Can Temptation Explain Housing Choices over the Life Cycle?

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Can Temptation Explain Housing Choices in Later Life?*

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Abstract. We use individual life-history data from twelve European countries, and duration analysis that controls for unobserved heterogeneity, to investigate whether observed patterns of investment in illiquid assets and housing are consistent with predictions based on "temptation preferences". A motivating model takes into account the standard motives for saving, but also recognizes that illiquid financial assets and housing may be used by individuals who find it hard to control the temptation linked to abundant cash on hand. Even controlling for many possible motives for purchasing housing, and for unobserved heterogeneity, individuals become significantly more likely to buy housing after investing in illiquid assets; this finding is consistent with the predictions of the model.
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1. Introduction

The standard life-cycle model predicts that households should accumulate assets while working, and decumulate these assets to fund consumption spending in retirement. Recent economic research has identified certain stylised facts about saving that seem puzzling within this benchmark. One strand of literature has discussed the "retirement savings puzzle" (Banks et al., 1998) that households seem to experience a discrete drop, rather than a smooth change, in consumption at the time they retire. A second puzzle is the fact that households seem to demand assets that commit them to lock away their funds for fixed periods of time, even though such commitment reduces the opportunity to use wealth in times of unexpected "rainy day" need. A third fact that standard models cannot easily explain is the relatively slow rate at which older households seem to decumulate wealth, with some retirees even continuing to save (see Attanasio and Weber, 2010, for a review of this and other puzzles.)

To the previous (by no means exhaustive) list, we may add the issue that elderly households seem reluctant to utilise their housing wealth to fund spending even when they appear "house rich but cash poor". Evidence on this in European (SHARE) data is provided by Angelini et al. (2009), which documents the extent to which a failure to downsize (or otherwise draw on) housing wealth is related to financial difficulties among the old. Furthermore, the issue runs deeper than a "no downsizing puzzle": Angelini et al. (2014) explore the determinants of home purchase past age fifty and the evidence indicates that some households increase their housing wealth, or become first-time house buyers, even around or just after the time of retirement. This is particularly surprising because the evidence refers to continental European countries where eviction and rent risks are quite low for sitting tenants (Angelini et al., 2011).

Many different ways to explain puzzles such as those listed above have been suggested. As highlighted by Attanasio and Weber (2010), non-standard preferences, such as quasi-hyperbolic discounting (Laibson, 1997; O'Donoghue and Rabin, 1999) or temptation and self-control preferences (Gul and Pesendorfer, 2001, 2004; Bucciol, 2012), may explain a taste for commitment in investment decisions and so contribute to the explanation of several apparent puzzles. The aim of this paper is, using European data, to investigate the empirical support for the idea that temptation, and a consequent taste for commitment, may be important in shaping households' saving and wealth allocation decisions. As we describe below, our interest is particularly in the choices about home-ownership.

Understanding how and why individuals make the saving and investment decisions that they do is of interest for both academic audiences and pensions practitioners. Understanding the reasons why individuals choose to own their home and largely fail to reduce housing equity in the last years of their life, is also an interesting research agenda for economists and social scientists (Venti and Wise, 2004; Angelini et al., 2014) and has important policy implications in ageing societies.

We are particularly interested in understanding whether temptation preferences, which can plausibly help to explain other consumption-saving puzzles, might also help explain observed relationships between patterns of investment in illiquid financial assets, and in housing. The idea that temptation and a desire for commitment might influence lifecycle patterns of home ownership is also taken up in a very recent contribution by Kovacs (2016); her simulations show that as housing becomes more illiquid (and even without an interaction with illiquid financial assets) this can lead tempted agents to increase the amount of housing that they own from early middle age onwards. Related research on non-standard preferences and housing comes from Ghent (2015), who looks at the implications of hyperbolic discounting for home-ownership rates and welfare in a model in which the interest rate is determined by credit market equilibrium. Regarding the failure to spend down housing wealth in old-age, Nakajima and Telyukova (2011) provide a survey of several possible explanations and an impressive, detailed analysis of home equity release in old age in a rich life-cycle model under uncertainty. Our empirical focus is different from these other papers. Furthermore, we believe that our approach of looking whether home-buying decisions, and their relationship to the purchase of illiquid assets, can support the hypotheses that temptation and a taste for commitment importantly shape behaviour, is entirely novel.

Temptation preferences give a high value to the commitment property of illiquid assets such as retirement assets or housing: since illiquid wealth cannot be disinvested immediately, agents cannot succumb to the temptation to spend it on current consumption. Removing this temptation can make agents better-off as they face lower self-control costs in trying to implement optimal forward-looking consumption and saving plans. Tempted individuals – who typically face a no-unsecured-borrowing condition that prevents them from falling into heavy debt early in life – look for ways to tie their hands, for example through holding illiquid assets. After retirement (once retirement accounts enter the decumulation phase), housing is the main (or often the only) illiquid asset that families can still choose to invest in. If temptation is a key driver of saving decisions, and particularly decisions about retirement savings, then this should affect households' decisions about how much to invest in illiquid financial assets and in housing.

We look for prima facie evidence for the role of housing wealth as a commitment device by using micro-data to investigate whether individuals who engage in financial activities that help to control temptation, are subsequently more likely than others to become home owners. In particular, we look at whether individuals who engage in long-term saving plans by investing in individual retirement accounts and/or life-insurance policies, then have an increased likelihood of investing in housing. In Section 2 we outline a theoretical model to better justify our claim that our empirical work provides an indication of a role for temptation preferences. To carry out our empirical analyses, we need a household-level dataset containing information on holdings of illiquid financial assets and of housing: an ideal dataset is SHARE, the Survey of Health, Ageing and Retirement in Europe. Using this panel dataset we observe over the lifetime behaviour regarding holding and accumulation of the relevant assets, and we are able to relate this behaviour to characteristics such as education and risk attitude, as well as demographic and economic variables.

The purpose of this paper, then, is to understand how the decision to purchase a house for the first time is related to the holding of illiquid financial assets (retirement accounts and life insurance policies) that can be seen as ways to tie one's hands (commitment devices). We perform a discrete-time duration analysis through a logit regression model. This allows us to estimate the hazard rate of first-time house purchase, conditional on the ownership of illiquid financial assets and a number of observable characteristics, including a measure of permanent income. Given that ownership of illiquid financial assets may proxy for differences in unobserved characteristics, we also allow for unobserved heterogeneity by means of a bivariate mixed proportional hazard model with shared frailty, and check how the relationship between becoming a homeowner and the ownership of illiquid financial assets varies across the population of interest. We explain in detail in Section 4 why we believe our empirical models are appropriate for the question at hand, and to the best of our knowledge we are the first to employ this hazard model, with unobserved heterogeneity, in the context of house-purchase decisions. To briefly anticipate, we find that even controlling for many possible motives for purchasing housing, and for unobserved heterogeneity, individuals are seen to become significantly more likely to buy housing after investing in illiquid assets; this finding is consistent with the predictions of a model with illiquid financial assets, housing and temptation preferences.

The remainder of the paper is organised as follows. Section 2 sketches a theoretical framework for the temptation motive with housing and illiquid assets; Section 3 describes the data; Sections 4 comments on the parameter estimates of the duration model with and without unobserved heterogeneity. Finally, Section 5 concludes.

2. A theoretical framework

In this section we describe a lifecycle consumption-savings model with two types of illiquid asset (a financial asset and housing), and temptation preferences. The purpose of the discussion is to formalise implications of the model which we can then look for in the data.

The economic framework consists of a life-cycle model in which time is discrete and t denotes adult age. An agent lives for a maximum of T periods: K as a worker and $T-K$ as a retiree. For the sake of simplicity, the retirement age K is taken to be exogenous. At any age t, individuals face a fixed probability π of surviving until the next period. Death is certain at the beginning of period $T+1$.

At every point in time *t*, an individual has to choose non-durable consumption $C_t \geq 0$, contribution $X_t \geq 0$ (if $t < K$) or withdrawal $X_t \leq 0$ (if $t \geq K$) from an illiquid retirement asset, and housing tenure, $H_t = \{0,1\}$. Choices are conditional on cash-on-hand (liquid personal wealth plus disposable income), S_t, and the size of the retirement asset, A_t, at the beginning of time *t*, and housing tenure in the previous period, H_{t-1}. The housing tenure variable is an indicator for renting $(H_t = 0)$ or owning $(H_t = 1)$ the home.

2.1. Assets

Agents may hold liquid and illiquid financial assets throughout their life. Liquid assets are personal savings. Illiquid assets are the savings accumulated in retirement plans, which generally have the following features: i) contributions are possible in any period before retirement age; ii) contributions are matched by the employer; iii) contributions are tax deductible; iv) withdrawals from the account balance are always granted after retirement, and only in exceptional cases before retirement. In this stylised model, we capture features (ii) and (iii) by assumptions about the rate of return (see next paragraph). To make the retirement asset an effective commitment device during the working life, features (i) and (iv) are particularly important and we capture these by assuming that contributions are always possible for agents of working age ($t < K$), while withdrawals are *only* possible at ages $t \geq K$, once the pensionable age is reached.

For the sake of simplicity we assume that returns on assets are certain. Both personal (*S*) and retirement (*A*) assets are invested in a diversified portfolio of stocks, bonds, and safe assets that accumulates at a given market rate of return. However, before retirement age effective returns for the individual on retirement assets are higher than returns on liquid assets ($R_A > R_S$ if $t < K$) because of employer matching and tax deductions. As a result, workers face a trade-off: on the one hand they have the incentive to save in illiquid assets because of their higher returns but, on the other, they have a disincentive to do so because their savings will not be available until retirement.

