right) + (1 - \xi) \cdot w^a_{R,t}, \tag{7}$$

where ξ measures the worker's bargaining power. A strong position (high ξ) pushes up the wage.

Bargaining leads to tax shifting. Employers' contributions, $t^{E,F}$ and $t^{F,F}$, are a pure factor tax which reduces the firm's reservation wage, and are partly shifted to workers. The consumption tax erodes purchasing power. To compensate, workers demand a higher reservation wage so that consumption taxes get partly shifted to firms. Similarly, higher wage taxes and social contributions boost the reservation wage, leading workers to insist on higher wages. Employment raises future pensions, both in the earnings linked and capital funded pillars, which squeezes implicit contribution taxes and reduces wage demands of workers. A higher replacement rate in unemployment insurance clearly drives up wages. When unemployment benefits are added to the assessment base, unemployment becomes less detrimental since it still creates pension claims. This also strengthens the worker's fallback position and her wage.

General Equilibrium: Aggregation is in two stages: (i) analytical aggregation of agents in the same age state a, but with different life-cycle histories, into a common age group; and (ii) aggregation across groups, giving macroeconomic variables such as $A \equiv \sum_a A^a$. Reverse insurance redistributes accidental bequests from the deceased to surviving persons which eliminates γ^a in aggregate private asset accumulation as in (4),

$$GA_{t+1} = R_{t+1} \left[A_t + Y_t + Z_t - (1 + t^c_t) C_t\right], \tag{8}$$

where $Y \equiv \sum_a Y^a$ and $Y^a = x^a \cdot \bar{y}^a \theta^a + (1 - x^a) \cdot (1 - t^{w,a}) \sum_j P^{j,a}$. Note $x^a = 1$ for prime age workers and $x^a = 0$ for fully retired persons.

An equilibrium is found when private behavior is optimal, budget constraints are fulfilled, and markets clear. The public sector includes unemployment insurance and social assistance on top of other redistributive and consumption spending, plus the PAYG and funded pension pillars. We allow for accumulation of government debt D^G. Taxes and spending must thus fulfill an intertemporal constraint. In capital market equilibrium, assets of households and pension funds are invested in domestic equity V, government debt and and international bonds D^F,

$$A_t + A_t^F = V_t + D_t^G + D_t^F. \tag{9}$$

The economy accumulates net foreign assets $GD_{t+1}^F = R_{t+1} \left(D_t^F + T_t^B \right)$ where T^B is the trade surplus. The current account reflects the savings investment identity.

3 Model Calibration

This section reviews empirical evidence on labor market behavior, investment and savings, discusses institutional and economic parameters, and finally turns to demographic projections.

3.1 Behavioral Elasticities

Hours Worked: People supply more hours, or provide more effort on the job, if the current real wage net of taxes is high and if current earnings create additional benefits such as higher unemployment benefits, or higher future pensions in an earnings linked system. The econometric estimates of Disney (2004) show that men are not very responsive to a change in the effective contribution tax while women's activity rates are strongly affected. These findings are consistent with most of the empirical literature, see Blundell and MaCurdy (1999) for a survey. The calibrated model uses a consensus value for the wage elasticity of hours worked equal to .3.

Job Search: According to a study by Belot and van Ours (2001) for 18 OECD countries, a one percent increase in the replacement ratio results in a .7 percent rise in the unemployment rate. They also estimate that a one percentage point increase in the income tax rate shrinks the

unemployment rate by .12 percentage points. Gerfin and Lechner (2002) find positive effects of a wage subsidy for temporary jobs on employment in the regular Swiss labor market. The estimates of Scarpetta (1996) imply that a 10% increase in the replacement ratio of unemployment benefits leads to an unemployment rate higher by about 1.3 percentage points. This coefficient compares with an estimate of 1.7 in Layard et al. (1991) and 1.1 in Nickel (1997). The model exhibits a search elasticity with respect to the replacement rate of 1.2.

Labor Market Participation: Immervoll et al. (2007) review the literature on labor market participation. Participation elasticities differ across groups. Low skilled households react strongly to participation incentives, and women have a much higher elasticity than men (Eissa and Hoynes, 2004). In constrast, skilled people with high earnings respond little (Blundell, 1995). Calibration supports a semi-elasticity of .2, meaning that a 10 percent increase in replacement income triggers a reduction of the participation rate by 2 percentage points.

Retirement Decision: Gruber and Wise (2004, 2007) document participation tax rates and their impact on retirement behavior. Bütler (2009) discusses how old age benefits affect retirement in Switzerland. Dorn and Sousa-Poza (2010) analyze retirement determinants in an international context. Early retirement not only rises because workers prefer to retire early, but also because the social security system creates incentives for firms to shed older workers. For Germany, Börsch-Supan (2000) estimates that a decrease in benefits by 12% reduces the retirement probability of the 60 years old from 39.3 to 28.1%, implying a semi-elasticity equal to .93. This value falls with age and is estimated at .45 for 64 year-olds. At the average retirement age of 64, the model supports a retirement elasticity of .5.

Training: Training is more attractive if it yields a larger present value of income and pays off over a longer working period. Postponing retirement thus encourages training. Lau and Poutvaara (2006) emphasize that an increase in retirement age and a strong link between pensions and contributions boost investment in education. Fouarge and Schils (2009) empirically investigate how much older workers' training investments depend on the pension system. Kane (2006) summarizes the evidence on how tuition affects enrollment. Using different data sets and identification methods, various studies largely arrive at the same conclusion: An increase in tuition of $1,000 results in a decrease in college enrollment of 4 to 6 percentage points.

