Life-cycle determinants of credit to households☆

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Abstract

This paper applies a life-cycle model with individual income uncertainty to investigate the determinants of credit to households. We show that the value of household credit to GDP ratio depends on (i) the lending-deposit interest rate spread, (ii) individual income uncertainty, (iii) individual productivity persistence, and (iv) the generosity of the pension system. Subsequently, we provide empirical evidence for the predictions of the theoretical model on the basis of data for OECD and EU countries.

Key words: Household credit, life cycle economies, banking sector.
JEL classification: E21, E43, E51.

1. Introduction

Economic policy makers, macroprudential supervisors or investors need reliable empirical estimates of the equilibrium level of credit in the economy. When the level of credit is low, high dynamics of credit might reflect an adjustment to the equilibrium, financial deepening in emerging economies for instance. When the level of credit is high, even a one-digit growth rate of credit may be considered excessive. Deviations of credit from its equilibrium often lead to a widening of macroeconomic imbalances, e.g. rising inflation, asset bubbles, inefficient booms and bursts or instability of the financial system. Moreover, banks are also interested in the relationship between their credit policies and the state of the economy, since macroeconomic instability caused by excessive credit supply usually hits them back by deteriorating their assets. This, in turn, may even cause a banking crisis.

The issue of the equilibrium level of credit in the economy is addressed in the literature from different perspectives. Several papers use theoretical models to analyze the equilibrium level of credit over business cycles by identifying phases of credit rationing or credit booms (Kiyotaki and Moore, 1997; Azariadis and Smith, 1998; Lorenzoni, 2008). In the similar spirit, DSGE models have been used recently to analyze the

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asymmetry in the behavior of borrowers and lenders in reaction to structural, and in particular financial shocks (Iacoviello, 2005; Gerali et al., 2010).

The other group of articles is rather empirical in nature and estimate a long-run relationship between the aggregated value of credit and a set of standard macroeconomic factors such as output, prices or interest rates. The main finding of these studies is that for most countries the value of credit tend to increase with GDP and asset prices, and to decrease with the level of interest rates (see Egert et al., 2007 and references therein).

While earlier theoretical and empirical studies mostly concentrated on the aggregate level of credit to the private sector or the level of credit supplied to firms, more recent research touches the problem of credit to households. A number of studies investigate credit markets in a general equilibrium framework, taking into account a default risk, idiosyncratic uncertainty and life-cycle profile of income (Lawrance, 1995; Ludvigson, 1999; Athreya, 2002; Chatterjee et al., 2007; Livshits et al., 2007).

Our aim is to contribute to the above literature by proposing a life-cycle model with individual income uncertainty that can be used to assess how various macroeconomic factors affect the equilibrium value of household credit. We show that its value depends on (i) the lending-deposit interest rate spread, (ii) individual income uncertainty, (iii) individual productivity persistence, and (iv) the generosity of the pension system. Subsequently, on the basis of aggregate data for OECD and European Union (EU) countries, we find some empirical support for the predictions of the theoretical model.

The rest of the paper is organized as follows. Section 2 outlines the life-cycle model we use for our simulations. Section 3 describes the benchmark parameterization and solution of the model. Section 4 contains the results of simulations aimed at detecting the determinants of household credit. Section 5 presents the empirical evidence. The last section discusses areas for future research.

2. The model

In this section we present a dynamic, life-cycle general equilibrium model with individual income uncertainty, which in many aspects is similar to that developed by Huggett (1996). The novelty of our model is that it includes banks that differentiate between rates for deposits and loans. The detailed structure of the model is as follows.

2.1. Consumers

Each period, which corresponds to one year, a new generation of consumers is born. The duration of each consumer's life is uncertain. The exogenous probability of surviving to age $j+1$ conditional on surviving to age j, which is the same for all individuals, is equal to s_j, where $j \in \mathcal{J} = \{1, 2, \dots, J\}$. Death is sure after period J, which means $s_J = 0$. The resulting unconditional probability of surviving till age j at time of birth amounts to $S_j = S_{j-1}s_{j-1}$ for $j \in \mathcal{J}/\{1\}$, where $S_1 = 1$.

Population is growing at an annual gross rate γ and thus the population of cohort j is $N_j = S_j\gamma^{-(j-1)}$, where the population of the newborn cohort is normalized to one, $N_1 = 1$. Consequently, total population amounts to $N = \sum_{j\in\mathcal{J}} N_j$.

Individuals derive utility from consumption c, which is maximized over their lifespan according to:

$$E_0 \left\{ \sum_{j \in \mathcal{J}} \beta^j S_j u(c_j) \right\}, \tag{1}$$

where β is the time discount factor and E_0 is the expectation operator conditional on information available at the beginning of period 1.

The life of individuals consists of two parts.[1] During initial J_1 years they participate in the labor market by suppling a fixed part of their available time $\bar{l}$ and receiving renumeration:

$$y(j, u) = (1 - \tau_w - \kappa) w \bar{l} z_j(e) \text{ for } 1 \leq j \leq J_1. \tag{2}$$

Here τ_w is the income tax rate, κ denotes the social contribution rate and w stands for real wages. The term $z_j(e)$ describes individual productivity that depends on age j and idiosyncratic productivity e. The age component of productivity is deterministic, whereas the idiosyncratic component e is stochastic and takes one value from the set $\mathcal{E} = \{e_1, e_2, \ldots, e_M\}$. This component follows a Markov process with a transition matrix π, so that the probability distribution of next period productivity e' equals to:

$$p(e') = \pi p(e). \tag{3}$$

It can be noted that since productivity shocks are independent across agents, the uncertainty at the individual level does not lead to aggregate uncertainty over labor supply.

In the second part of life individuals are on mandatory retirement and receive pensions:

$$y(j, e) = b \text{ for } j > J_1 \tag{4}$$

that do not depend on age, individual productivity or earnings history.[2]

Individual income can be spend on consumption c or saved in the form of bank deposits that pay a rate $r_d(1 - \tau_r)$, where τ_r is a capital tax rate. Moreover, individuals are allowed to borrow from banks at a rate $r_{l,j}$ that depends on age due to reasons discussed in the next subsection. We do not impose any limits on the amount of debt, but the terminal condition stating that if an individual survives till the terminal age J, the value of her net worth must be null. The resulting budget constraint is of the form:

$$a' = \begin{cases} a(1 + r_d(1 - \tau_r)) + y(j, e) + tr - c & \text{for } a \geq 0 \\ a(1 + r_{l,j}) + y(j, e) + tr - c & \text{for } a < 0 \end{cases} \tag{5}$$

[1] Persons under working age are excluded from the analysis

[2] This assumptions can be viewed as an approximation of a redistributive pay-as-you go pension system. Moreover, it eases the computational burden since a variable capturing an individual's earnings history needs not be included in the consumer optimization problem.

where a' is net financial position (net worth) in the next period and tr denotes transfers from accidental bequests.

The value function of an individual at age j with the individual state $x = (a, e)$ is the solution to the following dynamic programming problem:

$$V_j(x) = \max_c \left\{ u(c) + \beta s_j E[V_{j+1}(x')|x] \right\}, \tag{6}$$

subject to (2)-(5) and conditions stating that at birth and after period J net worth is null.

2.2. Banks

The banking sector is perfectly competitive. Banks are maximizing profits from granted loans cr and collected deposits dep, for which net real interest rates are equal to r_l and r_d, respectively. The difference between collected deposits and granted loans is covered by participation in the bond market, where funds can be raised or deposited at rate r. Profits of a representative bank are equal to:

$$\mathcal{P}_b = (r_l - r)\, cr + (r - r_d) dep - \Psi(cr, dep), \tag{7}$$

where Ψ is an increasing and differentiable cost function with the first derivatives Ψ_1 and Ψ_2. Expression (7) is maximized for:

$$\begin{aligned} r_l &= r + \Psi_1(cr, dep) \\ r_d &= r - \Psi_2(cr, dep). \end{aligned} \tag{8}$$

Apart from the existence of the fixed costs, while taking loan an individual is obliged to insure against the risk of unexpected death, in case of which her loan is not repaid. The resulting real lending rate for individuals at age j amounts to:

$$r_{l,j} = r_l + (1 - s_j)(1 + r_l). \tag{9}$$

In the case of unexpected death of a depositary, her deposit is taken by the government and equally distributed among all individuals in the form of transfers.

Two things should be noted. First, we justify the existence of the interest rate spread solely by fixed costs and the probability of death, whereas in reality other factors are also significant (see e.g. Saunders and Schumacher, 2000 for an extended discussion).[3] Second, the above specification implies null profits of the banking sector.

