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Can temptation explain housing choices over the life cycle?

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Abstract

We use individual life history data from 12 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 recognises 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, a large fraction of individuals become significantly more likely to buy housing after investing in illiquid assets; this finding is consistent with the predictions of the model.

KEYWORDS

bivariate mixed proportional hazard, duration model, housing, temptation

JEL CLASSIFICATION

D12; D14; G11

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, Blundell, & Tanner, 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 & Weber, 2010, for a review of this and other puzzles). Fourth, the displacement effect between pension wealth and private savings estimated in the data is far from perfect: if the pension system becomes less generous, individuals do not increase their savings enough to smooth their consumption over the life cycle (Alessie, Angelini, & van Santen, 2013).

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, Brugiavini, and Weber (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, Brugiavini, and Weber (2014) explore the determinants of home purchase past age of 50 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, Laferrère, & Weber, 2011).

Many different ways to explain puzzles such as those listed above have been suggested. As highlighted by Attanasio and Weber (2010), nonstandard preferences, such as quasi-hyperbolic discounting (Laibson, 1997; O'Donoghue & Rabin, 1999) or temptation and self-control preferences (Buccioli, 2012; Gul & Pesendorfer, 2001, 2004), 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 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. 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. More specifically, we use European microdata to investigate whether individuals who engage in long-term saving plans that help to control temptation (individual retirement accounts and/or life insurance policies), are subsequently more likely than others to become homeowners.

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 (Angelini et al., 2014; Venti & Wise, 2004) and has important policy implications in ageing societies.

The idea that temptation and a desire for commitment might influence life cycle patterns of homeownership 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 nonstandard preferences and housing comes from Ghent (2015), who looks at the implications of hyperbolic discounting for homeownership 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 at 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.

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. In this panel dataset, we observe ownership and accumulation of the relevant assets over the lifetime, and so we are able to relate this behaviour to characteristics such as education and risk attitude, as well as demographic and economic variables.

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-purchasing 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 and Sections 4 comments on the parameter estimates of the duration model with and without unobserved heterogeneity. Finally, Section 5 concludes. An appendix provides details on the derivation of the theoretical model and the construction of a variable used in the empirical analysis.

2 | A THEORETICAL FRAMEWORK

In this section, we describe a life cycle consumption-saving 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 that 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 nondurable 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: (a) contributions are possible in any period before retirement age, (b) contributions are matched by the employer, (c) contributions are tax deductible, (d) withdrawals from the account balance are always granted after retirement, and only in exceptional cases before retirement. In this stylised model, we capture features (b) and (c) by assumptions about the rate of return (see next paragraph). To make the retirement asset an effective commitment device during the working life, features (a) and (d) 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

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

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

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

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

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

with $S_{t+1} \geq 0$, that is, borrowing is not possible.¹ The parameter P indicates the house price, which, like the asset return, is assumed to be constant,² and ϕ denotes a transaction cost proportional to the house price that is applied when selling or buying a house. The absolute value $|H_t - H_{t-1}|$ is equal to 1 when there is a change in home tenure ($H_t \neq H_{t-1}$) and 0 otherwise. In addition, in every time period, the homeowner 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, $-(1+\phi)PH_t$ is the cost of home purchase, $-\psi PH_t$ is the home maintenance cost, $-\rho P(1-H_t)$ 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: (a) the agent rented and now rents ($H_{t-1} = H_t = 0$), in which case she pays rent costs $-\rho P$; (b) the agent rented and now owns ($H_{t-1} = 0; H_t = 1$), in which case she pays the purchase price and maintenance costs $-(1+\phi)P - \psi P$; (c) the agent owned and now rents ($H_{t-1} = 1; H_t = 0$), in which case she pays rent costs and she gets revenues from home selling, $-\rho P + (1-\phi)P$; and (d) the agent owned and now owns ($H_{t-1} = H_t = 1$), 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 suboptimal 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 well-being. 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

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

¹This assumption is strong but useful to simplify the model. In practice, mortgage markets allow borrowing to finance a fraction of the housing value. 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, Bottazzi, Low, Nesheim, & Wakefield, 2012; Attanasio, Leicester, & Wakefield, 2011, and, alongside flexible labour supply, in Bottazzi, Low, & Wakefield, 2007), would not alter the model's predictions as they would not undo the potential for housing to act as a commitment device. Similarly, mortgage interest tax relief (which exists in several European countries) would make mortgages more appealing, but would not alter the possibility to only partially finance the purchase of a house, or, importantly, the commitment role of housing. 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.

²In reality, house prices are not constant over time but we make this assumption to simplify the model. The implications of the model would not change if we accounted for time-varying but deterministic house prices.

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, $u(C_t, H_t)$, 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, $v(C_t^*, H_t^*)$ and the utility reflecting the actual decisions, $v(C_t, H_t)$. 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, consumption cannot exceed the portion of cash on hand available at the moment. The largest possible consumption is achieved only in the presence of: (a) home renting rather than homeownership, (b) no contribution to retirement assets before retirement and (c) 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., homeownership and investment in retirement assets) that reduce her future consumption choice set, and 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 $S_t \geq C_t + X_t + P(1 + \phi + \psi) - Y_{t+1}/R_S$. 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 nontempted 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 incentive for tempted individuals to hold them. After retirement, then, homeownership is the only viable commitment device.

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

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

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

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

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

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

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 nontempted individuals and this explains why, *ceteris paribus*, a tempted individual will consume more and save less than an otherwise identical nontempted 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:

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

2. Are willing to save in illiquid assets (retirement assets and housing) rather than liquid assets (because illiquid assets provide commitment);
3. Are likely to save in illiquid assets at an earlier stage than in housing (because liquidity constraints prevent home purchase at early ages);
4. 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, and are the result of the specific self-control problems of tempted agents, that generally have problems in accumulating wealth through liquid assets (prediction 1), and attribute higher value to illiquid assets compared to liquid ones (because they provide commitment; prediction 2). Predictions (3) and (4) do not necessarily require tempted agents and are consequences, or likely consequences, of realistic assumptions about credit constraints and the nature of the assets that are available and that provide commitment. However, tempted agents pay more attention to commitment and are likely to prefer accumulating wealth in illiquid assets rather than in liquid assets in order to avoid self-control problems (in line with prediction 3).

Our claim in this paper is not that these insights are new (1 and 2 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 microdata, 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 from 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

FIGURE 1 Liquid and illiquid wealth allocation in a life cycle model with temptation

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 homeownership should: (a) be positively correlated with the holding of (illiquid financial) retirement assets and (b) follow the purchase of retirement assets. Our goal is to check if the data are consistent with these two predictions.

3 | THE DATA

Our main source of microdata 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),³ 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 13 European countries; however, we exclude Poland from the analysis because of unreliable retrospective information on income.⁴ Information from SHARELIFE is merged with information on current income and education from the second wave of SHARE (we consider the average over the five “constructed variables” imputations—see Christelis, 2011, for details on the multiple imputations methodology used in SHARE), and with permanent income estimates from Weiss (2012).