In what follows we use A_t to denote the retirement account consisting of all the savings in illiquid assets made up to year t, including their returns, and use S_t to denote the personal account consisting of earnings in year t and all the savings in liquid assets made up to year t, including their returns. The personal account thus includes all the wealth immediately available for consumption, or cash-on-hand.

Given current asset holdings, S_t and A_t, and housing tenure, H_{t-1}, at time t the agent determines the optimal level of consumption, $C_t > 0$, housing tenure, $H_t = \{0,1\}$, as well as the contribution to/withdrawal from the retirement account, X_t. Here

$$\begin{aligned} X_t &\geq 0 \quad \text{if } t < K; \\ X_t &\leq 0 \quad \text{if } t \geq K. \end{aligned}$$

The evolution of the *illiquid* retirement account is given by

$$A_{t+1} = R_A \left(A_t + X_t \right)$$

with $A_{t+1} \geq 0$. Anything left after consumption and changes to housing tenure and the retirement account, is saved in the personal account. The evolution of this *liquid* personal account is then given by

$$S_{t+1} = R_S \left(S_t - C_t - X_t + \left((1-\phi) PH_{t-1} - PH_t \right) \left| H_t - H_{t\text{-}1} \right| - \psi PH_t - \rho P \left(1 - H_t \right) \right) + Y_{t+1}$$

with $S_{t+1} \geq 0$, i.e., borrowing is not possible. The parameter P indicates the house price, while ϕ denotes a transaction cost proportional to the house price that is applied when selling a house. The absolute value $\left| H_t - H_{t\text{-}1} \right|$ is equal to 1 when there is a change in home tenure $\left(H_t \neq H_{t-1} \right)$ and 0 otherwise. In addition, in every time period the home-owner spends a fraction $\psi \in [0,1]$ of the house value on maintenance and repairs (as in Li and Yao, 2007). In contrast, the renter spends a fraction $\rho \in [0,1]$ of the home value in rent. Therefore $(1-\phi) PH_{t-1}$ is the revenue from home selling net of transaction costs, $-PH_t$ is the cost of home purchase, $-\psi PH_t$ is the home maintenance cost, $-\rho P \left(1 - H_t \right)$ is the rent cost, and Y_{t+1} is next year's income.

The evolution of liquid personal assets thus depends on the housing tenure decision. Four cases are possible: i) the agent rented and now rents $\left(H_{t-1} = H_t = 0 \right)$, in which case she pays rent costs $-\rho P$; ii) the agent rented and now owns $\left(H_{t-1} = 0; H_t = 1 \right)$, in which case she pays the purchase price and maintenance costs $-P - \psi P$; iii) the agent owned and now rents $\left(H_{t-1} = 1; H_t = 0 \right)$, in which case she pays rent costs and she gets revenues from home selling, $-\rho P + (1-\phi) P$; iv) the agent owned and now owns $\left(H_{t-1} = H_t = 1 \right)$, in which case she pays maintenance costs $-\psi P$.

2.2. Preferences

Gul and Pesendorfer (2001) build a theoretical framework for temptation and self-control motive, where agents have preferences not only over alternatives but also over *sets* of alternatives. They define as tempting those alternatives that are sub-optimal from a forward-looking perspective, but optimal from a myopic perspective. Using all available cash to fund immediate consumption is one possible tempting alternative. When making their decisions, agents face a utility cost to exert self-control and avoid tempting alternatives. In the framework of Gul and Pesendorfer (2001), an agent may therefore prefer a given set of alternatives to another, larger set that includes the first set plus some tempting alternatives. Hence, the use of commitment devices that remove tempting alternatives from the choice set, may lead to an improvement in wellbeing. For instance in the context of consumption decisions, a retirement account is a commitment device because it results in a fraction of wealth being made unavailable for immediate consumption. Bucciol (2012) develops and simulates a temptation model with retirement accounts to estimate the degree of temptation. Our analysis derives from a variant of his framework that also includes housing assets.

In a fashion similar to Gul and Pesendorfer (2001, 2004), the uniperiodal utility function is defined as

$$U\left(C_t, H_t \middle| S_t, A_t, H_{t-1}\right) = u\left(C_t, H_t\right) - \left(v\left(C_t^*, H_t^*\right) - v\left(C_t, H_t\right)\right).$$

Here $u(\cdot)$ and $v(\cdot)$ are two von Neumann-Morgenstern utility functions and C^* and $H^*$are the choices corresponding to the maximum possible level of consumption. The first addend, $u\left(C_t, H_t\right)$, is the utility function as in standard models, while the second addend describes a temptation motive given by the difference between the utility under the tempting, myopic behaviour, $v\left(C_t^*, H_t^*\right)$, and the utility reflecting the actual decisions, $v\left(C_t, H_t\right)$. For the sake of tractability we restrict our attention to the case where $v(\cdot) = \lambda u(\cdot)$, with preference parameter $\lambda \geq 0$, the *degree of temptation*, measuring the agent's sensitivity to the tempting alternative. Note that preferences are standard when $\lambda = 0$. The larger is λ, the more temptation affects utility and so the stronger is the incentive to give in to temptation and to equalise consumption and cash-on-hand.

The tempting, myopic behaviour makes the individual consume as much as possible at time *t*, leaving no wealth to future periods. Since the individual is borrowing constrained,[1] consumption cannot exceed

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[1] Sophisticated credit instruments would change the details of the analysis somewhat, but realistic mortgage markets with both income-related and down-payment constraints (as modelled for instance in Attanasio et al., 2012), would not alter the

the portion of cash-on-hand available at the moment. The largest possible consumption is achieved only in the presence of: i) home renting rather than home ownership; ii) no contribution to retirement assets before retirement; iii) full withdrawal of retirement assets after retirement. Under this scenario we then have home renting, $H_t^* = 0$, no retirement asset contribution before retirement, $X_t^* = 0$ if $t < K$, full retirement asset withdrawal after retirement, $X_t^* = -A_t$ if $t \geq K$, and full consumption of all the liquid assets $C_t^* = S_t - X_t^* + (1-\phi) PH_{t-1} - \rho P$, in such a way that no personal assets are left for the future.

The second addend of the above equation can also be seen as the cost of exerting self-control and resisting temptation. In order to increase her utility, an agent should reduce the cost of self-control. To achieve this an agent may tie her hands by making some choices (e.g., home ownership and investment in retirement assets) that reduce her future consumption choice set, an in particular lower the size (and utility benefit) of the tempting alternative. This means that temptation, and the desire to mitigate it, can be a motivation for owning illiquid assets and housing.

It should be noticed, though, that while contributing to illiquid assets is possible at any time until retirement for any given amount (however small), housing purchase comes at a given cost that, due to borrowing constraints, can be afforded only when $S_{t+1} \geq 0,$ that is, when $S_t \geq C_t + X_t + P(1+\psi) - Y_{t+1}/R_S$. Hence housing is an actual option for commitment only when the individual has a relevant amount of liquid assets available. In a standard life-cycle model, and for many individuals, this typically happens in middle or old age. For an individual with self-control problems, however, holding a relatively large stock of liquid assets is costly. The only phase when this may happen is when retirement assets are no longer illiquid and can be freely withdrawn.

The decision on the contribution to retirement assets is relevant for the immediate availability of savings for consumption and housing needs: only personal assets are immediately available, while retirement assets will be available only from age *K*. In this context, tempted individuals before retirement are more attracted by retirement assets than non-tempted individuals, because of their commitment role. After retirement these assets are no longer illiquid (they may be withdrawn at any convenience) and hence the desire to purchase commitment no longer provides any additional

model's predictions as they would not undo the potential for housing to act as a commitment device. In her model with hyperbolic discounting, Ghent (2015) considers the possibility of foreclosure on loans. Foreclosure is almost unheard of in many European countries and in any case this possibility does not undermine housing's role as a commitment device in Ghent's model.

incentive for tempted individuals to hold them. After retirement, then, home ownership is the only viable commitment device.

Agents' intertemporal preferences at time t are described by the following expected utility function:

$$U\left(C_t, H_t \left| S_t, A_t, H_{t-1}\right.\right) + E_t\left[\sum_{k=t+1}^{T} (\beta\pi)^{k-t} U\left(C_k, H_k \left| S_k, A_k, H_{k-1}\right.\right)\right]$$

where β is the discount factor. For the sake of simplicity we omit potential bequest motives, which would not alter our qualitative conclusions.