[3]One important factor is the risk of default. Under assumption that all borrowers are subject to the exogenous probability of default (known a priori with certainty at the aggregate level), and all of them insure fully against that risk by paying the appropriate premium to the bank, the spread will also contain the default insurance.

2.3. Firms

The goods market is perfectly competitive. Identical firms of measure one are producing a homogeneous good Y using effective labor L and capital K:

$$Y = F(K, L). \tag{10}$$

We assume that F is strictly increasing and concave in both inputs, obeys the Inada conditions and is characterized by constant returns to scale.

Effective labor, which is hired from households, is remunerated at a gross wage w. In the case of capital, firms are financing its purchase by participating in the bond market, where funds can be raised at the real rate r. Moreover, the capital depreciates at an annual rate δ. Consequently, profits of a representative firm amount to:

$$\mathcal{P}_f = Y - wL - (r + \delta)K. \tag{11}$$

This expression is maximized if factor prices are equal to their marginal products:

$$\begin{aligned} F_K(K, L) &= r + \delta \\ F_L(K, L) &= w. \end{aligned} \tag{12}$$

2.4. The government

The role of the government is threefold. First, it collects taxes to finance public expenditures G, where it is assumed that the central budget is balanced:

$$G = \tau_r(r_d Dep) + \tau_w(wL). \tag{13}$$

The second role is to supervise the "pay as you go" pension system, which collects contributions from workers and distributes them equally among retirees. The retirement b is not related to earnings history, but equals to a fraction of the average net wage $\overline{w}$:

$$b = \theta\overline{w}, \tag{14}$$

where θ describes the average replacement ratio. The budget of the pension system is balanced, i.e.:

$$\kappa wL = b \sum_{j=J_1+1}^{J} N_j. \tag{15}$$

Finally, the government is responsible for collecting accidental bequests, the aggregate value of which amounts to B, and distributing them in the form of transfers. The value of the transfer is the same for all individuals and amounts to:

$$tr = \frac{B}{\gamma N}. \tag{16}$$

2.5. Aggregation and stationary equilibrium

In this subsection we will discuss a concept of stationary equilibrium of the model economy. We start by defining aggregate variables. Then, we present stationary equilibrium conditions.

Given the heterogeneity across individuals in terms of age j and the individual state $x = (a, e)$, we need some measure of the distribution. Let $(\mathcal{X}, \mathcal{B}, \phi_j)$ be a probability space, where $\mathcal{X} = \Re \times \mathcal{E}$ is the state space, $\mathcal{B}$ is the Borel σ-algebra on $\mathcal{X}$ and ϕ_j a probability measure. For each set $B \in \mathcal{B}$ the share of individuals with $x \in B$ in total population of cohort j is given by $\phi_j(B)$. Since individuals are born with no assets nor debt, the distribution ϕ_1 is given exogenously be the initial distribution of productivity u. To calculate remaining ϕ_j we need to define a transition function $Q_j(x, B)$, which describes the probability that an individual at age j with the current state x will transit to the set B next period. The distributions can be then obtained recursively as:

$$\phi_{j+1}(B) = \int_{\mathcal{X}} Q_j(x, B) d\phi_j, \text{ for all } B \in \mathcal{B}. \tag{17}$$

Finally, let us define $c_j(x)$ and $a'_j(x)$ as policy functions of individuals at age j for consumption and next-period asset holdings. The aggregate variables, which are consistent with individual behavior are as follows.

Consumption:	$C = \sum_{j \in \mathcal{J}} N_j \int_{\mathcal{X}} c_j(x) d\phi_j$
Effective labor:	$L = \bar{l} \sum_{j \in \mathcal{J}} N_j \int_{\mathcal{X}} z_j(x) d\phi_j$
Capital:	$K' = \sum_{j \in \mathcal{J}} N_j \int_{\mathcal{X}} a'_j(x) d\phi_j$
Accidental bequests:	$B = \sum_{j \in \mathcal{J}} (1 - s_j) N_j \int_{\mathcal{X}} a'_j(x)(1 + r(1 - \tau_r)) d\phi_j$

A stationary equilibrium is defined as the policy functions of individuals $c_j(x)$ and $a'_j(x)$, labor and capital demand of firms (K and L), factor prices (w and r), transfers (tr), tax rates (τ_r and τ_w) and government spending (G), social contribution rate (κ) and the value of pension (b), as well as distributions $\{\phi_j : j \in \mathcal{J}\}$, that fulfill the following conditions:

1. The policy functions $c_j(x)$ and $a'_j(x)$ are optimal in terms of the optimization problem given by (6).
2. Factor prices are equal to marginal products given by (12).
3. The goods market clears: $F(K, L) = C + G + K' - (1 - \delta)K$.
4. Capital stock per capta is constant: $K' = \gamma K$.

5. The government budget is balanced (eq. 13).
6. The budget of the pension system is balanced (eqs. 14 -15).
7. Aggregate transfers are equal to accidental bequests (eq. 16).
8. Distributions ϕ_j are invariant and consistent with individual behavior.

2.6. Solution of the model

We start the computation of the stationary equilibrium by discretizing the space for net financial position a over grid points $\mathcal{A} = \{a_1, a_2, \ldots, a_m\}$. We set the bounds a_1 and a_m at levels not constituting a constraint on the optimization problem. The number of grid points is chosen to be $m = 701$, but we do not restrict the choices to lie in the grid, but use interpolation to cover any intermediate choices.

The algorithm is as follows (see Huggett, 1996 or Heer and Maussner, 2005, p. 390):

1. Set the initial value of K.
2. Compute r and w with (12) that are consistent with K.
3. Solve the Bellman equation (6) by backward induction and compute the value function $V_j(x)$ and policy functions $c_j(x)$ and $a'_j(x)$ for $(x, j) \in \mathcal{A} \times \mathcal{E} \times \mathcal{J}$.
4. Given the initial distribution ϕ_1, which is known, compute distributions ϕ_j for $j > 1$ by forward induction.
5. Compute next-period capital stock K'.
6. In case of convergence ($K' = \gamma K$) stop. Otherwise repeat from step 2 with the value of K from the last iteration.

All computations were done with Gauss codes of Heer (2004), which we translated to Matlab and extended.

3. Parameterization and solution of the model

3.1. Parameterization

The model frequency is annual and its parameters are calibrated partly on the basis of the relevant literature and partly so that the stationary equilibrium matched selected long-run averages for the US economy. The benchmark parameter values are displayed in Table 1.

We assume that individuals become economically active at age 20, work for maximum 43 years, and at age 63 go for mandatory retirement that lasts up to 28 years. This means that the model describes the behavior of $J = 71$ cohorts of age from 20 to 90. The conditional survival probabilities s_j, which are taken from U.S. Census Bureau (2009, Sec. 2, Tab. 105), are presented on the left panel of Figure 1. The population growth rate is fixed at 1% per year ($\gamma = 1.01$), which reflects the US 1980-2008 average. The resulting share of retirees (aged 63-90) in total population (aged 20-90) amounts to 24.7%. This compares to the observed ratio in the US of about 20% in 2008 and the projected ratio of about 25% in 2020 (U.S. Census Bureau, 2009, Sec. 1, Tab. 7-10).

Individuals spend 30% of their time available at work ($\bar{l}$)[4] and derive utility from consumption, which is of the CRRA form:

$$u(c) = \begin{cases} \frac{c^{1-\eta}-1}{1-\eta} & \text{for } \eta \neq 1, \eta > 0 \\ \ln c & \text{for } \eta = 1. \end{cases} \tag{18}$$

The value of the relative risk aversion coefficient η is set to 2, which is in the middle of the range commonly used in the literature. The discount factor β is fixed at a standard value of 0.98.

The idiosyncratic productivity $z_j(e)$ is assumed to be of the form:

$$z_j(e) = \bar{z}_j \times e, \tag{19}$$

where $\bar{z}_j$ describes a deterministic age-profile of productivity and the logarithm of e follows an AR(1) process:

$$\ln e' = \rho \ln e + \varepsilon,\ \varepsilon \sim N(0, \sigma_\varepsilon^2). \tag{20}$$

The values for $\bar{z}_j$, which are presented on the right panel of Figure 1, are taken from Huggett (1996).[5] The figure shows that the median productivity[6] is initially low, amounting to about one quarter of the average, then increases steadily to reach a peak for individuals aged about 50, and declines thereafter. The values of ρ and σ_ε^2 are set to 0.96 and 0.045 (see Huggett, 1996, and the discussion therein). For computational reasons, the autoregressive process given by (20) is approximated by a nine state Markov chain with the method proposed by Tauchen (1986).

