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Social security and entrepreneurial activity

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Abstract

We solve the dynamic occupational choice problem of a finitelylived, borrowing constrained household which faces exogenously given stochastic wages and business returns. Entrepreneurship means investing personal wealth into a risky asset and neither receiving wage income nor paying social security contributions. Social security bene- fits in retirement depend on the number of contribution periods. We show that, entrepreneurial activity depends negatively on the generosity of the social security system and non-monotically on the size of the system. Numerical results for a multi-period version suggest that for reasonable parameter values the relationship between the size of the social security system and entrepreneurial activity is negative. In simulation experiments, we find that lowering social security contributions for the young has a relatively larger effect on entrepreneurial activity than other ways to reduce the size of the system.

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Contents

1 Introduction

The economic literature on social security reform and the implications of ageing for existing social security systems has been growing enormously in recent years. While the policy debate focuses very much on available options to ensure the solvency of social security systems, the academic literature has focused on the welfare evaluation of various pension reform proposals such as the introduction of private occupational pensions and individual-based pension savings accounts. A relatively small part of the academic literature has moved on to study the structural consequences of changing social security systems for the labour market, capital markets and economic growth. In this paper we study the effects of changes in dependent employment-based social security systems on the incentives for households to take entrepreneurial risk. While the social security literature has recognized that earnings and rate of return uncertainty, social risk sharing and the optimal amount of risk households assume through their portfolio decisions are central concepts for the design of "optimal" social security systems, the interaction of social security system design with entrepreneurial risk taking has been largely neglected so far.

This is unfortunate, since there appears to be evidence that countries in which the social security system is less generous and comprehensive, like the United States and Great Britain, the propensity to take entrepreneurial risk is higher than in other countries. Due to measurement problems that are quite difficult to overcome, there is relatively little comparable data on the extent of entrepreneurial activity across countries however. Most of the empirical literature on entrepreneurial risk-taking focuses on the share of business-owners and self-employed within the working-age population as an indicator of entrepreneurial activity. Unfortunately, this measure does not represent well the concept of entrepreneurial activity that we want to focus on however. This stock measure does not capture well the dynamic element of "creative destruction" and selection that has been stressed by Knight (1921), Schumpeter (1934) and modern theories of endogenous growth based on entrepreneurial activity and selection (see Aghion and Howitt (1992) or Acemoglu, Aghion, and Zilibotti (2002)). These theories stress the fact that a continuing process of technological innovation, market entry and selection for which entrepreneurial risk-taking plays an important role drives economic growth and that households must be compensated to be willing to take this risk. The number of business start-ups or the share of households running newly created private businesses or currently setting up private firms are more likely to capture the dynamic element of entrepreneurial selection that these endogenous growth theories refer to.

FIGURE 1

Figure 1 plots observations of an index of entrepreneurial activity and social security contribution rates for some European countries and the US. The data on entrepreneurial activity shown here are taken from an international survey conducted in 2002 by GEM (Reynolds, Bygrave, Autio, Cox, and Hay (2003))[1]. For this survey, households are asked among other things whether they are currently involved in the start-up of an enterprise or whether they own and operate a business that is less than 42 months

[1] The survey has been conducted for various years with varying participation by countries. Data for Portugal are taken from the 2001 survey and for Greece from the 2003 survey.

old. The Entrepreneurial Activity index represents the share of respondents which answer “Yes” to one of these questions. In order to understand better, whether the formation of a new business represents innovative activity, households are also asked whether they start/run the business because they see an economic opportunity, or whether they start/run the business for lack of other options. The EA-index used in the figure refers only to “opportunity” entrepreneurs, but results for a the combined index are similar. The index is contrasted with data on the size of the social security system. We measure the size of the system by the social security contribution rate. The rates used only cover the contributions made for old-age, survivor and disability pensions. They do not include unemployment, sickness or accident insurance contributions. In itself of course, this evidence is not sufficient to establish a negative relation between entrepreneurial activity and the size of the social security system, because other factors like the state of demand, the availability of credit and business regulations or the tax code clearly are important determinants of household’s occupational choice decisions as well. In empirical work, it is important to control for these differences. However, the graph at least shows that there is a suspicious correlation between these two phenomena across countries and we therefore interpret Figure 1 as suggesting the possibility of a negative relationship between the size of the social security system and the extent of entrepreneurial activity within a country. Interestingly, this empirical finding is in contrast with the previous theoretical literature on the topic, which suggested a positive impact of social security on entrepreneurial activity through a risk-sharing effect (see for example Boadway, Marchand, and Pestieau (1991)). An important assumption in these models is that the coverage by social security system is as encompassing for entrepreneurs than for worker. We slightly refine this assumption by assuming that all households are covered by the social security system, but that social security contributions are wage-based and that the magnitude of social security benefits increases with the number of contribution years. We further generalize these models by considering borrowing-constraints for households and fixed costs of business startups.

We analyze the relationship between entrepreneurial risk-taking by households and the design of the social security system in the context of a dynamic occupational choice model, based on Evans and Jovanovic (1989) and Hintermaier and Steinberger (2005), which formalizes the idea that the social security system affects the extent of entrepreneurial risk taking in an economy. The model is set in a partial equilibrium context, taking the distribution of wages and private business returns as given. Analytical results are derived for the 2-period case, in which the occupational choice decision is mutually exclusive and households decide once and for all whether to work for a risky wage or become entrepreneurs by investing some part of their wealth in a risky asset. This section shows how the initial wealth of households affects the occupational choice decision[2] and that in general there is an inversely U-shaped relationship between the size of the social security system and entrepreneurial activity. To the left of the individually optimal social security contribution rate, increasing the size of the social welfare system raises the welfare of workers while leaving the welfare of entrepreneurs unchanged. This reduces the incentive to take entrepreneurial

[2] In the 2-period version, starting a business is equivalent to business ownership for the entire working life, since agents make their occupational choice decision only once in a lifetime.

risk. To the right of the individually optimal social security contribution rate, the opposite holds. For a given distribution of initial wealth, there is therefore a non-monotonic relationship between the size of the social security system and the extent of entrepreneurial activity in the economy. With respect to the generosity of the social security system, the analytical results are more clear-cut. A larger internal rate of return of the social security system unambiguously increases worker welfare without affecting the welfare of entrepreneurs. The extent of entrepreneurial activity in the economy therefore decreases in response to an increase in the generosity of the social security system.