2.3. The optimisation problem

We represent the agent's optimisation problem using the recursive value function

$$V\left(S_t, A_t, H_{t-1}\right) = \max_{C_t, X_t}\left\{U\left(C_t, H_t \left| S_t, A_t, H_{t-1}\right.\right) + \pi\beta E_t\left[V\left(S_{t+1}, A_{t+1}, H_t\right)\right]\right\}$$

subject to the above budget and borrowing constraints. The control variables of the problem are $\left\{C_t, X_t, H_t\right\}_{t=1}^{T}$, and the state variables are $\left\{t, S_t, A_t, H_{t-1}\right\}_{t=1}^{T}$. At any age $t < T$, optimising behaviour (disregarding corner solutions) will satisfy the following system of two equations (see the appendix for their derivation), with $1\{t \geq K\}$ an index function equal to 1 if $t \geq K$ and 0 otherwise:

$$\frac{\partial u\left(C_t, H_t\right)}{\partial C_t} = \pi\beta R_S E_t\left[\frac{\partial u\left(C_{t+1}, H_{t+1}\right)}{\partial C_{t+1}} - \frac{\lambda}{1+\lambda}\frac{\partial u\left(C^*_{t+1}, H^*_{t+1}\right)}{\partial C^*_{t+1}}\right]$$

$$R_A E_t\left[\frac{\partial u\left(C_{t+1}, H_{t+1}\right)}{\partial C_{t+1}} - \frac{\lambda}{1+\lambda}\frac{\partial u\left(C^*_{t+1}, H^*_{t+1}\right)}{\partial C^*_{t+1}} 1\{t \geq K\}\right] = R_S E_t\left[\frac{\partial u\left(C_{t+1}, H_{t+1}\right)}{\partial C_{t+1}} - \frac{\lambda}{1+\lambda}\frac{\partial u\left(C^*_{t+1}, H^*_{t+1}\right)}{\partial C^*_{t+1}}\right].$$

The first equation is the consumption Euler equation for tempted agents. In the case of no temptation ($\lambda = 0$) this equation becomes the familiar consumption Euler equation which can be interpreted as saying that the marginal cost of saving and giving up a unit of consumption in the current period, is set equal to the appropriately discounted expected marginal benefit of extra consumption next period. With positive λ, the equation illustrates that, for tempted individuals, the marginal cost of giving up one unit of current consumption must be set equal to this same marginal benefit *minus* the marginal cost of resisting additional temptation in the next period. Thus the marginal benefit of saving is smaller for tempted than for non-tempted individuals and this explains why, *ceteris paribus,* a tempted individual will consume more and save less than an otherwise identical non-tempted individual. The cost of resisting additional temptation is partly mitigated when consumption is given up for the purchase of illiquid assets. In particular, neglecting cross-derivative effects, when a house is bought $H_{t+1} = 1$ and the marginal consumption benefit is larger in the next period.

The second equation is the equation determining contributions to or withdrawals from the retirement asset. Notice that, after retirement, $R_A = R_S$ and the left-hand side and the right-hand side of the equation coincide. This implies that a retired agent is completely indifferent between personal and retirement assets, as they are both liquid and provide the same return. This is not the case before retirement, when $R_A > R_S$ and retirement assets are illiquid. We indeed see that the marginal cost of giving up one unit of future retirement savings must be equal to the marginal benefit of owning one unit of future personal savings *minus* the marginal cost of resisting the additional temptation in the next period. Hence, ceteris paribus, tempted individuals appreciate retirement assets more than non-tempted individuals do, because these assets provide commitment against the temptation to immediately consume all available resources.

2.4. Predictions

This stylised model thus predicts that tempted agents:

i) Find it more difficult to accumulate personal savings (because they tend to consume all their wealth);

ii) Are willing to save in illiquid assets (retirement assets and housing) rather than liquid assets (because illiquid assets provide commitment);

iii) Are likely to save in retirement assets at an earlier stage than in housing (because liquidity constraints prevent home purchase at early ages);

iv) Can save in commitment devices only through housing wealth after retirement (because retirement assets become liquid).

The first two of these predictions can be seen by inspecting the Euler equations of the previous subsection; predictions (iii) and (iv) are consequences, or likely consequences, of realistic assumptions about credit constraints and the nature of the assets that are available and that provide commitment. Our claim in this paper is not that these insights are new ((i) and (ii) are certainly known consequences of the temptation model). Rather, the novelty of our exercise is to explore whether observed patterns of asset ownership and home purchase in micro data, are consistent with these implications of the model.

Figure 1 summarises a typical life-cycle pattern from this model. The agent starts her adult life without savings in liquid or illiquid assets. Then, as time goes by, she accumulates savings in the form of liquid wealth. Since this gives rise to self-control problems, the agent starts saving in liquid assets together with illiquid assets (that provide commitment). This happens since age A, when illiquid saving is made through the purchase of retirement assets. After a few further years, more liquid wealth is accumulated, again inducing self-control problems. However, this time the agent can afford the purchase of housing (at age B). The decision is motivated by the fact that the alternative option of saving in retirement assets will no longer provide commitment in a near future, when the agent becomes retired at age C.

Turning to how we can compare the model's prediction to the data, in a period of life when cash on hand is high (relative to permanent income), a tempted individual is likely to turn to financial commitment devices and subsequently (once credit constraints have been overcome) to invest in housing. Thus, for tempted individuals home ownership should: (a) be positively correlated with the holding of (illiquid financial) retirement assets; (b) follow the purchase of retirement assets. Our goal is to check if the data are consistent with these predictions.

FIGURE 1 ABOUT HERE

3. The Data

Our main source of micro data is SHARELIFE, the third wave of the Survey of Health, Ageing and Retirement in Europe (SHARE), that asks respondents aged 50 and over to record life-history events regarding housing, health, children, relationships, employment and financial investments. For our purposes, information on previous investments in retirement accounts and life insurance policies (i.e., illiquid financial assets)[2], as well on the year in which assets were first owned, is particularly important. SHARE respondents are a representative sample of the 50+ population in thirteen European countries; however, we exclude Poland from the analysis because of unreliable retrospective information on income[3]. Information from SHARELIFE is merged with information on current income and education from the second wave of SHARE (we consider the average over the 5 "constructed variables" imputations – see Christelis, 2011, for details on the multiple imputations methodology used in SHARE), and with permanent income estimates from Weiss (2012).

[2] We also consider life insurance policies as illiquid financial assets. In many policies savings cannot be withdrawn for several years, or they can be withdrawn after paying large penalties.

[3] Trevisan et al. (2011) argue that Poles answering the SHARE questionnaire got confused between new and old Zloty around the devaluation in 1995 and misreported earnings during the high inflation of the 80s and 90s.

We reshape SHARELIFE as a longitudinal dataset, that is, for each respondent we have as many observations as years of adult age. By "adult age" we mean any age between the age in which the individual became independent (when she started to live on her own or when she established her own household) and the age in the year before the interview, with a minimum at age 19 and a maximum at age 80. Our dependent variable is the dummy variable "owner", taking the value 1 if the individual is home-owner at a given age, and 0 otherwise. We include in the sample all observations from individuals who have never been home-owners (for whom the variable "owner" is equal to 0 at all ages), and, for individuals who have owned their home, all observations up to the age at which the home-ownership first occurred (thus for these observations the variable "owner" is equal to 0 at all ages but the last one). We can therefore estimate duration models on the timing of the first home purchase.

Table 1 reports the definition of all the variables used in this analysis. The variables in the specification can be thought of as falling into five groups: financial ones (illiquid assets, i.e., life insurance policies and retirement accounts, and risk tolerance[4]), demographics (age, gender, education, health status), household composition (marital status, number of children, household size), occupation and income (unemployment, retired, permanent income), and finally control variables (country, cohort). To avoid potential simultaneity between home ownership and the other dimensions of the analysis, we take lags of time-varying explanatory variables. This means, for instance, that we relate home ownership in year t to household size in year $t-1$ (rather than household size in year t, which might be affected by home ownership in year t). For the ownership of illiquid assets, we take the second lag (i.e., the value in year $t-2$) because the purchase of a house is often associated to the holding of a life insurance policy. Alongside this indicator of ownership, we also include a measure of the number of years since illiquid assets were first owned, which might capture the time elapsed since commitment devices were first demanded.

TABLE 1 ABOUT HERE

Summary statistics on our variables are reported in Table 2, separately for the full sample and the sub-sample of those who have ever owned illiquid assets. As expected, illiquid asset owners on average have

[4] We use the self-assessed answer to a question on portfolio allocation between riskless and risky assets. Available options are: (1) Take substantial financial risks expecting to earn substantial returns; (2) Take above average financial risks expecting to earn above average returns; (3) Take average financial risks expecting to earn average returns; (4) Not willing to take any financial risks. Most answers are concentrated in option (4). The variable we include in the specification is a dummy equal to 1 if the individual declares to be willing to take at least some risk, i.e., if she reports any option between (1) and (3).

higher permanent income. On average they are also older, more highly educated and more likely to be males.

TABLE 2 ABOUT HERE

4. Regression Analysis

In this section we present our duration models of entry in to home-ownership. Using the data just described, we are able to control for many factors that are likely to influence house purchase choices and that may also be correlated with the decision to buy illiquid assets. In Subsection 4.1 we present duration models that control for a range of covariates. There may also be unobserved factors that could lead to a spurious correlation between the ownership of illiquid assets and house purchase, and so in subsection 4.2 we extend the model to also take account of unobserved heterogeneity.

4.1 Baseline Hazard Model

Table 3 presents parameter estimates from a discrete duration model, estimated with a standard logit regression following Jenkins (1995). We always report average marginal effects multiplied by 100 to facilitate reading. Each number in the table can then be interpreted as the effect of a unit increase in the explanatory variable on the percentage probability of transiting into home-ownership in a given year.

TABLE 3 ABOUT HERE

Columns (1) to (3) of the table display the average marginal effects for the equation explaining the probability of first becoming a home-owner as a function of ownership of illiquid assets, controlling for risk attitude, age, gender, education, time-varying demographics (family size, marital status, number of children), employment status, income, country and cohort dummies. In particular, controlling for family composition is crucial to properly distinguish the temptation motive for first home purchase from the demographic motive (that relates the home purchase decision to variations in family size and composition). The three columns of Table 3 differ in their treatment of income, respectively current, permanent including pensions, and permanent excluding pensions.

We see from column (1) that the coefficient on having illiquid assets is positive and significant: past illiquid asset holding is associated with an 0.549 percentage point increase in the probability of purchasing a house, in line with our expectations if consumers use illiquid assets as a commitment device to keep temptation under control. However, the longer the individual has had illiquid assets, the weaker the effect: in fact, one more year with illiquid assets reduces by 0.042 percentage points the probability to purchase a house, and so the sign is reversed about thirteen years (0.549/0.042) after purchasing the asset. This suggests that tempted individuals with abundant cash on hand first buy commitment devices in the more easily accessible form of illiquid financial assets, and then also try to rapidly buy house.