Finally, following Huggett (1996) and taking the evidence that earnings inequality is increasing with age (Heathcote et al., 2005), we set the variance of log-productivity in cohort 1 at two thirds of unconditional productivity for the logarithm of e:

$$\sigma_1^2 = \frac{2}{3} \times \frac{\sigma_\varepsilon^2}{1-\rho^2}.$$

As regards the production function, we assume that it is of the Cobb-Douglas form:

$$F(K, L) = K^\alpha L^{1-\alpha}. \tag{21}$$

The elasticity α is set to 0.3 and the depreciation rate δ is fixed at 0.08, so that in the stationary equilibrium the labor share in income and the values for capital-output and investment-output ratios reflect the long-term average for the US economy.

[4] On the basis of the American Time Use Survey: http://www.bls.gov/news.release/atus.nr0.htm.

[5] In particular we took the values from the website of Dean Corbae: http://sites.google.com/site/deancorbae/teaching.

[6] Given the log-normal distribution of e, the mean productivity of cohort j is equal to $\bar{z}_j \exp(\sigma_j^2/2)$, where σ_j^2 is the variance of the logarithm of idiosyncratic productivity among individuals of age j.

Next, we fix public consumption expenditures G at 20% of output and choose the capital tax rate τ_r to be 0.15, which corresponds to the long-term capital gains rate in the US in 2008. The replacement rate θ is set to 0.40, which reflects the average value in the US in 2006 (OECD, 2009). Finally, we assume that in equilibrium the interest rate spreads $\Psi_1 = r_l - r$ and $\Psi_2 = r_d - r$ are equal to 2 percentage points and 1 percentage point, respectively. The total lending-deposit interest rate spread of 3 percentage points reflects the observed 1980-2008 average spread of 3.1 percentage points between the interest rate charged by US banks on loans to prime private sector customers minus the treasury bill interest rate.[7]

3.2. Solution of the benchmark model

The stationary equilibrium values for key variables and ratios are as follows (Table 2). The shares of private consumption, investment and government spending in GDP are 56.2%, 23.8% and 20.0%, respectively. The capital-output ratio amounts to 2.643, which implies the market real interest rate at 3.3%. The resulting deposit and lending rates are 2.3% and 5.3%. The income tax and social contribution rates consistent with balanced budget conditions (13) and (15) are equal to 27.5% and 8.4%, respectively. Finally, the value of household credit amounts to 14.3% of GDP and the population with non-positive financial assets constitute 32.5% of total population.

It is worthy to mention that our model does not distinguish between consumption of durables (e.g. housing) and nodurables. Therefore, the value of 14.3% of GDP might be interpreted here as a level of consumer credit in the economy rather than the value of mortgage loans. In fact, the volume of housing loans in developed countries (58% of GDP on average in the EU in 2009) is usually a multiple of the calculated household credit, while the level of consumer credit is often close to this value (8.6% on average in the EU in 2009).

Figure 2 presents life-cycle paths for the average values of key model variables. It shows that the average income of workers, which is defined as the sum of labor income, capital income and transfers, is hump-shaped. This is mostly due to the shape of the deterministic component of idiosyncratic productivity $\bar{z}_j$ (see left panel of Figure 1). The average income of retirees is almost flat. The lifetime profile of consumption is also hump-shaped, but its variability is much lower than that of income. It can be noticed that the consumption profile to some extent tracks the profile of income, which is in line with the empirical evidence presented by Carroll and Summers (1989).

As regards the path of the average net financial position and the average value of credit, it reflects the life-cycle profiles of income and consumption. In initial periods, when income is relatively low, individuals are taking loans as they expect that their income will increase in the future. Consequently the share of population with non-positive financial position is high. Then, individuals accumulate financial assets to protect against expected income decrease in the retirement period. The average value

[7]According to the World Bank data: http://data.worldbank.org/indicator/FR.INR.RISK.

of net financial position reaches a peak for cohorts of age around 60. In the last periods individuals are using their life-time savings to keep consumption above their income, which is determined by the value of pension.

4. Simulation results

This section presents the results of a series of simulations that were aimed to quantify how different factors influence the amount of household credit in the economy. In particular, we investigate how life-cycle decisions depend on:

- the cost-effectiveness of the banking sector;
- individual income uncertainty;
- the persistence of an individual productivity process;
- the generosity of the social security system;

The results are presented in the below subsections.

4.1. Interest rate spread

We start by investigating how the effectiveness of the financial sector, measured by the lending-deposit interest rate spread $r_l - r_d$, affects the economy. In all scenarios we assume that the lending-market rate spread is twice higher than the market-deposit rate spread, $r_l - r = 2(r - r_d)$.

An increase of the spread affects the economy in the following way. A decrease of the deposit rate deter individuals from savings. The aggregate value of deposits, and hence capital, is falling, which leads to an increase of the market rate. As regards the lending rate, it is rising due to changes of the spread and the market rate. This discourages individuals from taking loans. As a result, the value of household credits shrinks.

The results, which are presented in Table 3 and Figure 3, show that an increase of the spread from the baseline value of 3 percentage points to 6 percentage points raises the lending rate from 5.3% to 7.8%, and decreases the household credit to GDP ratio from 14.3% to 7.2%. Moreover, a decline in the stock of capital means that output, wages and pensions are lower by about 2%. The decline in the welfare is even more pronounced, because apart from the fall in income, high spread impedes consumption smoothing in the life-cycle (see right-upper panel of Figure 3). Finally, according to the results, in the environment of null spread the aggregate value of household credit amounts to 27.8% of output.

Apart from the reasons discussed above, a large gap between the interest rate on liabilities and assets may dampen the amount of credit in the economy because households may use their assets to finance consumption instead of incurring more debt. Moreover, the high cost of carrying liabilities relative to the return on assets prompts the repayment of existing debt. These channels, which might be significant in practice, are not accounted for in our model because individuals are not allowed to have both positive deposits and positive loans.

4.2. Idiosyncratic productivity uncertainty

In the second set of simulations, we investigate how the volatility σ_ε^2 of the individual productivity process e, given by (20), affects the economy. Let us emphasize two issues. First, higher σ_ε^2 does not alter the transition matrix π, but raises the dispersion among the values from the set $\mathcal{E}$. Second, it leads to a raise in effective labor supply L due to reasons discussed in footnote 6. Consequently, this has a positive effect on output, the average wage and the value of pension (see Table 4).

What is more interesting for our investigation, is how changes in individual uncertainty affect the process of capital accumulation, the level of the real interest rate and the amount of credit in the economy. It is well known in the literature that if individuals are risk averse then an increase in future income uncertainty leads to a buildup of precautionary savings (see Zeldes, 1989, for a theoretical model and Carroll and Samwick, 1998, for an empirical evidence). In our model a change of σ_ε^2 from 0.045 to 0.075 leads to an increase of the capital-output ratio from 2.643 to 2.865, i.e. by 8.4%. Consequently, the market interest rate declines from 3.3% to 2.5%. Even though the decline in the lending rate, higher uncertainty deters individuals from taking loans, and the share of household credit in GDP declines from 14.3% to 13.4%. If individual uncertainty is low, $\sigma_\varepsilon^2 = 0.015$, then the value of household credit amounts to 18.9% of GDP. Finally, it can be noted that consumption profile over the life-cycle is smoother in the environment of lower uncertainty (see Table 4 and Figure 4).

4.3. Individual productivity persistence

The next set of simulations aim at analyzing how the persistence of the individual productivity process, measured by parameter ρ from equation (20), influences life-cycle decisions and the value of aggregate variables in the stationary equilibrium. The value of ρ determines the transition matrix π, and given the value of variance σ_ε^2, it also defines set $\mathcal{E}$. In order to maintain a sensible comparison, in below simulations we alter the value of σ_ε^2 so that the unconditional variance $\sigma_\varepsilon^2/(1-\rho^2)$ was the same as in the benchmark economy. This means that the values of set $\mathcal{E}$ are kept constant.

The estimates of ρ for the US vary in the literature. According to Floden and Lindé (2001) the value of ρ is 0.91, whereas Storesletten et al. (2004b) find evidence that it is somewhere between 0.94 and 0.96. Moreover, in the subsequent article, the same authors estimate that ρ is very close and insignificantly different from unity, which would imply that the productivity process is nonstationary (Storesletten et al., 2004a). They also show that for any value of $\rho > 0.91$ their theoretical, life-cycle model is able to replicate consumption inequality in the US. For that reason, in our simulations we consider values of ρ ranging from 0.90 to 0.98.