Savings and Investment: Households save to smooth consumption over periods of uneven

income. A larger pension replacement rate reduces the need for private savings. In contrast, a longer remaining lifetime and early retirement boost savings since individuals must maintain living standards over prolonged retirement. Higher interest rates encourage savings. Smoothing consumption depends on the intertemporal elasticity of substitution with estimates fluctuating around .5. We take a conservative estimate of .35 in Table 1. The elasticity of investment with respect to the user cost of capital varies around unity, implying a substitution elasticity between capital and labor of roughly .8. Adjustment costs slow down capital accumulation in an open economy with a fixed interest rate. Altig et al. (2001) discuss these parameters.

3.2 Economic and Institutional Parameters

Table 1 shows key data and parameters of the model. The numbers depict the growth trend of the Swiss economy. The average unemployment rate is 3.6% in the initial steady state (ISS). It varies during the life-cycle, being larger for younger workers (see Table 2). The labor market participation rate is 74% on average. The retirement age, equal to 64 on average, is relatively high by international comparison. Approximately 40% of workers 60-69 years-old are still active in the labor market. Table 2 shows the age structure: the 60-69 years-old represent about 13% of the population. The dependency ratio (the ratio of retirees to workers) is 28% in the ISS.

Except for retirement, Table 1 shows effective tax rates for the first group which corresponds to the 20-29 years old. The effective tax on hours worked mirrors the wage tax burden of 26% on average. It is also inflated by the tax component of PAYG contributions and the consumption tax. The effective rate is about 22% for the youngest workers. The participation tax rate of 28% is rather low while the effective tax on job search is almost twice as big.[10] There are two reasons. First, unemployment benefits are much more generous than social assistance. Second, only a quarter of the non-participating are covered by social assistance so that, across all households, social benefits are less important for participation decisions. Finally, the participation tax on retirement choice is 51% which is relatively low by international standards. The Swiss PAYG pillar includes pension supplements for each year of postponed retirement equal to 6.8%. The funded pillar involves only a low effective tax rate by construction.

Table 2 reports life-cycle and demographic parameters. The life-cycle income profile depicts

[10] The rate of 65% is well in the range of values compiled by Immervoll et al. (2007) for Europe.

the usual hump-shaped pattern. Income of retired groups mostly consists of pensions. Disposable income of active groups reflects wage profiles and a directly progressive tax which is highest for people with earnings at the peak of their career. As is typical for life-cycle models, the marginal propensity to consume rises with age so that the oldest persons have the highest consumption propensity and the lowest savings rate because they expect the shortest remaining life-time.

Table 1: Model Parameters

Households and Production		
r	0.035	annual real interest rate
g	0.018	growth rate of labor productivity
δ	0.100	depreciation rate of capital
σ^K	0.800	elasticity of capital labor substitution
σ^C	0.350	intertemporal elasticity of substitution
$\bar{u}$	0.036	average unemployment rate
$\bar{\delta}$	0.740	average participation rate
x *)	0.400	retirement age/participation rate 60-69 years old
N^R/N^W	0.277	retiree-worker ratio
Welfare System		
ρ^u	0.540	replacement rate of unemployment benefits
ρ^a	0.230	replacement rate of social assistance
τ_1^L	0.223	effective tax rate, hours worked
τ_1^P	0.280	effective tax rate, prime age participation
τ_1^S	0.651	effective tax rate, job search
τ^R	0.510	effective tax rate, continued work

Legend: *) The retirement date corresponds to the share of active households in the group of 60-69 years old.

The model captures the characteristics of the Swiss pension system with three pillars: the mandatory PAYG and funded pillars, and voluntary private savings with preferential tax treatment as a third pillar. PAYG pension spending represents 6.6% of GDP of which about 3/4 are covered by contributions. The gross replacement rate in the PAYG pillar is 40%. Only 60% of PAYG pensions are earnings-linked. The flat component is due to the fact that the

tax-benefit-link is eliminated for minimum pensions of low income households and maximum pensions of people with earnings in excess of an upper income threshold. The division into a flat and a variable part is important for the size of the implicit tax: the larger the share of the flat part is, the higher is the contribution tax. The total effective average employee and employer contribution is about 8.3%, yielding an implicit tax rate of about 2% in the youngest age group.

Table 2: Demographic and Life-Cycle Parameters

Age Group	a	1	2	3	4	5	6	7	8
Cohort		20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
Population share	N^a/N	0.20	0.19	0.18	0.16	0.13	0.09	0.04	0.01
Age retention rate	ω^a	0.90	0.91	0.91	0.92	0.93	0.95	0.97	1.00
Survival rate	γ^a	1.00	0.99	0.99	0.98	0.97	0.95	0.93	0.90
Marg.prop.consume		0.03	0.04	0.05	0.05	0.06	0.08	0.10	0.12
Disp.wage income.	$\bar{y}^a$	0.67	0.96	1.11	1.10	0.75	0.67	0.63	0.60
Wage tax rate	$t^{w,a}$	0.24	0.26	0.28	0.29	0.25	0.25	0.25	0.25
Labor productivity	$\bar{\theta}^a$	1.43	1.95	2.23	2.26	1.85	-	-	-
Participation rate	δ^a	0.65	0.75	0.80	0.80	0.65	-	-	-
Unemployment rate	u^a	0.04	0.04	0.03	0.03	0.03	-	-	-

Legend: $1-\gamma^a$ is the mortality rate and $1-\omega^a$ is the transition rate to the next age state.

Adding funded and mandatory PAYG pensions yields a gross replacement rate of about 60% of the last wage income in total. Of total pension income, 65% stems from the PAYG and 35% from the funded pillar. Funded pensions not only reflect accumulated contributions but also earned interest. The tax component of funded pillar contributions is clearly lower but remains positive due to administrative costs. We assume that overhead costs consume 1% of the return on pension assets. Hence, pension funds generate an effective return of 2.5% which is lower than the market interest rate of 3.5%. Total pension assets amount to 125% of GDP.