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 homeowner at a given age, and 0 otherwise. We include in the sample all observations from individuals who have never been homeowners (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 homeownership 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 tolerance⁵), demographics (age, gender, education, health status),

³We 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.

⁴Trevisan, Pasini, and Rainato (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.

⁵We 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 and (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, that is, if she reports any option between (1) and (3).

TABLE 1 Variable definitions

Variables	Meaning
<i>Dependent</i>	
Owner	Dummy = 1 if homeowner, =0 otherwise
<i>Financial</i>	
Illiquid assets	Dummy = 1 if owner of illiquid assets (life insurance and/or retirement accounts), =0 otherwise
Illiquid assets ($t-1$)	Dummy = 1 if held illiquid assets (life insurance or retirement accounts) 2 years before, =0 otherwise
Years illiquid assets	Years (≥ 2) since first holding of illiquid assets
Risk tolerant	Dummy = 1 if risk tolerant (<i>categories 1–3 in question as068_ wave 2</i>)
<i>Demographic</i>	
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 1 year before, =0 otherwise
<i>Household composition</i>	
Household size ($t-1$)	Household size 1 year before
One child ($t-1$)	Dummy = 1 if had one child 1 year before, =0 otherwise
Two children ($t-1$)	Dummy = 1 if had two children 1 year before, =0 otherwise
Three or more children ($t-1$)	Dummy = 1 if had three or more children 1 year before, =0 otherwise
Partner ($t-1$)	Dummy = 1 if with a partner 1 year before, =0 otherwise
Widow ($t-1$)	Dummy = 1 if widow 1 year before, =0 otherwise
Divorced ($t-1$)	Dummy = 1 if divorced 1 year before, =0 otherwise
<i>Occupation and income</i>	
Unemployed ($t-1$)	Dummy = 1 if unemployed 1 year before, =0 otherwise
Retired ($t-1$)	Dummy = 1 if retired 1 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 (<i>excluding self-employed workers</i>)
Log permanent income (excluding pensions)	Logarithm of lifetime earnings estimate as of age ten, for the head and the partner, net of pensions (<i>excluding self-employed workers</i>)
<i>Control</i>	
Country: X	Dummy = 1 if country X, =0 otherwise (<i>baseline is Germany</i>)
Cohort: 19YY	Dummy = 1 if born in years 19YY–4–19YY, =0 otherwise (<i>baseline is years 1945–1949</i>)

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 homeownership and the other dimensions of the analysis, we take lags of

time-varying explanatory variables. This means, for instance, that we relate homeownership in year t to household size in year $t - 1$ (rather than household size in year t , which might be affected by homeownership 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.

Summary statistics on our variables are reported in Table 2, separately for the full sample and the subsample of those who have ever owned illiquid assets. As expected, illiquid asset owners on average have higher permanent income. On an average, they are also older, more highly educated and more likely to be males.

4 | REGRESSION ANALYSIS

In this section, we present our duration models of entry into homeownership. 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. In Appendix Table A3, we report the output of some robustness checks, using different lags for past illiquid assets as an explanatory variable, that confirm our benchmark findings.

4.1 | Baseline Hazard model

Table 3 presents parameter estimates from a discrete duration model, estimated with a standard logit regression following Jenkins (1995). In Appendix Table A1, we 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 homeownership in a given year.

The results reported in the table are for equations that explain the probability of first becoming a homeowner 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 and country and cohort dummies. Controlling for family composition is crucial to properly distinguish the temptation motive for first home purchase from the demographic motives that link 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.

The results show positive and significant coefficients on having illiquid assets, and this is in line with our expectations if consumers use illiquid assets as a commitment device to keep temptation under control. More specifically, the results in Column 1 indicate that past illiquid asset holding is associated with a 0.553 percentage point increase in the probability of purchasing a house. 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 13 years ($0.553/0.042$) 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 a house.

TABLE 2 Summary statistics ($N = 261,227$)

Variable	All ($N = 261,227$)				Illiquid assets owners ($N = 57,373$)	
	Mean	SD	Min.	Max.	Mean	SD
Owner	0.035	0.183	0	1	0.043	0.203
Illiquid assets ($t-2$)	0.195	0.397	0	1	0.890	0.313
Years of illiquid assets	3.310	8.717	0	80	15.070	12.990
Risk tolerant	0.254	0.435	0	1	0.315	0.465
Age	40.594	14.165	20	80	45.627	13.909
Female	0.556	0.497	0	1	0.459	0.498
High school	0.340	0.474	0	1	0.408	0.491
College	0.190	0.392	0	1	0.231	0.422
Poor health ($t-1$)	0.062	0.242	0	1	0.090	0.286
Household size ($t-1$)	3.008	1.439	1	14	2.976	1.365
One child ($t-1$)	0.230	0.421	0	1	0.227	0.419
Two children ($t-1$)	0.300	0.458	0	1	0.339	0.473
Three or more children ($t-1$)	0.197	0.398	0	1	0.211	0.408
Partner ($t-1$)	0.796	0.403	0	1	0.815	0.388
Widow ($t-1$)	0.029	0.168	0	1	0.033	0.178
Divorced ($t-1$)	0.022	0.146	0	1	0.026	0.160
Unemployed ($t-1$)	0.013	0.112	0	1	0.014	0.118
Retired ($t-1$)	0.100	0.299	0	1	0.140	0.347
Permanent income, k euros (excluding pensions)	8.276	6.735	0.048	71.670	9.989	6.861
Country: Austria	0.039	0.193	0	1	0.038	0.190
Country: Belgium	0.095	0.294	0	1	0.105	0.307
Country: The Czech Republic	0.117	0.321	0	1	0.079	0.269
Country: Denmark	0.083	0.275	0	1	0.111	0.314
Country: France	0.114	0.318	0	1	0.077	0.267
Country: Greece	0.047	0.212	0	1	0.005	0.067
Country: Italy	0.080	0.271	0	1	0.024	0.152
Country: The Netherlands	0.111	0.314	0	1	0.123	0.329
Country: Spain	0.034	0.182	0	1	0.009	0.097
Country: Sweden	0.076	0.264	0	1	0.101	0.301
Country: Switzerland	0.090	0.286	0	1	0.136	0.343
Cohort: 1919	0.017	0.130	0	1	0.007	0.081
Cohort: 1924	0.049	0.216	0	1	0.035	0.184
Cohort: 1929	0.091	0.288	0	1	0.071	0.256
Cohort: 1934	0.132	0.338	0	1	0.123	0.328
Cohort: 1939	0.154	0.361	0	1	0.158	0.365
Cohort: 1944	0.174	0.379	0	1	0.184	0.388
Cohort: 1954	0.145	0.352	0	1	0.160	0.366
Cohort: 1959	0.067	0.249	0	1	0.073	0.260