We test the robustness of our analytical findings by analyzing numerically the multi-period version of our dynamic occupational choice model. In the multi-period case, households decide each period on whether to be an entrepreneur or to work for a wage. The interactions between the social security system and entrepreneurial activity are therefore much more interesting. Households are able to build up private savings and start businesses later in their careers. They can also learn about the profitability of their business and revert back to employee status, if the business is unprofitable. The element of "entrepreneurial discovery" is captured fully only in this case. Also, the social security system provides a low-risk saving vehicle for the households, which tilts the portfolio choice of all households towards investing in the risky asset. We find again that everything else equal, the generosity of the pension system (measured by the internal rate of return) is negatively related to entrepreneurial risk-taking, because a more generous pension system makes wage work and saving through the social security system more attractive. For our calibration, also increasing the size of the social security system reduces the extent of entrepreneurial activity because private savings are reduced and also private business investment is lower. Additional experiments indicate that higher social security contributions early in the life-cycle reduce available resources at a point in time in which they are very valuable for prospective entrepreneurs. A high contribution rate for young households slows down the buildup of savings by these cohorts and affects adversely the extent of entrepreneurial activity at later ages. This mechanism reduces the share of entrepreneurs in the population, especially among young households starting out with low initial wealth. Reducing the social security contribution rates of the young households is therefore an effective way of affecting entrepreneurial activity in the economy.

Section 2 introduces the model and the 2-period version is solved in section 3. In section 4 we explain how the model is adapted to a multi-period framework and discuss calibration issues. Section 5 reports simulation results from the numerical solution of the model and we discuss the limitations of our analysis and the conclusions we draw from our analysis in section 6. The appendix contains a description of the computational methods we use to solve the multi-period case.

2 A life-cycle model of occupational choice

Lifetime is stochastic with δ_t denoting the survival probability from period $t-1$ to period t, conditional on survival until period $t-1$. Individuals have a maximum lifetime of T periods and discount utility at a constant and exogenous rate β. We impose fixed retirement at the end of period P.

Consequently, household i maximizes the discounted sum of period utilities over a fixed finite horizon of T periods:

$$\max_{B_{it}, W_{it+1}} E_0 \left[\sum_{t=1}^{T} \beta^{t-1} \left(\prod_{s=1}^{t} \delta_s \right) u(c_{it}) \right] \tag{1}$$

where E_0 denotes the expectation conditional on information available at time zero, c_{it} denotes consumption of household i in period t and $u(.)$ is a Von Neumann-Morgenstern utility function. B_{it} denotes the amount of wealth invested in a private business during period t and W_{it} denotes total household wealth.

During working-life households have to choose between wage work and managing their own business. The budget constraint reads

$$c_{it} = \mathbf{1}(B_{it} = 0)(1-\tau) w_{it} + (1+r)W_{it} - W_{it+1} + (\rho_{it} - r)B_{it} - \Psi(B_{it-1}, B_{it}) \tag{2}$$

for periods $t = 1, .., P$. In retirement, households cannot run their own business anymore and can only invest their private wealth in the publicly traded asset. Therefore the budget constraint changes to

$$c_{it} = v_{it} + (1+r)W_{it} - W_{it+1} \tag{3}$$

for the periods $t = P+1, ..., T$. We further assume a borrowing constraint on the publicly available asset and a collateral constraint for investment in the private business.

$$0 \leq B_{it} \leq W_{it}, W_{it} \geq 0, \forall t$$

The first term on the right hand side of the working-life budget constraint, $\mathbf{1}(B_{it} = 0)(1-\tau) w_{it}$, represents the stochastic wage income of the household net of social security contributions, where τ is the fixed proportional contribution rate of the social security system. If the household holds positive amounts of business wealth, this term equals zero because we assume that entrepreneurial households spend their entire working time managing the firm. Wage income has an age-dependent deterministic component

$$\bar{w}_t = at^2 + bt + c, \text{ for } 1 \leq t \leq P$$

and equals zero after retirement.

$$\log(w_{it}) = \left\{ \begin{array}{c} \bar{w}_t + \varepsilon_{it} \text{ for } 1 \leq t \leq P \\ 0 \text{ for } P < t \leq T \end{array} \right\}$$

The stochastic component of wage income ε_{it} represents uninsurable idiosyncratic labour market risk that follows a simple AR(1) process

$$\varepsilon_{it} = \phi \varepsilon_{it-1} + \xi_{it}$$

with ξ_{it} being an iid shock distributed as

$$\xi_{it} \sim N(0, \sigma_\xi)$$

and ε_{i0} is drawn from the invariant distribution of ε_t.

The second and third term, $(1+r)W_{it} - W_{it+1}$, capture current income from and future investment into a riskless, publicly traded asset. All households can invest their wealth into this asset, which delivers an exogenous and fixed rate of return r that is not subject to taxation. Entrepreneurial households additionally have the option to invest in their own business, which is captured by the last two terms, $(\rho_{it} - r)B_{it} - \Psi(B_{it-1}, B_{it})$. $(\rho_{it} - r)B_{it}$ denotes the income in excess of the financial market rate of return derived from the private business, and $\Psi(B_{it-1}, B_{it})$ measures transaction costs associated with private business investment. We specify transaction costs to capture the idea that private business investment is subject to a fixed startup cost $\Psi(B_{it-1}, B_{it}) = \mathbf{1}(B_{it} = 0, B_{it+1} > 0)\Phi$. The gross stochastic return of the private business is the sum of two stochastic components and a constant

$$\log(\rho_{it}) = \bar{\rho} + \eta_{it} + \rho\varepsilon_{it} \text{ for } 1 \leq t \leq P$$

where $\bar{\rho}$ denotes the mean profitability of all potential businesses, $\rho\varepsilon_{it}$ introduces correlation between wage income and business returns and the business return risk component η_{it} again follows an AR(1)-process

$$\eta_{it} = \theta\eta_{it-1} + \zeta_{it}$$

where ζ_{it} is an iid shock distributed as

$$\zeta_{it} \sim N(0, \sigma_\zeta)$$

and η_{i0} is drawn from the invariant distribution of η_t. It is important that households cannot observe the current realization of η_{it} unless they own a business. In the retirement period, private businesses do not generate a positive return. There is no agreement in the literature on whether η_{i0} and ε_{i0} or ζ_{it} and ξ_{it} should be correlated or not. Evans and Jovanovic (1989) argue that there is some evidence that entrepreneurial ability and wage ability are negatively correlated, but assume that the equivalents to these quantities are uncorrelated for reasons of tractability. We follow their assumption and also assume no correlation.