The effects of higher productivity process persistence on the economy are as follows. An increase in the persistence raises expected life-time earnings of high-productivity individuals and diminishes expected income of low-productivity individuals. The former are therefore reducing their precautionary savings, whereas the latter are less interested in taking loans. The overall impact on the capital-output ratio is negative, which leads to an increase in the real interest rate. This further leads to a contraction in demand for credit. In our model a change of ρ from 0.96 to 0.98 leads to a decrease of the capital-output ratio from 2.643 to 2.543 and an increase of the market interest rate from 3.3% to 3.7%. Finally, the share of household credit in GDP declines from 14.3% to 12.9%, even though the share of population with non-positive assets increases from 32.5% to 33.6% (see Table 5 and Figure 5).

4.4. Replacement ratio

In the last set of simulations we analyze the economic effects of the generosity of the pension system. For that purpose we calculate the stationary equilibrium for different values of the replacement rate of pensions relative to the average net wage earnings, which is defined by θ in (14).

In our model, changes in the replacement rate alter the uncertainty that individuals face with respect to their life-time resources. Higher θ means that uncertain income from labor is exchanged for certain income from pensions and thereby the variability of the life-cycle income profile becomes lower. As a result, higher θ means that the precautionary motive to accumulate savings is diminished, which leads to a decline in the stock of capital. An increase of the replacement ratio from 0.4 to 0.6 decreases the capital-output ratio from 2.643 to 2.533 and raises the interest rate from 3.3% to 4.2%. Even though uncertainty related to future income is lower, higher interest rate deters young workers from taking loans and leads to a decline in the value of household credit from 14.3% of GDP to 13.1% of GDP (see Table 6 and Figure 6).

5. Empirical evidence

In this section we test whether the implications of the theoretical model are confirmed by empirical data. For that purpose we model the dependency between household credit and a set of macroeconomic indicators in two ways. First, we focus on the developments of household credit in time by using panel data for 36 high and middle-income countries. Second, due to reasons discussed in the next subsection, we also analyze cross-sectional data to explain differences in the value of household credit among 27 EU countries. In both cases the most general specification, which encompasses all other specifications, is:

$$cr = \alpha + \alpha_1 \cdot spread + \alpha_2 \cdot incu + \alpha_3 \cdot pers + \alpha_4 \cdot repl + \beta \cdot X + \epsilon. \qquad (22)$$

The dependent variable $cr = \ln(Cr/Y)$ describes the logarithm of credit to household to GDP ratio, *spread* is the difference between the lending and deposit rates ($r_l - r_d$ in the theoretical model), *incu* and *pers* are individual income uncertainty and persistence (σ_ε^2 and ρ), whereas *repl* describes the replacement ratio (θ). In line with the simulations from the previous section, the expected sign for $\{\alpha_i : i = 1, 2, 3, 4\}$ is negative. Finally, X denotes a vector of control variables, which includes GDP per capita (*gdp_cap*) or disposable income per capita (*dispinc*), real interest rate (*rate*), unemployment rate (*unemp*) and the housing price index (*hpi*).

5.1. Data

In the two set of regressions we use two separate datasets. The first dataset spans over the 15-year period from 1995 to 2009 and comprises 36 countries, including those OECD and EU economies for which we were able to collect data on household credit and its regressors.[8]. In this case, however, the comparability of banking data is difficult to assess due to various accounting standards and aggregation techniques. Moreover, data for *incu* and *repl* were unavailable. For that reason we construct the second dataset, which consists of 27 EU countries and covers the five-year period from 2005 to 2009. This dataset includes countries for which financial standards are unified to a large extent and thereby banking data are comparable. Moreover, for this dataset we were able to collect data for all variables present in specification (22). However, due to short time dimension of this dataset, the use of panel data techniques does not seem well-founded. Consequently, we calculate five-year averages for all variables and use these averages as cross-sectional data in our estimations.

Among the variables present in specification (22), individual income uncertainty *incu* and persistence *pers* as well as the replacement ratio (*repl*) are not directly observable. Consequently, we need some observable measures of these variables. We approximate individual income uncertainty by the GINI coefficient of earnings because there should be a strong positive correlation between σ_ε^2 and the GINI value (see Table 4). In the case of individual income persistence, we measure it by the long-term unemployment rate, which is defined as the fraction of unemployed for over one year in total unemployment. We believe that this is a good proxy as it reflects the probability of staying in one of the states from the set $\mathcal{E}$. Finally, we approximate the replacement rate by the ratio of income from pensions of persons aged 65-74 to income from work of persons aged 50-59. A detailed description of data sources for all variables is provided in Table 7.

5.2. Estimation results

In our first set of regressions we focus on the behavior of household credit over time. We estimate the long-run relationship between household credit and the explanatory variables with panel cointegration techniques. In particular, we employ the continuously-updated fully-modified (CupFM) estimator developed by Bai, Kao, and Ng (2009), which allows for cross-sectional dependence.[9] The choice was motivated by the fact, that this estimator controls for the correlation among macroeconomic variables in different countries, e.g. due to common business cycles. As a robustness check,

[8]In particular, countries included in the panel are: Australia, Austria, Belgium, Bulgaria, Canada, Cyprus*, Czech Rep.*, Denmark, Estonia*, Finland*, France, Germany, Greece, Hungary*, Iceland*, Ireland*, Italy, Japan, Latvia*, Lithuania*, Luxemburg*, Mexico*, Netherlands, New Zealand, Norway, Poland*, Portugal, Slovakia*, Slovenia*, S. Korea, Spain, Sweden, Switzerland, Turkey*, United Kingdom, United States. Data on the housing price index are not available for countries with asterisk (*)

[9]We thank professor Chihwa Kao for providing us his GAUSS codes, which we adjusted for the purpose of this research.

we also applied other methods of estimation such as the continuously-updated bias-corrected (CupBC) estimator of Bai et al. (2009) or the fully modified OLS and DOLS estimators (Kao and Chiang, 2000). Even though the values of the estimated coefficients vary depending on the estimation technique, the general results from all methods are qualitatively very similar. The results from the other methods are available upon request.

Table 8 presents the results of estimations for 8 different specifications of model 22. The estimate of parameter α_1, which is related to the interest rate spread, is significantly negative in all regressions, even if the real interest rate is included in the model. This supports the implications of the theoretical model, which shows that changes in the interest rate spread should dampen the value of loans to households. Since the lending interest rate is usually approximated by the rate on mortgages (where the collateral values often exceed the values of loans) and by the rate on loans to prime customers in other cases, the risk premium is considerably reduced in the spread. Therefore, we can interpret the estimation result as an evidence of more costly banks providing less credit to the household sector. As regards the parameter related to individual income persistence, α_3, its estimates are always negative, but often not statistically significantly different from zero. This is also in accordance with the results of simulations from the previous section, which show that higher income persistence decreases the level of household credit.

The control variables: GDP per capita (approximating the average level of disposable income to each household) and the housing price index are also significant in all specifications and the estimates are of expected sign. In turn, the positive and usually not significant correlation between the real interest rate and the value of loans can be explained by the fact that changes in the spread explain changes in household credit better than the real interest rate itself. Another control variable, the unemployment rate, is usually not significant.

In the second set of regressions we use cross-sectional data to explain differences in the value of credit among 27 EU countries. This allows us to analyze the link between household credit and a wider range of explanatory variables, as specified in equation (22). The results, which are presented in Table 9, are as follows.

The coefficient related to the *spread* variable, α_1, is always negative, and sometimes significant. This confirms our panel data results and the implications of the theoretical model. The variable *incu* is somewhat negatively correlated with the dependent variable. The link becomes positive when more control variables are added to the regression, but remains insignificant. We also experimented with other measures of individual income uncertainty: the income quintile share ratio (income of the 20% richest to income of 20% poorest), the percentage of working households in the risk of poverty and the ratio of the number of households making ends meet without any problems and with great difficulty. The latter variable was significant in many specifications, pointing to the interpretation that a larger income discrepancy reduces the value of loans in the economy. However, this favorable result should be interpreted with a caution due to the possible impact of the credit burden on the living conditions of households. As regards the *pers* variable, the estimates of α_3 are negative and highly significant in all specifications. This result confirms the panel results and theoretical model simulations, which state that the value of household credit is negatively correlated with individual productivity persistence. For the replacement ratio (*repl*), the results show that it is negatively correlated with the value of credit in all specifications, but statistically insignificant. Given that the theoretical impact of the replacement ratio on the value of credit is low[10], this result is broadly with what we expect. Finally, from the set of control variables, only disposable income is significant in all specifications. The real interest rate and unemployment are statistically insignificant and their coefficients are of wrong sign.

