Universität St.Gallen

How Much Do Means-Tested Benefits Reduce the Demand for Annuities?

Monika Bütler, Kim Peijnenburg, Stefan Staubli

June 2011 Discussion Paper no. 2011-24

School of Economics and Political Science,
Department of Economics

University of St. Gallen

Editor:	Martina Flockerzi	
	University of St. Gallen	
	School of Economics and Political Science	
	Department of Economics	
	Varnbüelstrasse 19	
	CH-9000 St. Gallen	
	Phone	+41 71 224 23 25
	Fax	+41 71 224 31 35
	Email	seps@unisg.ch
Publisher:	School of Economics and Political Science	
	Department of Economics	
	University of St. Gallen	
	Varnbüelstrasse 19	
	CH-9000 St. Gallen	
	Phone	+41 71 224 23 25
Electronic Publication:	Fax	+41 71 224 31 35
	http://www.seps.unisg.ch	

How Much Do Means-Tested Benefits Reduce the Demand for Annuities?[1]

Monika Bütler, Kim Peijnenburg, Stefan Staubli

Author's address:

Prof. Dr. Monika Bütler
SEW-HSG Universität St. Gallen
Varnbüelstrasse 14
CH-9000 St. Gallen
Phone +41 71 224 23 20
Fax +41 71 224 23 02
Email monika.buetler@unisg.ch
Website www.sew.unisg.ch

Kim Peijnenburg
Department of Finance, CentER
Tilburg University
P.O. Box 90153
NL-5000 LE Tilburg
Phone +31 13 466 30 28
Email j.mj.peijnenburg@uvt.nl

Stefan Staubli
SEW-HSG, Universität St. Gallen
Varnbüelstrasse 14
CH-9000 St. Gallen
Phone +41 71 224 225 46
Fax +41 71 224 23 02
Email stefan.staubli@unisg.ch
Website www.sew.unisg.ch

[1] We thank seminar participants at the Netspar PensionWorkshop and various conferences for helpful comments and suggestions. Part of this research was conducted while Kim Peijnenburg was visiting the Wharton School of the University of Pennsylvania, and she is grateful for their hospitality. We kindly acknowledge a research paper grant from the Centre for Pensions and Superannuation (CPS) and Kim Peijnenburg acknowledges financial support from All Pensions Group (APG). The most recent version of this paper is available at www.kimpeijnenburg.com.

Abstract

We analyze the effect of means-tested benefits on annuitization decisions. Most industrialized countries provide a subsistence level consumption floor in old age, usually in the form of means-tested benefits or income supplements. The availability of such means-tested payments creates an incentive to cash out (occupational) pension wealth for low and middle income earners, instead of taking the annuity. Agents trade-off the advantages from annuitization, receiving the wealth-enhancing mortality credit, to the disadvantages, giving up "free" wealth in the form of means-tested supplemental benefits. We show that the availability of means-tested benefits can reduce the desired annuitization levels substantially. Moreover, the model's predicted annuitization rates as a function of the level of pension wealth are roughly consistent with the cash-out patterns of occupational pension wealth observed in Switzerland.

Keywords

Means-Tested Benefits, Occupational Pension, Annuity.

JEL Classification

D81, D91, G23, J26.

1. Introduction

Virtually all industrialized countries provide supplemental retirement benefits to prevent poverty in old age. These benefits are typically means-tested and eligibility is determined both on income and assets, although in some countries only pension income is taken into account. Supplemental retirement benefits are an important source of retirement provision. In OECD countries means-tested retirement benefits are almost 22% of average earnings and approximately 17% of individuals above age 65 claim such benefits (OECD (2011)).

While means-tested benefits are important to reduce poverty in old age, in this paper we show that the availability of these benefits can substantially reduce the propensity to annuitize pension wealth at retirement. Because means-tested benefits guarantee a minimum income in retirement, they provide an implicit insurance against the financial consequences of longevity similar to an annuity contract. This implicit insurance generates a strong incentive to cash-out accumulated pension wealth at retirement even if full annuitization were optimal in the absence of means-tested benefits.

Yaari's (1965) seminal paper demonstrated that a life-cycle consumer without a bequest motive should choose to annuitize his entire wealth to insure longevity risk. Davidoff et al. (2005) show that positive, but not necessarily complete annuitization remains optimal even with market incompleteness and liquidity constraints. The case for annuitization remains strong in the presence of bequest motives and under habit formations. However, when international numbers are analyzed, it is apparent that when given a choice, only a minority annuitizes voluntarily even in countries in which the pre-existing annuitization implied by the public pension system is small. Given the size of means-tested social insurance programs in industrialized countries, low annuitization rates may not be that surprising.

The Swiss case nicely illustrates the incentives generated by means-tested benefits to cash out pension wealth. Maximal first pillar benefits amount to roughly CHF 2,000 per month. At the same time, there are also means-tested supplements to first pillar benefits that lift the available income to roughly CHF 3,000 a month. An individual with a monthly second pillar benefit of less than CHF 1,000 a month, which corresponds to accumulated occupational pension wealth of approximately CHF 170,000, is always better off withdrawing the money upon retirement, spending it quickly and then applying for means-tested benefits. While the incentives are clear for individuals with low pension wealth and no other form of wealth, for middle-income individuals there is a trade-off. The retiree weighs the benefits from taking the lump sum, "free" means-tested benefits after withdrawal, against the disadvantages, not receiving the wealth enhancing mortality credit and a non-flat consumption pattern.

To quantify the impact of means-tested benefits on the annuitization rate, we analyze optimal annuity demand and consumption/savings decisions in a realistic life-cycle model under a social security scheme in which means-tested benefits can be claimed if income and wealth fall below a certain level. The model also includes inflation risk and equity risk, and allows for differential tax treatments of annuity payments versus lump sum withdrawals.

The model is calibrated to Switzerland, which is an interesting case to study for a number or reasons. First, it combines a relatively low level of pre-existing annuitization by the first pillar, with generous means-tested benefits that exceed first pillar benefits by roughly 50%. Second, most individuals have accumulated a large capital stock at retirement through the mandatory occupational pension scheme. The average Swiss retiree has a capital stock of approximately CHF 300,000 to CHF 400,000 which translates into a second pillar income that approximately equals first pillar benefits. Third, a relatively high fraction of individuals voluntarily annuitize their pension wealth and there is a considerable variability of cash-out decisions against which the theoretical predictions can be compared. Bütler and Teppa (2007) and Bütler et al. (2011) show with micro data from pension providers that the propensity to annuitize increases in pension wealth, which is consistent with the incentives generated by means-tested benefits.

The main contributions of our paper are twofold. First, we find that means-tested benefits have a sizeable impact on optimal annuitization levels. Especially for agents with a low income and wealth level, the effect is substantial. If these retirees could not claim means-tested benefits, they would annuitize a large fraction of their second pillar pension wealth, while the optimal annuity level is often zero when means-tested supplemental income is available to them. So in contrast to previous research, we find that means-tested benefits can provide a potential explanation for the low voluntary annuitization of second pillar pension wealth and financial wealth of individuals. Second, when comparing the observed annuity decisions of individuals regarding their second pillar pension wealth to the optimal annuity levels, we find a close match. Using Swiss administrative data of occupational pension providers we see a clear pattern: Agents with low pension wealth levels tend to take the lump sum while agents with higher second pillar pension wealth annuitize more often. Our life-cycle model matches this pattern closely and we find that means-tested benefits provide an important explanation for the observed annuitization behavior of individuals.

A great amount of literature has attempted to shed light on the "annuity puzzle". Adverse selection and administrative loads[5] (Mitchell et al. (1999), Finkelstein and Poterba (2002), Finkelstein and Poterba (2004), and Rothschild (2009)) and the existence of first-pillar annuities (Brown et al. (2001), Dushi and Webb (2004)) can rationalize the preference for a lump sum instead of an annuity income to some degree. Further potential arguments against annuitization include intra-family risk-sharing (Kotlikoff and Spivak (1981) and Brown and Poterba (2000)), incomplete annuity markets (Peijnenburg et al. (2011a)), bequest motives (Friedman and Warshawsky (1990), Bernheim (1991), and Brown (2001)), and a desire to insure against expenditure spikes (Peijnenburg et al. (2011b)).[6] Nonetheless, the low observed annuitization rates remain hard to reconcile with economic theory. Furthermore, some recent work includes behavioral explanations of individuals low annuitization behavior .[7]

Our paper relates to several studies that have examined the effect of means-tested social insurance programs on savings and labor supply. Theoretical work by Hubbard et al. (1995) and Sefton et al. (2008) demonstrate that means-tested welfare programs discourage savings by households with low expected lifetime income. Empirical evidence for this prediction is provided by Neumark and Powers (1998) and Powers (1998) using U.S. data. Neumark and Powers (2000) demonstrate that means-tested supplementary retirement benefits reduce pre-retirement labor supply. Friedberg (2000) finds similar evidence by exploiting changes in the earnings test rules for recipients of Social Security benefits in the US. However, the existing literature has largely ignored the role of means-tested social insurance programs on the decision to annuitize pension wealth. The only exception, to our knowledge, is the paper by Pashchenko (2010) who investigates different determinants of the annuitization decision using a simulation model parameterized for the U.S. She demonstrates that a minimum con-

[5]Direr (2010) explores how annuities should be taxed when facing adverse selection problems.

[6]See Brown (2007), for an excellent review of this literature.

[7]See, for example, Brown et al. (2008) who find that people are more likely to annuitize when the choice is presented to them in a consumption framework then when it is presented in an investment framework. Other behavioral explanations such as mental accounting are examined in Hu and Scott (2007) and Brown (2007).

sumption floor reduces the participation rate in voluntary annuity markets, particularly at the bottom of the income distribution.

Our analysis differs from the study by Pashchenko (2010) in several respects. First, we explore the impact of *means-tested benefits* while Pashchenko (2010) focuses on a *consumption floor*. Both are additional income given to agents provided by the government, but they differ with respect to how wealth is treated and how generous the transfer is. With means-tested benefits agents are usually allowed to keep a certain level of wealth, so means-tested benefits are not reduced dollar for dollar with additional wealth. A minimum consumption floor, on the other hand, is only paid out after all wealth has been depleted. Furthermore, in contrast to Pashchenko (2010) we compare actual individual level annuity choices to the predicted levels.

Contrary to most other papers on the determinants of annuity demand, our analysis concentrates on the decision to annuitize pension wealth in fully-funded pension plans that are either mandated or strongly favored by government regulation. These schemes play a large role in the provision of retirement income in most industrialized countries. Annuitization in these plans is thus a more pressing concern for public policy than in voluntary annuity markets, which traditionally have a low annuitization rate. Furthermore, our paper is one of the few papers on annuity demand that employ individual level data to explore determinants of annuity choices.

The paper proceeds as follows. Section 2 describes the life-cycle model used for the simulations of annuitization decisions in the presence of means-tested benefits. Section 3 gives an overview of the Swiss pension system to which the model is calibrated and which serves as an illustration for the quantitative impact of means-tested benefits. Section 4 summarizes the data and presents descriptive statistics and Section 5 presents the results and discusses alternative interpretations of our results. Possible policy implications will be discussed in Section 6 and Section 7 draws conclusions.

2. A life-cycle model during retirement with means-tested benefits and optimal annuitization

Means-tested supplemental benefits create an incentive to cash out accumulated second pillar wealth. If pension income is fully taken into account when calculating the amount of means-tested benefits, an annuity, even small, is detrimental to the eligibility for means-tested benefits. If the combined income from the first and second pillar is below the consumption floor guaranteed by means-tested benefits, a single individual should in most cases choose the lump sum, draw it down, and then apply for means-tested benefits. While the incentives for individuals with low pension wealth are mostly straightforward, for middle-income individuals there is a trade-off. The retiree weighs the benefits from taking the lump sum, "free" means-tested benefits after withdrawal, against the disadvantages, not receiving the welfare enhancing mortality credit (longevity insurance) and a decrease in consumption once the capital is depleted.

The effect of means-tested benefits on annuitization decisions is further complicated by a number of institutional details specific to a country. First, the eligibility for means-tested benefits depends on *total* wealth and not only on pension wealth. Therefore, even for low levels of pension wealth, taking the annuity may be optimal if non-pension wealth is high. Second, differences in taxation may either favor one of the two polar options (100% annuitization vs 100% lump sum) or induce a certain split between the two. In the Swiss case, which will serve as an illustration for the calibration, the annuity is subject to normal income tax rates, while the lump sum is taxed only once (at retirement). Third, since annuities are typically not indexed to inflation, uncertainty about future prices reduces the demand for these annuities.