3.3 Demographic Change In Switzerland

The demographic scenario published by the Swiss Federal Statistical Office projects population growth from 7.2m in 2005 to 8.1m in 2050. This increase is not due to immigration or higher

fertility but rather to higher life-expectancy. Lower mortality rates result in more old people. The dependency ratio, measuring the ratio of people older than 65 and those aged 20 to 64, must inevitably rise. The population share of the over 65 years old is expected to reach 28%, compared to 16% in 2005. The dependency ratio will be almost double in 2050 (see Figure 1).

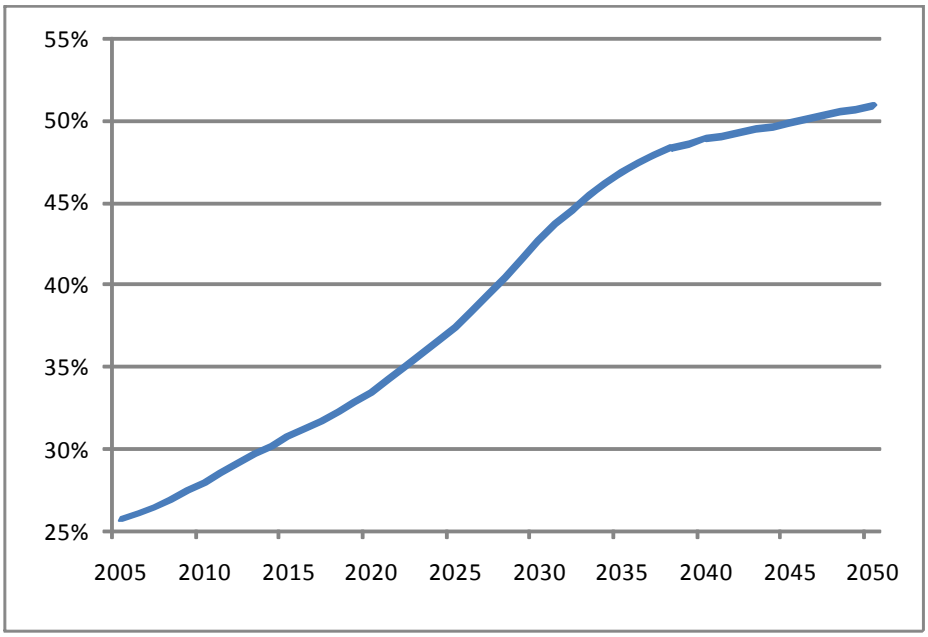

Figure 1: Old Age Dependency Ratio

Demographic change is governed by three factors: mortality and life-expectancy, fertility, and migration. There are three official scenarios with respect to life-expectancy in Switzerland (see Bundesamt für Statistik, 2006). An intermediate scenario assumes that better prevention and medical advancements raise life-expectancy at birth to 85.0 years for men and 89.5 years for women in 2050, compared to 78.6 and 83.7 years in 2005. The average fertility was 1.4 children per woman in 2005. The intermediate scenario assumes that rising public awareness of the families' economic and social importance leads to increased support. As a result, the currently low fertility is expected to rise somewhat. Finally, the average scenario assumes that current trends in net migration will be extended into the future. The free movement of persons will yield only transitory effects on the net immigration from new EU member states.

A restriction in using a model of balanced growth is that simulations must assume the economy to start from a stationary state. Neither the economy nor the population are in a steady state at any point in time so that data must be averaged over time. However, the

key macro and demographic indicators, such as the current dependency ratio, are correctly implemented. The old-age dependency ratio is expected to double and eventually reach a ratio of roughly 0.5. Aging means that survival rates rise already in earlier stages of the life-cycle. A 60 year old person will reach more probably the age of 70, and a 70 year old is more likely to live until the age of 80, etc. Lower mortality rates at younger ages imply that a much larger share of people reaches the age of 90-99 years old.