During retirement household i receives a non-stochastic pension benefit, constant throughout retirement and dependent on the number of contribution years. Households, which accumulate less than M worker contribution years m_i, receive a minimum pension $\bar{v}$. Because the pension benefit only depends on the number of contribution years, the public retirement system provides partial insurance against low wage realizations for workers. Because entrepreneurial households do not receive a wage, they cannot contribute to the public retirement system and do not accumulate benefits on top of the minimum pension. We compute the pension benefit for household i as:

$$v_i = \left\{ \begin{array}{c} \bar{v} \text{ for } 0 \leq m_i < M \\ \frac{1+g}{T-P} \sum_{t=1}^{P} \tau \exp(\bar{w}_t) \left(\frac{1}{P} \sum_{t=1}^{P} \mathbf{1} \left(B_{it} = 0 \right) \right) \text{ for } M \leq m_i \leq P \end{array} \right\} \quad (4)$$

where g is the internal rate of return of the pension system. This simple formula obviously does not do justice to the complicated real-world benefit calculation rules, but captures a trade-off between entrepreneurial risk-taking and saving through the social security system which is inherent also in the more complicated systems.

In the next section, we will analyze the model in the 2-period case to derive some qualitative results. Sections 4 and 5 will be devoted to the numerical analysis of a multiperiod version of the model.

3 The 2-period case

Setting $T = 2$ and $P = 1$ allows for a drastic reduction in the complexity of the model. With these simplifications the model essentially contains a $0-1$ choice between becoming an entrepreneur or a worker during working life. By choosing between entrepreneurship and wage work households also choose between getting a full pension or a minimum pension. Under the additional assumptions that the minimum pension and startup costs are zero ($\Phi = \bar{v} = 0$), the model can be written as

$$\max_{e,B_{i1},W_{i2}} E_0 \left[u(c_{i1}) + \beta\delta_2 u(c_{i2}) \right]$$

subject to

$$\begin{aligned} c_{i1} &= (1-e)(1-\tau)\, w_{i1} + (1+r)W_{i1} - W_{i2} + e(\rho_{i1} - r)B_{i1} \\ c_{i2} &= (1+g)\,\tau\bar{w}_1 (1-e) + (1+r)W_{i2} \\ (1-e)B_{i1} &= 0, W_{i2} \geq 0 \text{ and } 0 \leq B_{i1} \leq \alpha W_{i1} \end{aligned}$$

Here we have replaced the indicator function $\mathbf{1}(B_{it} = 0)$ in the budget constraint with an equivalent indicator variable, e, which takes on the value 0 if the household decides to work for a wage and 1 if the household chooses to be an entrepreneur. In the 2-period case, the random variables w_{i1} and ρ_{i1} are distributed as $N(\bar{w}_1, \sigma_\xi)$ and $N(\bar{\rho}, \sigma_\zeta)$ assuming implicitly that both w_0 and ρ_0 are equal to 0 for all households.

Figure 2 shows the timeline of events in the 2-period-model. Random variables are realized at the end of each period but prior to the consumption decision such that households know their private realizations when making their consumption-saving decision . This assumption yields a deterministic Euler equation to determine the level of savings W_{i2}.

FIGURE 2

3.1 Optimal decisions

Households choose e to maximize $V^* = \max(V_{e=0}, V_{e=1})$. For the choice of B_{i1} and W_{i2}, we have the following necessary conditions.

$$u\prime(c_{i1}) - \beta\delta_2(1+r)\,u\prime(c_{i2}) = \lambda_{W_{i2}\geq 0} \tag{5}$$

$$eE_0\left[u\prime(c_{i1})(\rho_{i1}-r)\right] = \lambda_{B_{i1}\leq \alpha W_{i1}} - \lambda_{B_{i1}\geq 0} - \lambda_{B_{i1}(1-e)=0} \tag{6}$$

which together with the decision about e determine the solution of the occupational choice and consumption problem[3]. The first equation is a standard, constrained Euler equation, determining the choice of savings W_{i2}. The second equation gives the optimal amount of investment in the first period, B_{i1}, and is relevant only for entrepreneurs.

Households who decide to take up wage work must also choose $B_{i1} = 0$ and equation (6) is therefore trivially fulfilled. They choose their optimal consumption levels and retirement savings in accordance with the Euler equation

$$\begin{aligned} & u\prime\left((1-\tau)\,w_{i1} + (1+r)W_{i1} - W_{i2}\right) \\ = \;& \beta\delta_2(1+r)\,u\prime\left((1+g)\,\tau\bar{w}_1 + (1+r)W_{i2}\right) + \lambda_{W_{i2}\geq 0} \end{aligned} \tag{7}$$

Households who take entrepreneurial risk, set $e = 1$ and additionally choose B_{i1} according to

$$E_0\left[u\prime\left((1+r)W_{i1} - W_{i2} + (\rho_{i1}-r)B_{i1}\right)(\rho_{i1}-r)\right] = \lambda_{B_{i1}\leq \alpha W_{i1}} \tag{8}$$

when ρ_{i1} is still random. Notice that the choice of B_{i1} could be constrained by the level of initial wealth of the household which is captured

[3] While the Euler equations are deterministic, randomness of w_{i1} and ρ_{i1}does affect the value functions and hence also affects the choice of e.

through the multiplier $\lambda_{B_{i1} \leq \alpha W_{i1}}$. The deterministic Euler equation of entrepreneurial households has the following form

$$\begin{aligned} & u\prime\left((1+r)W_{i1} - W_{i2} + (\rho_{i1} - r)B_{i1}\right) \\ = \; & \beta\delta_2\left(1+r\right)u\prime\left((1+r)W_{i2}\right) + \lambda_{W_{i2}\geq 0} \end{aligned} \tag{9}$$

and W_{i2} is again determined after the realization of the business return ρ_{i1} was observed.

By substituting the optimal choices of W_{i2} and B_{i1} into the value functions $V_{e=0}$ and $V_{e=1}$, we obtain the solution to the household problem. Figure 3 shows a graph of the two value functions and the selection into entrepreneurship depending on the level of initial wealth W_{i1}.