In the next section, we present a life-cycle model that incorporates several important aspects of the annuitization decision, including means-tested benefits, non-pension wealth, differential taxation of the annuity income compared to the lump sum, and a stochastic asset return process in the presence of inflation.

2.1. Individual's preferences and constraints

The analysis is for the retirement phase of the life cycle and no active decision with respect to the retirement timing is made. After retirement the agent faces the decision whether to (partially) annuitize the pension wealth or take it as a lump sum. Subsequently lump sum taxes are levied, which is only done once, at retirement.[8] For his entire life the agent receives an annuity income from the first and second pillar and annual income taxes are levied on this. The agent decides optimally how much to consume and, subsequently, the remaining wealth (if any) is divided optimally between stocks and bonds. The optimal consumption and investment decisions are made annually, while the optimal choice about which fraction of the second pillar pension wealth to annuitize takes place once, at retirement.

[8]In Switzerland, not only lump sum taxes are levied but also annual wealth taxes. In the analysis we abstract from wealth taxes because these tax rates are very low and for wealth levels up to CHF 100'000 no taxes are paid.

More formally, we examine an agent during retirement with age $t = 1, ..., T$, where $t = 1$ is the retirement age and T is the maximum age possible. Let p_t denote the probability of surviving to age t, conditional on having lived to period $t-1$. The individuals' preferences are presented by a time-separable, constant relative risk aversion utility function and the individual derives utility from real consumption, C_t. Lifetime utility equals

$$V = E_0 \left[\sum_{t=1}^{T} \beta^{t-1} \left(\left(\prod_{s=1}^{t} p_s \right) \frac{C_t^{1-\gamma}}{1-\gamma} \right) \right], \tag{1}$$

where β is the time preference discount factor, γ denotes the level of risk aversion, and C_t is the level of date t real consumption. Nominal consumption is given by $\overline{C_t} = C_t \Pi_t$, where Π_t is the price index at time t.

The second pillar wealth, W^{pw}, can be transformed into an annuity income, taken as a lump sum, or a combination of both:

$$W^{pw} = W^{ls} + W^{a}, \tag{2}$$

where W^{ls} is the amount taken as a lump sum and W^{a} is the part of the pension wealth annuitized. The annuity income, Y_t^{II}, is given by

$$Y_t^{II} = W^{a} c, \tag{3}$$

where c is the conversion rate. The second pillar annuity income provides a nominal income, while the first pillar income is inflation protected. A tax is levied once on the part of the second pillar pension wealth that is taken as a lump sum, τ_{ls}. The lump sum tax depends on the amount withdrawn progressively, the marginal tax rate increases with the lump sum amount. Total net wealth at time $t = 1$, W_1, is the sum of net non-annuitized pension wealth plus non-pension financial wealth, W^{npw}:

$$W_1 = (1 - \tau_{ls}) W^{ls} + W^{npw}. \tag{4}$$

The income tax, τ_i, is progressive and levied over the sum of first and second pillar pension income.

The net means-tested benefits M_t equal

$$M_t = \max(\tilde{M}_t - Y_t^{I} - Y_t^{II} - rW_t - gW_t, 0) \tag{5}$$

where $\tilde{M}_t$ is the guaranteed consumption level. The applicable income to base the amount of means-tested benefits on consists of first pillar pension income Y_t^I, second pillar pension income Y_t^{II}, investment income (wealth times a fictitious investment return r), and a fraction g of wealth. The incomes Y_t^I and Y_t^{II} are defined net of taxes.

There are two assets individuals can invest in, stocks and a riskless bond. w_t is the fraction invested in equity, which yields a gross nominal return of R_{t+1}. The nominal return on the riskless bond is denoted by R_t^f. The intertemporal budget constraint of the individual is, in nominal terms, equal to

$$W_{t+1} = (W_t + Y_t^I + Y_t^{II} + M_t - \overline{C_t})(1 + R_t^f + (R_{t+1} - R_t^f)w_t), \tag{6}$$

where W_t is the amount of financial wealth at time t. If the agent receives means-tested benefits, his consumption is always at least as high as the guaranteed income level, $\tilde{M}_t$.

The individual faces a number of constraints on the consumption and investment decisions. First, we assume that the retiree faces borrowing and short-sales constraints

$$w_t \geq 0 \text{ and } w_t \leq 1. \tag{7}$$

Second, we impose that the investor is liquidity constrained

$$\overline{C_t} \leq W_t, \tag{8}$$

which implies that the individual can not borrow against future annuity income to increase consumption today.

2.2. Financial market

The asset menu of an investor consists of a riskless one-year nominal bond and a risky stock. The return on the stock is normally distributed with an annual mean nominal return μ_R and a standard deviation σ_R. The interest rate at time $t+1$ equals

$$r_{t+1} = r_t + a_r(r_t - \mu_r) + \epsilon_{t+1}^r, \tag{9}$$

where r_t is the instantaneous short rate and a_r indicates the mean reversion coefficient. μ_r is the long run mean of the instantaneous short rate, and ϵ_t^r is normally distributed with a zero mean and standard deviation σ_r. The yield on a risk-free bond with maturity h is a function of the instantaneous short rate in the following manner:

$$R_t^{f(h)} = -\frac{1}{h}\log(A(h)) + \frac{1}{h}B(h)r_t, \tag{10}$$

where $A(h)$ and $B(h)$ are scalars and h is the maturity of the bond. The real yield is equal to the nominal yield minus expected inflation and an inflation risk premium.

We have to model inflation, because we examine optimal annuitization levels in a world in which second pillar annuities are nominal. For the instantaneous *expected* inflation rate we assume

$$\pi_{t+1} = \pi_t + a_\pi(\pi_t - \mu_\pi) + \epsilon_{t+1}^{\pi}, \tag{11}$$

where a_π is the mean reversion parameter, μ_π is long run expected inflation, and the error term $\epsilon_t^\pi \sim N(0, \sigma_\pi^2)$. Subsequently the price index Π follows from

$$\Pi_{t+1} = \Pi_t \exp(\pi_{t+1} + \epsilon_{t+1}^{\Pi}), \tag{12}$$

where $\epsilon_t^\Pi \sim N(0, \sigma_\Pi^2)$ are the innovations to the price index. We assume there is a positive relation between the expected inflation and the instantaneous short interest rate, that is the correlation coefficient between ϵ_t^r and ϵ_t^Π is positive. The benchmark parameters are presented in Section 3.3.

2.3. Numerical method for solving the life-cycle problem

Due to the richness and complexity of the model it cannot be solved analytically hence we employ numerical techniques instead. We use the method proposed by Brandt et al. (2005) and Carroll (2006) with several extensions added by Koijen et al. (2010). Brandt et al. (2005) adopt a simulation-based method which can deal with many exogenous state variables. In our case $X_t = (R_t^f, \pi_t)$ is the relevant exogenous state variable. Wealth acts as an endogenous state variable. For this reason, following Carroll (2006), we specify a grid for wealth *after* (annuity) income, and consumption. As a result, it is not required to do numerical rootfinding to find the optimal consumption decision.

The optimization problem is solved via dynamic programming and we proceed backwards to find the optimal investment and consumption strategy. In the last period the individual consumes all wealth available. The value function at time T equals:

$$J_T(W_T, R_T^f, \pi_T) = \frac{(W_T + Y_t^I + Y_t^{II} + M_T)^{1-\gamma}}{1-\gamma}. \tag{13}$$

The value function satisfies the Bellman equation at all other points in time,

$$V_t(W_t, R_t^f, \pi_t) = \max_{w_t, C_t} \left(\frac{C_t^{1-\gamma}}{1-\gamma} + \beta p_{t+1} E_t(V_{t+1}(W_{t+1}, R_{t+1}^f, \pi_{t+1})) \right). \tag{14}$$

In each period we find the optimal asset weights by setting the first order condition equal to zero

$$E_t(C_{t+1}^{*-\gamma}(R_{t+1} - R_t^f)/\Pi_{t+1}) = 0, \tag{15}$$

where C_{t+1}^* denotes the optimal real consumption level. Because we solve the optimization problem via backwards recursion we know C_{t+1}^* at time $t+1$. Furthermore we simulate the exogenous state variables for N trajectories and T time periods hence we can calculate the realizations of the Euler conditions, $C_{t+1}^{*-\gamma}(R_{t+1} - R_t^f)/\Pi_{t+1}$. We regress these realizations on a polynomial expansion in the state variables to obtain an approximation of the conditional expectation of the Euler condition

$$E\left(C_{t+1}^{*-\gamma}(R_{t+1} - R_t^f)/\Pi_{t+1}\right) \simeq \tilde{X}_p' \theta_h. \tag{16}$$

In addition we employ a further extension introduced in Koijen et al. (2010). They found that the regression coefficients θ_h are smooth functions of the asset weights and consequently we approximate the regression coefficients θ_h by projecting them further on polynomial expansion in the asset weights:

$$\theta_h' \simeq g(w)\psi. \tag{17}$$

The Euler condition must be set to zero to find the optimal asset weights

$$\tilde{X}_p' \psi g(w)' = 0. \tag{18}$$

Due to the maximization function in the budget constraint, see (5) and (6), there are two euler conditions for the optimal consumption level. One for when the agent *does* receive means-tested benefits and a second for when the agent *does not* receive means-tested benefits:

$$C_t^{*-\gamma} = \beta p_{t+1} E_t \left(\frac{\Pi_t}{\Pi_{t+1}} C_{t+1}^{*-\gamma} R_{t+1}^{P*} \right) \text{ if } M_t = 0, \tag{19}$$

$$C_t^{*-\gamma} = \beta p_{t+1} (1 - r - g) E_t \left(\frac{\Pi_t}{\Pi_{t+1}} C_{t+1}^{*-\gamma} R_{t+1}^{P*} \right) \text{ if } M_t > 0. \tag{20}$$

This complicates the optimization procedure for consumption and details describing the method are in Appendix A.

3. Calibration: case study Switzerland

The availability of means-tested benefits obviously reduces the demand for an annuity. The more important question is the quantitative impact of this type of re-insurance on the cash-out decision at retirement. To evaluate the importance of means-tested benefits for retired individuals we calibrate the model to the Swiss case. Switzerland is an interesting case as it combines a relatively low level of pre-existing annuitization by the first pillar with generous means-tested benefits that exceed first pillar benefits by roughly 50%. Moreover, most individuals have accumulated a large capital stock at retirement through the mandatory occupational pension scheme. The average Swiss retiree can expect a second pillar income approximately equals first pillar benefits if he annuitizes his pension wealth. At least 25% of the accumulated pension wealth can be withdrawn as a lump sum, but most plans do not limit the fraction that can be cashed out or apply a higher limit.

3.1. The Swiss pension system: the first and the second pillar

Switzerland's pension system mainly consists of two pillars, the first pillar is a publicly financed pay-as-you-go scheme and the second pillar is a fully funded occupational pension scheme. The *first pillar* aims at providing a basic level of income to all retired residents in Switzerland. It is financed by government revenues and a payroll tax which is proportional to labor income. Benefits are strongly dependent on the number of years contributed, but only to a limited degree on the average working income. In particular, individuals whose income is high enough to qualify for the second pillar usually get a first-pillar income between 90 and 100 percent of the maximal first pillar benefits. The statutory retirement age is 64 for women and 65 for men. Working beyond age 64/65 is possible, but most work contracts specify a retirement age that coincides with the statutory retirement age.

The *second pillar* is an employer-based, fully funded occupational pension scheme which not only provides retirement benefits, but also insurance in case of disability and for survivors. The scheme is compulsory for all employees with annual earnings above roughly CHF 20,000. Around 96 percent of working men and 83 percent of working women are covered by an occupational pension plan. However, it does not cover non-working individuals. As a consequence, the lowest income quartile — and thus the individuals with the lowest life expectancy — are not or only marginally included in these schemes.

Occupational pension plans are heavily regulated and although they typically work as a defined contribution system, far reaching income guarantees are included. Introduced in 1985, the main goal of the second pillar is to maintain pre-retirement income. Including income from the first pillar, the target replacement rate of most pension funds is approximately 50-60 percent of insured income, corresponding to a net replacement rate of 70-80 percent. Income above CHF 80,000 is covered by the so-called super-mandatory part of the system. Although the employers are free to offer super-mandatory coverage, a large majority do as occupational pensions are viewed as an important tool to attract qualified workers in a tight labor market.