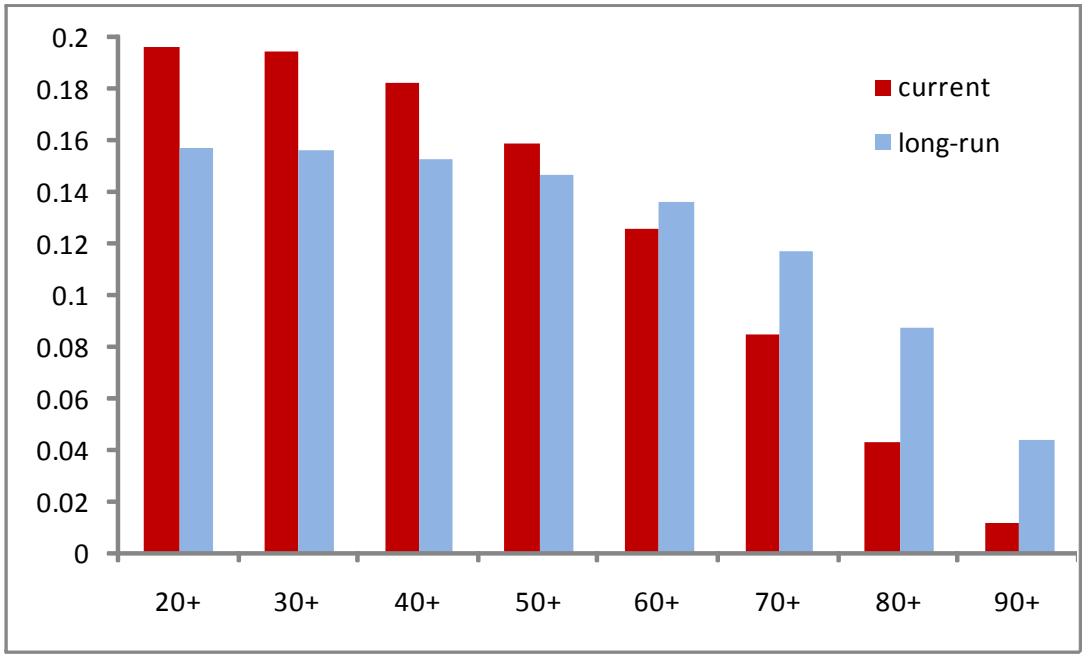

Figure 2: Population Structure

For a given inflow of new borns, lower mortality rates change both the structure and the size of the population. Keeping the inflow of newborns constant, the size of the older population grows when mortality declines. Figure 2 shows how, in turn, the share of older age groups rises while the share of younger cohorts shrinks. The bars illustrate the relative weights. The long-run age composition is determined exclusively by survival and mortality rates. A lower permanent inflow of new generations, brought about by a lower fertility rate or as a result of immigration, cannot change the demographic structure in the long-run but can only scale down total population. The inflow in the model is set such that population size grows by 10% in the long-run, roughly in line with the above mentioned demographic projections for Switzerland.

4 Quantitative Policy Analysis

4.1 Long-Run Effects of Aging

We first quantify the long-run economic impact of aging. The scenario consists of three elements: (i) the dependency ratio roughly doubles due to increased longevity; (ii) the total population rises by 10% in the long-run; and (iii) the working age population declines by about 6%. As a benchmark, the government is assumed to follow a passive strategy, leaving current benefit rules unchanged and merely adjusting wage taxes and contribution rates to balance budgets. The long-run effects are reported in column 'Age' of Table 3. Contribution rates and wage tax rates must strongly increase, and the pure demographic effect implies a large decline in per capita income. The higher tax and contribution rates strongly discourage labor supply, leading to a further reduction in per capita income beyond the demographic and mechanical budget effects.

Table 3 shows a large long-run impact of aging on public finances and the economy. Fiscal balance requires to add 7.1 percentage points to the wage tax schedule over the entire income range. On top of that, contribution rates to the PAYG pillar of both employees and employers must also be raised by the same amount. Altogether, the statutory labor tax burden rises by 21 percentage points. Contributions only partly count as a tax. The effective tax on hours worked thus rises by roughly 10 percentage points, and similarly the participation tax. Aggregate labor supply shrinks due to fewer hours worked and lower participation of prime age workers. The effective tax rate on job search rises to a lesser extent since unemployment benefits are partly indexed to net wages so that a higher wage tax rates not only reduce the value of work but also the value of unemployment. Still, the tax distortion rises substantially from an already high level, and leads to an increase in the unemployment rate from 3.6% in the absence of aging to 5.5%. This large effect also results as inflated wage costs discourage job creation of firms.

The scenario induces a tendency for early retirement. Increased longevity leads to a large cut in funded pensions which, other things equal, encourages postponed retirement. In contrast, rising taxes favor early retirement. Although higher wage taxes reduce both wages and pensions, higher contribution rates exclusively diminish active income and make work relatively less attractive compared to retirement. This second effect dominates and induces early retirement. The participation rate among the 60-69 years old shrinks from .4 to .35. The scenario implies

diverse training incentives for different life-cycle groups which overall result in moderately higher average labor productivity. With this exception, all labor market responses work to magnify substantially the demographically induced reduction of the workforce. Total employment thus falls by 11.8% in absolute levels. Since aging has no consequences for long-run capital intensity in a small economy with a fixed interest rate, the GDP level shrinks by the same percentage. However, GDP is divided over a 10% larger population so that per capita GDP falls by 20%. Asset wealth per capita strongly rises by 11% since individuals must save much more to complement pension income over a longer retirement period.

4.2 A Comprehensive Policy Approach

The effects of aging on the financing of social security can be offset in three ways: reduced benefits, higher contributions, and an increase in the retirement age. Simple analytics imply that increased longevity can be offset by a 'neutral' increase in the retirement age that keeps pension system balanced without raising contributions or cutting pension replacement rates. Intuitively, if agents spend three quarters of their adult life in work and one quarter in retirement, then each additional year of life-extension should be divided in the same way. The argument implies that an increase in retirement age is a central policy response to prevent large increases in tax rates or a declining replacement rates.

We evaluate a comprehensive reform with six elements: (i) raising the retirement age; (ii) eliminating the upper income threshold so that PAYG pensions become earnings linked also for incomes in excess of this ceiling; (iii) eliminating unemployment benefits from the contribution base so that unemployment no longer adds to pension entitlements; (iv) taking measures to reduce administrative costs in the funded pillar by half a percentage point; (v) tightening active labor market policy to limit rising unemployment; (vi) pushing life-long training to strengthen the contribution base but also to improve the employability of older workers and facilitate the rise in retirement age. In all cases, the VAT is raised by 4 percentage points. The VAT is considerably less harmful to incentives for extensive labor supply than wage taxes because it taxes income in both active and inactive states while the wage tax reduces only employed income. Wage tax and contribution rates are adjusted to continuously assure fiscal balance. The higher VAT limits these tax increases so that financing of social security becomes less damaging to

labor market performance. The columns in Table 3 present the cumulative impact. The last column shows the total impact of aging and policy reform.