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 ($t-2$)	0.172 ^{***} (0.040)	0.181 ^{***} (0.044)	0.177 ^{***} (0.044)
Years illiquid assets	-0.013 ^{***} (0.003)	-0.015 ^{***} (0.003)	-0.014 ^{***} (0.003)
Risk tolerant	0.216 ^{***} (0.022)	0.240 ^{***} (0.024)	0.247 ^{***} (0.024)
Age	0.069 ^{***} (0.007)	0.072 ^{***} (0.007)	0.076 ^{***} (0.007)
Age ²	-0.001 ^{***} (0.000)	-0.001 ^{***} (0.000)	-0.001 ^{***} (0.000)
Female	-0.049 ^{**} (0.020)	-0.010 (0.022)	-0.003 (0.023)
High school	0.128 ^{***} (0.025)	0.166 ^{***} (0.027)	0.170 ^{***} (0.027)
College	0.253 ^{***} (0.028)	0.305 ^{***} (0.029)	0.312 ^{***} (0.030)
Poor health ($t-1$)	-0.156 ^{***} (0.053)	-0.196 ^{***} (0.060)	-0.188 ^{***} (0.061)
Household size ($t-1$)	0.011 (0.017)	0.024 (0.019)	0.025 (0.020)
One child ($t-1$)	0.094 ^{***} (0.032)	0.071 ^{**} (0.036)	0.060 [*] (0.036)
Two children ($t-1$)	0.048 (0.043)	-0.010 (0.048)	-0.011 (0.050)
Three children ($t-1$)	-0.115 [*] (0.064)	-0.169 ^{**} (0.074)	-0.165 ^{**} (0.076)
Partner ($t-1$)	0.588 ^{***} (0.039)	0.605 ^{***} (0.042)	0.616 ^{***} (0.043)
Widow ($t-1$)	0.300 ^{***} (0.108)	0.359 ^{***} (0.123)	0.346 ^{***} (0.127)
Divorced ($t-1$)	0.052 (0.103)	0.012 (0.112)	0.027 (0.112)
Unemployed ($t-1$)	-0.304 ^{***} (0.105)	-0.283 ^{**} (0.110)	-0.279 ^{**} (0.110)
Retired ($t-1$)	0.092 (0.071)	0.098 (0.078)	0.144 [*] (0.080)
Log current income	0.153 ^{***} (0.013)		
Log permanent income		0.135 ^{***} (0.017)	

(Continues)

TABLE 3 (Continued)

	(1)	(2)	(3)
Log permanent income (excluding pensions)			0.094*** (0.012)
Country effects	YES	YES	YES
Cohort effects	YES	YES	YES
Observations	335,436	268,136	261,227
Log-likelihood	−46,745.851	−37,922.861	−37,026.273
McFadden's R^2	.058	.061	.062

Note: The table reports coefficient estimates from univariate logit 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 and 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.

*** $p < .01$; ** $p < .05$; * $p < .1$.

Not surprisingly, income has a strong, positive effect. The second and third specifications reported in Table 3 include a measure of the log of permanent, rather than current, income. Permanent income seems 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 homeowners. In Column 2, permanent income is computed following Weiss (2012) as the discounted present value at age ten of all future earnings plus pension benefits; for details see Appendix B.⁶ 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). In either specification, permanent income is seen to play a strong role in explaining the transition to homeownership and, reassuringly, the coefficients on the other variables of interest are rather stable as the income measure is changed.

Focusing on Column 3, the results indicate that a 1% increase in permanent income increases the probability of becoming a homeowner by 0.311 percentage points. Holding illiquid assets increases the probability of becoming a homeowner by more than half a percentage point, but this effect becomes null after slightly more than 12 (0.582/0.047) years of holding the asset. Finally, renters classified as risk tolerant are nearly 1% more likely to become homeowners 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 has on average a negative effect, but it follows the typical hump-shaped pattern, with the probability of purchasing a house increasing at young ages, reaching a maximum at age 38 (0.076/(2*0.001)), and then falling.

We conclude the section with Figure 2, a graphical representation of the hazard rates of homeownership, conditional on holding, or not holding, nonliquid financial assets. The hazard rate of homeownership at age t can be computed as

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

⁶Permanent income is a measure of present value at age ten of lifetime earnings, and is estimated controlling 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).

FIGURE 2 Hazard of homeownership (without unobserved heterogeneity)

Note: Hazard rates are estimated from Table 3, Column 3. The blue line corresponds to the case where the individual has not invested in illiquid financial assets. The red, dashed line corresponds to the case where the individual has invested in illiquid financial assets. The shaded areas represent confidence intervals. [Colour figure can be viewed at wileyonlinelibrary.com]

where $\bar{x}$ is the set of averages of the explanatory variables (conditional on age = t), and $\hat{\beta}$ is the parameter estimated 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).⁷ 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.

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 homeowners (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

⁷Thus, the two curves in the figure are calculated at the sample average of the explanatory variables (conditional on age), and differ only in the assumption on the holdings of illiquid assets. For the curve with assets, we set the variable “Illiquid assets (t-2)” to 1; for the curve without assets, we set this variable to 0 and, for coherence, in this case we also set to 0 the variable “Years illiquid assets”.

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. What this environment shares with ours is a concern that unobserved heterogeneity may skew the coefficients of interest in the duration analysis. In our illiquid assets and homeownership case, problems would arise if some “frailty” (thriftiness or impatience, for instance) 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 homeownership is coming from the purchase of illiquid financial assets being an indicator that an individual feels it is a good time to buy commitment.

In our regressions, we adopt the general approach taken by Melberg, Jones, and Bretteville-Jensen (2010), who tackle the issue of separating the “gateway effect” from the effect of frailty, by specifying a model where 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 dependent and explanatory variables is due to unobserved heterogeneity, and what part instead can be interpreted as the causal (gateway) effect. Like those authors, we use the mixed proportional hazard model with shared frailty introduced in Abbring and van den Berg (2003). The model is made of two separate 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 homeownership. This model allows us to estimate how the probability of becoming a homeowner 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.⁸

Table 4 shows the output of our regression analysis with unobserved heterogeneity; average marginal effects (multiplied by 100) are reported in Appendix Table A2. 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 instead use 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.⁹

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 heterogeneity is allowed, risk tolerance has a smaller marginal effect for both groups, and a significant effect only for

⁸We limit the analysis to two rather than more groups because, like in Melberg et al. (2010), the model does not converge to a stable solution when dealing with three or more groups.

⁹A formal likelihood ratio test strongly rejects the model without heterogeneity presented in Columns 1 and 2 in favour of the model with two-group heterogeneity presented in Columns 3–6.