Individuals are automatically enrolled in both the mandatory and super-mandatory part of the plan and in most cases do not have any choice during the accumulation phase with respect to how to invest the money. Contributions to the pension plan correspond to a certain fraction of the salary (usually 7-18 percent depending on age) of which the employer has to pay at least half. The capital is fully portable; when an employee starts working at another company, he receives all of the accumulated contributions (including the employer's part). The full sum has to be paid into the new fund.

The accrued retirement capital can be withdrawn either as a monthly life-long annuity (including a 60 percent survivor benefit), a lump sum or a mix of the two options. In some plans the cash-out limit is equal to 50 or 25 percent (the legal minimum) of accumulated capital. Depending on the regulation of the pension the individual must declare his choice between three months and three years prior to the effective withdrawal date depending on insurer regulations. Many pension insurers define a default option for the case when the beneficiary does not make an active choice.

Occupational pension annuities are strictly proportional to the accumulated retirement assets. The capital is translated into a yearly nominal annuity using a conversion rate. The conversion rate is independent of marital status, but depends on retirement age and gender. The law stipulates a minimum conversion rate in the mandatory part, which is currently 7.05 percent but will be lowered continuously to 6.8 percent in 2015. Pension funds are requested to index pension benefits to inflation if the financial situation of the fund allows for this. At present, few funds are able to index pensions to inflation mainly due to high liabilities created by a very high conversion factor in the mandatory part.

3.2. Means-tested supplemental benefits in Switzerland

If the total income does not cover basic needs in old age, means-tested supplemental benefits may be claimed as part of the first pillar. Like in most OECD countries, these benefits are means-tested so that only individuals whose income and assets are below a certain threshold are eligible. In Switzerland, the value of these benefits corresponds to 25% of average earnings, which is slightly above the average in OECD countries of 22% (OECD (2011)).

Since the inception of means-tested benefits in 1966, the fraction of the population beyond the retirement age receiving means-tested benefits has remained relatively constant at 12%. The share of benefit is increasing with age which is consistent with our hypothesis of spending down assets. In OECD countries around 17% of the population above age 65 receives means-tested benefits, although there is a considerable variation across countries depending on how low the eligibility threshold is set. For example, in Denmark and Australia between 70 to 80% of all retirees claim means-tested benefits, compared to less than 2% in Germany and Japan (OECD (2011)). In the United States the Supplemental Security Income (SSI) program ensures a minimum level of income for people over age 65 as well as the disabled and blind. The benefits are means-tested and an individual can have a maximum of $2000 of total assets to be eligible.

The annual means-tested benefits in Switzerland are determined by subtracting an individual's income from the so-called applicable expenditures. For married applicants expenditures and income of the spouse are taken into account as well. In addition, a child allowance is granted for each child below age 18 or until finishing schooling (at most age 25). The income used in the calculations of means-tested supplemental benefits is the sum of pension income from first and second pillars, investment income, and earnings plus one tenth of the wealth exceeding a threshold level of CHF 25,000. The relevant annual expenditures consist of a cost-of-living allowance, a health insurance premium of up to an upper limit of CHF 4,500, and rent or interest payments for the mortgage of up to a limit of 13,200 CHF. Summing up all the applicable expenditures, means-tested supplemental benefits guarantee a gross income of approximately 36,000 CHF for singles.

As shown in Table B.1, average annual means-tested supplemental benefits, conditional on claiming, for retired beneficiaries in 2008 were CHF 9,600 for single beneficiaries. The cost-of-living allowance, the health insurance premium, and rent payments are the largest categories on the expenditure side, while interest payments on mortgages are negligible. Because the value of a home is taken into account in the calculation of means-tested benefits, home owners rarely qualify for means-tested benefits. The main source of income, other than means-tested benefits, are first pillar benefits.

Table B.1

3.3. Benchmark parameters

In this section we set the parameter values for our specification of the life-cycle model, which are displayed in Table B.2. Our aim is to be as close as possible to the Swiss case to compare the results of the simulations with actual choice. Following related literature (Pang and Warshawsky (2010), and Yogo (2009)) we set the time preference discount factor, β, equal to 0.96. The risk aversion coefficient γ is assumed to be 3, which is consistent with Ameriks et al. (2010). As we consider individuals after retirement we set the time range from $t = 1$ to time $T = 36$, which corresponds to age 65 and 100 respectively. The survival probabilities are the current male survival probabilities in Switzerland and are obtained from the Human Mortality Database.[9] We assume a certain death at age 100.

The equity return is normally distributed with a mean annual nominal return, μ_R, of 6.5% (corresponding to a equity premium of 4%) and an annual standard deviation, σ_R, of 20%, which is in accordance with historical stock performance. The mean instantaneous short rate is set equal to 2.5%, the standard deviation to 1%, and the mean reversion parameter to -0.15. The correlation between the instantaneous short rate with the expected inflation is 0.4. The parameters for the inflation dynamics are estimated with data from the Swiss National Bank. Mean inflation is equal to 1.79%, the standard deviation of the instantaneous inflation rate is equal to 1.12%, the standard deviation of the price index equals 1.11%, and the mean reversion coefficient equals -0.165.

[9] We refer for further information to the website, www.mortality.org.

For old-age insurance we calibrate the model to the Swiss case. The I pillar annuity income, Y_1^I equals CHF 24,000 and is adjusted for inflation annually. This number approximately corresponds to the average first pillar income of individuals covered by occupational pensions. The gross guaranteed income level to determine the means-tested benefits, $\tilde{M}_t$, is CHF 36,000 in real terms. Under this assumption the maximum amount of means-tested benefits, M_t is CHF 12,000.[10] The fraction of wealth g that is taken into account when calculating the means-tested benefits is 0.1.[11] The conversion rate c that is used to translate the accumulated capital into a yearly nominal annuity income is set to 7.2%, which corresponds to the conversion rate applied to second pillar wealth for the period of our data. The lump sum tax τ_{ls} and the income tax τ_Y are progressive; the exact numbers are displayed in Appendix B. The applicable tax rates on income and lump sum payments are taken from the largest Swiss city, Zurich. Zurich's tax burden lies in the middle of all Swiss regions.

Table B.2

4. Data description, limitations and summary statistics

4.1. Data description

Our analysis relies on *administrative records* at the individual level from several Swiss companies with an autonomous pension fund and several large Swiss insurance companies that provide occupational pension plans for small and medium sized companies. For the companies in our sample, we were given information about all employees who retired over the period 1996 to 2006. Each individual is observed only once at retirement. The main sample consists of 23,637 men and 8,432 women. The data contains information on the date of birth, the retirement date, annuitization decision, amount of accumulated pension wealth, and conversion factor as well as company specific pension scheme information such as default and cash-out options.

[10] The average means-tested benefits actually paid out, conditional on means-tested benefits being positive, is CHF 9,600. This is less than the maximum of CHF 12,000, because in many cases only a fraction of the maximum means-tested benefits is payed out, because agents have positive pension wealth and/or non-pension wealth. This is similar in our simulations, were agents with a wealth level of for instance CHF 50,000 can apply for a fraction of the maximum means-tested benefits.

[11] We abstract from the threshold for wealth over which the fraction g is calculated, because this would add another maximization function into the budget constraint which would complicate the numerical optimization procedure even more. Furthermore, the threshold is only CHF 25,000 hence our assumption will not change the results much.

Since the amount of means-tested benefits depends on *total* wealth, information on non-pension wealth is important. This information is not recorded in the administrative data. Therefore, we utilize asset data from the first wave of the *Survey of Health, Aging and Retirement in Europe* (SHARE) in 2003 to estimate a distribution of liquid an illiquid non-pension wealth, see Tables B.3 and B.4. We see that 33% of retirees has a liquid non-pension wealth below CHF 50,000 and almost 11% of retirees has liquid non-pension wealth over CHF 550,000. Agents are heterogeneous in non-pension wealth and we take this into account when calculating the fraction of agents that annuitizes their pension wealth. If an agent has for instance non-liquid non pension wealth higher than CHF 96,000, this agent will not be eligible for means-tested benefits. So we assume that 58.1% of agents is not eligible for means-tested benefits and use the corresponding optimal annuity demand. In doing so, we assume that liquid and illiquid non-pension wealth are independent of each other and independent of pension wealth. We calculated these correlations using the SHARE data and they are low; the correlation between liquid and illiquid non-pension wealth is -0.01 and the correlation between pension wealth and total non-pension wealth, liquid non-pension wealth, and illiquid non-pension wealth is respectively 0.04, 0,16, and 0.14. The distributions of liquid and illiquid non-pension wealth will be used to calculate a weighted average of the optimal annuitization levels. Liquid non-pension wealth (NPW) corresponds to the sum of values of on the bank accounts, government and corporate bonds, stocks, mutual funds, individual retirement accounts, contractual savings for housing, cars and life insurance policies minus financial liabilities. Illiquid NPW is defined as the sum of the values of the primary residence net of the mortgage, other real estate, and the owned share of own business. Total NPW is the sum of liquid and illiquid NPW.

Table B.3

Table B.4

4.2. Data restrictions and limitations

Our administrative data does not always record marital status and there is no information concerning the age or income of the spouse. Therefore, we perform the simulation exercise for a single person household, although many retirees in our sample do not live in single person household. We are well aware of the importance of both marital status per se and socio-economic characteristics of the spouse (in particular age and income/wealth). However, even if such data was available, we expect the qualitative effects to be similar for married and single men. Our data spans a time in which wives did not work much and thus the additional pension wealth for married men in the second pillar can be expected to be small. Moreover, the additional income of the first pillar for the spouse just covers the additional expenditures that are credited against means-tested benefits. Hence, for a given second pillar income, a married couple faces a very similar trade-off as a single men. Bütler and Teppa (2007) in fact find little difference in the annuitization rates between married and single men for those pension funds that do provide information about marital status. The higher money's worth of the annuity for married individuals (due to survivor benefits and higher life expectancy) seems to be offset by a lower demand for insurance of married couples and/or bequest motives.

We restrict the data on annuitization decisions to men only. Women are not considered in the analysis as a number of important social security reforms implemented in recent years primarily affected women (such as an increase in the retirement age for women from 62 to 64 and the introduction of child care credits). We would also expect that neglecting the spousal income has larger consequences for women than for men, thereby making the difference in decisions across (unobserved) marital status more pronounced.

Because tax rates and tax schedules vary across Swiss cantons and municipalities, an individual's residence is potentially important for the annuitization decision. Unfortunately, this information is not recorded in the data. We therefore use data on applicable tax rates on income and lump sum payments from the largest city in Switzerland, Zurich. The tax rates are presented in Appendix B.

4.3. Summary statistics

Table B.5

Table B.5 reports key statistics for the variables of interest. Early retirement, starting at age 55, as well as working beyond planned retirement is possible. However, the average retirement age is close to the statutory retirement age of 65 for men. Average total pension wealth is about CHF 250,000. Furthermore, we can see from Table B.5 that a large fraction of the beneficiaries chose a polar option, either full lump sum or full annuity. The mean conversion rate in the mandatory part is 6.9, which is slightly lower than what we use in the life-cycle model. The reason is that some agents retire early and their conversion rate is lower, thereby lowering the mean conversion rate. 7.2% is the conversion rate at age 65.

Figure B.1

Figure B.1 illustrates the relationship between the pension wealth and the annuitization level of pension wealth for wealth levels below 700,000 CHF. The solid line represents the fitted values from a non-parametric regression of the fraction of pension wealth withdrawn as an annuity on pension wealth using a locally weighted regression (the bandwidth is set to 0.8).[12] The average annuitization level of pension wealth is very low for low levels of occupational pension wealth and increases continuously for higher levels of second pillar wealth. Note that most agents choose either 100% annuitization or 0% annuitization, hence this graph shows that the fraction of agents that annuitizes pension wealth increases with pension wealth. Agents are heterogeneous in their liquid and illiquid non-pension wealth, which gives some retirees an incentive to annuitize, while for the rest taking the lump sum is optimal. However, as pension wealth increases, the propensity for retirees to take the annuity instead of the lump sum increases. Furthermore, this pattern can be viewed as informal evidence that means-tested benefits affect the annuitization decision.

Given that the annuity is a normal income subject to income taxes, this additional income increases the effective marginal tax rate under the annuity option. The lump sum, on the other hand, is taxed only once and treated independently of other income. As illustrated in Figure B.2, this differential tax treatment implies that the present value of the lump sum's total tax bill is almost always smaller and increases at a lower rate that the annuity's tax burden, especially for larger capital stocks.

Figure B.2

5. Results: the effect of means-tested benefits on annuitization

First we show the optimal fraction of second pillar pension wealth taken out as an annuity for various pension wealth and non-pension wealth levels predicted by our life-cycle model and illustrate the trade-offs that retirees face due to means-tested benefits. In Section 5.3 we compare these findings with the observed annuitization decisions concerning the second pillar pension wealth of retirees. We find that we can match the actual pattern of annuitization well.