Table 3: Aging and Comprehensive Social Security Reform

	ISS	Age	Late	Ceil	Un	Adm	Mon	Train
Absolute Changes:								
Tax Increase i)	0.000	0.071	0.019	0.015	0.012	0.005	0.004	0.001
Implicit PAYG Tax ii)	0.016	0.075	0.025	0.007	0.005	0.001	0.001	-0.002
Eff. Tax on Hours ii)	0.223	0.320	0.243	0.224	0.223	0.213	0.216	0.211
Eff. Particip.Tax ii)	0.280	0.382	0.303	0.283	0.282	0.272	0.274	0.270
Eff. Tax on Search ii)	0.651	0.700	0.663	0.653	0.625	0.621	0.620	0.618
Eff. Retirement Tax	0.510	0.556	0.514	0.400	0.394	0.365	0.367	0.361
Pension Repl.Ratio	0.600	0.557	0.582	0.567	0.559	0.561	0.562	0.558
Retirement Date	0.400	0.348	0.801	0.811	0.811	0.814	0.814	0.815
Participation Rate	0.740	0.722	0.726	0.729	0.729	0.731	0.731	0.732
Unemployment Rate	0.036	0.055	0.042	0.039	0.032	0.030	0.025	0.024
Percentage Changes:								
Labor Force		-6.952	1.744	1.933	1.945	1.999	1.990	2.027
Gross Wage		-5.076	-1.535	-1.314	-1.619	-1.074	-1.739	-1.534
Hours Worked		-1.584	-1.223	-0.957	-0.962	-0.792	-0.850	-0.811
Labor Productivity		0.735	1.291	1.301	1.324	1.325	1.317	2.637
Labor Demand		-11.762	-0.746	0.455	1.254	1.954	2.318	3.962
GDP p.cap.		-19.939	-9.944	-8.854	-8.129	-7.494	-7.164	-5.672
Wealth p.cap.		11.231	1.025	2.036	2.381	1.475	0.957	-0.198

Legend: Columns report cumulative effects. i) Financing through higher wage tax and PAYG contributions. In the reform scenarios, 4 percentage points of VAT are also added. ii) Tax rate for 20-29 years-old; (Age): Aging without reform (no use of VAT financing); (Late): increase in retirement age; (Ceil): eliminate pension ceiling in PAYG pillar; (Un): no accumulation of pension entitlemensts of unemployed; (Adm): reduction of administrative costs in funded pillar; (Mon): monitoring of the unemployed; (Train): investment in training.

Raising Retirement Age: Keeping older workers in the labor force is the central piece of the reform package. Raising the statutory retirement age by 3 years means that the regular pension will be received only at the age of 68 instead 65, with no additional pension compen-

sation and an unchanged replacement rate. Column 'Late' in Table 3 reports long-run effects. Comparing to column 'Age' shows the differential impact of the reform while comparing to 'ISS' gives the total impact of aging and the higher retirement age. Recall that the (exogenous) long-run expected retiree-worker ratio as a result of aging is close to 0.5, almost twice as much as today's ratio of 0.27. Raising the retirement age reduces the number of pensioners and augments the active workforce, leading to a much smaller increase in the dependency ratio to 0.38. Still, the number of retirees is 40% higher than in the status quo. Hence, not only the VAT rate is up by 4%, but also the wage tax and contribution rates to the PAYG pillar have to rise each by 1.9 points to finance the large increase in pension spending due to longer life-spans.

Postponed retirement turns the decline in the labor force by 6.9% into a gain of 1.7% relative to the ISS. Effective tax rates are still higher for all margins of labor supply, although much less than in the pure aging scenario. Effective rates shrink considerably which boosts incentives for job search and reduces the unemployment rate from 5.5 to 4.2%. Training investments become more profitable since the returns accrue over a longer working life. Average labor productivity significantly improves by 1.3%, up from 0.7% in the aging scenario. To sum up, raising the retirement age provides a strong fiscal relieve, allows for a lower tax burden and strengthens incentives on all margins of labor supply. The measure thus offsets a large part of the negative economic incentives created by aging. Consequently, the decline in total labor demand is reduced to -0.7%, a huge improvement relative to the loss of -12% in the aging scenario. While the level of GDP is down by a moderate -0.7%, GDP per capita still declines by around -10% since GDP must be divided over more people. The loss in per capita GDP as a result of aging is halved. Finally, a higher retirement age strongly reduces life-cycle savings and wealth per capita since individuals need to save for a shorter remaining retirement period.

Strengthening the Tax-Benefit-Link: In Switzerland, the PAYG pillar limits benefits to a maximum amount so that contributions above an upper income threshold (equal to 84'240 Fr. per year) do no longer augment individual pensions. This income ceiling implies that pensions on incomes in excess of this threshold are no longer linked to individual earnings. In this upper income range, contributions are perceived as a full tax which adds to the general income tax and discourages labor market behavior. Currently, out of all pension payments from the PAYG pillar, 2% refer to minimum pensions, 60% to regular earnings linked pensions, and 38% on

maximum pensions above the income ceiling. In the simulation model, 40% of pensions in the status quo are flat and 60% are earnings linked. The scenario specifically assumes that the share of earnings linked PAYG pensions is raised to 90% (by adjusting up the parameter m^a in 5) and the flat pension reduced to 10%, rather than to 2%. This conservative assumption should allow for somewhat higher minimum pensions to cushion other negative distributional effects such as the reduction of the real pension value due to a higher VAT rate. Finally, to avoid an increase in pension levels when a larger part of income enters the benefit assessment, the scenario also assumes a moderate reduction of the replacement rate.

Column 'Ceil' reports the total long-run impact where the differential effect is seen by comparing to column 'Late'. The measure reduces the tax component in PAYG contributions to reap efficiency gains by strengthening the tax-benefit-link. The required increase in wage tax and contribution rates is reduced from 1.9 to 1.5%. Effective tax rates fall on all margins, and rather strongly in case of the effective retirement tax on account of a somewhat lower replacement rate. Consistent with the empirical evidence, retirement becomes much less sensitive to incentives when the retirement age is already very high. Hence, the old age participation rate rises only moderately. The reform stimulates labor supply on other margins as well but these effects (relative to column 'Late') remain limited. Total employment expands by more than one percentage point, turning a loss of -0.7% into a gain of 0.4%. GDP per capita now shrinks by 8.8%, instead of 9.9%. Strengthening the tax-benefit-link by eliminating the income ceiling yields an income gain of roughly one percentage point of GDP.