FIGURE 3

3.2 The social security system and occupational choice

After characterizing the general solution, we will now show the relationship between the size of the social security system and occupational choice. To obtain our analytical results, we choose a standard form of utility which makes the model more tractable and from now on assume that utility is of the CRRA-type, $u\left(c_{it}\right) = \frac{c_{it}{}^{1-\gamma}}{1-\gamma}$, $\gamma > 0$. The main object under study in this section is the value function for workers $V_{e=0}$, because the value function for entrepreneurs is not affected by variation in τ. We show that up to a threshold level $\bar{\tau}$ the value function of these workers $V_{e=0}$ is increasing in τ and hence that some social security is desirable from the point of view of unconstrained workers in this model[4]. Constrained workers would like to borrow against future income and would therefore always prefer a lower contribution rate. Whether a given worker household is constrained or unconstrained essentially depends on the level of initial wealth W_{i1} and the household's wage income realization w_{i1}. In the following, we assume that the initial wealth distribution is such that all workers would like to save a positive amount $W_{i2} > 0$. Obviously, because the occupational choice decision is mutually exclusive, there is a disincentive effect on taking entrepreneurial risk from the increase in the value function for workers.

This can be shown by comparing the threshold levels for taking entrepreneurial risk with and without social security. Under our assumption about the functional form of utility, the optimal savings decision for a worker saving a positive amount $W_{i2} > 0$ is given by

$$W_{i2} = \frac{(1-\tau)\, w_{i1} + (1+r)\, W_{i1}}{1+\delta^* + \delta^* r} - \frac{(\delta^* + \delta^* g)\, \tau \bar{w}_1}{1+\delta^* + \delta^* r}$$

where $\delta^* = (\beta \delta_2 (1+r))^{-\frac{1}{\gamma}}$ is an intertemporal discount factor which captures the joint effect on savings of time preference, stochastic mortality, real rate of interest and the desire to smooth consumption over time. Substituting into the budget constraint, we obtain analytical expressions for consumption in period 1 and 2.

$$c_{i1} = \frac{\delta^* (1+r)}{1+\delta^* + \delta^* r} \left((1-\tau)\, w_{i1} + (1+r) W_{i1}\right) + \frac{\delta^* (1+g)}{1+\delta^* + \delta^* r} \tau \bar{w}_1$$

and

$$c_{i2} = \frac{1+r}{1+\delta^* + \delta^* r} \left((1-\tau)\, w_{i1} + (1+r)\, W_{i1}\right) + \frac{1+g}{1+\delta^* + \delta^* r} \tau \bar{w}_1$$

[4] Making it possible for agents to use accrued social security benefits as collateral for consumption credit (thereby eliminating the borrowing constraint on W_{i2}) would eliminate the threshold level $\bar{\tau}$ and allow full diversification of wage risk.

Plugging these expressions back into the objective function and recognizing that the realization of income is initially unknown, we obtain the solution for the value function of a worker $V_{e=0}$.

$$V_{e=0} = \delta^{**} E_0 \left[\left(W_{i1}^{*} + (1-\tau) \frac{(1+r)\, w_1}{1+\delta^{*}+\delta^{*} r} + \tau \frac{(1+g)\, \bar{w}_1}{1+\delta^{*}+\delta^{*} r} \right)^{1-\gamma} \right]$$

with $\delta^{**} = \left(\frac{\delta^{*}}{1-\gamma} + \frac{\beta\delta_2(1+r)}{1-\gamma} \right)$ and $W_{i1}^{*} = \frac{(1+r)^2 W_{i1}}{1+\delta^{*}+\delta^{*} r}$.

If $g = r$, we obtain sharp conclusions: any unconstrained worker prefers a social security tax rate of 100%, because this enables him to fully share his labor income risk. This requires however, that the worker fully finances first-period consumption out of initial assets, which are likely to be too low for many households. For constrained workers, the optimal social security contribution rate is positive, but less than 100%, in this case. If $g < r$, which is the standard assumption, the desired contribution rate falls further, because there is also a loss of lifetime wealth associated with taxation through the social security system. In summary, unless the internal rate of return g is too low and hence the implicit price of insurance too high, there is a positive threshold level τ_i^{*} for each individual up to which social security is desirable for the household and raises the value of lifetime utility. Figure 4 shows the value functions for two households with different levels of initial wealth and $g = r$. Household 1 is endowed with a large initial wealth and is therefore unconstrained in his savings choice. This household also has a much higher valuation of entrepreneurship. Household 2 instead has a low level of initial wealth, with an interior optimum for the social security contribution rate and a low valuation of entrepreneurship.

FIGURE 4

What matters for occupational choice is the comparison between $V_{e=0}$ and $V_{e=1}$. There are three possible cases: Households can be indifferent about τ because they would always choose entrepreneurship for any value of τ. Another possibility is that households prefer the corner solution $\tau_i^* = 1$ because they have high initial wealth W_{i1}. These households will choose entrepreneurship for low contribution rates and remain entrepreneurial households as τ increases up to some threshold τ_2. Households with a somewhat lower level of τ_i^* will have a preference for entrepreneurship only if τ is very low. As τ increases, their worker value function increases as well, inducing them eventually to choose worker status. Only for very high levels of τ, say τ_3, the wealth constraint they are facing for consumption in the first period becomes so important that even higher τ induces these households to choose entrepreneurial activity. There is hence generally a U-shaped relationship between the size of the social security system and the extent of entrepreneurial activity. With respect to the generosity of the system, parametrized by the internal rate of return g, the conclusion is more straightforward. Higher g increases the attractiveness of the worker occupation without changing the value of entrepreneurship. The implication of this result is quickly stated. Since occupational choice is $0 - 1$ in the 2-period model, raising the value function of workers means creating disincentives for entrepreneurial risk taking and hence fewer households will choose to become entrepreneurs, if the social security system is more generous.

While the 2-period model conveys some insights into the relationship between social security and occupational choice, it does not fully capture the nature of entrepreneurial risk-taking, which allows households to "try" entrepreneurship for a short period of time. In the next section, we therefore explore to which extent the results extend to the multi-period case in which successive spells of entrepreneurship and work are possible by calibrating and solving numerically a 35-period version of the model.