[12]The locally weighted regression runs a separate regression for each observation in the data using observations in the neighborhood of that observation (and giving more weight to observations close to the observation of interest). Based on the estimate a fitted value is calculated for each observation. The line in the graph is the line through all these fitted observations.

5.1. *Optimal annuity demand: An illustrative example*

In this section we illustrate, with a simplified model, the trade-offs that agents face when deciding how much to annuitize. In this example we abstract from inflation, equity, taxes, and non-pension wealth. Whether to take a lump sum or an annuity (or a combination) depends on the consumption patterns that both options generate. The optimal consumption levels if the entire pension wealth is annuitized or taken as a lump sum are displayed in Figure B.3 for two different wealth levels.[13] When focussing on the graph on the left-hand side (pension wealth level of CHF 200,000), we see that the consumption stream for the first 10 years of retirement is much higher when the lump sum is taken than if the pension wealth is annuitized. After that consumption is slightly lower when the lump sum is taken compared to the full annuitization case, about CHF 2,000 lower per year. As the annuity income that can be generated via annuitizing all wealth (CHF 38,000), differs only to a small extent from the guaranteed income (CHF 36,000), it is optimal to take the lump sum, consume large amounts in the first retirement years, and subsequently apply for means-tested benefits in case the individual is still alive.

When comparing the consumption patterns if the wealth level is CHF 350,000, we see that, when the lump sum is taken, the consumption level is again higher for the first 10 years. However, after the lump sum is drawn down the difference between the annuity income (CHF 49,000) and the guaranteed level due to means-tested benefits (CHF 36,000) is much higher for this wealth level. Hence for this higher wealth level it is optimal to annuitize everything, because benefits from annuitization, a flat consumption pattern and receiving the wealth enhancing mortality credit, outweigh the benefits from a lump sum, receiving "free" wealth in the form of means-tested benefits.

Figure B.3

5.2. *Optimal annuity demand: The full model*

The illustrative example above ignored inflation, equity, taxes, and non-pension wealth. In this section we include step by step these important factors for annuity demand and determine the optimal annuitized fraction for individuals with different levels of pension wealth. Figure B.4 displays the optimal fraction of second pillar pension

[13] Note that the optimal consumption strategy is to consume the entire annuity income, because in this illustrative example we assume that the only risk that individuals face is longevity risk.

wealth annuitized as a function of pension wealth for different levels of means-tested benefits. Inflation and equity risk are included, but we assume taxes and non-pension wealth to be zero, both assumptions will be relaxed below. The dashed-squared line is for the case where agents can not apply for means-tested benefits. When pension wealth is CHF 100,000, agents optimally annuitize 50% of their pension wealth, whereas if pension wealth amounts to CHF 600,000 the optimal fraction annuitized is 90%.

There are two other reasons why agents annuitize less than 100%.[14] First, they want to keep a certain amount liquid to invest in equity. Agents face only inflation risk, but no background risk and income risk, hence the amount of risk that they are willing to hold via the equity market is high. This generates incentives to take at least a small part as a lump sum to increase the consumption levels in the future. Second, the annuity is a nominal annuity, while agents face inflation risk and prefer a real annuity.[15]

Figure B.4

The optimal annuity demand decreases when the means-tested benefits increase. Comparing the dashed-squared line (no means-tested benefits) with the dashed-dotted line (maximal means-tested benefits CHF 12,000), we see that the optimal fraction annuitized is lower if the government provides means-tested benefits. Retirees with a pension wealth equal and below CHF 500,000 optimally do not annuitize at all when the maximum means-tested benefits are equal to CHF 12,000. In that case agents should optimally take the lump sum, consume considerable amounts during early retirement years to draw down the lump sum, and subsequently apply for the generous means-tested benefits of CHF 12,000. The optimal fraction annuitized increases with pension wealth, since (1) choosing the lump sum generates a less-smooth consumption pattern for higher levels of pension wealth and (2) the difference between the guaranteed income and the annuity income resulting from full annuitization increases with the level of pension wealth. In more detail: If pension wealth is high, consumption is really high during the first retirement years while in later years the consumption equals the first pillar income plus the means-tested benefits (thus a very non-smooth

[14]Note that 50% annuitization seems low, but this is 50% annuitized of *pension wealth*, not *total wealth*. Agents already have more than 75% of their total wealth annuitized in the form of I pillar annuity income. The latter (CHF 24,000) is equivalent to a net present value of more than CHF 300,000.

[15]As expected, when running the simulations and excluding inflation risk and the possibility to invest in equity results in optimal annuitization levels of 100%.

consumption pattern for high pension wealth levels). However, for individuals with such a high pension wealth, an annuity income well above the means-tested benefits can be generated. These retirees optimally take the annuity as it generates a smooth and high consumption level over the entire lifetime. At a certain threshold the benefits from taking the lump sum, receiving "free wealth", are thus outweighed by the advantage of annuitizing, a smooth consumption pattern and receiving the wealth enhancing mortality credit.

In the previous results we abstracted from non-pension wealth assuming that agents have zero non-pension wealth, neither liquid nor illiquid. Figure B.5 shows the effect of liquid non-pension wealth on annuity demand. Furthermore we also include taxes, which we previously abstracted from. By comparing the dashed-dotted line in Figure B.5 and the dashed-dotted line in Figure B.4 we can disentangle the effect of taxes. Both graphs display the optimal annuitization levels if liquid non-pension wealth is zero and means-tested benefits of CHF 12,000 can be claimed. The only difference between those two lines is that in Figure B.5 taxes are included. For all pension wealth levels, the optimal annuitization levels are lower or equal for the case in which taxes are included. Progressive rates in both the income tax (which is levied on the annuity) and the tax on the cash-out, as well as the preferential tax treatment of the lump sum, induce a shift towards a higher cash-out rate for a given capital stock.

Figure B.5

The main purpose of Figure B.5 is to show the effect of liquid non-pension wealth on optimal annuity demand. The distinction between *liquid* and *illiquid* non-pension wealth is important, since liquid wealth can be drawn down and subsequently agents can receive means-tested benefits. While retirees can not easily draw down illiquid non-pension wealth, such as a house. For this reason almost no home owners can apply for means-tested benefits. If agents have large amounts of liquid non-pension wealth, they need to draw down not only the lump sum but also, on top of this, the liquid non-pension wealth to be able to apply for means-tested benefits. In Figure B.5 we present the effect of liquid non-pension wealth on the optimal fraction annuitized. We see that for higher levels of liquid non-pension wealth the optimal annuitization levels rises. This is intuitive since higher amounts of liquid non-pension wealth generate a very non-smooth consumption path over the life cycle, since retirees have to draw down also the liquid non-pension wealth to be able to apply for means-tested benefits.

Hence, if the agent takes the lump sum, the consumption pattern in expectation is extremely high in early years, and much lower later in life, which generates a welfare loss.

5.3. Comparing optimal annuity demand with observed decisions

We showed in Section 4.3 that when examining the data, the fraction of individuals who take an annuity depends positively on the amount of pension wealth. Individuals with low pension wealth levels are more likely to take the lump sum, while individuals with higher levels tend to annuitize their pension wealth. We hypothesize that means-tested benefits reduce the annuity demand in Switzerland and can explain the annuitization pattern found in the data. In Figure B.6 we compare the empirical annuitization pattern with the optimal annuitization pattern determined via the calibrated life-cycle model.

The solid line is the fitted regression line of the empirically observed fraction of accumulated pension wealth taken as an annuity. The non-parametric regression line illustrates the relationship between pension wealth and the fraction taken as an annuity.[16] Most agents either fully annuitize or take their entire pension wealth as a lump sum. Hence the solid line presents the fraction of individuals that take an annuity for varying pension wealth levels. The dashed line are the findings from the full life-cycle model including the eligibility of means-tested benefits.

When calculating the graph for the predicted annuity levels, we take into account that many factors, which are heterogenous among retirees, influence the annuity decision, most importantly liquid pension wealth and illiquid pension wealth. We use the empirical distribution of non-pension wealth, both liquid and illiquid, from the SHARE data, to calculate the propensity to annuitize for different pension wealth levels. More precise, the graphs in Figure B.6 show the weighted average of all the optimal annuitization levels as a function of second pillar pension wealth levels, taking into account liquid and illiquid pension wealth. The weights depend on the fraction of agents that fall into a certain category regarding the amount of liquid and illiquid pension wealth, assuming independency between second pillar pension wealth, liquid pension wealth, and illiquid pension wealth.[17] The distribution of liquid and illiquid pension wealth

[16]The solid line shows the fitted values from a locally weighted regression with the empirically observed fraction of pension wealth annuitized as dependent variable and pension wealth as independent variable. The bandwidth is set to 0.8.

[17]For instance, 58.1% of agents has illiquid non-pension wealth above CHF 96,000, which means

which we used to calculate the optimal annuitization pattern is displayed in Tables B.3 and B.4.

Both in the data and the model predictions, the likelihood of individuals to take the annuity increases with pension wealth. Note that the graphs do not imply that an individual with for instance a pension wealth of CHF 400,000 optimally annuitizes about 30% of his pension wealth. The 30% should be interpreted as a likelihood to annuitize averaged over all individuals with the same pension wealth. These agents differ in their liquid and illiquid non-pension wealth and thus whether it is optimal to annuitize or take the lump sum. When comparing the dashed line (model prediction with means-tested benefits) to the dotted line (model prediction without means-tested benefits) it is obvious that the predicted annuitization rate drops dramatically when agents can claim means-tested benefits. Comparing the optimal annuitization levels with means-tested benefits (dashed line) with the data (solid line), we find that both lines are remarkably close. Our calibrated life-cycle model with means-tested benefits can explain the empirically observed annuitization patterns in Switzerland well.

Figure B.6

In the data we saw that almost all agents choose either for full annuitization or full lump sum, only 6% chooses for a mix (see Table B.5). Thus when interpreting Figure B.6 which displays, for instance, that for agents with CHF 200,000 the average fraction annuitized is 50%, this means that about 50% of agents choose full annuitization and 50% choose the lump sum. We see a similar pattern for the simulations, the number of 0/1 decisions is high, 65%. Since the annuity is nominal and agents would like to invest in equity, slightly less than 100% annuitization can be optimal. However, in reality individuals tend to round of numbers hence most agents choose either 0% or 100%, not for instance 90%.

---

that they will not be eligible for means-tested benefits. Hence to calculate the propensity to annuitize (solid line), we use the optimal annuity demand corresponding to agents that can not claim means-tested benefits for this 58.1%. The independence assumption may be questioned, but it corresponds to the fact that the SHARE data do not show any correlation between non-pension wealth and pension wealth. A possible interpretation of this finding is that individuals with low pension wealth may compensate by saving more outside the second pillar. It could also be that individuals with high levels of non-pension wealth work less and thus accumulate less pension wealth (income effect).

5.4. *Alternative explanations and robustness tests*

Although the data fits the model's prediction well, other explanations might also be compatible with the observed annuitization pattern, most importantly differential mortality. It has been documented in the literature that wealthy people tend to live longer than less wealthy individuals (De Nardi et al. (2010)). De Nardi et al. (2010) find a difference of 4.6 years for a 70-year old when comparing the lowest income quintile with the highest for the US. Since the wealthy live longer in expectation, the annuity is relatively more attractive for them than the lump sum, compared to the less wealthy retirees. This could in theory explain the observed annuitization pattern to some degree. Unfortunately there are no data on mortality differences by pension wealth in Switzerland. However, it is very likely that mortality difference do not suffice to explain the cash-out pattern in Switzerland for the following reasons. First, differential mortality is far less prevalent in European countries than in the US. Kalwij et al. (2009) find that the difference between 65-year old men with a low income (defined as minimum income or no income) and 65-year old men with a high income (defined as two times the median) is at most 3 years, which is substantially less than in the US. Kalwij et al. (2009) use data from the Netherlands, which is a country that resembles Switzerland in terms of income distribution and health care. In addition, Kalwij et al. (2009) also reference similar studies concerning other European countries which find a differential of only 2 years. Reasons for the divergence between the US and Europe in mortality differences between income levels may be a more equal income distribution and universal health care coverage in most continental European countries. Another reason why differential mortality most likely can not explain the observed annuitization pattern in Switzerland is that our data does not include the poorest individuals which usually account for most of the mortality differential.