Eliminating Unemployment Benefits from Contribution Base: The PAYG pillar includes unemployment benefits in the pension assessment base. The problem with this rule is that it alleviates the consequences of unemployment and weakens job search incentives. Presumably, this rule is intended to prevent old-age poverty. Such a goal, however, is already addressed by the existence of minimum pensions which are raised as part of the preceding policy initiative. By eliminating this rule, pensions become linked exclusively to employment. Denying new pension entitlements during unemployment strengthens search incentives and favorably affects the unemployment rate. As column 'Un' in Table 3 shows, the effective tax rate on search is reduced by 3 percentage points, leading to a significant reduction in unemployment from 3.9 to 3.2%. Lower unemployment saves spending on social benefits and allows a small reduction in wage

tax and contribution rates, down from 1.5 to 1.2%. The gross wage falls more strongly since the reform cuts the workers' fallback option in wage bargaining. With higher job rents, firms expand labor demand by placing more vacancies, making possible the substantial reduction in the unemployment rate. The slight cut in the wage tax rate has positive side effects on other margins of labor supply. Therefore, effective employment and the level of GDP now expand by 1.3%, where the differential effect amounts to almost 1 percentage point. Accordingly, the loss in GDP per capita is reduced from 8.8 to 8.1%.

Reducing Administrative Costs of Funded Pillar: The fragmentation and complexity of the funded pillar with numerous pension funds and low returns have been criticized. Better supervision, more competition and more freedom of choice might yield a higher return. We cannot quantify the precise magnitude of the gains and assume, somewhat arbitrarily, that administrative costs can be cut from 1% to .5% of assets. The return in the second pillar thus rises from 2.5 to 3% while the net interest in the capital market remains at 3.5%. The contribution rate to the funded pillar is kept constant but contribution capital earns a larger interest and results in a larger pension. To keep the total pension replacement rate fixed, the PAYG pension is scaled down to offset the increase in private pensions. Budget savings are used to cut wage tax rates as well as employee and employer contributions to the PAYG system. Column 'Adm' reports that in long-run equilibrium these rates can be cut in total by roughly 2 percentage points ($3 \times (1.2 - .5)$ in the first line of Table 3). Effective tax rates are moderately reduced which stimulates all margins of labor supply. The unemployment rate drops further to 3%. Altogether, effective employment and per capita GDP expand by another .7%.

Tighter Monitoring of Unemployed: Sanctions against shirking in job search and monitoring of unemployed job seekers are often used instruments of active labor market policy. We assume that unemployment also yields some leisure utility, and that monitoring and sanctions in case of observed inactivity can reduce the value of being unemployed by a monetary equivalent of 5% of benefits. We assume that these activities are covered with no extra cost out of the existing budget for labor market policy. Column 'Mon' shows the quantitative impact. The intervention not only boosts search incentives. In eroding the fallback option, it also squeezes the reservation wage and thereby augments the total job rent. Wage bargaining splits the larger surplus between workers and firms so that the gross wage rate falls (by 1.7% instead of 1.1%)

which, in turn, boosts the job rent of firms. As a result, workers search more intensively, and firms find it more profitable to create jobs. The unemployment rate shrinks from 3 to 2.5%. The repercussions on wage taxes and on other dimensions of labor supply are basically insignificant. Overall, the effect on employment and GDP is an additional 0.4 percentage points, leading to a level effect of 2.3% relative to the ISS. The loss in GDP per capita is further reduced to 7.2%.

Incentives for Life-Long Training: Training may be an important means to compensate, at least partly, for the decline in labor supply resulting from a reduced inflow of young workers. Skill accumulation rests on households' willingness to reallocate time from work to training and on public spending. The scenario assumes that government raises the public input per trainee (teachers, learnings material, class-room and other resources) by one percent. Since the number of trainees rises, the government must spend about 2.7% more on training. However, this item amounts only to roughly 5% of tax revenue so that the effect on the public budget is rather limited. Households respond by using more time for training, incurring an opportunity cost in terms of forgone earnings. As a result of more training, average labor productivity rises by an additional 1.3% and ends up 2.6% higher than in the ISS. The higher quality of the workforce boosts effective employment by an extra 1.6%. All in all, the levels of effective employment and GDP are 4% higher than in the status quo. The loss in per capita income is limited to 5.7%, down from 7.2%. Other dimensions of aggregate labor supply are not much affected. To conclude, training seems an important policy area to cushion the economic impact of aging.

4.3 Life-Cycle Incidence

Aging and structural reform of social security may have an uneven impact on the life-cycle. Figure 3 reveals that strengthening training may disproportionately benefit older workers in the long-run. As workers respond to better incentives, the effects accumulate over the entire working life. Postponed retirement also stimulates training since returns accrue over a longer time period. The strongest effect is probably with persons near retirement. The skills of older workers are also of special interest since they affect their employability. Many observers are concerned that raising the retirement age could be ineffective because older workers may be difficult to employ. However, the simulations show that postponed retirement disproportionately favors training incentives and skills of older workers which enhances their employability.