TABLE 4 Model with unobserved heterogeneity

Variables	No heterogeneity		Heterogeneity, Group 1		Heterogeneity, Group 2	
	(1)	(2)	(3)	(4)	(5)	(6)
	Illiquid assets	Homeownership	Illiquid assets	Homeownership	Illiquid assets	Homeownership
Illiquid assets ($t-2$)		0.177 ^{***} (0.044)		0.404 ^{***} (0.067)		0.193 ^{***} (0.071)
Years illiquid assets		-0.014 ^{***} (0.003)		-0.027 ^{***} (0.005)		-0.001 (0.004)
Risk tolerant	0.223 ^{***} (0.012)	0.247 ^{***} (0.024)	0.012 (0.025)	0.267 ^{***} (0.034)	0.277 ^{***} (0.027)	0.234 ^{***} (0.032)
Age	0.155 ^{***} (0.003)	0.076 ^{***} (0.007)	0.249 ^{***} (0.006)	0.051 ^{***} (0.010)	0.181 ^{***} (0.007)	0.108 ^{***} (0.011)
Age ²	-0.001 ^{***} (0.000)	-0.001 ^{***} (0.000)	-0.001 ^{***} (0.000)	-0.001 ^{***} (0.000)	-0.001 ^{***} (0.000)	-0.002 ^{***} (0.000)
Female	-0.514 ^{***} (0.011)	-0.003 (0.023)	-0.410 ^{***} (0.023)	-0.053 [*] (0.031)	-0.679 ^{***} (0.025)	0.054 [*] (0.030)
High school	0.218 ^{***} (0.013)	0.170 ^{***} (0.027)	0.137 ^{***} (0.026)	0.117 ^{***} (0.036)	0.013 (0.030)	0.230 ^{***} (0.036)
College	0.225 ^{***} (0.015)	0.312 ^{***} (0.030)	0.072 ^{**} (0.032)	0.248 ^{***} (0.041)	0.158 ^{***} (0.033)	0.377 ^{***} (0.040)
Poor health ($t-1$)	0.093 ^{***} (0.020)	-0.188 ^{***} (0.061)	0.168 ^{***} (0.042)	-0.122 (0.086)	0.094 ^{**} (0.043)	-0.243 ^{***} (0.084)
Household size ($t-1$)	-0.057 ^{***} (0.007)	0.025 (0.020)	-0.155 ^{***} (0.016)	0.051 [*] (0.026)	-0.064 ^{***} (0.015)	-0.004 (0.026)
One child ($t-1$)	0.187 ^{***} (0.017)	0.060 (0.036)	0.447 ^{***} (0.038)	-0.016 (0.048)	0.234 ^{***} (0.040)	0.127 ^{***} (0.047)

(Continues)

TABLE 4 (Continued)

Variables	No heterogeneity		Heterogeneity, Group 1		Heterogeneity, Group 2	
	(1)	(2)	(3)	(4)	(5)	(6)
	Illiquid assets	Homeownership	Illiquid assets	Homeownership	Illiquid assets	Homeownership
Two children (<i>t</i> −1)	0.225 ^{***} (0.019)	−0.011 (0.050)	0.446 ^{***} (0.044)	−0.062 (0.066)	0.339 ^{***} (0.046)	0.050 (0.066)
Three children (<i>t</i> −1)	0.163 ^{***} (0.025)	−0.165 ^{**} (0.076)	0.325 ^{***} (0.061)	−0.226 ^{**} (0.102)	0.251 ^{***} (0.061)	−0.087 (0.104)
Partner (<i>t</i> −1)	0.333 ^{***} (0.018)	0.616 ^{***} (0.043)	0.500 ^{***} (0.039)	0.583 ^{***} (0.057)	0.606 ^{***} (0.042)	0.645 ^{***} (0.055)
Widow (<i>t</i> −1)	0.309 ^{***} (0.034)	0.346 ^{***} (0.127)	0.634 ^{***} (0.083)	0.271 (0.168)	0.211 ^{***} (0.078)	0.451 ^{**} (0.187)
Divorced (<i>t</i> −1)	0.112 ^{***} (0.036)	0.027 (0.112)	0.439 ^{***} (0.073)	−0.004 (0.155)	0.193 ^{**} (0.084)	0.045 (0.155)
Unemployed (<i>t</i> −1)	−0.392 ^{***} (0.045)	−0.279 ^{**} (0.110)	−0.398 ^{***} (0.093)	−0.149 (0.153)	0.029 (0.101)	−0.374 ^{***} (0.140)
Retired (<i>t</i> −1)	0.087 ^{***} (0.024)	0.144 [*] (0.080)	−0.212 ^{***} (0.052)	0.010 (0.115)	0.505 ^{***} (0.050)	0.268 ^{***} (0.110)
Log permanent income (excluding pensions)	0.231 ^{***} (0.006)	0.094 ^{***} (0.012)	0.165 ^{***} (0.014)	0.103 ^{***} (0.016)	0.303 ^{***} (0.015)	0.084 ^{***} (0.017)
Country effects	YES	YES	YES	YES	YES	YES
Cohort effects	YES	YES	YES	YES	YES	YES
Observations	261,227	261,227	136,403	136,403	124,824	124,824
Log-likelihood	−114,987.45	−37,026.273	−23,842.33	−18,096.69	−22,847.01	−18,847.214
McFadden's <i>R</i> ²	.164	.062	.647	.067	.671	.060

Note: The table reports coefficient estimates from the bivariate mixed proportional hazard analysis on the holding of illiquid assets and homeownership, unweighted (Columns 1 and 2) and weighted, using as weights the probability to belong to Group 1 (Columns 3 and 4) or Group 2 (Columns 5 and 6). Number of observations in Columns 3–6 are also probability weighted. Standard errors in parentheses. ****p* < .01; ***p* < .05; **p* < .1.

Group 2, while permanent income has a smaller marginal effect for both groups, and a larger effect for Group 2 compared to Group 1. On the other hand, allowing for heterogeneity leads to a large increase in the estimated impact of illiquid asset holding on the probability of purchasing a home for Group 1, but has little impact on this effect for Group 2: in Group 1 illiquid asset holding at ($t-2$) is associated with a 1.2 percentage point increase in the likelihood of house purchase, while in Group 2 the effect is

FIGURE 3 Hazard of homeownership (with unobserved heterogeneity)

Note: Hazard rates are estimated from Table 4, Column 4 for panel a) and Column 6 for panel b). The blue line corresponds to the case where the individual has not invested in illiquid financial assets. The red, dashed line corresponds to the case where the individual has invested in illiquid financial assets. The shaded areas represent confidence intervals.

[Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 5 Model with unobserved heterogeneity: mean of the two groups