A crude test on the importance of differential mortality for the annuitization decision in Switzerland is to compare cash-out patterns for men and women. Longevity differences between rich and poor individuals are much lower for women than for men. As a consequence we should observe a much steeper annuitization profile for men than for women. Figure B.7 does not support this interpretation, although the data on female cash-out decisions suffer from the mentioned shortcomings (changes in pension law, importance of marital status).

Figure B.7

Pashchenko (2010) tests the implications of a consumption floor on optimal annuity decisions, which is different from means-tested benefits. A consumption floor is a guaranteed income level in case the agent has no sufficient income and no wealth to be able to consume the guaranteed level. Hence the supplemental income from the government gets reduced one-for-one with the wealth of the agent. In the US a consumption floor is instated and agents can only apply for Supplemental Security Income (SSI) if they have wealth below $2,000. In contrast, means-tested benefits are more generous, since only a fraction of total wealth is taken into account when calculating the supplemental income (In Switzerland one-for-ten reduction, since the factor is 0.1.). Pashchenko (2010) finds that the participation level in the annuity market decreases for higher levels of the consumption floor. Similarly, Peijnenburg et al. (2011b) show that the level of annuitization is a decreasing function of a minimum consumption level. In Figure B.8 we compare the effect of means-tested benefits (dashed line) and a consumption floor (dotted line). The propensity to annuitize is lower when agents are offered means-tested benefits compared to a consumption floor. This is intuitive since means-tested benefits are more generous than a consumption floor and thus offer more protection against longevity risk. Hence modeling government supplements as a consumption floor instead of means-tested benefits, the latter being prevalent in most western countries, understates the effect that supplemental government income has on annuity demand.

Figure B.8

6. Policy implications

Means-tested benefits offer free longevity risk insurance to the individual. However, this can be very costly for the social insurance system because means-tested benefits create an externality on annuitization decisions. Individuals take means-tested benefits into account and annuitize a smaller fraction of their pension wealth than they would do otherwise. In this section we quantify the costs of paying out means-tested benefits. We compare the costs of the benchmark case, (1) means-tested benefits, with alternative poverty-alleviation schemes in old age: (2) mandatory annuitization (as for example in the Netherlands), (3) a minimum income requirement (MIR, as in the UK) and (4) a consumption floor (comparable to the US case).

All schemes we compare in this section guarantee the same gross minimum income in old age (CHF 36,000 per year), but do this in different ways. As a benchmark case we use the Swiss scheme to which our model is calibrated. Recall that this *means-tested benefits* scheme does not put any restrictions on the individual's annuitization choice and retirees are allowed to keep a certain amount of wealth and still be eligible for supplemental income. Furthermore, we compute the costs for the government of *mandatory full annuitization* of the entire second pillar pension wealth. In that case agents can still keep a certain amount of wealth and remain eligible for supplemental income, but they have no freedom about the fraction annuitized. Alternatively, individuals are required to annuitize up to an amount that would guarantee a nominal consumption equal to the level provided by means-tested benefits. This is the so-called *minimum income requirement* (MIR) which is used in the UK. To guarantee an income equal to the state guaranteed income level, agents need to annuitize at least CHF 167,000 of their pension wealth.[18] Analogue to the previous two cases, agents are allowed to keep a certain amount of wealth, and we assume that the rules in that respect are similar for all three schemes. Note that for lower pension capital stocks a minimum income requirement scheme is tantamount to mandatory full annuitization. As a final alternative we consider a *consumption floor* equal to the income guaranteed by means-tested benefits. As in the benchmark case this scheme puts no restrictions on the cash out decision. It ensures that a retiree will always consume an amount deemed necessary to finance a decent living, but it requires individuals to run down their entire wealth before applying for supplemental financial assistance.

To quantify the public costs of the different schemes we calculate the average net present value of means-tested benefits a person claims over a life time. We perform this analysis for varying levels of pension wealth and two levels of liquid non-pension wealth (NPW). Tables B.6 (for non-pension wealth of zero) and B.7 (NPW = CHF 200,000) show the average net present value of means-tested benefits per person for the four policies described above. An individual with a pension wealth of CHF 100,000 and zero non-pension wealth generates average costs of CHF 146,000 due to supplemental income if he can claim means-tested benefits, i.e. if he is free to cash out his entire pension wealth and is allowed to keep a certain amount of wealth liquid. For an individual with the same wealth level, mandatory full annuitization would decrease the net present value of costs to CHF 101,000, and the consumption floor policy would decrease the costs to CHF 95,000. The average costs in case retirees face a minimum

[18]A pension wealth income of approximately CHF 167,000 generates an income of CHF 12,000, using a conversion rate of 7.2%.

income requirement is similar as with mandatory annuitization, CHF 101,000, because for low pension wealth levels agents are obliged to fully annuitize their pension wealth levels. For higher pension wealth, the average costs of supplemental income schemes are lower as the agents need to draw down more wealth before being eligible for means-tested benefits. Wealthier agents thus apply for means-tested benefits at a later age. Note that the costs for the government if means-tested benefits are in place are always higher compared to the minimum-income requirement, and that the minimum income requirement is always more expensive than mandatory full annuitization. This is intuitive, because the wealth levels that agents are allowed to keep and still be eligible is exactly the same, the only difference between the schemes is the level of (mandatory) annuitization.

Table B.6

Table B.7

The difference in costs between the poverty-alleviation schemes is smaller for low levels of pension wealth compared to intermediate levels of pension wealth. Individuals with low wealth levels can claim supplemental income regardless of the scheme in place. The difference in costs for the government becomes large both in absolute and relative terms for intermediate levels of pension wealth (CHF 200,000 to 400,000). It then decreases for higher capital stocks as more individuals choose to annuitize voluntarily, and are thus less likely to claim supplemental income. With the exception of very low levels of capital, mandatory full annuitization is the least costly policy for the government. It ensures that individuals with intermediate and high pension wealth levels can always care for themselves.

Figure B.7 compares the average social costs per person for an agent with CHF 200,000 of liquid non-pension wealth. As expected, the costs are substantially lower compared to the case that an agent has zero liquid non-pension wealth. The agent needs to draw down (most) of this liquid non-pension wealth before applying for supplemental income.

It can be the case that most of the utility gains generated by the government spending are negated due to externalities created by poverty-alleviation policies. For that reason, we explore the welfare differences between the four poverty-alleviation schemes and determine whether some policies generate similar utilities but have large cost differentials. The certainty equivalent consumption for the four schemes to alleviate poverty are presented in Figures B.9 and B.10. In terms of individual utility the benchmark policy, means-tested benefits, clearly dominates all other options as it (1) puts the least restrictions on individual choice and (2) offers the most generous protection (level of transfers to retirees is the highest). Using the same argument the minimum income requirement scheme dominates the mandatory full annuitization system. The ranking of the consumption floor relative to the minimum income requirement and mandatory full annuitization case is not a priori clear. Furthermore, we see that the utility from the consumption floor scheme (with unrestricted cash-out decision) is very close to the utility when imposing a minimum income requirement. Combining Table B.6 and Figure B.9, we see that neither of the policies can generate similar utilities without being also more costly, hence no poverty-alleviation policy is dominated by another.

Figure B.9

Figure B.10

We demonstrate that it is possible to provide income protection in old age at substantially lower costs than the means-tested benefits scheme in place in many western countries. This can either be achieved by using a consumption floor or requiring individuals to annuitize a certain - albeit limited - amount of their pension wealth. Both policies impose less restriction on individual choice than mandatory annuitization and at the same time reduce the negative externalities individuals generate by strategically reducing the fraction of pension wealth annuitized. Lowering the costs for the government has large distributional consequences. It reduces the redistribution from the wealthy to the less wealthy among the retired, but also the redistribution from the young to the old in case the supplement income is paid out of general government revenues.

7. Conclusions

In this paper we examine the effect of means-tested benefits on optimal annuitization decisions of individuals at retirement. Means-tested benefits, which are typically thought of as poverty protection in old age, act like an additional insurance against the financial consequences of longevity. They may thus induce retirees to take the lump sum, draw it down to consume out of it, and subsequently apply for means-tested benefits when the lump sum is (largely) depleted. To quantify the impact of the incentive on the cash-out decision of an individual, we construct a rich life-cycle model in which individuals can rely on means-tested benefits in case their income is below a certain level. The model is then calibrated to Switzerland, a country for which the incentive is particularly strong due to a combination of a high guaranteed income and sizeable levels of pension wealth that can be cashed out.

The results from our life-cycle model indeed demonstrate that means-tested benefits substantially decrease the optimal annuity demand. Not surprisingly the effect is more pronounced for low wealth levels. If the pension wealth level is low the annuity income generated does not differ much from (or may even be smaller than) the guaranteed income. Taking the lump sum, consuming out of this, and then applying for means-tested benefits generates a higher consumption level. For high pension wealth levels, on the other hand, the annuity income is much higher than the income guaranteed by means-tested benefits. In that case the value of the longevity insurance implied by the annuity (also known as mortality credit) dominates the incentives of the free means-tested supplemental benefits.

In a second step we compare the results from the model with observed annuitization behavior. Our data consists of 22,000 individual retirement decisions provided by a number of Swiss pension funds. The predictions from the life-cycle model with means-tested benefits are close to the empirically observed annuitization pattern in Switzerland. The optimal annuity demand not only decreases due to means-tested benefits, but also generates a pattern that is remarkably close to the data both in terms of level and the correlation with pension wealth.

Although we derived the quantitative impact of means-tested benefits on the decision to annuitize for a single country, our results have further-reaching implications for the adequacy of income provided in old age. A partial shift from first to second pillar income provision in old age, as discussed in many countries, has to be evaluated carefully with respect to incentives that are created when allowing individuals to cash out second pillar wealth. A generous protection against poverty in old age may generate a strong tendency to quickly deplete pension wealth and apply for means-tested benefits — and thus potentially high costs for the welfare system. Policy makers will have to trade-off the benefits of leaving the annuitization choice to the individuals and the costs from doing so.

References

Ameriks, J., A. Caplin, S. Laufer, and S. Van Nieuwerburgh (2010). The joy of giving or assisted living? using strategic surveys to separate public care aversion from bequest motives. forthcoming in Journal of Finance.

Bernheim, D. (1991). How strong are bequest motives? evidence based on estimates of the demand for life insurance and annuities. *Journal of Political Economoy 99*, 899–927.

Brandt, M., A. Goyal, P. Santa-Clara, and J. Strond (2005). A simulation approach to dynamic portfolio choice with an application to learning about return predictability. *The Review of Financial Studies 18*(3), 831–873.

Brown, J., O. S. Mitchell, J. Poterba, and M. Warshawsky (2001). *The Role of Annuity Markets in Financing Retirement*. MIT Press.

Brown, J. R. (2001). Private pensions, mortality risk, and the decision to annuitize. *Journal of Public Economics 82*(1), 29–62.

Brown, J. R. (2007). Rational and behavioral perspectives on the role of annuities in retirement planning. *NBER Working Paper 13537*.

Brown, J. R., J. R. Kling, S. Mullainathan, and M. V. Wrobel (2008). Why don't people insure late life consumption? a framing explanation of the under-annuitization puzzle. *American Economic Review Papers and Proceedings 98*(2), 304–309.

Brown, J. R. and J. M. Poterba (2000). Joint life annuities and the demand for annuities by married couples. *The Journal of Risk and Insurance 67*(4), 527–553.

Bütler, M., S. Staubli, and M. G. Zito (2011). How much does annuity demand react to a large price change? mimeo, University of St Gallen.

Bütler, M. and F. Teppa (2007). The choice between an annuity and a lump-sum: Results from swiss pension funds. *Journal of Public Economics 91*, 1944–1966.

Carroll, C. (2006). The method of endogenous gridpoints for solving dynamic stochastic optimization problems. *Economics Letters 91*(3), 312–320.

Davidoff, T., J. Brown, and P. Diamond (2005). Annuities and individual welfare. *The American Economic Review 95*(5), 1573–1590.

De Nardi, M., E. French, and J. Jones (2010). Why do the elderly save? the role of medical expenses. *Journal of Political Economy 118*(1), 39–75.

Direr, A. (2010). The taxation of life annuities under adverse selection. *Journal of Public Economics 94*(1-2), 50–58.

Dushi, I. and A. Webb (2004). Household annuitization decisions: Simulations and empirical analyses. *Journal of Pension Economics and Finance 3*(2), 109–143.

Finkelstein, A. and J. Poterba (2002). Selection effects in the united kingdom individual annuities market. *The Economic Journal 112*, 28–42.

Finkelstein, A. and J. Poterba (2004). Adverse selection in insurance markets: Policyholder evidence from the u.k. annuity market. *Journal of Policital Economy 112*(1), 183–208.