The values of R^2 indicate that the variability of household credit among EU countries can be explained in 38% by differences in the interest spread, and in 45% by differences in individual productivity persistence. The contribution of variables *incu* and *repl* in explaining the variance of household credit is low. The value of $R^2 = 0.62$ in specification (5) indicates, that our theoretical model is relatively supported by the cross-sectional data for 27 EU countries.

Overall, we believe that both the panel data and cross-sectional regressions support the results from the theoretical model. This is especially true for the interest rate spread and individual productivity persistence. The measures of income uncertainty and replacement ratio for different countries are negatively correlated with the level of household credit, but the link is statistically insignificant.

6. Directions for future work

We have shown that apart from traditional determinants of credit, i.e. real interest rate and output, there are other factors that have impact on the value of credit in the economy, such as interest rate spread, individual income uncertainty and persistence or the structure of the pension system. Moreover, we have provided evidence, that the implications of the theoretical model are to some degree confirmed by the data for OECD and EU countries. In subsequent research we hope to consider several extensions to the presented work.

First, in the current setup of the theoretical model we have not addressed the observation that a large fraction of credit to households is in the form of mortgages. Since both our results and the results of Egert et al. (2007) or Hofmann (2004) show that house prices have a significant impact on the value of credit to households, it seems interesting to analyze this relation within a theoretical life-cycle model with housing. Even though this kind of models have already been developed by some authors (Fernandez-Villaverde and Krueger, 2004; Hintermaier and Koeniger, 2009; Yang, 2009), the question about the impact of house prices or the minimum value of mortgage down-payment on the amount of credit in the economy is still relatively unexplored.

[10]An increase of the replacement ratio from 40% to 60% decreases the value of household credit merely from 14.3% of GDP to 13.1% of GDP (see 6).

Second, in the current setup it is assumed that firms utilize capital that is borrowed from banks at the market rate. In practice, however, firms finance a large fraction of their assets with own capital (see Graham and Harvey, 2001, for empirical evidence), where the cost of external financing is usually higher than the risk-free interest rate (see Bernanke et al., 1999, and references therein). As a result, we believe that building a model with heterogeneous consumers and firms could help expand our understanding of the determinants of credit to the private sector. According to our best knowledge this kind of model has not been developed so far. However, theoretical models describing firms that are heterogeneous in terms of productivity, age or net worth has been developed (Hopenhayn, 1992; Cooley and Quadrini, 2001, e.g.), so some solution are present in the literature.

Finally, another potential extension of our work would rely on endogenizing the interest rate spread, which in the current version of the model depends solely on the fixed costs and the probability of unexpected death. The natural way to do so is to account for credit default risk and bankruptcy regulations, as it was done e.g. in Athreya (2002); Chatterjee et al. (2007); Livshits et al. (2007), but also other factors could be taken into account, such as monopolistic competition in the banking sector.

References

Athreya, K. B., 2002. Welfare implications of the bankruptcy reform act of 1999. Journal of Monetary Economics 49 (8), 1567–1595.

Azariadis, C., Smith, B., 1998. Financial intermediation and regime switching in business cycles. American Economic Review 88 (3), 516–36.

Bai, J., Kao, C., Ng, S., 2009. Panel cointegration with global stochastic trends. Journal of Econometrics 149 (1), 82–99.

Bernanke, B. S., Gertler, M., Gilchrist, S., 1999. The financial accelerator in a quantitative business cycle framework. In: Taylor, J. B., Woodford, M. (Eds.), Handbook of Macroeconomics. Elsevier, Ch. 21, pp. 1341–1393.

Carroll, C., Summers, L. H., 1989. Consumption growth parallels income growth: Some new evidence. NBER Working Papers 3090, National Bureau of Economic Research, Inc.

Carroll, C. D., Samwick, A. A., 1998. How important is precautionary saving? The Review of Economics and Statistics 80 (3), 410–419.

Chatterjee, S., Corbae, D., Nakajima, M., Ríos-Rull, J.-V., 2007. A quantitative theory of unsecured consumer credit with risk of default. Econometrica 75 (6), 1525–1589.

Cooley, T. F., Quadrini, V., 2001. Financial markets and firm dynamics. American Economic Review 91 (5), 1286–1310.

Egert, B., Backe, P., Zumer, T., 2007. Private-sector credit in Central and Eastern Europe: New (over)shooting stars? Comparative Economic Studies 49 (2), 201–231.

Fernandez-Villaverde, J., Krueger, D., 2004. Consumption and saving over the life cycle: How important are consumer durables? 2004 Meeting Papers 357b, Society for Economic Dynamics.

Floden, M., Lindé, J., 2001. Idiosyncratic risk in the United States and Sweden: Is there a role for government insurance? Review of Economic Dynamics 4 (2), 406–437.

Gerali, A., Neri, S., Sessa, L., Signoretti, F. M., 2010. Credit and banking in a DSGE model of the euro area. Journal of Money, Credit and Banking 42 (s1), 107–141.

Graham, J. R., Harvey, C. R., 2001. The theory and practice of corporate finance: Evidence from the field. Journal of Financial Economics 60 (2-3), 187–243.

Heathcote, J., Storesletten, K., Violante, G. L., 2005. Two views of inequality over the life cycle. Journal of the European Economic Association 3 (2-3), 765–775.

Heer, B., 2004. Overlapping Generations Models (GAUSS). QM&RBC Codes, Quantitative Macroeconomics & Real Business Cycles, No. 138.

Heer, B., Maussner, A., 2005. Dynamic General Equilibrium Modelling. Springer, Berlin.

Hintermaier, T., Koeniger, W., Jun. 2009. Debt portfolios. Working Papers 646, Queen Mary, University of London, School of Economics and Finance.

Hofmann, B., 2004. The determinants of bank credit in industrialized countries: Do property prices matter? International Finance 7 (2), 203–234.

Hopenhayn, H. A., 1992. Entry, exit, and firm dynamics in long run equilibrium. Econometrica 60 (5), 1127–50.

Huggett, M., 1996. Wealth distribution in life-cycle economies. Journal of Monetary Economics 38 (3), 469–494.

Iacoviello, M., 2005. House prices, borrowing constraints, and monetary policy in the business cycle. American Economic Review 95 (3), 739–764.

Kao, C., Chiang, M.-H., 2000. On the estimation and inference of a cointegrated regression in panel data. Advances in Econometrics 15, 179–222.

Kiyotaki, N., Moore, J., 1997. Credit cycles. Journal of Political Economy 105 (2), 211–48.

Lawrance, E. C., 1995. Consumer default and the life cycle model. Journal of Money, Credit and Banking 27 (4), 939–54.

Livshits, I., MacGee, J., Tertilt, M., 2007. Consumer bankruptcy: A fresh start. American Economic Review 97 (1), 402–418.

Lorenzoni, G., 2008. Inefficient credit booms. Review of Economic Studies 75 (3), 809–833.

Ludvigson, S., 1999. Consumption and credit: A model of time-varying liquidity constraints. The Review of Economics and Statistics 81 (3), 434–447.

OECD, 2009. Pensions at a Glance 2009: Retirement-Income Systems in OECD Countries. OECD, Paris.

Saunders, A., Schumacher, L., 2000. The determinants of bank interest rate margins: An international study. Journal of International Money and Finance 19 (6), 813–832.

Storesletten, K., Telmer, C. I., Yaron, A., 2004a. Consumption and risk sharing over the life cycle. Journal of Monetary Economics 51 (3), 609–633.

Storesletten, K., Telmer, C. I., Yaron, A., 2004b. Cyclical dynamics in idiosyncratic labor market risk. Journal of Political Economy 112 (3), 695–717.

Tauchen, G., 1986. Finite state markov-chain approximations to univariate and vector autoregressions. Economics Letters 20 (2), 177–181.

U.S. Census Bureau, 2009. Statistical abstract of the United States, 2010. U.S. Census Bureau, Washington, DC.

Yang, F., 2009. Consumption over the life cycle: How different is housing? Review of Economic Dynamics 12 (3), 423–443.

Zeldes, S. P., 1989. Optimal consumption with stochastic income: Deviations from certainty equivalence. The Quarterly Journal of Economics 104 (2), 275–98.