4 Numerical results for the multiperiod extension

While the theoretical results obtained in the previous section are quite insightful and convey important aspects of the relationship between entrepreneurial risk-taking and social security it suffers from an important drawback: occupational choice is a $0-1$ decision in the 2-period case. Especially with respect to entrepreneurial risk-taking such a setting does not capture an important aspect of risk taking in a multi-period setting: feedback from the market allows entrepreneurs to learn about the profitability of their business and eventually close it down. This learning effect is emphasized by Jovanovic (1982) and Hopenhayn (1992) and constitutes an important part of the process of market selection. Entry and exit can be accommodated in our framework by allowing for multiple periods, serially correlated business returns and imperfect information about business profitability. In this setting households can try entrepreneurship, find out about the profitability of their business and eventually return to employee status or start another business. This more involved structure of the model allows us to study how incentives for this dynamic aspect of entrepreneurship are affected by changes in parameters of the social security system. We expect the general ideas of the previous section to hold: up to some threshold level, a positive social security tax rate increases welfare of workers by offering insurance against wage uncertainty and a more generous pension system will lead more households to choose employee status, but other elements come into play. High contribution rates at young ages drain resources from households who would consider entrepreneurship and reenforce the negative effect of the social security system on entrepreneurial activity. Pension benefit rules also become important. Rules for pension provision that require households to remain dependently employed over a large part of the working life to receive a pension introduce strong marginal disincentives for workers with an incomplete employee contribution record and discourage workers from taking entrepreneurial risk.

In the next section we describe the implementation of the social security system in the multi-period model and discuss the calibration of the model using data from the US. We solve and simulate the calibrated versions of the model and report baseline and comparative statics results. A description of the numerical procedure used to solve the model is given in the appendix.

4.1 The design of the pension system

Most advanced economies have set up some form of universal coverage of citizens by the social security system. This coverage extends to both benefits and contributions and it is generally not possible to opt out of the social security system completely by choosing a particular occupation. At least a basic level of social assistance in old age is guaranteed for all citizens. In order to receive larger payments of social security benefits a history of regular contributions to the social security system is required however[5]. The specification of the pension system in the multi-period setting follows this general pattern. Both employee status and entrepreneurship provide some social insurance, but only employees participate in a more extensive system with a higher contribution rate and the level of benefits linked to the number of years worked.

We implement a simplified social security system that remains close to these stylized features of real-world social security systems, but does not increase computational costs too much. The social security budget is balanced, if in an economy with J households of each age t and a constant 1-period growth rate of labour productivity, g_l,

$$\sum_{t=1}^{P}\left(\left(\frac{1}{1+g_l}\right)^{t-1}\sum_{j=1}^{J}\tau\exp(w_{jt})\right)=\sum_{t=P+1}^{T}\left(\left(\frac{1}{1+g_l}\right)^{t-1}\sum_{j=1}^{J}v_j\right) \quad (10)$$

where the benefit formula is given by 4. Our definition of the pension benefit formula implies that the social security budget is always balanced, if there are no entrepreneurial households and the growth rate of labour productivity is 0. Then both sides of 10 approximately equal $P\sum_{t=1}^{P}\tau\exp(\bar{w}_t)$. A positive share of entrepreneurial households and a positive labour productivity growth rate would require that the social security system parameters M, $\bar{v}$, and τ are chosen in such a way that the social security budget is balanced. In our calibration exercise we choose the values of these parameters as close as possible to the empirically observed ones, leaving open the possibility

[5]Most countries also have special, generous schemes for some professions, but since entry into these occupations usually is not free and this option therefore often not available to the majority of households we do not take into account these special regulations.

that the system is not exactly balanced in each period, which has been the case historically in most countries.

We have fixed the retirement age for all occupational groups at $P = 21$ and disregard the retirement decision of households. Studying the retirement decision of various occupational groups seriously would require a much more involved structure with endogenous labour supply choice, unemployment and retirement disincentives of the social security system. Including these features would increase computational costs very much and there is no empirical evidence that entrepreneurial activity around the retirement age is quantitatively important. Our benefit formula 4 takes a somewhat extreme case of a strongly intergenerationally redistributive system by making benefits dependent only on the number of contribution periods. This assumption is made to reduce computational costs and avoid introducing another continuous state variable, “accrued pension wealth”, into the model. The number of contribution periods is sufficient as a state variable in our implementation. Most social security systems are characterized by a requirement for a minimum number of contribution periods to be eligible for benefits. We introduce this feature as well and also stipulate that to obtain the full benefit agents have to be working as an employee for their entire working-life. Becoming an entrepreneur for some period of time hence implies a loss of benefits proportional to the amount of time spent in self-employment.

4.2 Baseline calibration

The multi-period simulation is carried out over a total horizon of 35 periods. We assume that agents enter the model at age 20 and every period represents

2 years of life. Total lifetime therefore corresponds to 90 years and we set a fixed retirement date at the end of the 21^{st} period, corresponding to age 62. The utility function is again assumed to have the CRRA-form $(c_{it}) = \frac{{c_{it}}^{1-\gamma}}{1-\gamma}$, $\gamma > 0$ and we set relative risk aversion to $\gamma = 2$. The discount rate β is assumed to be 0.97 and the net risk-free return r equals 0.025 annually. All of these parameters are standard choices in the literature. The calibration of the wage income process is taken from a detailed study of household saving choices in the US by Laibson, Repetto, and Tobacman (1998). These authors estimate age-income profiles for various educational groups from PSID data. We select the median educational group (high school diploma) for which the deterministic age polynomial is estimated as $\bar{w}_t = \exp(8.835 + 0.058t - 0.017t^2/100 - 0.055t^3/10000)$. We convert the income process to a 2 year-frequency by time-aggregation. The resulting autocorrelation coefficient ϕ of the stochastic wage process is equal to 0.473 and the variance of the innovation to log income σ_ξ^2 is 0.0766. Draws of initial wealth are taken from a lognormal distribution, using the empirical mean of the US wealth distribution for the youngest cohort obtained from the 1998 Survey of Consumer Finances and the corresponding coefficient of variation of 6.53 both reported by Budria, Diaz-Gimenez, Quadrini, and Rios-Rull (2002). In the aggregation we use population weights from the 1998 issue of the CPS (Current Population Survey), truncated below age 20, and assume a long-run real income growth rate of 1%. Table 1 summarizes the choices of parameters that were taken from the literature.

Table 1:

Table 2 reports the choices for parameters that are not readily available in the literature and which concern the features of the entrepreneurial income process and the transaction costs associated with private businesses. We set the mean of log annual net private business returns to 0.13 to create sufficient incentives to run private businesses and introduce substantial serial return correlation by choosing $\theta = 0.88$. Business return innovations have relatively small variance of 0.005, but 1-period realized net returns nevertheless vary substantially ranging from -9% to 92%. Startup costs are chosen to be substantial with the chosen value for Φ implying costs of about $\$18,000$ or about one mean annual wage income of very young workers. Startup costs interact with the borrowing and short-selling constraints on households to limit entrepreneurial activity of young households. Finally, the parameter governing the correlation between wage income and business return realizations ρ is set to 0.15, implying a positive correlation of 0.278. Since households receive either wage income or business income, and households are always aware of their wage risk realizations the correlation between these two forms of income is not important for the portfolio decisions of households. These five parameters are set to match approximately, the empirically observed shares of business ownership and entrepreneurial activity in the US economy as observed by Gentry and Hubbard (2000) and the 2002 GEM study.