Friedberg, L. (2000). The labor supply effects of the social security earnings test. *The Review of Economics and Statistics 82*(1), 48–63.

Friedman, B. and M. Warshawsky (1990). The cost of annuities: Implications for saving behavior and bequests. *Quarterly Journal of Economics 105*, 135–154.

Hu, W. and J. Scott (2007). Behavioral obstacles in the annuity market. *Financial Analysts Journal 63*(6), 71–82.

Hubbard, R., J. Skinner, and S. Zeldes (1995). Precautionary saving and social insurance. *The Journal of Political Economy 103*(2), 360–399.

Kalwij, A., R. Alessie, and M. Knoef (2009). Individual income and remaining life expectancy at the statutory retirement age of 65 in the netherlands. Netspar Discussion Paper 09/2009 - 033.

Koijen, R., T. Nijman, and B. Werker (2010). When can life cycle investors benefit from time-varying bond risk premia? *Review of Financial Studies 23*(2), 741–780.

Kotlikoff, L. J. and A. Spivak (1981). The family as an incomplete annuities market. *Journal of Political Economy 89*(2), 372–391.

Mitchell, O., J. Poterba, M. Warshawsky, and J. R. Brown (1999). New evidence on the money's worth of individual annuities. *American Economic Review 89*(5), 1299–1318.

Neumark, D. and E. Powers (1998). The effect of means-tested income support for the elderly on pre-retirement savings: Evidence form the ssi program in the u.s. *Journal of Public Economics 68*(2), 181–206.

Neumark, D. and E. Powers (2000). Welfare for the elderly: The effects of ssi on pre-retirement labor supply. *Journal of Public Economics 78*(1-2), 51–80.

OECD (2011). Pensions at a glance 2011: Retirement-income systems in oecd and g20 countries. www.oecd.org/els/social/pensions/PAG.

Pang, G. and M. Warshawsky (2010). Optimizing the equity-bond-annuity portfolio in retirement: The impact of uncertain health expenses. *Insurance: Mathematics and Economics 46*(1), 198–209.

Pashchenko, S. (2010). Accounting for non-annuitization. Working paper, University of Virginia.

Peijnenburg, K., T. Nijman, and B. Werker (2011a). The annuity puzzle remains a puzzle. Working paper, Tilburg University.

Peijnenburg, K., T. Nijman, and B. Werker (2011b). Health cost risk and optimal retirement provision. Working paper, Tilburg University.

Powers, E. (1998). Does means-testing welfare discourage saving? evidence from a change in afdc policy in the united states. *Journal of Public Economics 68*(1), 33–53.

Rothschild, C. (2009). Adverse selection in annuity markets: Evidence from the british life annuity act of 1808. *Journal of Public Economics 93*(5-6), 776–784.

Sefton, J., J. Van De Ven, and M. Weale (2008). Means testing retirement benefits: Fostering equity or discouraging savings? *Economic Journal 118*(528), 556–590.

Yaari, M. (1965). Uncertain lifetime, life insurance and the theory of the consumer. *Review of Economic Studies 32*(2), 137–150.

Yogo, M. (2009). Portfolio choice in retirement: Health risk and the demand for annuities, housing and risky assets. NBER Working Paper No. 15307.

Appendix A. Method to determine the optimal consumption and investment decisions

Appendix A.1. Summary problem

We want to optimize over consumption and asset allocation dynamically. The exogenous state variables are the risk free rate and inflation. The endogenous state variable is wealth. Agents receive means-tested benefits and the amount depends on wealth and income.

Appendix A.2. Life-cycle optimization problem

The objective is to maximize the expected lifetime utility which is equal to

$$V = E_0 \left[\sum_{t=1}^{T} \beta^{t-1} \left(\left(\prod_{s=1}^{t} p_s \right) \frac{C_t^{1-\gamma}}{1-\gamma} \right) \right] \tag{A.1}$$

where β is the time preference discount factor, γ denotes the level of risk aversion, and C_t is the real amount of wealth consumed at the beginning of period t. The probability of surviving to age t, conditional on having lived to period $t-1$ is indicated by p_t. We define the nominal consumption as $\overline{C_t} = C_t \Pi_t$ and Π_t is the price index. The gross nominal equity returns are denoted by R_t and the riskless bond yields a constant gross nominal return of R_t^f.

The budget constraint of the individual is equal to

$$W_{t+1} = (W_t + Y_t^I + Y_t^{II} + M_t - \overline{C_t})(1 + R_t^f + (R_{t+1} - R_t^f) w_t). \tag{A.2}$$

w_t denotes the weight invested in stocks and M_t are the means-tested benefits at the beginning of period t. The individuals nominal consumption is indicated by $\overline{C_t}$ and Y_t^I is the after tax income from first pillar pension wealth and Y_t^{II} from second pillar pension wealth. Net means-tested benefits equal:

$$M_t = \max(\tilde{M}_t - Y_t^I - Y_t^{II} - rW_t - gW_t, 0), \tag{A.3}$$

where $\tilde{M}_t$ is the net amount of consumption/income guaranteed by the government. If income plus return on wealth plus a fraction of wealth g is lower than $\tilde{M}_t$, agents receive means-tested benefits. Rewriting the budget constraint:

$$W_{t+1} = (W_t + Y_t^I + Y_t^{II} + \max(\tilde{M}_t - Y_t^I - Y_t^{II} - rW_t - gW_t, 0) - \overline{C_t})(1 + R_t^f + (R_{t+1} - R_t^f)w_t). \tag{A.4}$$

The timing is as follows, first an individual receives income and (possibly) means-tested benefits, after which the individual consumes. Subsequently the remaining wealth is invested.

The individual faces a number of constraints on the consumption and investment decisions. First, we assume that the retiree faces borrowing and short-sales constraints

$$w_t \geq 0 \text{ and } w_t \leq 1. \tag{A.5}$$

Second, we impose that the investor is liquidity constrained

$$\overline{C_t} \leq W_t, \tag{A.6}$$

which implies that the individual can not borrow against future annuity income to increase consumption today. Furthermore, the agent can not save out of its means-tested benefits, but has to consume them:

$$C_t = \min(C_t^*, \tilde{M}_t) \text{ if } M_t > 0 \tag{A.7}$$

where C_t^* is the optimal consumption resulting from the optimization procedure.

The optimization problem is solved via dynamic programming and we proceed backwards to find the optimal investment and consumption strategy. In the last period the individual consumes all remaining wealth, hence we exactly know the utility from terminal wealth. Specifically the value at time T is equal to

$$J_T(W_T, R_T^f, \pi_T) = \frac{(W_T + Y_t^I + Y_t^{II} + M_T)^{1-\gamma}}{1-\gamma} \tag{A.8}$$

The value function satisfies the Bellman equation

$$V_t(W_t, R_t^f, \pi_t) = \max_{w_t, C_t} \left(\frac{C_t^{1-\gamma}}{1-\gamma} + \beta p_{t+1} E_t(V_{t+1}(W_{t+1}, R_{t+1}^f, \pi_{t+1})) \right) \tag{A.9}$$

We define the portfolio return as:

$$R_{t+1}^{P} = 1 + R_t^f + (R_{t+1} - R_t^f)w_t \tag{A.10}$$

Furthermore we denote the wealth level after annuity income, consumption, and means-tested benefits as:

$$A_t = W_t + Y_t^I + Y_t^{II} - \overline{C_t} + \max(0, M_t) \tag{A.11}$$

Appendix A.3. First order conditions

In order to find the optimal consumption and investment decisions we derive the euler conditions. The optimal asset allocation follows from

$$\frac{\partial V_t}{\partial w_t} = E_t\left(\frac{1}{\Pi_{t+1}} C_{t+1}^{*-\gamma}(R_{t+1} - R_t^f)\right) = 0. \tag{A.12}$$

To obtain the consumption policies we take the first order condition with respect to C_t

$$\frac{\partial V_t}{\partial C_t} = C_t^{*-\gamma} - \beta p_{t+1} E_t\left(\frac{\partial V_{t+1}}{\partial W_{t+1}} \Pi_t R_{t+1}^{P*}\right) = 0 \tag{A.13}$$

and calculate the derivative of the value function with respect to W_t

$$\frac{\partial V_t}{\partial W_t} = \beta p_{t+1} E_t\left(\frac{\partial V_{t+1}}{\partial W_{t+1}} R_{t+1}^{P*}\right)$$

$$\text{if } \max(\tilde{M}_t - Y_t^I - Y_t^{II} - rW_t - gW_t, 0) = 0 \tag{A.14}$$

$$\frac{\partial V_t}{\partial W_t} = \beta p_{t+1}(1 - r - g) E_t\left(\frac{\partial V_{t+1}}{\partial W_{t+1}} R_{t+1}^{P*}\right)$$

$$\text{if } \max(\tilde{M}_t - Y_t^I - Y_t^{II} - rW_t - gW_t, 0) > 0. \tag{A.15}$$

To solve for the optimal consumption, substitute (A.14) and (A.15) into (A.13) to get the following first order condition

$$C_t^{*-\gamma} = \beta p_{t+1} E_t \left(\frac{\Pi_t}{\Pi_{t+1}} C_{t+1}^{*-\gamma} R_{t+1}^{P*} \right)$$
$$\text{if } \max(\tilde{M}_t - Y_t^I - Y_t^{II} - rW_t - gW_t, 0) = 0 \tag{A.16}$$
$$C_t^{*-\gamma} = \beta p_{t+1}(1 - r - g) E_t \left(\frac{\Pi_t}{\Pi_{t+1}} C_{t+1}^{*-\gamma} R_{t+1}^{P*} \right)$$
$$\text{if } \max(\tilde{M}_t - Y_t^I - Y_t^{II} - rW_t - gW_t, 0) > 0 \tag{A.17}$$

Due to the complexity of the model it cannot be solved analytically. Instead we use numerical optimization techniques to solve the problem. The procedure for the optimal asset allocation is described in Section 2.3 and below we elaborate on the method used to obtain optimal consumption levels.

Appendix A.4. Optimization procedure for optimal consumption

Similar when calculating the optimal asset weights, we regress the realizations of the Euler condition on a polynomial expansion in the state variables to obtain an approximation of the conditional expectation of the Euler condition. However, now we calculate two potential optimal consumption levels, for both euler conditions (A.16) and (A.17), corresponding to whether or not the agent receives means-tested benefits. Note that $C_t^{*mtb} > C_t^{*nomtb}$, where C_t^{*mtb} is the optimal consumption if an agent receives means-tested benefits and C_t^{*nomtb} if the agent does not receive means-tested benefits. It can be see from (A.16) and (A.17) that the optimal consumption with means-tested benefits derived from the maximization procedure is always higher due to the additional factor $(1 - r - g)^{-(1/\gamma}$, which is always higher than 1. The means-tested benefits can be calculated if we know the optimal consumption levels:

$$M_t^{mtb} = \frac{\tilde{M}_t - Y_t^I - Y_t^{II} - (r+g)(A_t + C_t^{*mtb} - Y_t^I - Y_t^{II})}{1 - r - g} \tag{A.18}$$
$$M_t^{nomtb} = \tilde{M}_t - Y_t^I - Y_t^{II} - (r+g)(A_t + C_t^{*nomtb} - Y_t^I - Y_t^{II}). \tag{A.19}$$

Hence for every time period and every trajectory we have a set of optimal consumption and means-tested benefits: (C_t^{*mtb}, M_t^{mtb}) and $(C_t^{*nomtb}, M_t^{nomtb})$. However, we need to determine which set is the optimal set. We know that if the income level is higher than the guaranteed consumption level, then an agent does not receive means-tested benefits and the optimal consumption level is C_t^{*nomtb}. In case $Y_t < \tilde{M}_t$, then the optimal consumption result from applying the following rules:

$$\text{If } M_t^{mtb} > 0 \cap M_t^{nomtb} > 0 \text{ then } C_t^{*mtb} \tag{A.20}$$

$$\text{If } M_t^{mtb} > 0 \cap M_t^{nomtb} < 0 \text{ then } C_t^{*mtb} \tag{A.21}$$

$$\text{If } M_t^{mtb} <= 0 \cap M_t^{nomtb} < 0 \text{ then } C_t^{*nomtb} \tag{A.22}$$

$$\text{If } M_t^{mtb} <= 0 \cap M_t^{nomtb} > 0 \cap |M_t^{nomtb}| < |M_t^{mtb}| \text{ then } C_t^{*nomtb} \text{ else } C_t^{*mtb}. \tag{A.23}$$

These rules are based on whether the implied means-tested benefits due to the optimal consumption level is viable. Focussing on A.20, we see that $M_t^{mtb} > 0$ and $M_t^{nomtb} > 0$. However, it should not be that the means-tested benefits implied by the no-means-tested benefits consumption level are positive; M_t^{nomtb} should not be positive. Hence C_t^{*mtb} is optimal.