Not surprisingly, income has a strong, positive effect. In column (2) we replace the log of current income with the log of permanent income, computed only for employees as the discounted present value at age ten of all future earnings plus pension benefits[5]. This is a much more appropriate conditioning variable, as it captures long term differences in resources that should explain why people choose to purchase illiquid financial assets and to become home-owners. Permanent income indeed plays a strong role in explaining the transition into home-ownership, but the coefficients on the other variables of interest are fairly stable.

In column (3) we focus on a narrower definition of permanent income that includes earnings but excludes pensions (as these may be in part affected by the decision to invest in individual retirement accounts). This measure also has the predicted, strong, positive coefficient, leaving little effect on the other coefficients. Thus a 1% increase in permanent income increases the probability of becoming a home-owner by 0.311 percentage points; holding illiquid assets increases the probability by more than half a percentage point, but this effect becomes null after more than twelve years of holding (0.580/0.047); finally, renters classified as risk tolerant are nearly one percent more likely to become home-owners in any given year than are those that are more averse to risk. The coefficients related to the other control variables have the expected sign. For instance, age follows the typical hump-shaped pattern, with the probability of purchasing a house increasing at young ages, reaching a maximum at age 31 (0.247/(2*0.004)), and then falling.

TABLE 3 ABOUT HERE

We conclude the section with Figure 2, a graphical representation of the hazard rates of home ownership, conditional on the holding, and non-holding, of non-liquid financial assets. The hazard rate of home ownership at age *t* can be computed as

$$h\left(t \middle| x_t\right) = \frac{1}{1 + \exp\left\{ -\bar{x}' \hat{\beta} \right\}}$$

[5] Permanent income is a measure of lifetime earnings at age ten, which is estimated controlling also for early life conditions, such as the occupation of the main breadwinner, the number of books, the number of rooms per person and the presence of facilities (such as central heating and hot running water) in the parental home. For details on how this measure was computed see Weiss (2012).

where $\bar{x}$ is the set of averages of the explanatory variables (conditional on age=t), and $\hat{\beta}$ are the parameter estimates from the model using permanent income without pensions (column (3) of Table 3). To compute the hazard rates conditional on holding (not holding) liquid assets, we set the relevant x variable equal to 1 (0).[6] Figure 2 plots the age profile of hazard rates over the full sample age range, showing a standard inverted-U shape peaking at around age 33, when family formation is underway. Importantly, hazard rates for households holding illiquid assets are persistently higher than hazard rates for households not holding them.

FIGURE 2 ABOUT HERE

4.2 Controlling for Unobserved Heterogeneity

The estimates presented above do not take into account the potential confounding effect of unobserved heterogeneity in the desire to resist temptation and/or have access to illiquid financial, or real, assets. It is possible that equally tempted individuals react differently to their temptation: some are more likely to lock themselves in IRAs, to later become home-owners (as a way to have a guaranteed stream of housing consumption services for the rest of their lives); others instead cannot do so, because this form of financial investment is not available to them, or will not do so because they do not value future consumption enough (they are not only tempted, but also highly impatient). In short, our previous findings might result from a selection bias due to unobserved factors that influence the probability to own both illiquid financial assets and a house. Ignoring this unobserved heterogeneity might have resulted in a spurious correlation between the decision to own illiquid financial assets and the decision to purchase a house.

The empirical technique that we use to control for unobserved heterogeneity is one that has recently been used in the context of drug use. There the question of substance is whether the strong cross-sectional association between cannabis use and hard drugs use is spurious and due to some innate personality trait (frailty) or instead one can identify a "gateway effect" whereby cannabis is a stepping stone for hard drugs. As with all analogies, the parallel between the drug use example and our case, is imperfect: in the drug use case one can readily think of mechanisms (exposure to dealers, peer-pressure from other users) for a direct gateway effect. What the two cases share is a concern that unobserved heterogeneity may skew the coefficients of interest in the duration analysis. In our illiquid assets and

[6] Thus the two curves in the figure are calculated at the sample average of the explanatory variables, and differ only in the assumption on the holdings of illiquid assets. For the curve with assets, we set to 1 the variable on "Illiquid assets (t-2)"; for the curve without assets, we set to 0 the variable on "Illiquid assets (t-2)" and, for coherence, in this case we also set to 0 the variable on "Years illiquid assets".

home-ownership case, problems would arise if some "frailty" (thriftiness or impatience, for example) that is not controlled for by our list of regressors, means that some individuals are more likely to buy both illiquid financial, and real, assets. Thus, if our results are robust to controlling for heterogeneity that will increase our confidence in the idea that the link between purchasing illiquid financial assets and home-ownership is coming from the purchase of illiquid financial assets being an indicator that an individual feels it is a good time to buy commitment.

Both van Ours (2003) and Melberg et al. (2010) tackle the issue of separating the "gateway effect" from the effect of frailty, by specifying a latent class model where the hazard of using hard drugs is affected by previous use of cannabis, but some or all estimated parameters can differ across endogenously determined groups of the population. The estimates of the coefficients of interest change when heterogeneity can play a role, and this allows the identification of what part of correlation between the use of cannabis and of harder drugs is due to unobserved heterogeneity, and what part instead can be interpreted as the causal (gateway) effect. Typically, this analysis highlights the presence of two such groups, one of which appears more prone to using drugs, the other more resistant.

In our regressions, we adopt the more general approach taken by Melberg et al. (2010), whereby all parameters entering the model are allowed to vary across the two groups. Like those authors, we use the bivariate mixed proportional hazard model with shared frailty introduced in Abbring and Van Den Berg (2003). The model is made of two logistic regression equations, describing the outcome and treatment variables. In our case the treatment is the ownership of illiquid assets (life insurance policies or retirement accounts), while the outcome is home ownership. This model allows us to estimate how the probability of becoming a home-owner changes with and without the holding of illiquid assets in two groups, identified via variation in the timing of first investment in housing and in illiquid assets. Specifically, we estimate the posterior probability that each observation belongs to either group. The average estimated probability of belonging to Group 1 is 45.9%, with most probabilities close to either 0 or 1. In Table 4 we report summary statistics for all variables, weighted by the predicted probability of belonging to each group. The number of observations differs in the two groups because of the exclusion of observations with probability equal to 0.

The last column of the table reports the outcome of a t-test on the equality of the mean in the two groups. Due to the large sample size, we reject this hypothesis in almost all the variables. The table shows that the second group is generally less wealthy (9.5% lower permanent income) and less highly educated, possibly because it was born during the Great Depression or during World War II (years 1925-1944). The different availability of resources, and therefore access to credit, is reflected in more widespread holding of illiquid assets in the first group (26% as opposed to 14%). However, there is no difference in the fraction of home purchases (3.5% in both groups) and the time lag between the first purchase of illiquid assets and housing is smaller in the second group (2 rather than 4.8 years).

All in all, we may think of Group 2 as the group that is more prone to buy real assets: limited monetary resources notwithstanding, Group 2 is willing to purchase a house at the same rate as the better-off Group 1.

TABLE 4 ABOUT HERE

Table 5 shows the average marginal effects (multiplied by 100) of our regression analysis with unobserved heterogeneity. In column (2) we report the effects corresponding to the no heterogeneity model already presented in column (3) in Table 3. Column (1) does the same for the equation predicting the probability of becoming the owner of illiquid assets. The estimated effects of permanent income and risk tolerance on this dependent variable are large and significant. The model without unobserved heterogeneity in columns (1) and (2) provides a reference for our subsequent analysis. Columns (3) and (4) present the same effects computed using as weights the probabilities of belonging to Group 1. Columns (5) and (6) use instead the probability of belonging to Group 2. It is worth stressing that a different pair of logistic regressions is estimated across the two groups, and that each individual in the sample can belong to either one group or both, depending on the predicted probabilities that generate the individual weights in the logistic regressions.

TABLE 5 ABOUT HERE

Perhaps the most striking feature in the regressions on the purchase of illiquid assets is the huge difference between the estimated effect of permanent income and risk tolerance: when no heterogeneity is allowed, these effects are larger than when unobserved heterogeneity is allowed for. Similarly, the impact of illiquid asset holding on the probability to purchase a home is more than doubled when unobserved heterogeneity is allowed for. The remaining estimated marginal effects are not much affected by allowance for unobserved heterogeneity, with the possible exception that for Group 2 the probability of becoming a home-owner is more strongly affected by illiquid asset holding (1.58 as opposed to 1.21%.) This is clear also in Figure 3, which reports for the two groups the age profile of the hazard rate to purchase a house computed exactly as in Figure 2. The difference in hazard rates between illiquid asset owners and non-owners is much more marked in Group 2 (panel b) than in Group 1 (panel a). In both groups, however, the difference in hazard rates is more ample than predicted by the model without unobserved heterogeneity.

FIGURE 3 ABOUT HERE

For Group 2, the probability of becoming a home-owner also seems unaffected by family status and family composition, employment and health conditions. This pattern of coefficients seems in line with an explanation that focuses on limited access to illiquid financial investment for Group 2 individuals – and differences in access to financial markets that are correlated with income could also explain why permanent income effects are so different across columns (1), (3) and (5) in Table 5.

For our purposes, the key message of the analyses presented in this section is that controlling for unobserved heterogeneity does not undermine the result that the in the years after purchasing illiquid financial assets households have an increased risk of becoming first-time house buyers. Indeed, as is clearly illustrated by the comparison of Figures 2 and 3, point estimates of the association between the ownership of illiquid financial assets and the likelihood of becoming a home owner, actually increase (in both groups 1 and 2) when we control for unobserved heterogeneity is controlled for.