Table 2

Table 3 reports the baseline parameters of the pension system. We set the minimum number of contribution periods to receive a pension to 18 years and the social security tax rate on gross wage income, τ, to 12.5%, corresponding to the current social security system contribution rate in the

US. We set the minimum social security benefit to 480$ on a monthly basis and the full employment history benefit to $1,121$\$ monthly.

Table 3

The next section reports results from simulation experiments in order to gauge the quantitative impact of changes in parameters of the social security system and to check whether the theoretical predictions of the 2-period model extend to the multi-period case.

5 Simulation experiments

We determine the simulated impact of changes in parameters of the social security system by comparing the numerical solutions obtained from our model for various sets of parameters. This implies that we cannot make statements about the transitional path of the economy, as it moves from one set of parameters to the other and we have to bear in mind that the stochastic processes for wages and business returns are assumed to be fixed when interpreting the results. As usual in a partial equilibrium study, the model presumes a stationary equilibrium of the aggregate economy and the simulation results can therefore only be interpreted as indications for the long-run consequences of parameter changes if the aggregate wage and return dynamics are not affected strongly by parametric changes in the social security.

In order to compare our model solutions, we first fix matrices of shock realizations, Z_w and Z_b, for wage and business return risk. We simulate a population of $N = 100000$ households and these matrices have dimensions

$(P \times N)$ and $(P^2 \times N)$, respectively. We also fix a vector initial assets of length N, drawn from our calibrated distribution. Starting from the initial asset position , we apply the policy rules computed through the algorithm described in the appendix to recover the optimal asset and consumption paths for the households given the shock realizations. From these sets of paths, we draw the inferences described below.

5.1 Sensitivity to social security system parameters

The baseline calibration yields a business owner share of 8.86% in the population and an entrepreneur activity index of 4.97. Most businesses are relatively young and the average age of firms is 10.1 years (the median age is 4 periods = 8 years). The number of startup firms, defined as firms at age 1 or 2 periods is $3,056$ in the baseline calibration, which amounts to a share of 3.06% of young business owners in the population. Using the 1998 population weights, the social security system is slightly overfunded given the parameters of the social security system and hence aggregate contribution payments somewhat exceed aggregate benefit payouts. About 30% of private savings is held in the form of private business assets.

We now report the comparative statics results from the solution and simulation of the model after changing two important social security parameters one at a time. The first of these parameters is the size of the social security system, captured by τ. The second of these parameters is the generosity of the social security system captured by the internal rate of return g. Changing the size of the social security system from 12.5% to 13.5% percent affects the level of entrepreneurial activity negatively. We therefore confirm the results of the 2-period case also for the multiperiod model. By raising the amount of contributions, we also increase the implied retirement benefits using formula 4 which rise to $1210 for the full employment history benefit and $518 for the minimum pension. As expected, increasing the size of the social security system leads to a drop in aggregate private savings by 4.62%. The business owner share in the population drops to 8.18% and the entrepreneur activity index to 4.55. Average firm age rises to 10.36 years and the number of startup firms decreases by 8.4%. The main reason for the decrease in entrepreneurial activity is the drop in private savings, which is quite pronounced. Both the share of savings invested in private businesses and the number of private businesses are smaller, if forced saving through the social security system is increased. Average business size is slightly higher however, which implies that the reduction in savings leads to fewer small and young businesses in the firm population. From the perspective of households, households with low initial assets are most affected in their occupational choice by the change in the size of the social security system.

We obtain somewhat weaker effects from increasing the generosity of the social security system. Even increasing the full employment history benefit by 10% from $1,121$\$ to $1,230$\$ monthly while leaving the minimum social security payment unchanged, affects negatively the incentives to take entrepreneurial risk. This again confirms our results from the 2-period model. But quantitatively, the effect is much smaller. The share of business owners now is 8.38% and the entrepreneurial activity index reads 4.66. Again, the reduction in entrepreneurial activity is caused by a reduction in aggregate private savings, which decrease by 2.82%.

An interesting result emerges from comparing two ways of reducing the size of the social security system. In the first computational experiment, social security contributions are cut for every working households by 1 percentage point from 12.5% to 11.5% percent. In the other experiment, only young households benefit from a cut in social security contribution rates, and the reduction is larger for them: τ is decreased from 12.5% to 6.25% for households in the initial 5 periods. In sum, the changes in the contribution rates have almost identical effects on retirement benefits. The full employment history benefit decreases to 1031$ monthly in the first case, and to 1028$ monthly in the case where the reduction is focused on the young. The minimum benefit is 440$ per month in both experiments. Despite the similar magnitude of the cuts in the size of the social security system, the second experiment induces a noticably stronger effect on entrepreneurial activity and private savings than the flat reduction. In the second case, the business owner share increases to 10.08% and the entrepreneurial activity index is 5.68, 0.59 percentage points and 0.22 points higher than in the first experiment, respectively. Aggregate savings and the share of savings invested in private businesses are higher in both experiments than in the baseline case, but the quantitative effect is higher in the second experiment again. Figure 4 compares the absolute differences with respect to the baseline case of startup rates by age for three of the four experiments we have discussed here.

FIGURE 5

The figure shows that startup rates vary the most from age 35 to 55. Before age 35, households are severely borrowing constrained in our model and only high skill-high initial wealth households own a private business. The effect on startup rates from cutting social security contributions for the young is strongest for households in their 40's. At that age households which have benefited from the low social security contribution rates and faced the prospect of low retirement benefits arrive with higher private wealth than households in the baseline simulation. Hence, they find entrepreneurship more attractive and decide to start a business. Older households also start businesses more often if social security contributions by the young are cut, but for households in their 50's, the experiment with a flat cut of contribution rates for every household yields an even stronger effect on startup rates. The strongest effect on business startup rates by households close to retirement age is provided by a change in the generosity of the system. A more generous system discourages these households to attempt entrepreneurship and induces them to continue accumulating pension wealth, which they do at a higher rate than in the baseline case. Startup behaviour up to age 40 is not affected at all by changes in the generosity of the social security system.