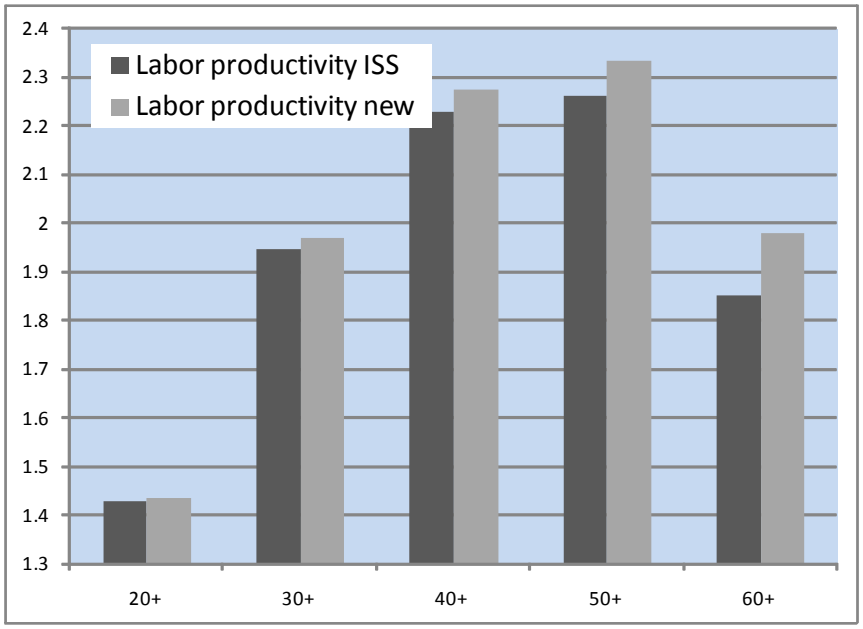

Figure 3: Life-Cycle Productivity

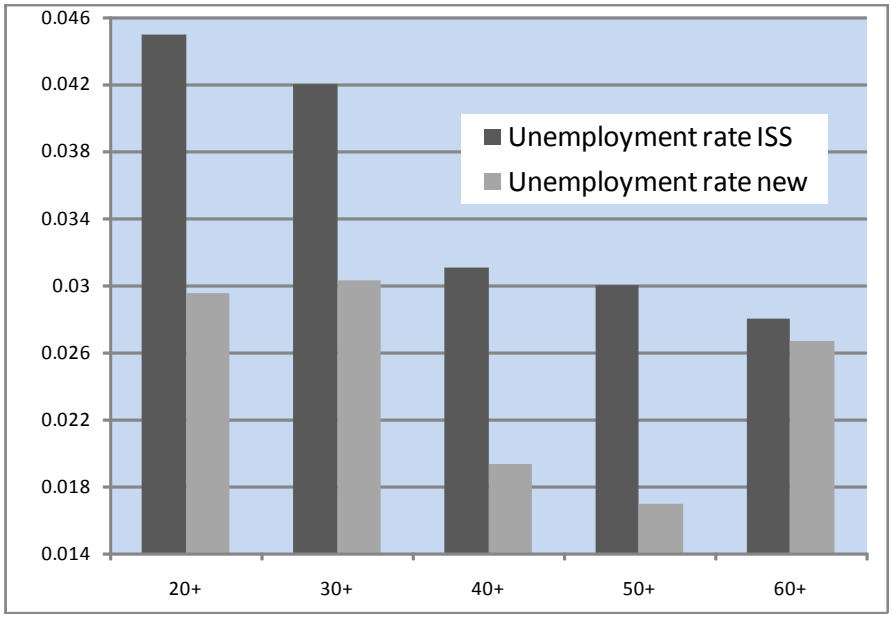

Figure 4: Life-Cycle Unemployment

The life-cycle pattern in Figure 4 points to the different unemployment incidence for young and old workers. Unemployment among younger workers falls quite sharply, by 1.5 percentage points for the 20-29 years-old. The main reason is the elimination of unemployment benefits from the contribution base as well as stronger monitoring as part of active labor market policy.

A stronger tax-benefit link also encourages job search and reduces unemployment. Unemployment among older workers, in contrast, is hardly affected at all. Delaying actual retirement by about four years amounts to a strong increase of labor supply which prevents a more significant reduction in the unemployment rate. By international comparison, old age unemployment still remains very low. The present framework does not lend support to the view that postponing retirement is ineffective because older workers might be difficult to employ.

4.4 Transitional Adjustment

Table 3 reports long-run values. However, short- and medium-run effects are of special interest to policy makers. Given that demographic change is a slow process extending over several decades, policy measures should also be introduced with roughly the same speed. Hence, our scenario gradually implements reform according to $y_t = y_\infty + (y_0 - y_\infty) \times 0.95^t$ where y is an element of the policy package with value y_0 in the initial equilibrium and y_∞ after complete implementation. The adjustment speed 0.95 implies a half-life of $t_{0.5} \approx 13.5$ years, i.e. half of the policy change is completed within 13.5 years, half of the remaining part takes another 13.5 years etc. We refrain from any more elaborate transition strategies. Public debt and real public spending are kept constant in per capita terms. The response to policy shocks and aging can easily lead to non-monotonic adjustment since demographic change with overlapping generations, economic adjustment such as savings, investment and skill formation, and gradual policy implementation occur at different speeds. Figure 5 shows that the old-age dependency ratio may take up to 6 decades to fully adjust. The horizontal axis measures time (in years) after the reform.

The economic dependency ratio is the ratio of retired to active persons and is rather more important for fiscal balance and economic performance than the demographic dependency ratio which is the ratio of persons older than 65 over younger ones. As Figure 5 illustrates, the large increase in retirement age adds additional workers, shrinks the number of retired persons and, thereby, squeezes the economic dependency ratio by about 12 percentage points in the long-run. The value for tax rates and employment gains in Figure 6 converge to the long-run values listed in Table 3. Given the delayed implementation, there is no policy change at all in period zero, but the anticipation of improved labor market incentives in future periods leads to an immediate, endogenous increase in the retirement age and old age participation rate from 0.4

to 0.43. Together with other labor supply responses, effective employment jumps up by 0.7%, allowing an instantaneous cut in the wage tax rate and employer plus employee contribution rates to the PAYG pillar by -0.2 percentage points.