5. Conclusion

In this paper we have used individual life-history data from twelve European countries, and duration analysis that controls for unobserved heterogeneity, to investigate whether observed patterns of investment in illiquid assets and housing are consistent with predictions based on "temptation preferences".

The illustrative model that we considered (Section 2) takes into account the standard motives for saving and investing in illiquid assets such as housing or retirement accounts, and also adds a "temptation motive" (à la Gul and Pesendorfer, 2001, 2004). The equations of the model make it clear why illiquid assets may be used by individuals who find it hard to resist the temptation presented by a large stock of accessible "cash on hand". Particularly in the absence of other appropriate assets, for example as pensions approach the decumulation phase, housing may be the only asset that provides this commitment technology.

The prima facie evidence we produced is consistent with the notion that, when tempted individuals first resort to illiquid financial assets to control temptation, they are then more likely to use housing as a commitment device. Our estimates also suggest that there is a lot of heterogeneity in the access to illiquid financial investment prior to home purchase. This may reflect institutional features of this specific type of financial market, or more broadly different access to credit across Europe at different points in time.

The analysis we presented in this paper is suggestive, but tentative. A structural model is necessary to better investigate the commitment effect of the temptation preferences as opposed to limited access to financial markets, credit constraints or other reasons (e.g., strategic interactions between non-cooperative family members) that may induce a fraction of individuals to purchase their home soon after locking assets away in illiquid financial assets. This is left for future research.

Appendix: Solution to the Life-cycle Problem

The model solution is derived as follows. We derive the value function with respect to the choice variables C_t and X_t (first-order conditions) and the state variables S_t and A_t (envelope conditions). Manipulating the four conditions we find an expression for the first-order conditions of C_t and X_t that does not involve the derivative of the value function. Finally, housing tenure H_t is chosen from the maximisation of the value function in the two alternative cases where $H_t = 0$ or $H_t = 1$.

To derive the system of equations, we compute the first-order conditions of $V\left(S_t, A_t, H_{t-1}\right)$ with respect to C_t and X_t:

$$\begin{aligned} &\frac{\partial V\left(S_t, A_t, H_{t-1}\right)}{\partial C_t} = 0 = \\ &= \frac{\partial U\left(C_t, H_t \left| S_t, A_t, H_{t-1}\right.\right)}{\partial C_t} - \pi\beta R_S E_t\left[\frac{\partial V\left(S_{t+1}, A_{t+1}, H_t\right)}{\partial S_{t+1}}\right]; \end{aligned} \tag{1}$$

$$\begin{aligned} &\frac{\partial V\left(S_t, A_t, H_{t-1}\right)}{\partial X_t} = 0 = \\ &= \pi\beta E_t\left[R_A \frac{\partial V\left(S_{t+1}, A_{t+1}, H_t\right)}{\partial A_{t+1}} - R_S \frac{\partial V\left(S_{t+1}, A_{t+1}, H_t\right)}{\partial S_{t+1}}\right]. \end{aligned} \tag{2}$$

We then use the envelope theorem and derive $V\left(S_t, A_t, H_{t-1}\right)$ with respect to S_t and A_t:

$$\begin{aligned} &\frac{\partial V\left(S_t, A_t, H_{t-1}\right)}{\partial S_t} = \\ &= \frac{\partial U\left(C_t, H_t \left| S_t, A_t, H_{t-1}\right.\right)}{\partial S_t} + \pi\beta R_S E_t\left[\frac{\partial V\left(S_{t+1}, A_{t+1}, H_t\right)}{\partial S_{t+1}}\right]; \end{aligned} \tag{3}$$

$$\frac{\partial V\left(S_t, A_t, H_{t-1}\right)}{\partial A_t} = \\ = \frac{\partial U\left(C_t, H_t \left| S_t, A_t, H_{t-1}\right.\right)}{\partial A_t} + \pi\beta R_A E_t\left[\frac{\partial V\left(S_{t+1}, A_{t+1}, H_t\right)}{\partial A_{t+1}}\right]. \tag{4}$$

Using (1) and (3), we find that

$$\frac{\partial V\left(S_t, A_t, H_{t-1}\right)}{\partial S_t} = \frac{\partial U\left(C_t, H_t \left| S_t, A_t, H_{t-1}\right.\right)}{\partial S_t} + \frac{\partial U\left(C_t, H_t \left| S_t, A_t, H_{t-1}\right.\right)}{\partial C_t}. \tag{5}$$

Furthermore, subtracting (3) from (4) and using (2),

$$\frac{\partial V\left(S_t, A_t, H_{t-1}\right)}{\partial A_t} - \frac{\partial V\left(S_t, A_t, H_{t-1}\right)}{\partial S_t} \\ = \frac{\partial U\left(C_t, H_t \left| S_t, A_t, H_{t-1}\right.\right)}{\partial A_t} - \frac{\partial U\left(C_t, H_t \left| S_t, A_t, H_{t-1}\right.\right)}{\partial S_t}. \tag{6}$$

Plugging (5) into (6) yields

$$\frac{\partial V\left(S_t, A_t, H_{t-1}\right)}{\partial A_t} = \frac{\partial U\left(C_t, H_t \left| S_t, A_t, H_{t-1}\right.\right)}{\partial A_t} + \frac{\partial U\left(C_t, H_t \left| S_t, A_t, H_{t-1}\right.\right)}{\partial C_t} \tag{7}$$

Hence we can use (5) and (7) to rewrite the first-order conditions (1) and (2) as follows:

$$\frac{\partial U\left(C_t, H_t \left| S_t, A_t, H_{t-1}\right.\right)}{\partial C_t} = \\ \pi\beta R_S E_t\left[\frac{\partial U\left(C_{t+1}, H_{t+1} \left| S_{t+1}, A_{t+1}, H_t\right.\right)}{\partial S_{t+1}} + \frac{\partial U\left(C_{t+1}, H_{t+1} \left| S_{t+1}, A_{t+1}, H_t\right.\right)}{\partial C_{t+1}}\right] \tag{8}$$

and

$$R_A E_t\left[\frac{\partial U\left(C_{t+1}, H_{t+1} \left| S_{t+1}, A_{t+1}, H_t\right.\right)}{\partial A_{t+1}} + \frac{\partial U\left(C_{t+1}, H_{t+1} \left| S_{t+1}, A_{t+1}, H_t\right.\right)}{\partial C_{t+1}}\right] \\ = R_S E_t\left[\frac{\partial U\left(C_{t+1}, H_{t+1} \left| S_{t+1}, A_{t+1}, H_t\right.\right)}{\partial S_{t+1}} + \frac{\partial U\left(C_{t+1}, H_{t+1} \left| S_{t+1}, A_{t+1}, H_t\right.\right)}{\partial C_{t+1}}\right]. \tag{9}$$

Now, because

$$\frac{\partial U\left(C_t,H_t\left|S_t,A_t,H_{t-1}\right.\right)}{\partial C_t}=\frac{\partial u\left(C_t,H_t\right)}{\partial C_t}+\frac{\partial v\left(C_t,H_t\right)}{\partial C_t}=\left(1+\lambda\right)\frac{\partial u\left(C_t,H_t\right)}{\partial C_t};$$
$$\frac{\partial U\left(C_t,H_t\left|S_t,A_t,H_{t-1}\right.\right)}{\partial S_t}=-\frac{\partial v\left(C_t^*,H_t^*\right)}{\partial C_t^*}=-\lambda\frac{\partial u\left(C_t^*,H_t^*\right)}{\partial C_t^*}; \tag{10}$$
$$\frac{\partial U\left(C_t,H_t\left|S_t,A_t,H_{t-1}\right.\right)}{\partial A_t}=\begin{cases}0 & t<K\\ -\frac{\partial v\left(C_t^*,H_t^*\right)}{\partial C_t^*}=-\lambda\frac{\partial u\left(C_t^*,H_t^*\right)}{\partial C_t^*} & t\geq K\end{cases}$$

we can rewrite equations (8) as

$$\begin{aligned}&\left(1+\lambda\right)\frac{\partial u\left(C_t,H_t\right)}{\partial C_t}=\\&\pi\beta R_S E_t\left[\left(1+\lambda\right)\frac{\partial u\left(C_{t+1},H_{t+1}\right)}{\partial C_{t+1}}-\lambda\frac{\partial u\left(C_{t+1}^*,H_{t+1}^*\right)}{\partial C_{t+1}^*}\right]\end{aligned} \tag{11}$$

and equation (9) as

$$\begin{aligned}&R_A E_t\left[\left(1+\lambda\right)\frac{\partial u\left(C_{t+1},H_{t+1}\right)}{\partial C_{t+1}}\right]=\\&=R_S E_t\left[\left(1+\lambda\right)\frac{\partial u\left(C_{t+1},H_{t+1}\right)}{\partial C_{t+1}}-\lambda\frac{\partial u\left(C_{t+1}^*,H_{t+1}^*\right)}{\partial C_{t+1}^*}\right]\end{aligned} \tag{12}$$

if $t<K$, and

$$\begin{aligned}&R_A E_t\left[\left(1+\lambda\right)\frac{\partial u\left(C_{t+1},H_{t+1}\right)}{\partial C_{t+1}}-\lambda\frac{\partial u\left(C_{t+1}^*,H_{t+1}^*\right)}{\partial C_{t+1}^*}\right]=\\&=R_S E_t\left[\left(1+\lambda\right)\frac{\partial u\left(C_{t+1},H_{t+1}\right)}{\partial C_{t+1}}-\lambda\frac{\partial u\left(C_{t+1}^*,H_{t+1}^*\right)}{\partial C_{t+1}^*}\right]\end{aligned} \tag{13}$$

if $t\geq K$. We can further simplify Equations (11)-(13) dividing by $\left(1+\lambda\right)$, to obtain the equations shown in the main text.