Tables and figures

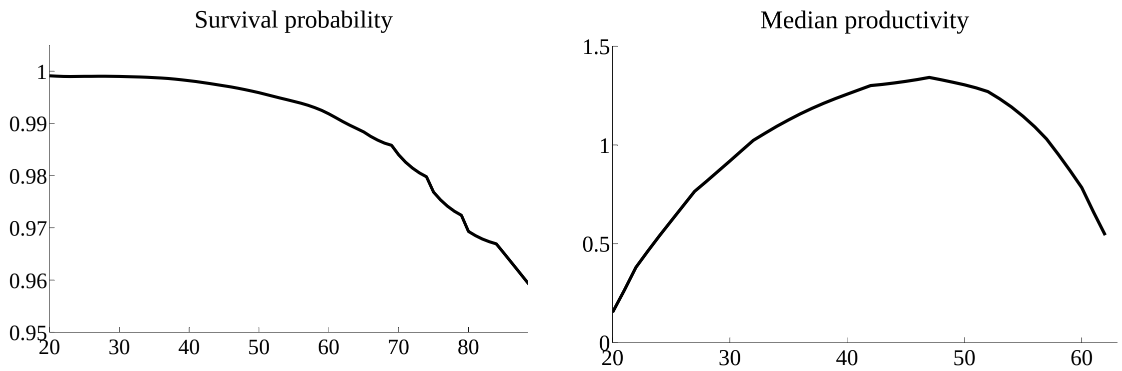
Table 1: Parameterization of the benchmark model

Population growth rate	γ	1.01
Number of cohorts	J	71
Number of working cohorts	J_1	43
Share of retirees in adult population		0.247
Discount factor	β	0.98
Risk aversion	η	2
Persistence of idiosyncratic productivity process	ρ	0.96
Variance of idiosyncratic productivity process	σ_ε^2	0.045
Capital share	α	0.30
Depreciation rate	δ	0.08
Lending-market rate spread	Ψ_1	0.02
Market-deposit rate spread	Ψ_2	0.01
Government spending share in output	G/Y	0.20
Capital tax rate	τ_r	0.15
Replacement rate	θ	0.40

Table 2: Solution of the benchmark model

GDP	Y	0.436
Capital-output ratio	K/Y	2.643
Investment-output ratio	I/Y	0.238
Private consumption-output ratio	C/Y	0.562
Deposit rate	r_d	0.023
Market rate	r	0.033
Lending rate	r_l	0.053
Income tax rate	τ_w	0.275
Social contribution rate	κ	0.084
Household credit to GDP ratio	Cr/Y	0.143
Share of population with non-positive assets		0.325

Figure 1: Survival probability and median productivity



Source: U.S. Census Bureau (2009, Sec. 2, Tab. 105) and Huggett (1996).

Figure 2: Life-cycle path for key variables

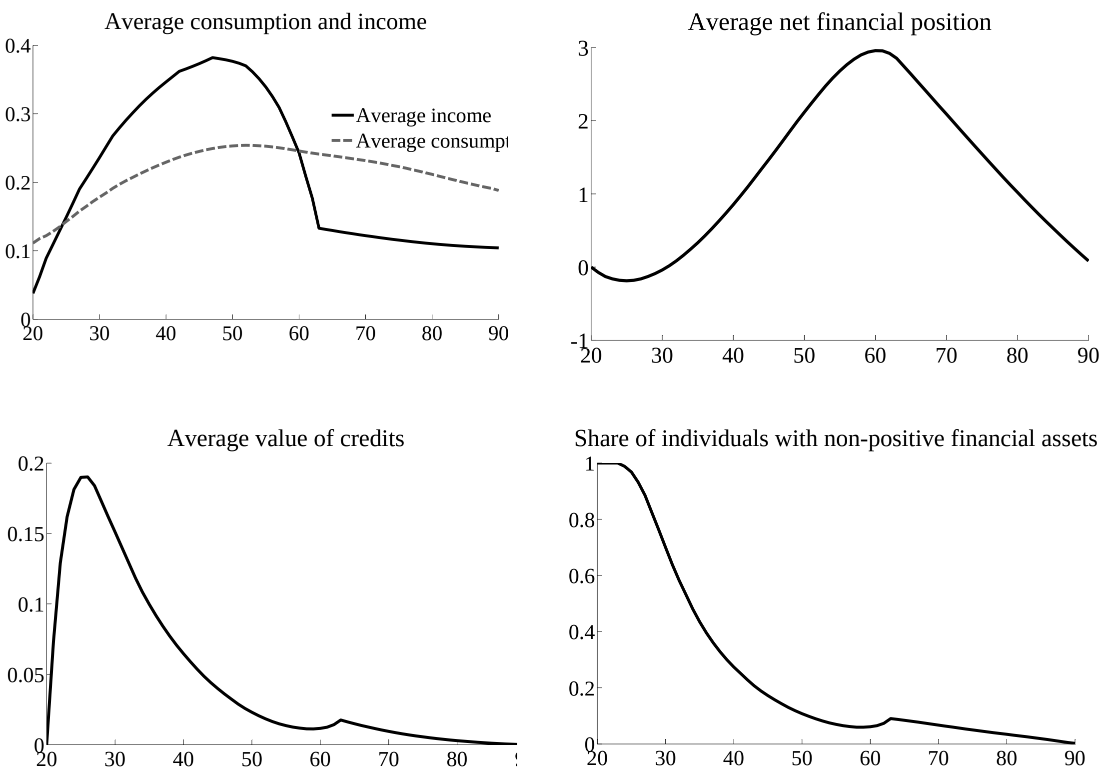


Table 3: Interest rate spread and the stationary equilibrium

	Interest rate spread: $r_l - r_d$				
	0.00	0.015	0.03	0.045	0.06
Output (Y)	0.441	0.439	0.436	0.432	0.427
Deposit rate (r_d)	0.030	0.026	0.023	0.020	0.018
Market rate (r)	0.030	0.031	0.033	0.035	0.038
Lending rate (r_l)	0.030	0.041	0.053	0.065	0.078
Average net wage ($\bar{w}$)	0.264	0.262	0.260	0.257	0.253
Pension (b)	0.106	0.105	0.104	0.103	0.101
Capital-output ratio (K/Y)	2.732	2.689	2.643	2.585	2.528
Household credit to GDP ratio (Cr/Y)	0.278	0.200	0.143	0.102	0.072
Share of population with non-positive assets	0.383	0.353	0.325	0.298	0.273

Notes: The baseline value of the spread is 0.03.