Variable	Group 1	Group 2	Difference
Owner	0.031	0.038	−9.721 ^{***}
Illiquid assets ($t-2$)	0.172	0.221	−31.198 ^{***}
Years of illiquid assets	2.527	4.165	−48.184 ^{***}
Risk tolerant	0.242	0.268	−15.357 ^{***}
Age	41.487	38.620	33.724 ^{***}
Female	0.576	0.534	21.580 ^{***}
High school	0.335	0.345	−5.541 ^{***}
College	0.176	0.205	−18.997 ^{***}
Poor health ($t-1$)	0.061	0.064	−4.043 ^{***}
Household size ($t-1$)	3.013	3.002	1.950 [*]
One child ($t-1$)	0.226	0.234	−4.661 ^{***}
Two children ($t-1$)	0.303	0.296	4.393 ^{***}
Three or more children ($t-1$)	0.208	0.184	15.372 ^{***}
Partner ($t-1$)	0.792	0.801	−5.213 ^{***}
Widow ($t-1$)	0.035	0.023	18.470 ^{***}
Divorced ($t-1$)	0.023	0.020	5.274 ^{***}
Unemployed ($t-1$)	0.011	0.015	−9.138 ^{***}
Retired ($t-1$)	0.110	0.088	19.234 ^{***}
Permanent income, k euros (excluding pensions)	7.848	8.744	−34.072 ^{***}
Country: Austria	0.039	0.038	1.920 [*]
Country: Belgium	0.094	0.096	−1.784 [*]
Country: The Czech Republic	0.122	0.111	9.345 ^{***}
Country: Denmark	0.079	0.087	−6.890 ^{***}
Country: France	0.107	0.122	−12.615 ^{***}
Country: Greece	0.038	0.057	−23.370 ^{***}
Country: Italy	0.075	0.085	−8.836 ^{***}
Country: The Netherlands	0.108	0.114	−4.480 ^{***}
Country: Spain	0.035	0.034	1.171
Country: Sweden	0.073	0.078	−4.902 ^{***}
Country: Switzerland	0.115	0.063	46.772 ^{***}
Cohort: 1919	0.028	0.006	42.825 ^{***}
Cohort: 1924	0.075	0.021	64.033 ^{***}
Cohort: 1929	0.140	0.039	91.222 ^{***}
Cohort: 1934	0.067	0.202	−100.000 ^{***}
Cohort: 1939	0.202	0.101	72.039 ^{***}
Cohort: 1944	0.224	0.118	71.897 ^{***}
Cohort: 1954	0.096	0.198	−75.039 ^{***}
Cohort: 1959	0.047	0.088	−41.399 ^{***}
Observations	136,383	124,844	

Note: The last column reports the result of a t -test on the equality of the means.

*** $p < .01$; ** $p < .05$; * $p < .1$.

slightly below 0.7 percentage points. Figure 3 reports the age profile of the hazard rate to purchase a house for the two groups, computed exactly as in Figure 2. The difference in hazard rates between illiquid asset owners and nonowners is much more marked in Group 1 (panel a) than in Group 2 (panel b). In both groups, however, the difference in hazard rates is larger than predicted by the model without unobserved heterogeneity.

This pattern of coefficients (and marginal effects) seems in line with an explanation that focuses on a smaller degree of temptation for Group 2 individuals—whose investment in both illiquid and real assets is mostly driven by risk tolerance and lifetime resources, in line with the predictions of a standard life cycle model. Group 1 individuals, instead, conform more closely with the predictions of the temptation model: illiquid assets are purchased irrespective of risk considerations, because of their commitment device properties, and their ownership then strongly predicts the homeownership decision a few years later.

Our approach splits the sample in two groups, by estimating the posterior probability that each observation belongs to either group. The average estimated probability of belonging to Group 1 is 52.2%, with most probabilities close to either 0 or 1. In Table 5 we report summary statistics for all variables, separately for the two groups. We assign an observation to Group 1 (Group 2) if the probability of belonging to Group 1 is larger than 0.5 (lower than or equal to 0.5). 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 wealthier (11.4% higher permanent income) and more highly educated, possibly because of its lower average age (fewer individuals were born in the 1920s or earlier). The different availability of resources, and therefore access to credit, is reflected in more widespread holding of illiquid assets in the second group (22% as opposed to 17%) and in the fraction of home purchases (3.8% in Group 2, 3.1% in Group 1) and the time lag between the first purchase of illiquid assets and housing is larger in the second group (4.2 rather than 2.5 years).

These statistics confirm that we may think of Group 2 as the group that is less affected by temptation, and hence more likely to invest in human capital, enjoy higher lifetime earnings and accumulate more assets.

For our purpose, the key message of the analyses presented in this section is that controlling for unobserved heterogeneity does not undermine the result that in the years after purchasing illiquid financial assets households have an increased probability 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 homeowner, actually increase (in both Groups 1 and 2) when we control for unobserved heterogeneity. But controlling for unobserved heterogeneity is important, because it is likely that the degree of temptation markedly differs between the two groups that we have identified in our empirical analysis.

5 | CONCLUSION

In this paper, we have used individual life history data from 12 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 & 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”. 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 illiquid financial investment prior to home purchase. This is likely to reflect different degrees of temptation across individuals, but could also reflect different institutional features of this specific type of financial market, or 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 noncooperative 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.

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APPENDIX A

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 $V(S_t, A_t, H_{t-1})$ with respect to C_t and X_t :

$$\begin{aligned} \frac{\partial V(S_t, A_t, H_{t-1})}{\partial C_t} &= 0 = \\ &= \frac{\partial U(C_t, H_t | S_t, A_t, H_{t-1})}{\partial C_t} - \pi \beta R_S E_t \left[\frac{\partial V(S_{t+1}, A_{t+1}, H_t)}{\partial S_{t+1}} \right]; \end{aligned} \quad (A1)$$

$$\begin{aligned} \frac{\partial V(S_t, A_t, H_{t-1})}{\partial X_t} &= 0 = \\ &= \pi \beta E_t \left[R_A \frac{\partial V(S_{t+1}, A_{t+1}, H_t)}{\partial A_{t+1}} - R_S \frac{\partial V(S_{t+1}, A_{t+1}, H_t)}{\partial S_{t+1}} \right]. \end{aligned} \quad (A2)$$

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

$$\begin{aligned} \frac{\partial V(S_t, A_t, H_{t-1})}{\partial S_t} &= \\ &= \frac{\partial U(C_t, H_t | S_t, A_t, H_{t-1})}{\partial S_t} + \pi \beta R_S E_t \left[\frac{\partial V(S_{t+1}, A_{t+1}, H_t)}{\partial S_{t+1}} \right]; \end{aligned} \quad (A3)$$

$$\begin{aligned} \frac{\partial V(S_t, A_t, H_{t-1})}{\partial A_t} &= \\ &= \frac{\partial U(C_t, H_t | S_t, A_t, H_{t-1})}{\partial A_t} + \pi \beta R_A E_t \left[\frac{\partial V(S_{t+1}, A_{t+1}, H_t)}{\partial A_{t+1}} \right]. \end{aligned} \quad (A4)$$

Using (A1) and (A3), we find that

$$\frac{\partial V(S_t, A_t, H_{t-1})}{\partial S_t} = \frac{\partial U(C_t, H_t | S_t, A_t, H_{t-1})}{\partial S_t} + \frac{\partial U(C_t, H_t | S_t, A_t, H_{t-1})}{\partial C_t}. \quad (A5)$$

Furthermore, subtracting (A3) from (A4) and using (A2),

$$\begin{aligned} \frac{\partial V(S_t, A_t, H_{t-1})}{\partial A_t} - \frac{\partial V(S_t, A_t, H_{t-1})}{\partial S_t} &= \\ &= \frac{\partial U(C_t, H_t | S_t, A_t, H_{t-1})}{\partial A_t} - \frac{\partial U(C_t, H_t | S_t, A_t, H_{t-1})}{\partial S_t}. \end{aligned} \quad (A6)$$

Plugging (A5) into (A6) yields

$$\frac{\partial V(S_t, A_t, H_{t-1})}{\partial A_t} = \frac{\partial U(C_t, H_t | S_t, A_t, H_{t-1})}{\partial A_t} + \frac{\partial U(C_t, H_t | S_t, A_t, H_{t-1})}{\partial C_t} \quad (A7)$$