References

Abbring, J.H.., Van Den Berg, G. 2003. The Non-parametric Identification of Treatment Effects in Duration Models. *Econometrica 71*, 1491-1517.

Angelini, V., Brugiavini, A., Weber, G. 2009. Ageing and Unused Capacity in Europe: Is There an Early Retirement Trap? *Economic Policy 59*, 453-508.

Angelini, V., Brugiavini, A., Weber, G. 2014. The Dynamics of Homeownership among the 50+ in Europe. *Journal of Population Economics 27*, 797-823.

Angelini, V., Bucciol, A., Wakefield, M., and Weber, G. 2013. "*Can Temptation Explain Housing Choices in Later Life?*," Netspar Discussion Paper DP05/2013-021.

Angelini, V., Laferrère, A., Weber, G. 2011. Homeownership in Old Age at the Crossroad Between Personal and National Histories. In Boersch-Supan, A., Brandt, M., Hank, K., Schroeder, M. (Eds.) The Individual and the Welfare State – Life Histories in Europe, Springer, 81-92

Attanasio, O., Bottazzi, R., Low, H., Nesheim, L., Wakefield, M. 2012. Modelling the Demand for Housing over the Life Cycle. *Review of Economic Dynamics 15*, 1-18.

Attanasio, O., Leicester, A., Wakefield, M. 2011. Do House Prices Drive Consumption Growth? The Coincident Cycles of House Prices and Consumption in the UK. *Journal of the European Economic Association 9,* 399-435.

Attanasio, O., Weber, G. 2010. Consumption and Saving: Models of Intertemporal Allocation and Their Implications for Public Policy. *Journal of Economic Literature 48*, 693-751.

Banks, J., Blundell, R., Tanner, S. 1998. Is There a Retirement-Savings Puzzle?, *American Economic Review 88*, 769-788.

Bottazzi, R., Low, H., Wakefield, M. 2007. Why Do Home Owners Work Longer Hours? IFS Working Paper W07/10.

Bucciol, A. 2012. Measuring Self-control Problems: A Structural Estimation. *Journal of the European Economic Association 10,* 1084-1115.

Christelis, D. 2011. Imputation of Missing Data in Waves 1 and 2 of SHARE. SHARE Working Paper 01-2011.

Ghent, A. 2015. Home Ownership, Household Leverage, and Hyperbolic Discounting, *Real Estate Economics 43*, 750-781.

Gul, F., Pesendorfer, W. 2001. Temptation and Self-Control. *Econometrica 69*, 1403-1435.

Gul, F., Pesendorfer, W. 2004. Self-Control and the Theory of Consumption. *Econometrica 72,* 119-158.

Jenkins, S.P. 1995. Easy Estimation Methods for Discrete-Time Duration Models. *Oxford Bulletin of Economics and Statistics 57,* 129-136.

Kovacs, A. 2016. "*Present Bias, Temptation and Commitment Over the Life-cycle: Estimating and Simulation Gul-Pesendorfer Preferences*", University of Oxford Department of Economics Discussion Paper Series, Number 796 (http://www.economics.ox.ac.uk/materials/papers/14522/paper-796.pdf).

Laibson, D. 1997. Golden Eggs and Hyperbolic Discounting. *The Quarterly Journal of Economics 112,* 443-77.

Li, W., Yao, R. 2007. The Life-Cycle Effects of House Price Changes. *Journal of Money, Credit and Banking 39,* 1375-1409.

Melberg, H.O., Jones, A., Bretteville-Jensen, A.L. 2010. Is Cannabis a Gateway to Hard Drugs? *Empirical Economics 38*, 583-603.

Nakajima, M., Telyukova, I.A. 2011. Home Equity in Retirement. WP 11-15, the Federal Reserve Bank of Philadelphia.

O'Donoghue, T., Rabin, M. 1999. Doing It Now or Later. *American Economic Review 89*, 103-124.

van Ours, J.C. 2003. Is Cannabis a Stepping-Stone for Cocaine?, *Journal of Health Economics 22*, 539-554.

Trevisan, E., Pasini, G., Rainato, R. 2011. Cross-country Comparison of Monetary Values from SHARELIFE. SHARE Working Paper 02–2011.

Venti, S.F., Wise, D.A. 2004. *Aging and Housing Equity: Another Look*. In D. A. Wise (Ed.) Perspectives on the Economics of Aging, University of Chicago Press, 127-180.

Weiss, C.T. 2012. Two Measures of Lifetime Resources for Europe using SHARELIFE. SHARE Working Paper 06-2012.

Table 1. Variable definitions

Variables	Meaning
Dependent	
Owner	Dummy =1 if home owner, =0 otherwise
Financial	
Illiquid assets	Dummy =1 if owner of illiquid assets (life insurance and /or retirement accounts) , =0 otherwise
Illiquid assets (t-2)	Dummy =1 if held illiquid assets (life insurance or retirement accounts) two years before, =0 otherwise
Years illiquid assets	Years (≥2) since first holding of illiquid assets
Risk tolerant	Dummy =1 if risk lover *(categories 1-3 in question as068_, wave 2)*
Demographic	
Age	Age
Age^2	Age squared
Female	Dummy =1 if female, =0 otherwise
High school	Dummy =1 if high school degree at most, =0 otherwise [from SHARE]
College	Dummy =1 if college degree at most, =0 otherwise [from SHARE]
Poor health (t-1)	Dummy =1 if poor health status one year before, =0 otherwise
Household composition	
Household size (t-1)	Household size one year before
One child (t-1)	Dummy =1 if had one child one year before, =0 otherwise
Two children (t-1)	Dummy=1 if had two children one year before, =0 otherwise
Three or more children (t-1)	Dummy=1 if had three or more children one year before, =0 otherwise
Partner (t-1)	Dummy =1 if with a partner one year before, =0 otherwise
Widow (t-1)	Dummy =1 if widow one year before, =0 otherwise
Divorced (t-1)	Dummy =1 if divorced one year before, =0 otherwise
Occupation and income	
Unemployed (t-1)	Dummy =1 if unemployed one year before, =0 otherwise
Retired (t-1)	Dummy =1 if retired one year before, =0 otherwise
Log current income	Logarithm of household total net income, corrected for PPP-adjusted exchange rate [from SHARE]
Log permanent income	Logarithm of lifetime earnings estimate as of age ten, for the head and the partner *(excluding self-employed workers)*
Log permanent income (excluding pensions)	Logarithm of lifetime earnings estimate as of age ten, for the head and the partner, net of pensions *(excluding self-employed workers)*
Control	
Country: X	Dummy =1 if country X, =0 otherwise *(baseline is Germany)*
Cohort: 19YY	Dummy =1 if born in years 19YY-4 – 19YY, =0 otherwise *(baseline is years 1945-1949)*

Table 2. Summary statistics (N=261,227)

	All (N=261,227)		Illiquid assets owners (N=59,585)	
Variable	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Owner	0.035	0.183	0.044	0.205
Illiquid assets (t-2)	0.195	0.397	0.886	0.317
Years of illiquid assets	3.310	8.717	15.001	12.961
Risk tolerant	0.254	0.435	0.315	0.465
Age	40.594	14.165	45.723	13.914
Age^2	1,848.544	1,297.585	2,284.231	1,328.574
Female	0.556	0.497	0.461	0.498
High school	0.340	0.474	0.405	0.491
College	0.190	0.392	0.231	0.421
Poor health (t-1)	0.062	0.242	0.090	0.286
Household size (t-1)	3.008	1.439	2.988	1.367
One child (t-1)	0.230	0.421	0.226	0.418
Two children (t-1)	0.300	0.458	0.339	0.473
Three or more children (t-1)	0.073	0.260	0.075	0.263
Partner (t-1)	0.796	0.403	0.816	0.387
Widow (t-1)	0.029	0.168	0.033	0.179
Divorced (t-1)	0.022	0.146	0.026	0.159
Unemployed (t-1)	0.013	0.112	0.014	0.118
Retired (t-1)	0.100	0.299	0.140	0.347
Log permanent income (excluding pensions)	8.587	1.120	8.923	0.315
Country: Austria	0.039	0.193	0.036	0.187
Country: Belgium	0.095	0.294	0.106	0.308
Country: Czech Republic	0.117	0.321	0.081	0.273
Country: Denmark	0.083	0.275	0.110	0.312
Country: France	0.114	0.318	0.083	0.276
Country: Greece	0.047	0.212	0.004	0.066
Country: Italy	0.080	0.271	0.023	0.149
Country: Netherlands	0.111	0.314	0.119	0.324
Country: Spain	0.034	0.182	0.011	0.104
Country: Sweden	0.076	0.264	0.101	0.302
Country: Switzerland	0.090	0.286	0.134	0.340
Cohort: 1919	0.017	0.130	0.007	0.086
Cohort: 1924	0.049	0.216	0.035	0.184
Cohort: 1929	0.091	0.288	0.069	0.254
Cohort: 1934	0.132	0.338	0.123	0.328
Cohort: 1939	0.154	0.361	0.156	0.362
Cohort: 1944	0.174	0.379	0.184	0.387
Cohort: 1954	0.145	0.352	0.161	0.368
Cohort: 1959	0.067	0.249	0.072	0.259

Note. Illiquid asset owners refer to the sub-sample of individuals who held illiquid financial assets at least at some point in their life.