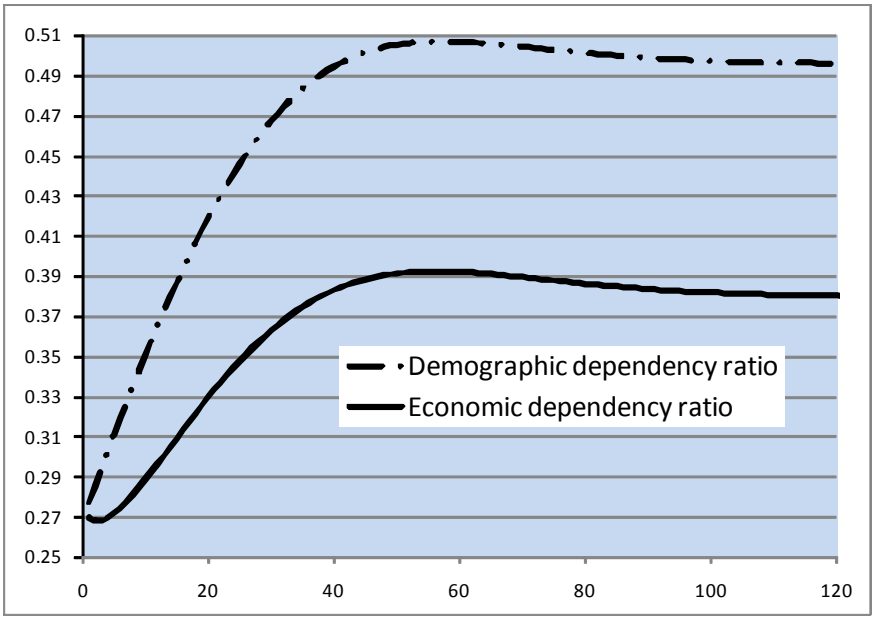

Figure 5: Demographic and Economic Dependency Ratios

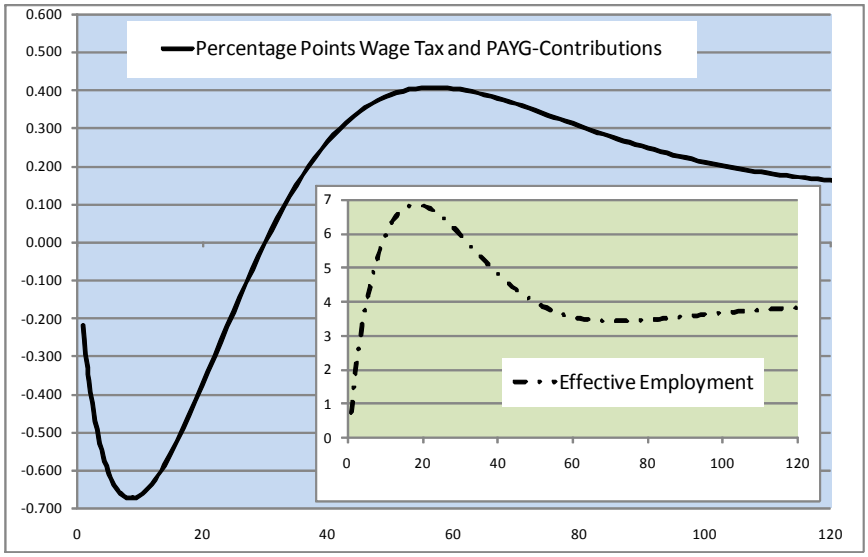

Figure 6: Wage Tax, PAYG Contributions and Employment

When the policy changes slowly set in, the retirement age rises and ultimately boosts the participation rate among 60-69 years old to 81%, up from 40% initially. Accordingly, the economic dependency ratio in Figure 5 rises much less dramatically than the demographic ratio.

Although policy changes are gradually phased in, they are still 'too fast' to some extent, boosting labor market incentives by more than what would be required to prevent a change in tax and contribution rates. Accordingly, tax rates significantly fall in a first phase to a maximum of 0.7 percentage points in period 9, or a total of 2 points if the wage tax rate and the employer and employee contribution rates to the PAYG pillar are added up. The employment rate thus overshoots, leading to a maximum gain of 6.8% in period 18 before the economy approaches a long-run equilibrium with more moderate employment gains as reported in Table 3. In general, it is difficult to devise a phasing-in policy that would completely avoid any non-monotonic or overshooting adjustment in labor market behavior due to overly fast or too slow policy implementation. In principle, it would be possible to use debt policy to smooth tax rates over time and to distribute employment gains more evenly across generations.

5 Conclusions

Increased longevity induces a large demographic change. It thereby creates difficult challenges in financing social security and could substantially reduce per capita income. In Switzerland, the old-age dependency ratio will approximately double and the population is expected to grow by 10% until 2050. A large shock must have large consequences. In this study, we have used a rich computational model of life-cycle labor supply, unemployment and retirement, explicitly including the separate PAYG and funded pillars of the Swiss pension system, to quantify the potential impact of aging. When benefit rules are kept constant and the government follows a passive policy of raising wage taxes and social security contributions, the consequences might be rather bleak. Simulations show that the labor tax burden might need to rise by 22 percentage points and per capita income could fall by roughly the same amount.

Such a scenario is neither politically realistic nor reasonable but serves as a reference point. We have found that a comprehensive policy approach can largely alleviate the unfavorable consequences of aging on per capita income. The financing of social security with largely the same replacement rates as today might require only a moderately higher tax burden. By far the most important measure is an increase in retirement age by about 4 years so that longer lived future generations roughly split their extended total life-time between work and retirement in

the same way as present generations must do. The comprehensive policy approach investigated in this paper includes further structural reform of the pension system and other measures to stimulate training. All in all, the results show that this reform package could limit the increase of the tax burden to 4 percentage points of value added tax and keep the loss in per capita income to a moderate 6%. To put this number in perspective, a period of zero growth over 3-4 years relative to continued trend growth would yield the same decline in per capita income.

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