6 Conclusions

We have shown in a dynamic model of occupational choice how the size and generosity of the welfare system are linked to incentives for entrepreneurial risk-taking. For borrowing-constrained households, the propensity to invest in a privately-owned business depends on the household's current wealth. In a stylized 2-period version of the model, occupational choice is mutually exclusive and households decide whether to be entrepreneurs or workers only once in a lifetime. In that case, we find that the relationship between the size of the welfare system and entrepreneurial activity is inversely U-shaped. To the left of the individually optimal social security contribution rate, increasing the size of the welfare system raises the welfare of workers while leaving the welfare of entrepreneurs unchanged. This reduces the incentive to take entrepreneurial risk. To the right of the individually optimal social security contribution rate, the opposite holds. A larger internal rate of return of the pension system however unambiguously increases worker welfare without affecting the welfare of entrepreneurs. For a given distribution of initial wealth and given income possibilities the extent of entrepreneurial activity in the economy therefore decreases in response to an increase in the generosity of the social security system and responds non-monotically to increase in the size of the social security system.

To learn more about the relationship between the size of the social security system and the extent of entrepreneurial activity we have analyzed numerically the multi-period case, calibrating the stochastic processes for wages and business returns to exhibit considerable serial correlation, including fixed startup costs for private businesses and allowing households to choose their occupational status in every period. The magnitude of social security benefits granted to households depends on the amount of years spent in dependent employment and hence on the number of contribution years, but does not depend directly on the sum of contributions, and there is a minimum benefit granted to every household, even those who have not contributed anything to the system. These social insurance features of the system provide positive incentives for households to take entrepreneurial risk (this point was emphasized by Boadway, Marchand, and Pestieau (1991)).

We calibrate the model to match empirical features of the US economy and solve the model using numerical dynamic programming techniques. Simulations experiments suggest that for reasonable parameter values the relationship between the size of the social security system and entrepreneurial activity is negative, because both total private savings and private business investment. We also find again that the generosity of the pension system (measured by the internal rate of return) is negatively related to entrepreneurial risk-taking, because a more generous pension system makes wage work and saving through the social security system more attractive. The strongest effect on entrepreneurial activity is provided by changes in the social security contribution rate of the young households, because those households are the most constrained and additional resources allow them to improve their lifetime welfare by taking more entrepreneurial risk.

Whether policy conclusions can be drawn from this analysis depends strongly on whether the partial equilibrium perspective that we are taking is empirically relevant and whether entrepreneurial activity in our sense affects the long-run growth rate as hypothesized by the Schumpeterian growth theories. If the latter is the case, the dynamic effects of increasing entrepreneurial activity by reducing the size of the social security system are important. If, in the other hand, classical growth theory is a more accurate representation of the growth process and technological progress is largely independent of the extent of entrepreneurial risk-taking by households, then increasing entrepreneurial activity will have only static, redistributive effects and the rationale for implementing these changes is much weaker.

7 Appendix

7.1 Computational method

With our choice of utility function, the main source of problems in the analytical analysis of entrepreneurial portfolio choice under uncertainty is the borrowing constraint and the fact that investment into the firm is subject to adjustment costs and imperfect information. These features make the saving allocation problem inherently dynamic. The reason for this is that the expected rate of return on investment into the private business asset depends on whether a positive amount is invested and second, that there are fixed costs of starting a business. Our informational assumptions imply that the saving allocation problem of households is a problem of optimal sequential experimentation (sometimes also called "bandit" problems). Dynamic programming techniques are very well suited to study this kind of problems. The computational method we use is finite state, finite horizon dynamic programming with a continuous approximation of the value function in the wealth dimension. We discretize the state space, defined over total wealth, portfolio shares and uncertainty states. We use a grid of 45 points in the wealth dimension and a grid of 3 points in the portfolio choice dimension. The uncertainty grids are 5 and 3 grid points wide and equally spaced on the interval [− *std. dev.*, *std. dev.*]. This amounts to a total of $45 * 3 * 5 * 3 = 2025$ gridpoints on the value function at each age and for each feasible value of the number of contribution periods.

The problem is solved recursively backward, starting from a value function equal to 0 in the last period. Fineness of the grids basically determines computation time, which is linear in lifetime. During retirement, households are not allowed to run a business and their income is deterministic such that the solution of their optimal consumption-savings decision is simple and relatively fast due to the use of continuous approximation techniques using orthogonal polynomials. The maximization step at each node of the grid is carried out via a line-search algorithm that does not require the computation of numerical derivatives. In working age, households face a complicated dynamic portfolio choice problem in addition to the consumption-saving decision. Solving for the optimal policy rules in working age is a computationally intensive procedure, since a large number of those rules must be calculated for each period. Continuous approximation speeds up computation a lot also at this stage as well, but computation time is still about 2 hours per period. Once the optimal policy rules are computed, aggregation and the simulation of a large number of individuals do not increase computation time by much. In order to perform the simulations we fix a random draw of wage and business return shocks for each agent and compute optimal paths using the policy rules computed before. Most statistics are based on this sample of time series paths for consumption and asset holdings. To compute some of the reported statistics, such as the share of entrepreneurs in the economy, we draw a random population sample using the CPS weights from this sample of time series to obtain a representative cross-section of agents.

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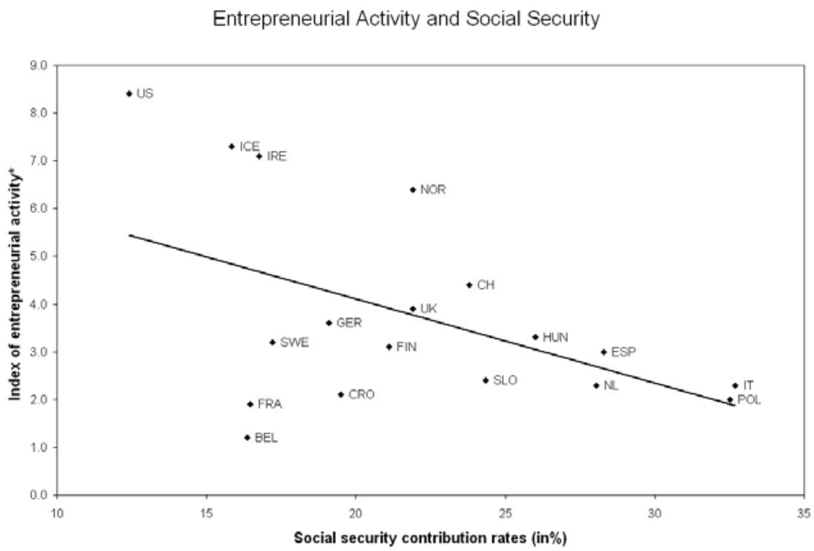