Table 3. Rent-Own transitions: model without unobserved heterogeneity

	(1)	(2)	(3)
Illiquid assets (t-2)	0.549***	0.593***	0.580***
	(0.130)	(0.145)	(0.146)
Years illiquid assets	-0.042***	-0.048***	-0.047***
	(0.008)	(0.009)	(0.009)
Risk tolerant	0.691***	0.791***	0.815***
	(0.072)	(0.079)	(0.080)
Age	0.218***	0.234***	0.247***
	(0.021)	(0.024)	(0.025)
Age^2	-0.004***	-0.004***	-0.004***
	(0.000)	(0.000)	(0.000)
Female	-0.166***	-0.043	-0.022
	(0.064)	(0.073)	(0.075)
High school	0.410***	0.546***	0.561***
	(0.079)	(0.088)	(0.089)
College	0.817***	1.007***	1.035***
	(0.089)	(0.097)	(0.098)
Poor health (t-1)	-0.494***	-0.637***	-0.612***
	(0.171)	(0.198)	(0.201)
Household size (t-1)	0.017	0.002	0.008
	(0.037)	(0.042)	(0.043)
One child (t-1)	0.374***	0.369***	0.330***
	(0.082)	(0.092)	(0.093)
Two children (t-1)	0.251***	0.185*	0.179*
	(0.087)	(0.100)	(0.102)
Three children (t-1)	-0.501***	-0.407*	-0.406*
	(0.185)	(0.217)	(0.222)
Partner (t-1)	1.874***	2.021***	2.068***
	(0.124)	(0.137)	(0.139)
Widow (t-1)	0.937***	1.132***	1.094***
	(0.345)	(0.405)	(0.419)
Divorced (t-1)	0.141	0.002	0.055
	(0.330)	(0.368)	(0.369)
Unemployed (t-1)	-0.973***	-0.931***	-0.922**
	(0.336)	(0.361)	(0.363)
Retired (t-1)	0.285	0.320	0.475*
	(0.229)	(0.257)	(0.265)
Log current income	0.494***		
	(0.043)		
Log permanent income		0.446***	
		(0.056)	
Log permanent income (excluding pensions)			0.312***
			(0.041)
Country effects	YES	YES	YES
Cohort effects	YES	YES	YES
Observations	335,436	268,136	261,227
Log-likelihood	-46,743.732	-37,923.715	-37,026.969
McFadden's R^2	0.058	0.061	0.062

*Note. The table reports 100 times the average marginal effects from univariate probit models. The dependent variable is a dummy equal to 1 if the household purchases a house for the first time. Column (1): we exclude observations reporting no income. Columns (2)-(3): we exclude observations on self-employed workers (8.89% of the respondents) as well as the top and bottom 1% of the permanent income estimates. Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1*

Table 4. Model with unobserved heterogeneity: mean of the two groups

Variable	Group 1	Group 2	Difference
Owner	0.035	0.035	0.000
Illiquid assets (t-2)	0.261	0.140	0.120***
Years of illiquid assets	4.800	2.049	2.750***
Risk tolerant	0.262	0.247	0.015***
Age	40.295	40.848	-0.553***
Age²	1,817.534	1,874.788	-57.254***
Female	0.538	0.571	-0.033***
High school	0.349	0.332	0.017***
College	0.204	0.178	0.026***
Poor health (t-1)	0.065	0.061	0.004***
Household size (t-1)	2.984	3.029	-0.045***
One child (t-1)	0.225	0.235	-0.010***
Two children (t-1)	0.303	0.297	0.006***
Three or more children (t-1)	0.064	0.080	-0.016***
Partner (t-1)	0.799	0.794	0.005***
Widow (t-1)	0.025	0.032	-0.007***
Divorced (t-1)	0.022	0.022	0.001
Unemployed (t-1)	0.015	0.011	0.005***
Retired (t-1)	0.092	0.106	-0.013***
Log permanent income (excluding pensions)	8.636	8.545	0.009***
Country: Austria	0.035	0.041	-0.006***
Country: Belgium	0.095	0.096	-0.001
Country: Czech Republic	0.113	0.120	-0.007***
Country: Denmark	0.088	0.078	0.010***
Country: France	0.104	0.123	-0.019***
Country: Greece	0.075	0.023	0.052***
Country: Italy	0.068	0.089	-0.021***
Country: Netherlands	0.106	0.115	-0.009***
Country: Spain	0.025	0.042	-0.017***
Country: Sweden	0.078	0.074	0.004***
Country: Switzerland	0.091	0.089	0.002***
Cohort: 1919	0.031	0.006	0.025***
Cohort: 1924	0.085	0.019	0.065***
Cohort: 1929	0.045	0.131	-0.086***
Cohort: 1934	0.085	0.171	-0.087***
Cohort: 1939	0.118	0.184	-0.066***
Cohort: 1944	0.138	0.204	-0.066***
Cohort: 1954	0.209	0.091	0.118***
Cohort: 1959	0.052	0.079	-0.027***
Observations	204,939	172,314	

*Note. The last column reports the result of a t-test on the equality of the means. *** p<0.01, ** p<0.05, * p<0.1*

Table 5. Model with unobserved heterogeneity

VARIABLES	No heterogeneity (1) Illiquid assets	(2) Home-Ownership	Heterogeneity, group 1 (3) Illiquid assets	(4) Home-Ownership	Heterogeneity, group 2 (5) Illiquid assets	(6) Home-Ownership
Illiquid assets (t-2)		0.580***		1.210***		1.577***
		(0.146)		(0.219)		(0.241)
Years illiquid assets		-0.047***		-0.021*		-0.074***
		(0.009)		(0.012)		(0.016)
Risk tolerant	3.146***	0.815***	0.820***	0.954***	0.560***	0.721***
	(0.169)	(0.080)	(0.157)	(0.111)	(0.125)	(0.106)
Age	2.232***	0.247***	0.360***	0.244***	0.888***	0.243***
	(0.039)	(0.025)	(0.048)	(0.036)	(0.029)	(0.032)
Age^2	-0.017***	-0.004***	0.006***	-0.004***	-0.003***	-0.004***
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)
Female	-7.248***	-0.022	-3.541***	0.095	-2.283***	-0.126
	(0.153)	(0.075)	(0.145)	(0.103)	(0.113)	(0.097)
High school	3.068***	0.561***	0.895***	0.648***	0.859***	0.488***
	(0.179)	(0.089)	(0.174)	(0.125)	(0.128)	(0.114)
College	3.164***	1.035***	1.777***	1.222***	0.561***	0.888***
	(0.213)	(0.098)	(0.196)	(0.137)	(0.162)	(0.130)
Poor health (t-1)	1.303***	-0.612***	0.470	-0.924***	0.584***	-0.316
	(0.284)	(0.201)	(0.286)	(0.290)	(0.201)	(0.270)
Household size (t-1)	-0.281***	0.008	0.694***	-0.078	-0.456***	0.077
	(0.077)	(0.043)	(0.077)	(0.063)	(0.060)	(0.053)
One child (t-1)	1.603***	0.330***	0.325*	0.469***	1.584***	0.188
	(0.204)	(0.093)	(0.191)	(0.129)	(0.148)	(0.120)
Two children (t-1)	1.673***	0.179*	0.566***	0.323**	1.596***	0.060
	(0.194)	(0.102)	(0.190)	(0.146)	(0.143)	(0.131)
Three children (t-1)	-0.894**	-0.406*	-4.021***	-0.475	-0.655**	-0.417
	(0.360)	(0.222)	(0.362)	(0.351)	(0.311)	(0.272)
Partner (t-1)	4.516***	2.068***	1.934***	2.202***	2.320***	1.967***
	(0.263)	(0.139)	(0.252)	(0.191)	(0.189)	(0.176)
Widow (t-1)	4.855***	1.094***	0.807	1.608***	2.713***	0.806
	(0.482)	(0.419)	(0.610)	(0.613)	(0.384)	(0.542)
Divorced (t-1)	1.896***	0.055	2.345***	-0.371	0.866**	0.390
	(0.511)	(0.369)	(0.522)	(0.549)	(0.348)	(0.474)
Unemployed (t-1)	-5.572***	-0.922**	-0.586	-0.986**	-1.896***	-0.837*
	(0.645)	(0.363)	(0.626)	(0.465)	(0.459)	(0.505)
Retired (t-1)	1.235***	0.475*	1.814***	0.781**	-0.976***	0.154
	(0.336)	(0.265)	(0.354)	(0.364)	(0.239)	(0.360)
Log permanent income	3.227***	0.312***	1.043***	0.233***	0.866***	0.369***
(excluding pensions)	(0.091)	(0.041)	(0.085)	(0.058)	(0.070)	(0.053)
Country effects	YES	YES	YES	YES	YES	YES
Cohort effects	YES	YES	YES	YES	YES	YES
Observations	261,227	261,227	204,939	204,939	172,314	172,314
Log-likelihood	-11,5005.14	-37,026.969	-22,619.156	-16,980.863	-20,344.623	-19,942.656
McFadden's R^2	0.164	0.062	0.686	0.063	0.674	0.066

*Note. The table reports 100 times the average marginal effects from the bivariate mixed proportional hazard analysis on the holding of illiquid assets and home ownership, unweighted (Columns (1)-(2)), and weighted, using as weights the probability to belong to group 1 (Columns (3)-(4)) or group 2 (Columns (5)-(6)). The full regression output is reported in the Appendix Table A3. Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1*

Figure 1. Liquid and illiquid wealth allocation in a life-cycle model with temptation