Appendix B. Tax rates in Switzerland

We use the tax rates for singles, which are displayed in Table B.8.

Table B.8

Figure B.1: Empirical annuitization levels of second pillar pension wealth

We show the annuity decisions of retirees regarding second pillar pension wealth of Swiss pension funds. The dots are the decisions of individuals and the solid line is the fitted values from a non-parametric regression of the fraction of pension wealth withdrawn as an annuity on pension wealth using a locally weighted regression.

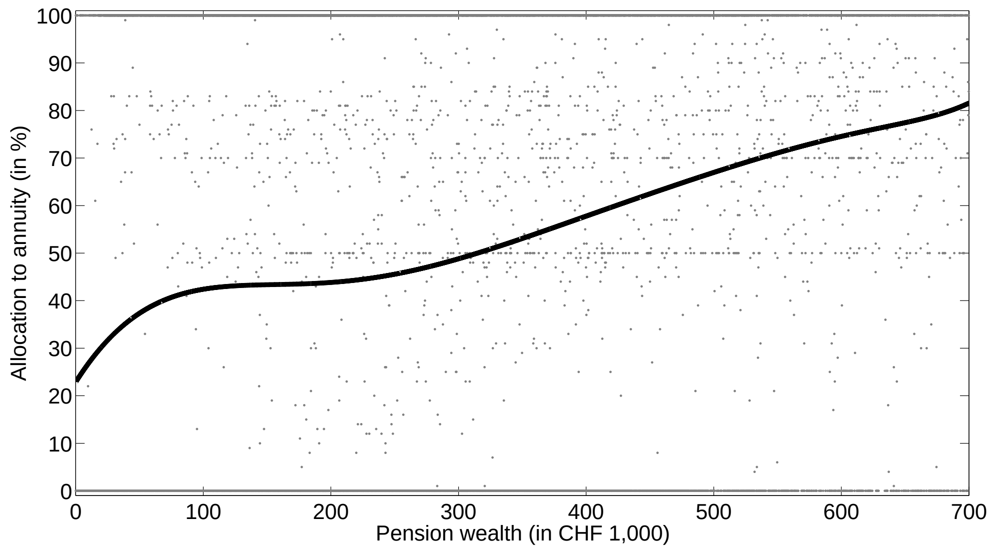

Figure B.2: Net present value of tax payments for the annuity and the lump sum

The taxes are discounted with a 3% interest rate and taking into account survival probabilities. Applicable tax rates are taken from the city of Zurich. All the parameters are as in the benchmark case.

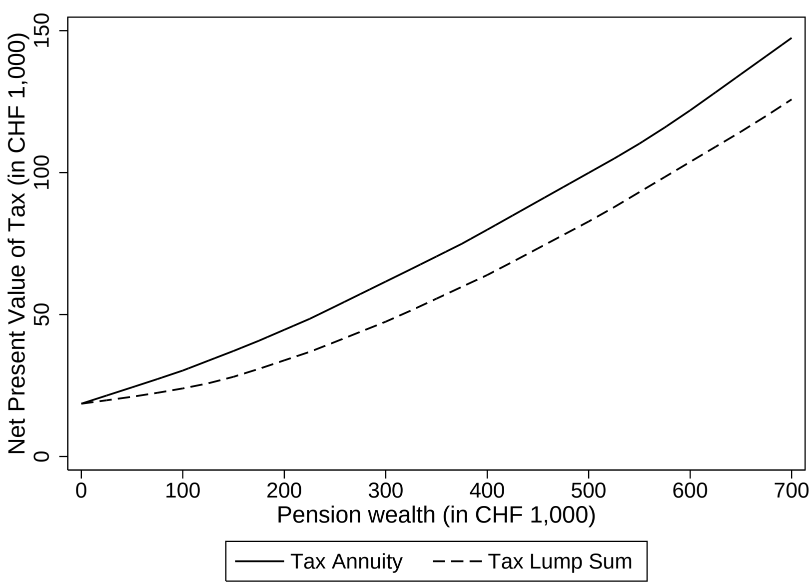

Figure B.3: Optimal consumption patterns: Illustrative example

The figure displays the consumption pattern if an individual (1) annuitized his entire pension wealth or took the (2) lump sum. Equity, inflation, non-pension wealth, and taxes are excluded from the model, the only risk that agents face is longevity risk. If the pension wealth level equals CHF 200,000 it is optimal to choose the consumption stream corresponding to taking the lump sum while if the wealth level is CHF 350,000 the consumption stream from full annuitization is preferred. The guaranteed income equals CHF 36,000.

(a) wealth CHF 200,000 (b) wealth CHF 350,000

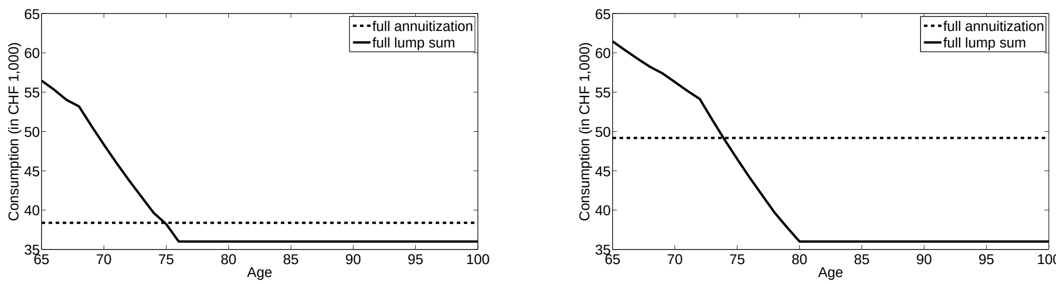

Figure B.4: Influence of means-tested benefits on optimal annuitization levels

The figure displays the optimal annuitization levels for varying levels of means-tested benefits. We assume the agent has zero non-pension wealth and does not pay taxes. The rest of the parameters are as in the benchmark case.

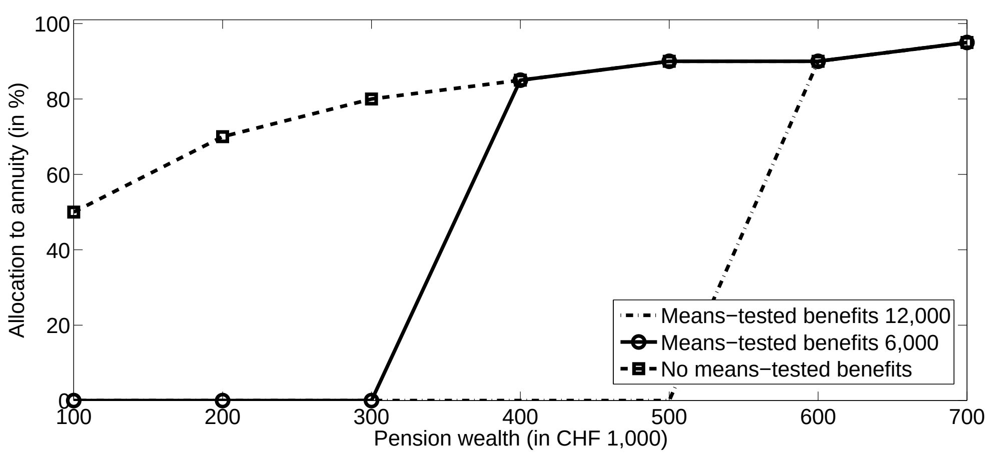

Figure B.5: Influence of liquid non-pension wealth on optimal annuitization levels
The figure displays the optimal annuitization levels for varying levels of liquid non-pension wealth. Agents can apply for means-tested benefits and taxes are included. We assume the agent has zero illiquid non-pension wealth. The rest of the parameters are as in the benchmark case

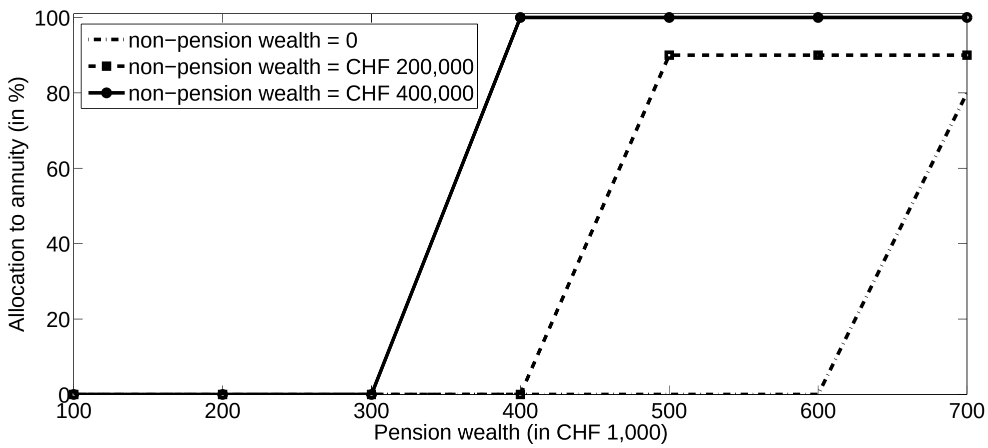

Figure B.6: Comparison optimal annuitization pattern and empirical annuitization pattern
The figure displays the optimal and the empirical average fraction annuitized for varying wealth levels. The optimal fraction is displayed for two cases: (1) assuming agents can apply for means-tested benefits (MTB) and (2) assuming they cannot apply for means-tested benefits. The optimal fraction is the weighted average of all the optimal annuitization levels for varying liquid-non pension wealth and illiquid non-pension wealth. Weights derived from the SHARE dataset are used, assuming independency between pension wealth, illiquid non-pension wealth, and liquid non-pension wealth. All the parameters are as in the benchmark case.

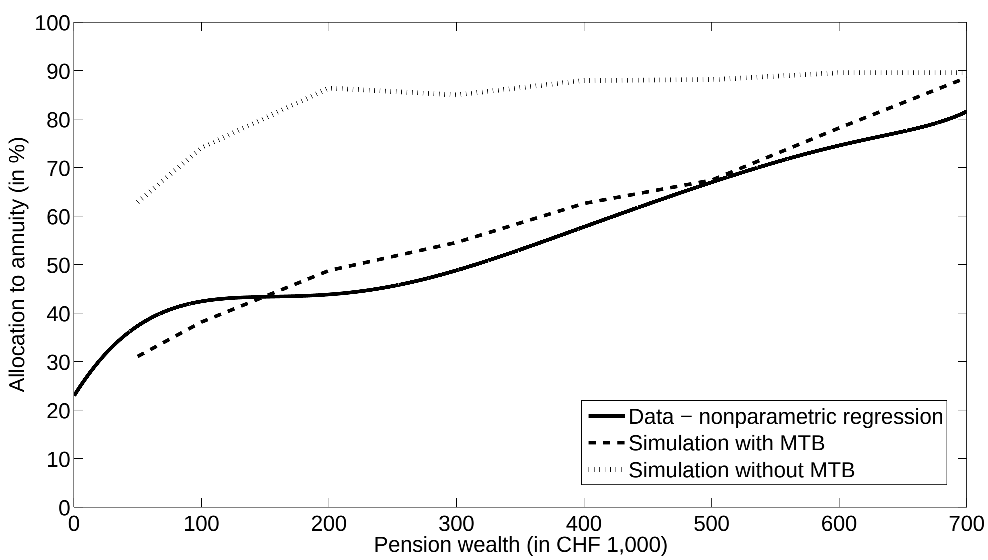

Figure B.7: Comparison empirical annuitization levels women and men
All the parameters are as in the benchmark case.