Hence, we can use (A5) and (A7) to rewrite the first-order conditions (A1) and (A2) as follows:

$$\begin{aligned} & \frac{\partial U(C_t, H_t | S_t, A_t, H_{t-1})}{\partial C_t} = \\ & \pi \beta R_S E_t \left[\frac{\partial U(C_{t+1}, H_{t+1} | S_{t+1}, A_{t+1}, H_t)}{\partial S_{t+1}} + \frac{\partial U(C_{t+1}, H_{t+1} | S_{t+1}, A_{t+1}, H_t)}{\partial C_{t+1}} \right] \end{aligned} \quad (A8)$$

and

$$\begin{aligned} & R_A E_t \left[\frac{\partial U(C_{t+1}, H_{t+1} | S_{t+1}, A_{t+1}, H_t)}{\partial A_{t+1}} + \frac{\partial U(C_{t+1}, H_{t+1} | S_{t+1}, A_{t+1}, H_t)}{\partial C_{t+1}} \right] \\ & = R_S E_t \left[\frac{\partial U(C_{t+1}, H_{t+1} | S_{t+1}, A_{t+1}, H_t)}{\partial S_{t+1}} + \frac{\partial U(C_{t+1}, H_{t+1} | S_{t+1}, A_{t+1}, H_t)}{\partial C_{t+1}} \right]. \end{aligned} \quad (A9)$$

Now, because

$$\begin{aligned} & \frac{\partial U(C_t, H_t | S_t, A_t, H_{t-1})}{\partial C_t} = \frac{\partial u(C_t, H_t)}{\partial C_t} + \frac{\partial v(C_t, H_t)}{\partial C_t} = (1 + \lambda) \frac{\partial u(C_t, H_t)}{\partial C_t}; \\ & \frac{\partial U(C_t, H_t | S_t, A_t, H_{t-1})}{\partial S_t} = -\frac{\partial v(C_t^*, H_t^*)}{\partial C_t^*} = -\lambda \frac{\partial u(C_t^*, H_t^*)}{\partial C_t^*}; \\ & \frac{\partial U(C_t, H_t | S_t, A_t, H_{t-1})}{\partial A_t} = \begin{cases} 0 & t < K \\ -\frac{\partial v(C_t^*, H_t^*)}{\partial C_t^*} = -\lambda \frac{\partial u(C_t^*, H_t^*)}{\partial C_t^*} & t \geq K \end{cases} \end{aligned} \quad (A10)$$

we can rewrite Equation (A8) as

$$\begin{aligned} & (1 + \lambda) \frac{\partial u(C_t, H_t)}{\partial C_t} = \\ & \pi \beta R_S E_t \left[(1 + \lambda) \frac{\partial u(C_{t+1}, H_{t+1})}{\partial C_{t+1}} - \lambda \frac{\partial u(C_{t+1}^*, H_{t+1}^*)}{\partial C_{t+1}^*} \right] \end{aligned} \quad (A11)$$

and Equation (A9) as

$$\begin{aligned} & R_A E_t \left[(1 + \lambda) \frac{\partial u(C_{t+1}, H_{t+1})}{\partial C_{t+1}} \right] = \\ & = R_S E_t \left[(1 + \lambda) \frac{\partial u(C_{t+1}, H_{t+1})}{\partial C_{t+1}} - \lambda \frac{\partial u(C_{t+1}^*, H_{t+1}^*)}{\partial C_{t+1}^*} \right] \end{aligned} \quad (A12)$$

if $t < K$, and

$$\begin{aligned} & R_A E_t \left[(1 + \lambda) \frac{\partial u(C_{t+1}, H_{t+1})}{\partial C_{t+1}} - \lambda \frac{\partial u(C_{t+1}^*, H_{t+1}^*)}{\partial C_{t+1}^*} \right] = \\ & = R_S E_t \left[(1 + \lambda) \frac{\partial u(C_{t+1}, H_{t+1})}{\partial C_{t+1}} - \lambda \frac{\partial u(C_{t+1}^*, H_{t+1}^*)}{\partial C_{t+1}^*} \right] \end{aligned} \quad (A13)$$

if $t \geq K$. We can further simplify Equations (A11)–(A13) dividing by $(1 + \lambda)$, to obtain the equations shown in the main text.

Permanent income measurement

In this Appendix, we sketch a short description of the approach used to compute permanent income; for full details see Weiss (2012). Permanent income is a measure of lifetime earnings discounted at age 10, which is estimated combining observations on past annual earnings with predictions on future annual earnings up to age 110. Past and future earnings figures are then transformed using Purchasing Power Parity (PPP) exchange rates and Consumer Price Index (CPI) measures into 2006 euros (the sources are OECD and national institutes of statistics).

For past earnings, SHARELIFE informs on the length of each employment spell and the amount of earnings at the beginning of each individual's personal history. The discounted sum of all past earnings is defined as follows:

$$A = \sum_{j=1}^J y_j \sum_{k=1}^{K_j} \frac{(1 + g_j)^{k-1}}{(1 + r)^{S_j - (B+11) + k}}$$

and takes the sum of the annual earnings y_j , across all past employment spells $j, j = 1, \dots, J$. Annual earnings refer to the beginning of each employment spell, and grow every year $k, k = 1, \dots, K_j$ of the employment spell j at a fixed rate g_j specific to the spell. They are discounted at a fixed interest rate r , growing exponentially with $S_j - (B + 11) + k$, where S_j is the year when the employment spell j started and B is the birth year.

Future earnings include pension entitlements and, in case the individual is still working at the interview year, future labour income. If the individual is retired at the interview year, we know her current pension revenue y ; if the individual is still working at the interview year, we forecast future pensions as a fraction y of current income, where the fraction is determined by the self-assessed expected replacement rate. For workers we also know the self-assessed expected retirement age R . This generates the flow of discounted future pension entitlements defined as follows:

$$B = y \sum_{t=p}^{110} \frac{s_t}{(1 + r)^{I - (B+11) + t}}$$

where $p = \min \{a, R + 1\}$ is the minimum between the current age and the expected age at the beginning of retirement, and I is the interview year. The pension amount does not vary over the years, and generates a constant flow up to age 110, when death is certain. Future pensions are weighted with the probability s_t of being alive at age t conditional on being alive at age a ; the probabilities vary across country, gender, year of birth and age and come from the Human Mortality Database.

For individuals still working at the interview year ($a \leq R$), we assume that they will continue working without breaks until the expected retirement age R . We then compute earnings forecasts y_a at age a from OLS regressions of observed log-income on a squared polynomial on potential experience, socio-demographic characteristics and 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. The regressions are estimated separately for males and females. The discounted sum of future labour income is defined as follows:

$$C = y_a \sum_{t=a}^R \frac{s_t (1+g)^{t-a}}{(1+r)^{I-(B+1)+t}}$$

and takes current annual earnings y_a projected ahead with growth rate g , weighted with the probability s_t of being alive at age t conditional on being alive at age a .