Figure 3: Interest rate spread and life-cycle decisions

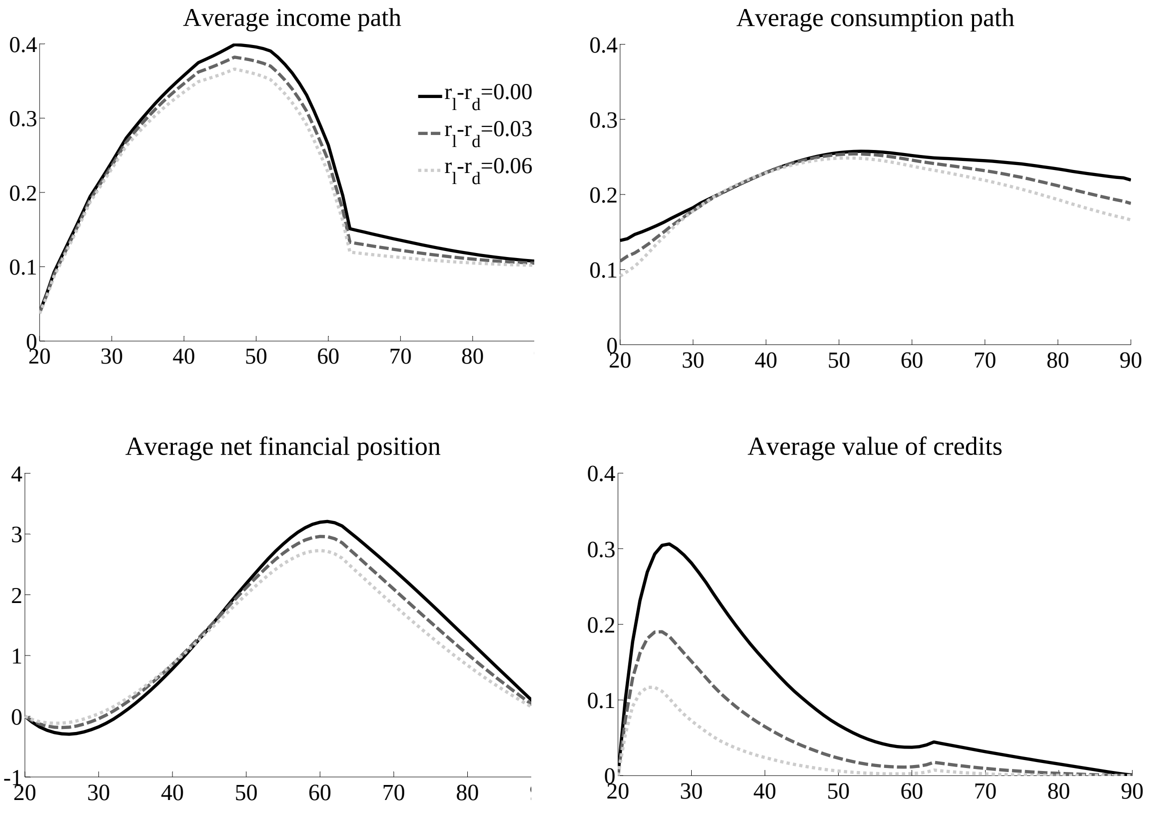


Table 4: Individual income uncertainty and the stationary equilibrium

	Individual productivity volatility σ_ε^2				
	0.015	0.030	0.045	0.060	0.075
Output (Y)	0.349	0.391	0.436	0.482	0.532
Effective labor (L)	0.241	0.263	0.287	0.312	0.339
Market rate (r)	0.046	0.039	0.033	0.029	0.025
Average net wage ($\bar{w}$)	0.210	0.234	0.260	0.287	0.316
GINI of earnings	31.4	38.6	44.2	48.6	52.4
Pension (b)	0.084	0.093	0.104	0.115	0.126
Capital-output ratio (K/Y)	2.364	2.527	2.643	2.767	2.865
Household credit to GDP ratio (Cr/Y)	0.189	0.159	0.143	0.135	0.134
Share of population with non-positive assets	0.325	0.322	0.325	0.330	0.339

Notes: The baseline value of the idiosyncratic productivity volatility is 0.045.

Figure 4: Individual income uncertainty and life-cycle decisions

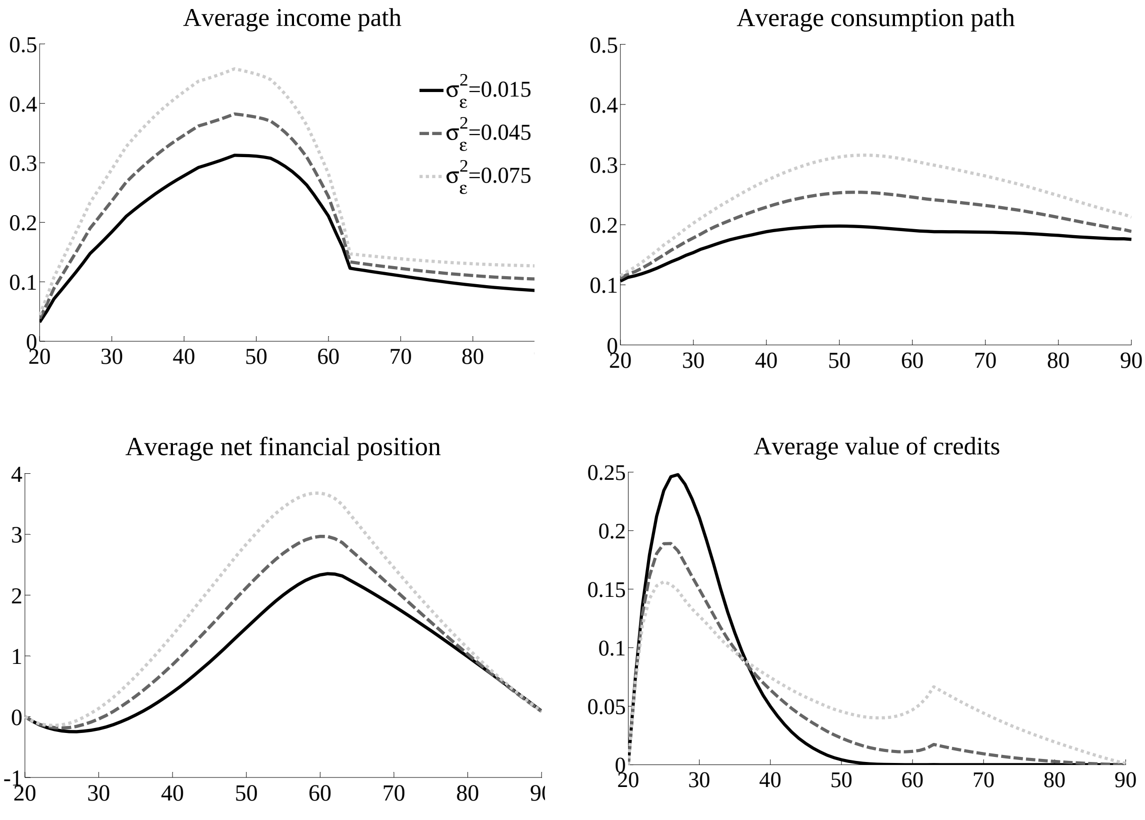


Table 5: Individual productivity persistence and the stationary equilibrium

	Productivity persistence ρ				
	0.90	0.94	0.96	0.97	0.98
Output (Y)	0.436	0.437	0.436	0.434	0.428
Market rate (r)	0.031	0.032	0.033	0.035	0.037
Average net wage ($\bar{w}$)	0.260	0.260	0.260	0.259	0.256
Pension (b)	0.104	0.104	0.104	0.103	0.102
Capital-output ratio (K/Y)	2.680	2.673	2.643	2.611	2.543
Household credit to GDP ratio (Cr/Y)	0.176	0.158	0.143	0.135	0.129
Share of population with non-positive assets	0.306	0.317	0.325	0.330	0.336

Notes: The baseline value of the population growth rate is 1.01.

Figure 5: Individual productivity persistence and life-cycle decisions

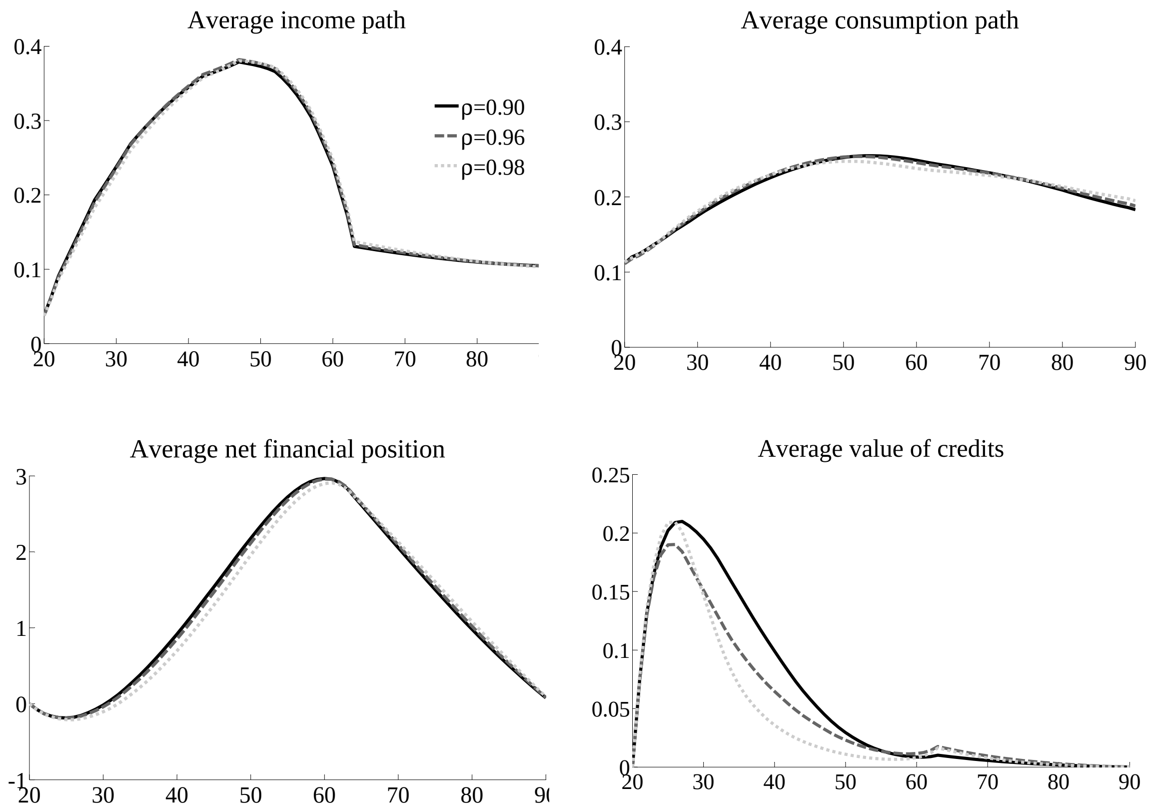


Table 6: Replacement rate and the stationary equilibrium

	Replacement rate θ				
	0.2	0.3	0.4	0.5	0.6
Output (Y)	0.456	0.445	0.436	0.428	0.421
Market rate (r)	0.022	0.028	0.033	0.038	0.042
Average net wage ($\bar{w}$)	0.287	0.272	0.260	0.248	0.238
Pension (b)	0.057	0.082	0.104	0.124	0.143
Social contribution rate (κ)	0.044	0.065	0.084	0.103	0.120
Capital-output ratio (K/Y)	2.966	2.778	2.643	2.533	2.444
Household credit to GDP ratio (Cr/Y)	0.152	0.149	0.143	0.137	0.131
Share of population with non-positive assets	0.308	0.318	0.325	0.329	0.332