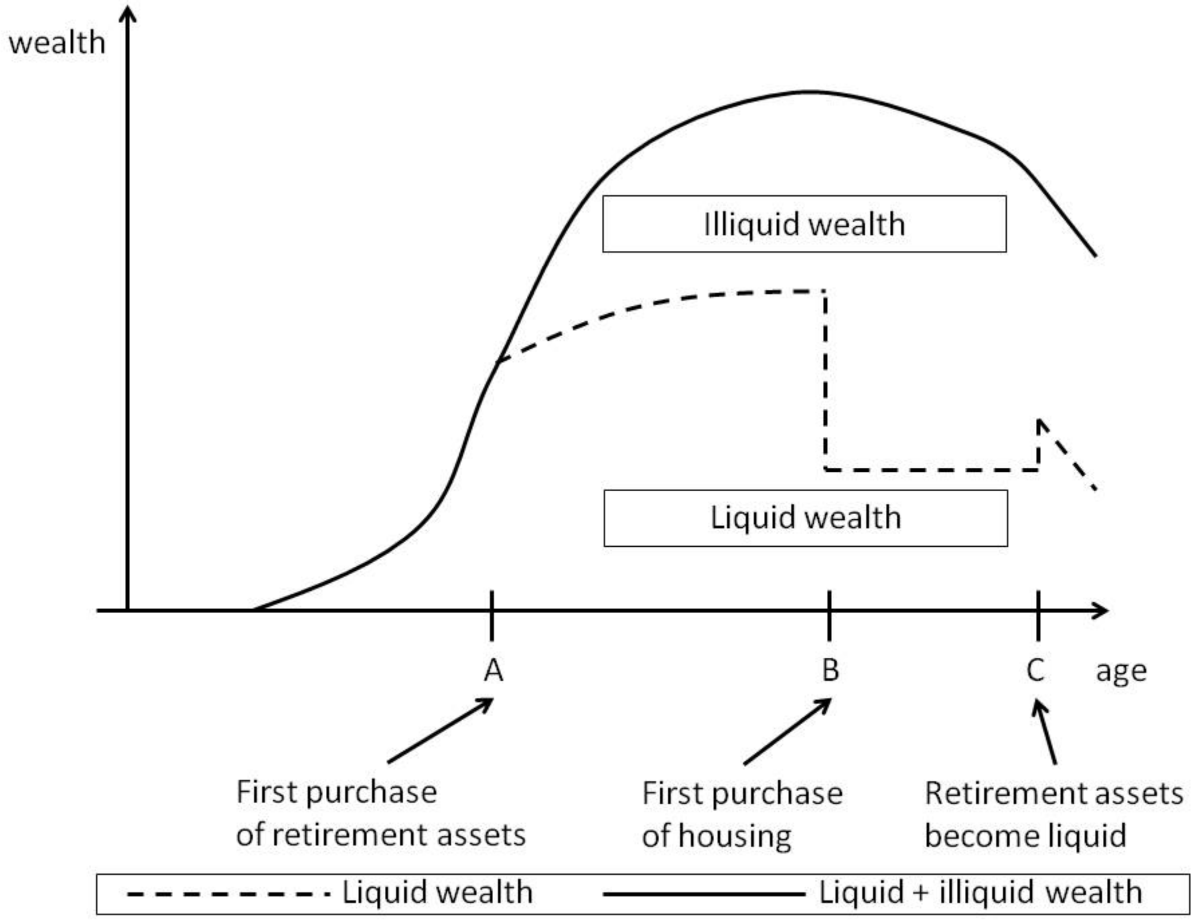
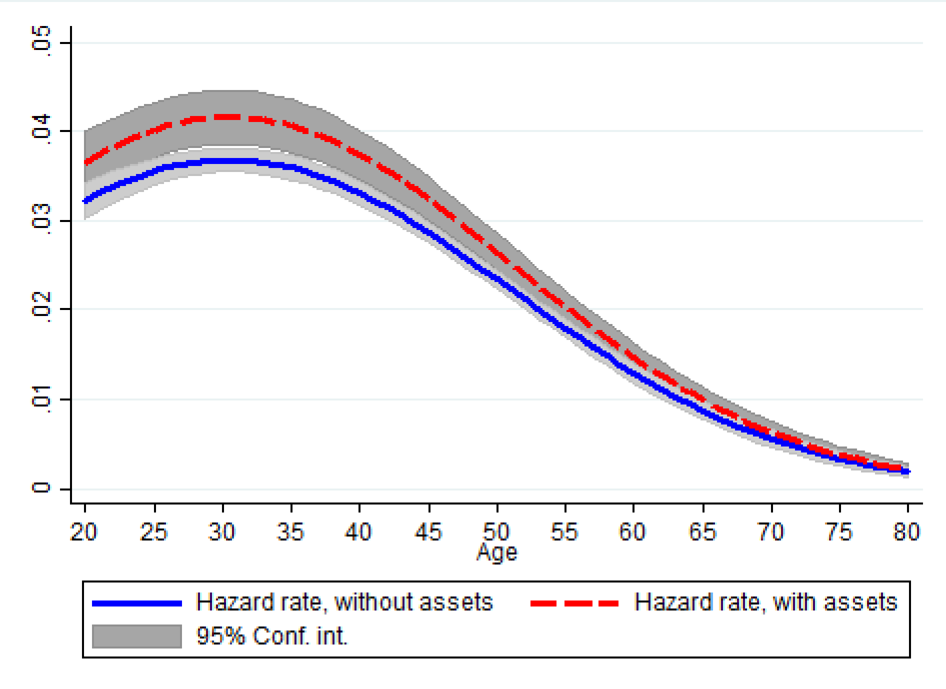


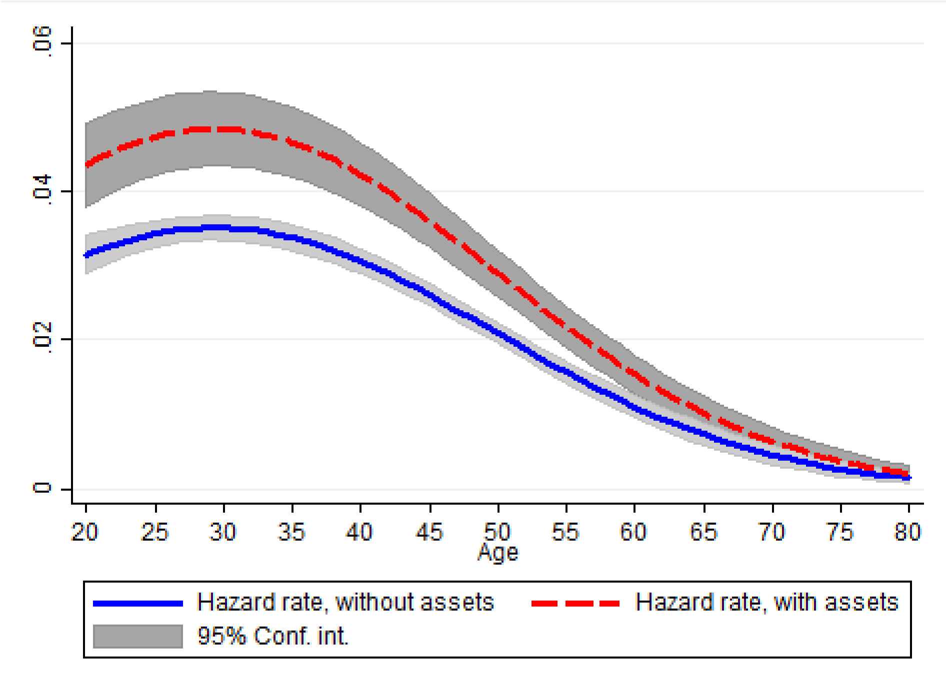
Figure 2. Hazard of home ownership (without unobserved heterogeneity)



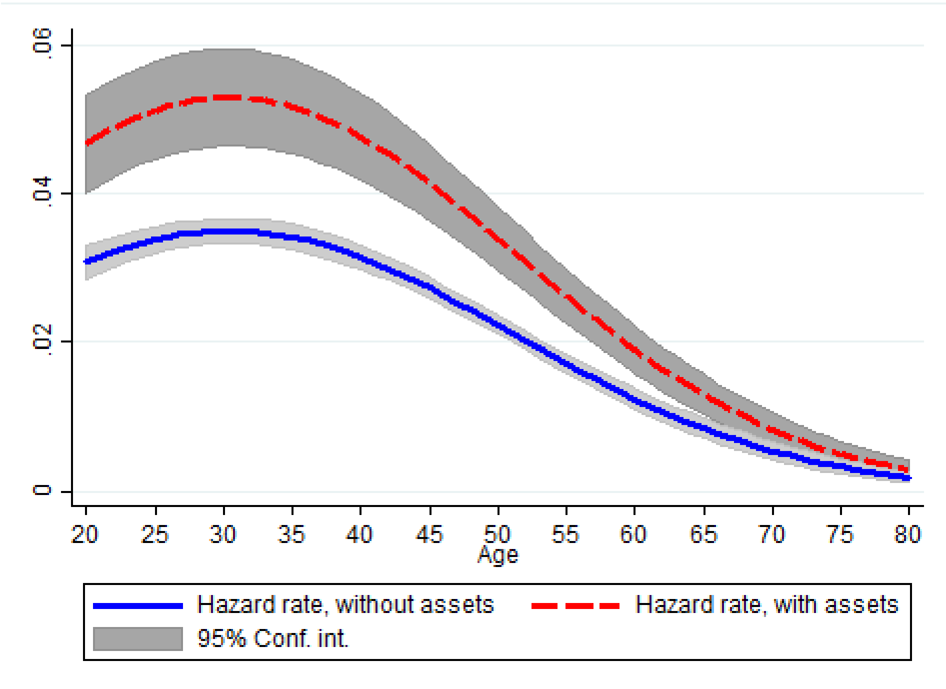
Note. Hazard rates are estimated from Table 3, Column (3).

Figure 3. Hazard of homeownership (with unobserved heterogeneity)

a) Group 1



b) Group 2



Note. Hazard rates are estimated from Table 5, Column (4) for panel a) and Column (6) for panel b).