In our calibration, we follow Weiss (2012) and set the interest rate $r = 0.02$, while the growth rates g_j before the interview year are defined as the difference between the last and the first earnings in the employment spell, divided by the length of the spell. SHARELIFE informs on the first earnings but not on the last earnings, which are then estimated with an OLS regression in the same fashion as future earnings. Similarly, the growth rate g for earnings after the interview year is obtained from the difference between the last and the first earnings, divided by the spell from current age and up to retirement; in this case both earnings are estimated with an OLS regression.

The sum of A , B and (for workers at the interview year) C determines permanent income, while A (or the sum between A and C for workers at the interview year) determines permanent income excluding pensions. For individuals that are married or living together with a partner, the measure of permanent income also incorporates an amount corresponding to the expected pension as a widow, widower or surviving civil partner, where the amount of survivor pension is set to 60% of the pension of the partner, corrected for the probability of death of the partner.

Robustness checks

TABLE A1 Rent-own transitions: model without unobserved heterogeneity (average marginal effects $\times 100$)

	(1)	(2)	(3)
Illiquid assets ($t-2$)	0.553*** (0.130)	0.595*** (0.145)	0.582*** (0.146)
Years illiquid assets	-0.042*** (0.008)	-0.048*** (0.009)	-0.047*** (0.009)
Risk tolerant	0.692*** (0.072)	0.789*** (0.079)	0.814*** (0.080)
Age	-0.035*** (0.004)	-0.033*** (0.005)	-0.033*** (0.005)
Female	-0.159** (0.064)	-0.032 (0.073)	-0.009 (0.075)
High school	0.411*** (0.079)	0.546*** (0.088)	0.561*** (0.089)
College	0.812*** (0.090)	1.001*** (0.097)	1.029*** (0.098)
Poor health ($t-1$)	-0.500*** (0.171)	-0.643*** (0.198)	-0.618*** (0.201)
Household size ($t-1$)	0.036 (0.053)	0.078 (0.0063)	0.083 (0.066)
One child ($t-1$)	0.302*** (0.104)	0.232** (0.117)	0.197* (0.120)
Two children ($t-1$)	0.154 (0.137)	-0.034 (0.159)	-0.035 (0.164)
Three children ($t-1$)	-0.368* (0.207)	-0.556** (0.242)	-0.544** (0.250)
Partner ($t-1$)	1.890*** (0.125)	1.986*** (0.139)	2.030*** (0.142)
Widow ($t-1$)	0.963*** (0.345)	1.179*** (0.405)	1.139*** (0.419)
Divorced ($t-1$)	0.167 (0.330)	0.038 (0.368)	0.090 (0.370)
Unemployed ($t-1$)	-0.975*** (0.336)	-0.929** (0.362)	-0.920** (0.363)
Retired ($t-1$)	0.294 (0.229)	0.322 (0.257)	0.475* (0.265)
Log current income	0.493*** (0.043)		
Log permanent income		0.444*** (0.056)	

(Continues)

TABLE A1 (Continued)

	(1)	(2)	(3)
Log permanent income (excluding pensions)			0.311*** (0.041)
Country effects	YES	YES	YES
Cohort effects	YES	YES	YES
Observations	335,436	268,136	261,227
Log-likelihood	−46,745.851	−37,922.861	−37,026.273
McFadden's R^2	.058	.061	.062

Note: The table reports 100 times the average marginal effects from univariate logit 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 and 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.

*** $p < .01$; ** $p < .05$; * $p < .1$.

TABLE A 2 Model with unobserved heterogeneity (average marginal effects $\times 100$)

Variables	No heterogeneity		Heterogeneity, Group 1		Heterogeneity, Group 2	
	(1)	(2)	(3)	(4)	(5)	(6)
	Illiquid assets	Homeownership	Illiquid assets	Homeownership	Illiquid assets	Homeownership
Illiquid assets ($t-2$)		0.582 ^{***} (0.146)		1.231 ^{***} (0.206)		0.685 ^{***} (0.254)
Years illiquid assets		-0.047 ^{***} (0.009)		-0.081 ^{***} (0.014)		-0.004 (0.013)
Risk tolerant	3.177 ^{***} (0.169)	0.814 ^{**} (0.080)	0.064 (0.136)	0.814 ^{***} (0.104)	1.517 ^{***} (0.146)	0.830 ^{***} (0.113)
Age	0.742 ^{***} (0.007)	-0.033 ^{***} (0.004)	0.748 ^{***} (0.006)	-0.040 ^{***} (0.006)	0.662 ^{***} (0.007)	-0.028 ^{***} (0.006)
Female	-7.731 ^{***} (0.153)	-0.009 (0.075)	-2.206 ^{***} (0.126)	-0.163 [*] (0.095)	-3.723 ^{***} (0.136)	0.193 [*] (0.106)
High school	3.104 ^{***} (0.179)	0.561 ^{***} (0.089)	0.738 ^{***} (0.140)	0.358 ^{***} (0.111)	0.070 (0.165)	0.819 ^{***} (0.128)
College	3.205 ^{***} (0.213)	1.029 ^{***} (0.098)	0.390 ^{**} (0.174)	0.758 ^{***} (0.126)	0.868 ^{***} (0.183)	1.340 ^{***} (0.142)
Poor health ($t-1$)	1.317 ^{***} (0.284)	-0.618 ^{***} (0.201)	0.906 ^{***} (0.225)	-0.373 (0.263)	0.518 ^{**} (0.237)	-0.864 ^{***} (0.299)
Household size ($t-1$)	-0.811 ^{***} (0.094)	0.083 (0.066)	-0.835 ^{***} (0.087)	0.156 [*] (0.081)	-0.348 ^{***} (0.083)	-0.013 (0.093)
One child ($t-1$)	2.657 ^{***} (0.248)	0.197 (0.120)	2.408 ^{***} (0.204)	-0.047 (0.148)	1.280 ^{***} (0.221)	0.451 ^{***} (0.169)
Two children ($t-1$)	3.199 ^{***} (0.275)	-0.035 (0.164)	2.400 ^{***} (0.239)	-0.191 (0.203)	1.860 ^{***} (0.253)	0.179 (0.236)

(Continues)

TABLE A 2 (Continued)