Figure 1: Some cross-country evidence

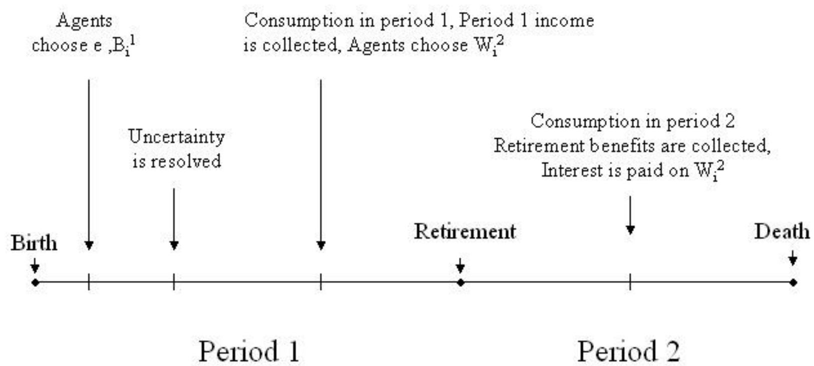

Figure 2: Timeline of the 2-period case

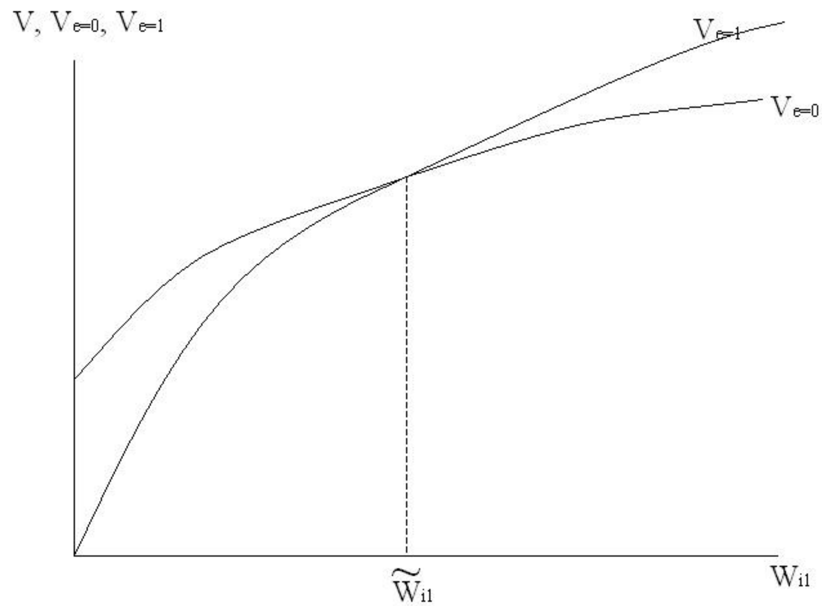

Figure 3: Initial wealth affects occupational choice

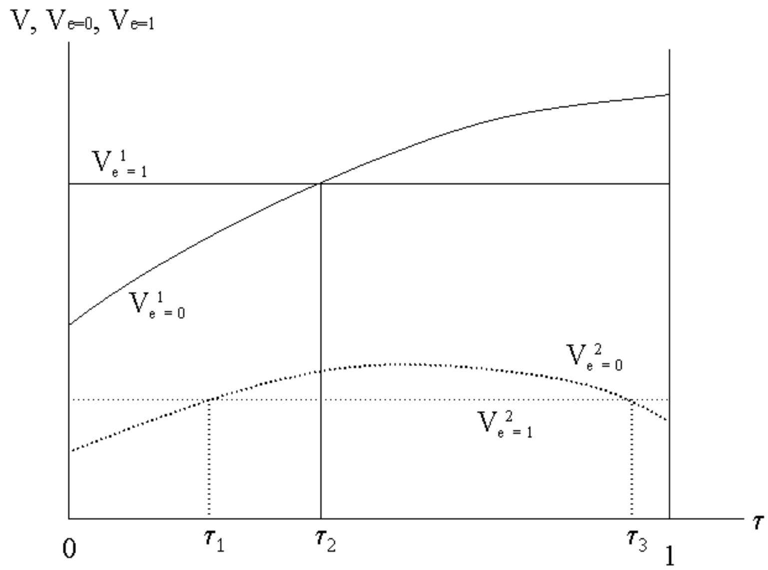

Figure 4: Occupational choice and social security

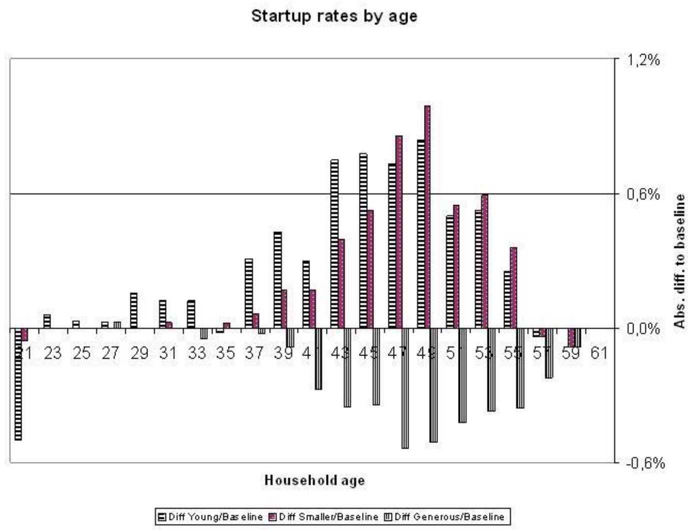

Figure 5: Startup rates by age

TABLE 1:

Fixed parameters	
γ	2
β	0.97
r	0.025
ϕ	0.473
σ_{ξ}^{2}	0.077
g_{l}	0.01

TABLE 2:

Calibrated parameters	
$\bar{\rho}$	0.13
θ	0.88
σ_{ζ}^{2}	0.005
Φ	1.8
ρ	0.15

TABLE 3:

Pension system parameters

M	9
$\bar{v}$	0.623
τ	0.125