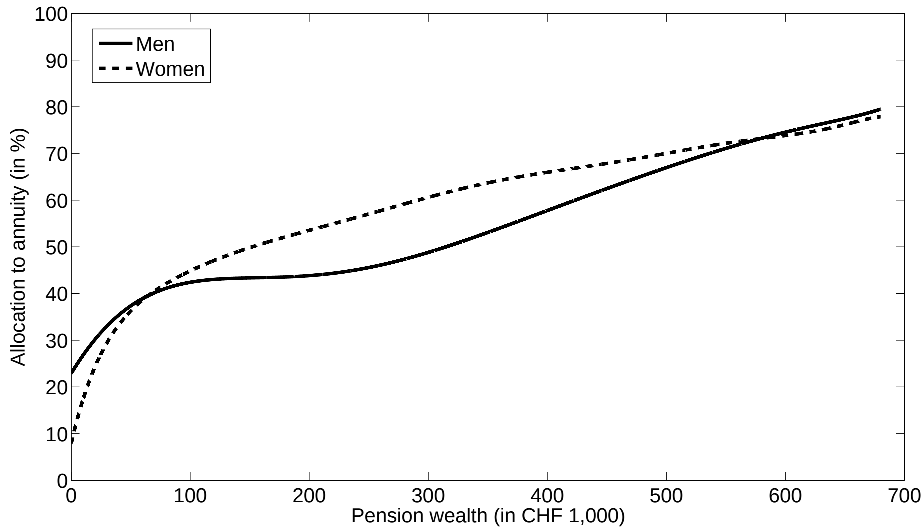

Figure B.8: Comparison of the influence of (1) means-tested benefits and (2) a consumption floor on optimal annuitization levels
The figure displays the optimal and the empirical average fraction annuitized for varying wealth levels. The optimal fraction is displayed assuming agents can receive (1) means-tested benefits or a (2) consumption floor. The optimal fraction is the weighted average of all the optimal annuitization levels for varying liquid-non pension wealth and illiquid non-pension wealth. Weights derived from the SHARE dataset are used, assuming independency between pension wealth, illiquid non-pension wealth, and liquid non-pension wealth. All the parameters are as in the benchmark case.

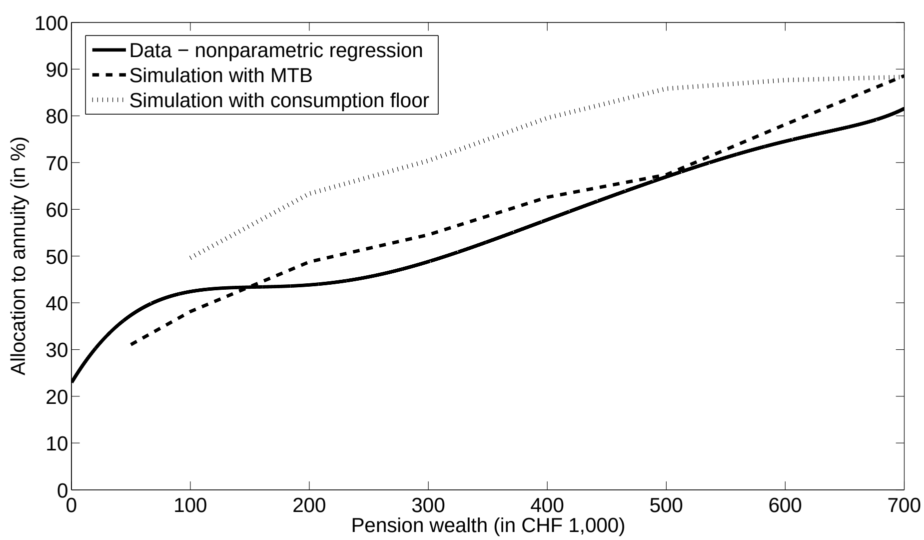

Figure B.9: Certainty equivalent consumption for different old-age poverty alleviation schemes, zero liquid non-pension wealth (in CHF 1,000)
All the parameters are as in the benchmark case.

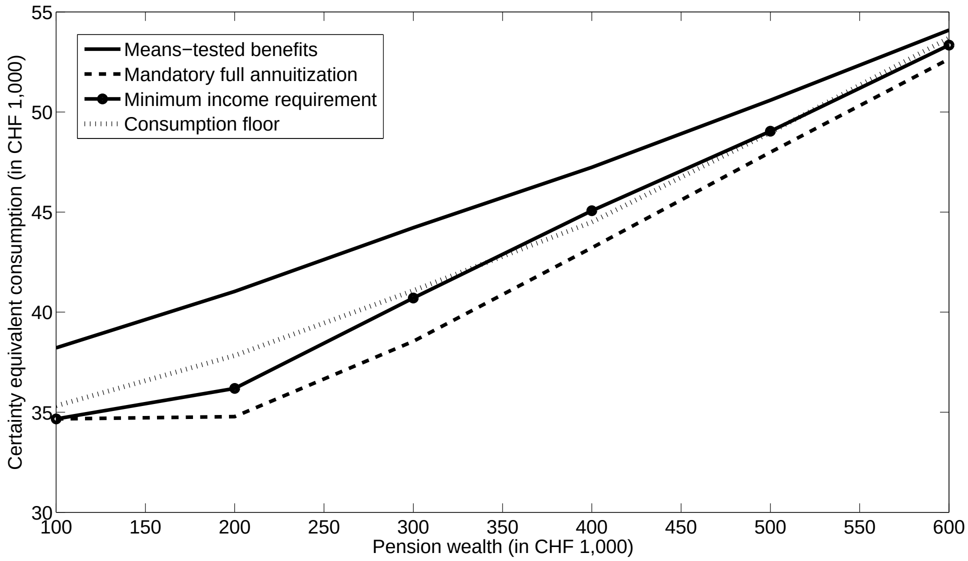

Figure B.10: Certainty equivalent consumption for different old-age poverty alleviation schemes, CHF 200,000 liquid non-pension wealth (in CHF 1,000)
All the parameters are as in the benchmark case.

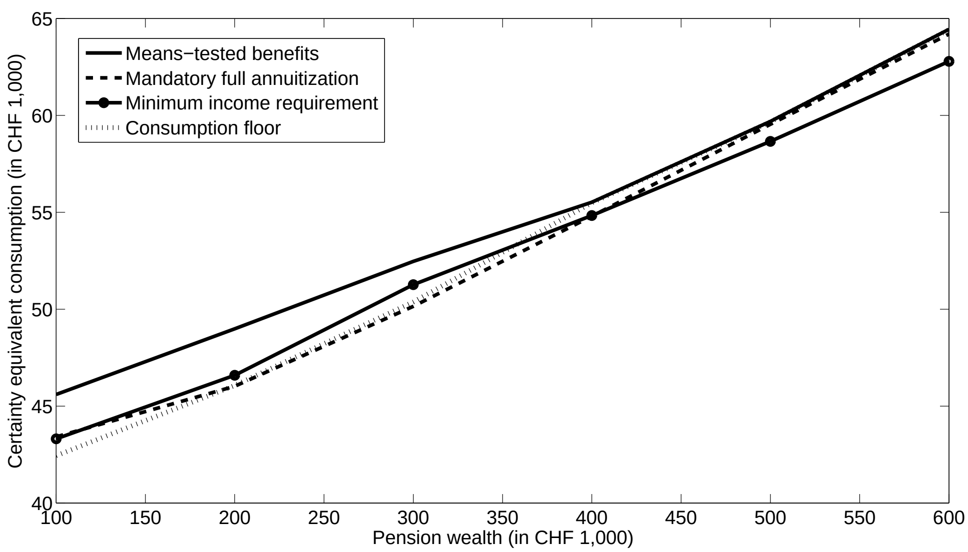

Table B.1: Maximum and average means-tested benefits of single retired recipients in 2008

Means-tested benefits correspond to the difference between applicable expenditures and income but cover at least the health insurance premium.

Components	Maximum	Average
Applicable expenditures		
Cost-of-living allowance	18,144	18,144
Rent/Interest on mortgage	13,200	10,212
Health insurance premium	4,500	3,996
Other expenses	-	84
Total	35,844	32,436
Applicable income		
First pillar benefits	26,520	19,944
Other pension benefits	-	1,524
Wage income	-	84
Own rent	-	504
Investment income	-	288
Wealth consumption	-	636
Other income	-	180
Total	-	23,160
Means-tested benefits	35,844	9,612
Net wealth	-	20,140
Wealth (after deduction)	-	6,411

Table B.2: Benchmark parameters

Description	parameter value
Time preference discount factor (β)	0.96
Risk aversion coefficient (γ)	3
Mean return on stocks (μ_R)	6.5%
Standard deviation stock returns (σ_R)	20%
Mean interest rate (μ_r)	2.5%
Standard deviation interest rate (σ_r)	1%
Mean reversion parameter interest rate (a_t)	0.15
Mean inflation (μ_π)	1.79%
Standard deviation instantaneous inflation (σ_π)	1.12%
Standard deviation price index (σ_Π)	1.11%
Correlation interest rate and expected inflation	0.4
Mean reversion coefficient expected inflation (a_π)	0.165
I pillar income at $t = 1$ (Y_1^I)	CHF 24,000
Guaranteed consumption level at $t = 1$ ($\tilde{M}_1$)	CHF 36,000
Fraction of wealth taking into account to calculate MTB (g)	0.1
Conversion rate (c)	7.2%

Table B.3: Distribution of liquid non-pension wealth

The distribution is derived using SHARE-Swiss data from 2003. We use information from all retired men with second pillar wealth below CHF 700,000 (93 observations). The mean liquid non-pension wealth is CHF 197,265.

liquid non-pension wealth	% in wealth category
0 - 50,000	33.3
50,000 - 150,000	28.0
150,000 - 250,000	10.8
250,000 - 350,000	10.8
350,000 - 450,000	3.2
450,000 - 550,000	3.2
550,000 -	10.8

Table B.4: Distribution of illiquid non-pension wealth

The distribution is derived using SHARE-Swiss data from 2003. We use information from all retired men with second pillar wealth below 700,000 CHF (93 observations). The mean liquid non-pension wealth is CHF 231,987.

illiquid non-pension wealth	% in wealth category
0	38.7
1 - 96,000	3.2
96,000 -	58.1

Table B.5: Summary statistics of pension funds data, men

Variable	Mean	Median	S.D.	Min	Max
Age at retirement	63.9	65.0	1.8	55.0	70.7
Conversion rate					
Mandatory Part	6.928	7.150	0.424	5.210	8.043
Supermandatory Part	6.740	6.863	0.523	4.816	8.043
Pension wealth	249,797	212,591	165,387	102	699,892
Share Annuity	44.3	0	49.7	0	100
Share Lump Sum	49.9	0	50.0	0	100
Share Mixed	5.8	0	23.4	0	100
Observations	22,261				

Table B.6: Costs of the means-tested benefits, non-pension wealth CHF 0 (in CHF 1,000).

The graph displays the average net present value of the means-tested benefits payed out to agents. To calculate the net present value we use the Vasicek model for the term structure of interest rates. The non-pension wealth is *liquid* non-pension wealth.

pension wealth	MTB	mandatory full annuitization	MIR	consumption floor
100	146	101	101	95
200	106	24	38	51
300	77	3	20	28
400	57	0	14	12
500	44	0	11	1
600	34	0	8	0

Table B.7: Costs of the means-tested benefits, non-pension wealth CHF 200,000 (in CHF 1,000).

The graph displays the average net present value of the means-tested benefits payed out to agents. To calculate the net present value we use the Vasicek model for the term structure of interest rates. The non-pension wealth is *liquid* non-pension wealth.

pension wealth	MTB	mandatory full annuitization	MIR	consumption floor
100	68	40	40	23
200	50	10	14	11
300	39	2	10	3
400	30	0	8	1
500	0	0	0	0
600	0	0	0	0

Table B.8: Tax rates for the lump-sum and income

The tax rates are for singles.

community and cantonal lump-sum tax		federal lump sum tax	
tax rate (in%)	amount	tax rate (in%)	amount
4.66	up to 118500	0	up to 12600
6.99	next 41000	0.154	next 14800
9.32	next 67000	0.176	next 8500
11.65	next 82000	0.528	next 12000
13.98	next 95000	0.594	next 15000
16.31	next 109000	1.188	next 4800
18.64	next 149000	1.32	next 22100
20.97	next 286000	1.76	next 27000
23.3	next 285000	2.2	next 35900
25.63	next 449000	2.64	next 502300
27.96	next 584000	2.3	above 655000
30.29	above 2265500		
community and cantonal income tax		federal income tax	
tax rate (in%)	amount	tax rate (in%)	amount
0	up to 7750	0	up to 12600
4.66	next 4,100	0.77	next 14,800
6.99	next 4,100	0.88	next 8,500
9.32	next 6,700	2.64	next 12,000
11.65	next 8,200	2.97	next 15,000
13.98	next 9,500	5.94	next 4,800
16.31	next 10,900	6.6	next 22,100
18.64	next 14,900	8.8	next 27,000
20.97	next 28,600	11	next 35,900
23.3	next 28,500	13.2	next 502,300
25.63	next 44,900	11.5	above 655,000
27.96	next 58,400		
30.29	above 226,550		