Notes: The baseline value of the replacement ratio is 0.40.

Figure 6: Replacement rate and life-cycle decisions

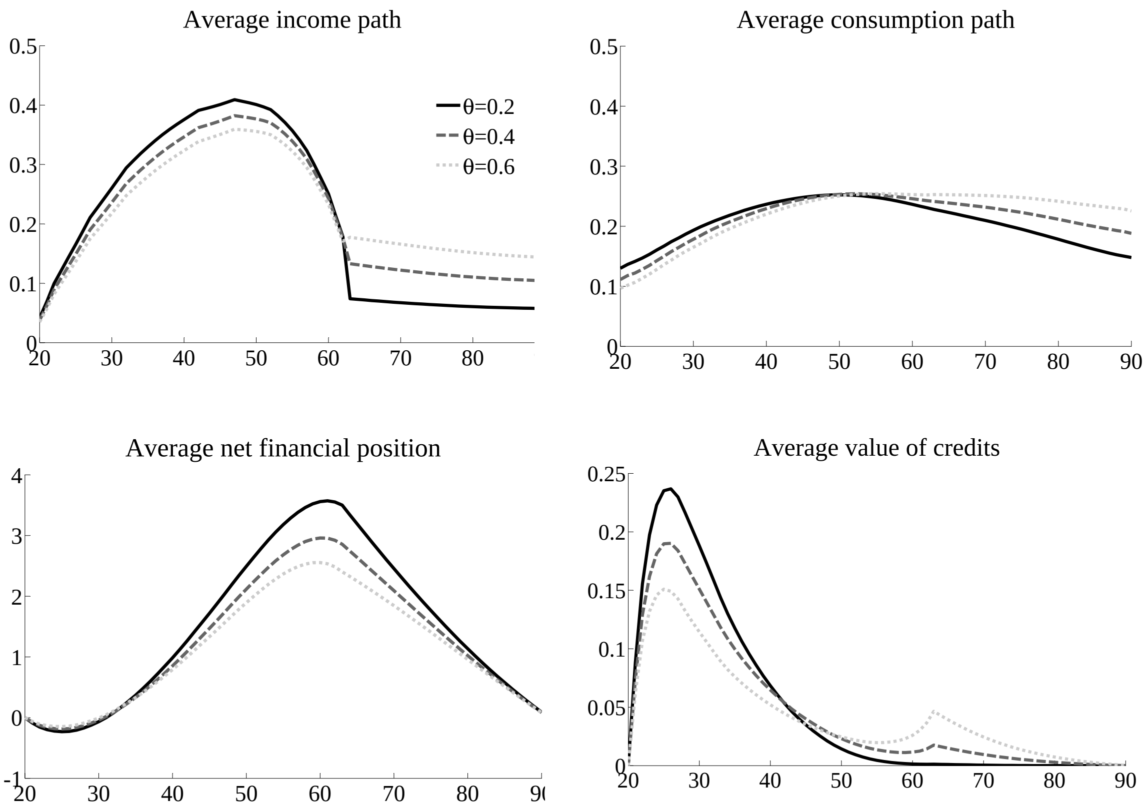


Table 7: Data sources

variable	definition	source
	Panel data	
Cr	value of household loans	OECD, BIS Data Bank, ECB, national central banks, Ecowin
GDP	nominal GDP	World Bank WDI
r_l	rate on housing loans or loans for primer customers	BIS Data Bank, ECB, IMF IFS
r_d	deposit rate	IMF IFS, ECB
$pers$	long-term unemployment	World Bank WDI, Eurostat
gdp_cap	log of GDP per capita at const. prices	World Bank WDI
r	real market rate	World Bank WDI
$unemp$	unemployment rate	World Bank WDI, Ecowin, OECD
hpi	log of the housing price index	BIS Data Bank, national central banks and stat. offices, Global Property Guide
	Cross-sectional data	
Cr	value of household loans	ECB
GDP	nominal gross domestic product	AMECO
r_l	interest rate on housing loans	ECB
r_d	deposit rate	ECB
$incu$ also:	GINI coefficient income quantile share ratio S80/S20 ratio of workers at risk of poverty ratio of households making ends...	Eurostat SILC
$pers$	long-term unemployment	Eurostat
$repl$	replacement ratio	Eurostat
$dispinc$	gross national disp. income per capita	AMECO
$unemp$	unemployment rate	AMECO
r	real market rate	AMECO

Notes: Variables present in model 22 are defined as: $cr = \ln(Cr/GDP)$, $spread = \ln(\frac{1+r_l}{1+r_d})$ and $rate = \ln(1+r)$.

Table 8: Models explaining household loans using panel data from OECD and EU countries

Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
spread (α_1)	-3.23		-3.52	-6.56	-6.91	-6.76	-9.07	-4.67
	(2.36)		(2.57)	(5.89)	(6.15)	(5.99)	(6.06)	(3.40)
pers (α_3)		-0.10	-0.02	-0.82	-0.91	-0.72	-0.27	-0.04
		(0.46)	(0.06)	(2.54)	(2.86)	(2.09)	(0.69)	(0.09)
gdp_cap				3.52	3.39	3.43	2.79	1.648
				(14.2)	(13.8)	(12.5)	(7.27)	(4.33)
rate					0.94	0.84	-0.13	2.70
					(1.60)	(1.41)	(0.18)	(3.98)
unemp						0.38	-1.69	0.30
						(0.32)	(1.32)	(0.25)
hpi								0.77
								(7.41)
N	36	36	36	36	36	36	21	21
T	14	14	14	14	14	14	14	14

Notes: The dependent variable is the log-level of household credit to GDP. The main explanatory variables are the interest rate spread (*spread*) and the measure of productivity persistence (*pers*). Additional control variables are: real GDP per capita (*gdp*), real interest rate (*rate*), unemployment ratio (*unemp*), and the housing price index (*hpi*). N is the number of countries and T is the number of years. The t statistics are presented below parameter estimates.

Table 9: Models explaining household loans using cross-sectional data from EU countries

Specification	(1)	(2)	(3)	(4)	(5)	(6)
const	4.52	4.27	4.92	3.28	5.48	2.96
	(21.3)	(4.98)	(18.1)	(6.59)	(6.62)	(2.42)
spread (α_1)	-27.7				-19.4	-5.22
	(3.93)				(3.03)	(0.65)
incu (α_2)		-1.72			0.08	2.35
		(0.60)			(0.04)	(1.02)
pers (α_3)			-2.93		-2.22	-1.54
			(4.49)		(3.56)	(2.22)
repl (α_4)				-0.66	-0.69	-1.37
				(0.99)	(0.72)	(1.42)
dispinc						0.49
						(2.59)
rate						0.74
						(0.13)
unemp						1.58
						(0.38)
N	27	27	27	27	27	27
R^2	0.38	0.01	0.45	0.04	0.62	0.72

Notes: The dependent variable is the log-level of household credit to GDP. The main explanatory variables are the interest rate spread (*spread*), the measure of income uncertainty (*incu*), the measure of productivity persistence (*pers*), and the replacement ratio (*repl*). Additional control variables are disposible income (*dispinc*), real interest rate (*rate*), and unemployment ratio (*unemp*). N is the number of observations and R^2 is the coefficient of determination. The t statistics are presented below parameter estimates.