Variables	No heterogeneity		Heterogeneity, Group 1		Heterogeneity, Group 2	
	(1)	(2)	(3)	(4)	(5)	(6)
	Illiquid assets	Homeownership	Illiquid assets	Homeownership	Illiquid assets	Homeownership
Three children (<i>t</i> − 1)	2.327*** (0.361)	−0.544** (0.250)	1.748*** (0.326)	−0.689** (0.310)	1.376*** (0.335)	−0.310 (0.369)
Partner (<i>t</i> − 1)	4.741*** (0.261)	2.030*** (0.142)	2.691*** (0.210)	1.778*** (0.175)	3.321*** (0.229)	2.294*** (0.199)
Widow (<i>t</i> − 1)	4.394*** (0.486)	1.139*** (0.419)	3.414*** (0.446)	0.827 (0.514)	1.159*** (0.427)	1.602** (0.664)
Divorced (<i>t</i> − 1)	1.589*** (0.513)	0.090 (0.370)	2.361*** (0.392)	−0.013 (0.471)	1.059** (0.460)	0.159 (0.551)
Unemployed (<i>t</i> − 1)	−5.572*** (0.645)	−0.920** (0.363)	−2.143*** (0.500)	−0.456 (0.468)	0.158 (0.554)	−1.330*** (0.498)
Retired (<i>t</i> − 1)	1.234*** (0.336)	0.475* (0.265)	−1.142*** (0.278)	0.030 (0.350)	2.770*** (0.275)	0.954** (0.393)
Log permanent income (excluding pensions)	3.288*** (0.091)	0.311*** (0.041)	0.886*** (0.075)	0.314*** (0.050)	1.663*** (0.081)	0.298*** (0.060)
Country effects	YES	YES	YES	YES	YES	YES
Cohort effects	YES	YES	YES	YES	YES	YES
Observations	261,227	261,227	136,403	136,403	124,824	124,824
Log-likelihood	−114,987.45	−37,026.273	−23,842.33	−18,096.69	−22,847.01	−18,847.214
McFadden's <i>R</i> ²	.164	.062	.647	.067	.671	.060

Note: The table reports 100 times the average marginal effects from the bivariate mixed proportional hazard analysis on the holding of illiquid assets and homeownership, unweighted (Columns 1 and 2) and weighted, using as weights the probability to belong to Group 1 (Columns 3 and 4) or Group 2 (Columns 5 and 6). Number of observations in Columns 3–6 are also probability weighted. Standard errors in parentheses.

****p* < .01; ***p* < .05; **p* < .1.

TABLE A3 Model with unobserved heterogeneity (dependent variable: homeownership)

Variables	Benchmark		1-period lag		3-periods lag	
	(1)	(2)	(3)	(4)	(5)	(6)
	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2
Illiquid assets ($t-1$)			0.548 ^{***} (0.062)	0.360 ^{***} (0.067)		
Illiquid assets ($t-1$)	0.404 ^{***} (0.067)	0.193 ^{***} (0.071)				
Illiquid assets ($t-1$)					0.362 ^{***} (0.072)	0.241 ^{***} (0.075)
Years illiquid assets	-0.027 ^{***} (0.005)	-0.001 (0.004)	-0.028 ^{***} (0.004)	-0.003 (0.004)	-0.026 ^{***} (0.005)	-0.003 (0.004)
Risk tolerant	0.267 ^{***} (0.034)	0.234 ^{***} (0.032)	0.266 ^{***} (0.034)	0.232 ^{***} (0.032)	0.266 ^{***} (0.034)	0.234 ^{***} (0.032)
Age	0.051 ^{***} (0.010)	0.108 ^{***} (0.011)	0.052 ^{***} (0.010)	0.104 ^{***} (0.011)	0.050 ^{***} (0.010)	0.108 ^{***} (0.011)
Age ²	-0.001 ^{***} (0.000)	-0.002 ^{***} (0.000)	-0.001 ^{***} (0.000)	-0.002 ^{***} (0.000)	-0.001 ^{***} (0.000)	-0.002 ^{***} (0.000)
Female	-0.053 [*] (0.031)	0.054 [*] (0.030)	-0.048 (0.031)	0.060 ^{**} (0.030)	-0.056 [*] (0.031)	0.054 [*] (0.030)
High school	0.117 ^{***} (0.036)	0.230 ^{***} (0.036)	0.116 ^{***} (0.036)	0.231 ^{***} (0.036)	0.118 ^{***} (0.036)	0.231 ^{***} (0.036)
College	0.248 ^{***} (0.041)	0.377 ^{***} (0.040)	0.251 ^{***} (0.041)	0.376 ^{***} (0.040)	0.247 ^{***} (0.041)	0.378 ^{***} (0.040)
Poor health ($t-1$)	-0.122 (0.086)	-0.243 ^{***} (0.084)	-0.122 (0.086)	-0.247 ^{***} (0.084)	-0.122 (0.086)	-0.243 ^{***} (0.084)
Household size ($t-1$)	0.051 [*] (0.026)	-0.004 (0.026)	0.052 ^{**} (0.026)	-0.003 (0.026)	0.050 [*] (0.026)	-0.004 (0.026)
One child ($t-1$)	-0.016 (0.048)	0.127 ^{***} (0.047)	-0.014 (0.049)	0.126 ^{***} (0.047)	-0.015 (0.048)	0.128 ^{***} (0.047)
Two children ($t-1$)	-0.062 (0.066)	0.050 (0.066)	-0.060 (0.067)	0.048 (0.066)	-0.064 (0.066)	0.050 (0.066)
Three children ($t-1$)	-0.226 ^{**} (0.102)	-0.087 (0.104)	-0.225 ^{**} (0.102)	-0.086 (0.104)	-0.227 ^{**} (0.102)	-0.087 (0.104)
Partner ($t-1$)	0.583 ^{***} (0.057)	0.645 ^{***} (0.055)	0.574 ^{***} (0.057)	0.640 ^{***} (0.055)	0.584 ^{***} (0.057)	0.647 ^{***} (0.055)
Widow ($t-1$)	0.271 (0.168)	0.451 ^{**} (0.187)	0.258 (0.169)	0.450 ^{**} (0.187)	0.274 (0.168)	0.451 ^{**} (0.187)
Divorced ($t-1$)	-0.004 (0.155)	0.045 (0.155)	-0.012 (0.155)	0.044 (0.155)	-0.002 (0.154)	0.046 (0.155)

(Continues)

TABLE A3 (Continued)

Variables	Benchmark		1-period lag		3-periods lag	
	(1)	(2)	(3)	(4)	(5)	(6)
	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2
Unemployed ($t-1$)	-0.149 (0.153)	-0.374 ^{***} (0.140)	-0.141 (0.154)	-0.371 ^{***} (0.140)	-0.155 (0.153)	-0.373 ^{***} (0.140)
Retired ($t-1$)	0.010 (0.115)	0.268 ^{**} (0.110)	0.016 (0.115)	0.261 ^{**} (0.111)	0.009 (0.115)	0.268 ^{**} (0.110)
Log permanent income (excluding pensions)	0.103 ^{***} (0.016)	0.084 ^{***} (0.017)	0.102 ^{***} (0.016)	0.083 ^{***} (0.017)	0.103 ^{***} (0.016)	0.084 ^{***} (0.017)
Country effects	YES	YES	YES	YES	YES	YES
Cohort effects	YES	YES	YES	YES	YES	YES
Observations (probability-weighted)	136,403	124,824	136,333	124,894	136,471	124,756
Log-likelihood	-18,096.69	-18,847.214	-18,041.841	-18,871.875	-18,151.323	-18,795.720
McFadden's R^2	.04	.060	.068	.061	.067	.060

Note: The table reports coefficient estimates from the bivariate mixed proportional hazard analysis on the holding of illiquid assets and homeownership, and weighted, using as weights the probability to belong to Group 1 (Columns 1, 3 and 5) or Group 2 (Columns 2, 4 and 6). Standard errors in parentheses.

*** $p < .01$; ** $p < .05$; * $p < .1$.